The Unofficial *2018 Standard Specifications for Construction*

Applicable to projects advertised on or after October 22, 2019

DISCLAIMER

This copy of the *2018 Standard Specifications for Construction* is an unofficial copy**. It is provided here for informational purposes only.**

The Unofficial *2018 Standard Specifications for Construction* (hereinafter referred to as the *Unofficial Specifications Book*) incorporates, to the best of the Agency's ability, all modifications made to the Standard Specifications by General Special Provision. The Agency has also fixed any small errors or errata, such as incorrect spellings or missing punctuation, that have been found. However, this unofficial copy as a whole has not been vetted or formally approved by the Specifications Committee. **As a result, the *Unofficial Specifications Book* is neither legally nor contractually binding.** It is provided here for informational purposes only, and no guaranty of any sort is provided regarding the contents herein. All efforts have been made to accurately incorporate the necessary changes, however, the Vermont Agency of Transportation takes no responsibility for any errors or omissions in this copy.

A red border has been added around the pages of the *Unofficial Specifications Book* to signify that the contents have not been formally vetted and approved, and to distinguish between the unofficial and official specifications. The date that the *Unofficial Specifications Book* was last updated is also indicated within the document. In order to ensure that only the relevant changes are shown, the reader should check this date to verify that the version they are using is the last version released before the project in question advertised. The date of advertising can be found on the upper right corner of the Project Special Provisions.

Please note that due to the various deletions and additions made in the *Unofficial Specifications Book*, the page numbers in this document will not necessarily match those in the *2018 Standard Specifications for Construction*.

For official, legally binding specifications, always refer to the official *2018 Standard Specifications for Construction* and the latest edition of the General Special Provisions adopted at the time of advertising for the contract in question.

FEATURES AND SUGGESTIONS

The *Unofficial Specifications Book* is primarily intended as a tool that allows the reader to see how the General Special Provisions are incorporated into the book by providing a continuous document that includes those changes. It is also intended to allow easier cross referencing and viewing on electronic devices. In order to accomplish this, the *Unofficial Specifications Book* has a number of features designed to facilitate its navigation and use.

1. The document is fully searchable. To perform a keyword search, press **Ctrl + F**.

2. The Table of Contents, Index of Pay Items and all other internal cross references are linked and will lead to the indicated Section, Subsection or Table within the document.

3. Certain external cross references are also linked. AASHTO, ASTM and other standards are not generally linked because they require a paid subscription to view. Note that you will need internet access to view these external resources.

4. All links are indicated with blue text. They are periodically checked for accuracy, but we cannot guarantee that they will work, especially for external sites. If any appear to be broken, please notify the Pre-Contract and Specifications Unit at AOT.HWYPrecontractSpecifications@vermont.gov.

5. Divisions and Sections are bookmarked. These bookmarks should have shown up on the left side of the screen when you opened the document.

6. After clicking on an internal cross reference link, you may wish to return to the page you started from. To do so, press **Alt + Left Arrow**, which will take you to the last page view. Please note that you may need to do this several times if you scrolled down the page after clicking the link.

7. Differences between the official and unofficial specifications have been identified as follows:

    a. On the following pages you will find lists of both General Special Provisions that have been incorporated, as well as errata that have been corrected, along with the general locations of the changes.

    b. Text that has been modified by General Special Provision (but not errata) has been highlighted in yellow within the body of the document. Portions that were deleted have been identified as such using bold text that is highlighted in yellow.

        Part of the text of this example paragraph has changed. It is different in some way from the official specifications and is highlighted to indicate that. This unhighlighted text has not changed and is the same as the text in the book. **This sentence deleted.**

        This paragraph deleted.

        This table deleted.

GENERAL SPECIAL PROVISIONS

The table below lists General Special Provisions (GSP) that have been adopted as modifications to the *2018 Standard Specifications for Construction*. General Special Provisions are adopted by the Specifications Committee and serve as additions or modifications to the Standard Specifications. This table only provides the general outline of the changes made. For the specific changes, please refer to the official General Special Provisions, which may be found at: http://vtrans.vermont.gov/highway/construct-material/construct-services/pre-contractspecifications/2018

The table is organized by subsection. Not all General Special Provisions are listed individually – modifications which were made to adjacent subsections for the same general reason may be combined within the table. Entries in bold text indicate the most recent changes, while regular text indicates previously approved changes.

Subsections Changed	Broad Description of Changes	Date of GSP
Subsection 101.02	Replaced "Columbus Day" with "Indigenous Peoples' Day" to reflect change in state law.	7-23-2019
Subsection 101.02	**Deleted all references to Supplemental Specifications.**	**10-22-2019**
Subsection 103.03	Legal reference to sales tax regulations corrected.	8-8-2018
Subsection 105.05(a)	**Deleted all references to Supplemental Specifications and modified the Contract Document Precedence to reflect the elimination of Supplemental Specifications.**	**10-22-2019**
Subsection 105.05(d)	**Deleted all references to Supplemental Specifications.**	**10-22-2019**
Subsection 105.14	Corrected double numbering by re-lettering list parts.	8-8-2018
Subsection 105.16	Corrected legal reference.	8-8-2018
Subsection 106.09(c)	**Revised the stockpiling requirements for raw materials.**	**10-22-2019**
Subsections 203.03 and 204.03	Added a requirement to submit construction drawings when required by OSHA or VOSHA.	7-23-2019
Subsection 210.03	Modified requirements for length of time milled surface can remain unpaved	7-23-2019
Subsection 406.03B	Added requirements for the contractor to provide Hamburg Wheel-Track and FIT testing data in mix designs.	7-23-2019
Subsection 406.03C (Table 406.03I)	Corrected an outdated reference and slightly modified Note 4.	7-23-2019
Subsections 406.03C(e) and 406.19(c)	Changed names of subsections to better match their contents and the names of other subsections.	8-8-2018
Subsection 406.14	**Added a requirement to use a self-propelled pneumatic tired roller for the levelling course of pavement.**	**10-22-2019**
Subsection 407.03	Deleted and replaced several paragraphs to correct equations and the table.	7-23-2019

Subsections Changed	Broad Description of Changes	Date of GSP
Section 418	**Created a new section for Asphaltic Approach Material.**	**10-22-2019**
Subsection 501.03	**Deleted and replaced the entire subsection to update testing and mix design requirements.**	**10-22-2019**
Subsection 501.04	**Deleted and replaced paragraphs 1 through 3 to update the batching requirements.**	**10-22-2019**
Subsection 501.05(a)	**Deleted and replaced parts (2) and (3) to update the mixing and delivery requirements.**	**10-22-2019**
Subsection 506.02	Updated the name of the subsection for one of the materials and added a new material subsection to the list.	7-23-2019
Subsection 506.03	Deleted and replaced multiple paragraphs to clarify requirements for fabrication drawings, the use of subcontractors for fabrication, and the level of plant certification required.	7-23-2019
Subsection 506.03(c)(1)	Deleted and replaced the subsection to provide additional details about inspectors.	7-23-2019
Subsections 506.03(d)(3) and 506.03(e)	Minor wording changes.	7-23-2019
Subsection 506.04(c)	Deleted and replaced subsection to modify welding procedures.	7-23-2019
Subsection 506.05(b)	Deleted a sentence.	7-23-2019
Subsection 506.06(b)	Deleted and replaced subsection to modify inspector requirements.	7-23-2019
Subsection 506.10(d)	Minor wording changes.	7-23-2019
Subsection 506.10(e)(1)	Deleted two paragraphs.	7-23-2019
Subsection 506.12(d)	Minor wording changes.	7-23-2019
Subsection 506.14	Deleted and replaced subsection to clarify surface preparation requirements.	7-23-2019
Subsection 506.18(b)	Deleted and replaced parts (2) and (3) to clarify alignment, drilling and reaming requirements.	7-23-2019
Subsections 506.19(a) and 506.19(b)	Minor wording changes.	7-23-2019
Subsection 506.19(c)	Added a sentence stating that standard bolts are to be Grade A 325.	8-8-2018
Subsection 506.19	Relabeled existing part (d) as part (e) and broke the existing part (c) in half, creating a new part (d) in the process. Done to correct duplicate list numbering in part (c). Also corrected internal cross references.	8-8-2018
Subsections 506.19(d)(1) and 506.19(e)	Minor wording changes.	7-23-2019
Subsection 506.23	Deleted and replaced entire subsection to add additional coating requirements.	7-23-2019
Subsection 506.25	Deleted and replaced entire subsection.	7-23-2019
Subsections 510.12(b) and 540.11(b)	Corrected internal cross references.	8-8-2018

Subsections Changed	Broad Description of Changes	Date of GSP
Subsection 516.02	**Updated materials listing to reflect name change of Subsection 707.15**	**10-22-2019**
Subsection 519.02	**Deleted and replaced subsection to reflect changes made in Subsection 726.11.**	**10-22-2019**
Subsection 524.02	**Updated materials listing to reflect name change of Subsection 707.15**	**10-22-2019**
Subsection 540.02	**Updated material listing to reflect changes made in Subsection 726.11.**	**10-22-2019**
Subsection 540.10	**Updated internal cross reference to reflect changes made in Subsection 726.11.**	**10-22-2019**
Subsection 540.12	Corrected internal cross reference.	8-8-2018
Subsection 540.14(b)	**Replaced the word "prestressed" with the word "precast".**	**10-22-2019**
Subsection 543.04	Deleted and replaced sentence to correct submittal requirements.	7-23-2019
Subsection 605.02	**Updated materials listing to reflect name change of Subsection 707.15**	**10-22-2019**
Subsection 605.02	Added a new material subsection to the list and deleted internal cross reference. Changes made to conform to new Section 720.	8-8-2018
Subsection 625.02	Deleted incorrect material reference.	1-18-2019
Subsection 630.01	Minor wording changes.	7-23-2019
Subsection 630.02(b)	Deleted and replaced subsection to modify flagger apparel requirements.	7-23-2019
Subsection 630.04(a)	Modified flagger training requirements.	1-18-2019
Subsection 631.08	Modified requirements for grout molds.	1-18-2019
Subsection 631.09	**Deleted a sentence that dictated an Agency process.**	**10-22-2019**
Subsection 641.02	Deleted and replaced several paragraphs in order to add new subparts and clarify the difference between the traffic control items.	7-23-2019
Subsection 641.03	Added paragraph requiring security system for PCMS.	1-18-2019
Subsection 641.07	Deleted and replaced entire subsection to clarify basis of payment.	7-23-2019
Subsection 646.02	Deleted and replaced multiple entries in the materials list.	7-23-2019
Subsection 646.04	Minor wording changes.	7-23-2019
Subsection 646.07	Deleted and replaced parts (a) and (b) to redefine marking tape types.	7-23-2019
Subsection 646.07	Deleted parts (c) and (d).	7-23-2019
Subsection 646.07	Relabeled parts (e) and (f) as the new parts (c) and (d).	7-23-2019
Subsection 646.07	Inserted a new part (e) for preformed thermoplastic and relabeled part (g) as part (f).	1-18-2019
Subsections 646.07(c)(1) and 646.07(f)(1)	Minor wording changes.	1-18-2019
Subsection 646.08	Changed the name of part (a) to reflect redefined marking tape types.	7-23-2019
Subsection 646.09 (Table 646.09A)	Replaced the column headers of the table.	1-18-2019

Subsections Changed	Broad Description of Changes	Date of GSP
Subsections 646.13 and 646.14	Deleted all references to “Raised Pavement Markers, Type II”, including the pay item.	7-23-2019
Subsection 649.02	Deleted and replaced existing subsection so it would conform with the new Section 720.	8-8-2018
Subsection 653.02	Added new material subsections to the list and deleted internal cross reference. Changes made to conform to new Section 720.	8-8-2018
Subsection 653.08(a)(1), 653.09(a), 653.09(b)(1) and 653.09(b)(3)	Corrected references to various geotextile requirements to conform to new Section 720.	8-8-2018
Subsection 675.02	Deleted internal cross reference.	1-18-2019
Subsection 675.07(b)(2)	Deleted and replaced subsection to modify the requirements.	7-23-2019
Subsection 675.07(d)	Added two new sentences to add additional requirements for fasteners.	7-23-2019
Subsection 677.03	Added a sentence removing the requirement for field verification of DTI’s.	8-8-2018
Subsection 678.09	Added a sentence removing the requirement for field verification of DTI’s.	8-8-2018
Subsection 679.02	Deleted one materials section listing and added two new ones to match changes in Subsection 753.04.	1-18-2019
Subsection 679.05	Deleted existing first sentence and added two new paragraphs	1-18-2019
Subsection 680.02	Deleted internal cross reference.	1-18-2019
Subsection 702.06 (Table 702.06A)	Deleted and replaced table to correct some temperatures and add a new row.	7-23-2019
Subsection 704.10(a)	Corrected AASHTO references.	7-23-2019
Subsection 707.14 (Table 707.14A)	Corrected AASHTO references.	1-18-2019
Subsection 707.15	**Deleted and replaced entire subsection to update requirements.**	**10-22-2019**
Subsection 707.17	**Added a new subsection to provide material requirements for the new Section 418.**	**10-22-2019**
Subsection 708.03	Deleted and replaced entire subsection to provide new requirements.	7-23-2019
Subsection 708.06	Deleted and reserved entire subsection.	1-18-2019
Subsection 708.08 (Table 708.08C)	Added two rows to the table	7-23-2019
Subsection 708.11	Deleted and reserved entire subsection.	7-23-2019
Subsection 708.12	Deleted and replaced entire subsection to provide new requirements.	7-23-2019
Subsection 711.02	Corrected internal cross reference.	1-18-2019
Subsections 713.04 and 713.05	Corrected AASHTO references.	1-18-2019
Subsection 714.05	Deleted and replaced the first sentence to provide new requirements.	7-23-2019
Subsection 714.06	Deleted and replaced the first sentence to provide new requirements.	7-23-2019

Subsections Changed	Broad Description of Changes	Date of GSP
Section 720	Deleted and replaced entire section in order to align it with current AASHTO specifications.	8-8-2018
Subsection 720.03 (Table 720.03A)	**Updated the MARV value for Apparent Opening Size (mm).**	**10-22-2019**
Subsection 720.06 (Table 720.06A)	**Updated the MARV value for Apparent Opening Size (mm).**	**10-22-2019**
Subsections 725.01(d) and 725.02(a)	Deleted and replaced both parts to update requirements.	1-18-2019
Subsection 726.09	Deleted and replaced entire subsection to clarify the requirements.	7-23-2019
Subsection 726.11	**Deleted and replaced entire subsection to update the requirements for waterproofing membrane systems.**	**10-22-2019**
Subsection 753.04	Created separate requirements for steel and aluminum bracket arms.	1-18-2019
Section 754	Created a new section for pavement marking materials.	7-23-2019
Alphabetical Index of Pay Items	Corrected the name of item 406.38.	7-23-2019
Alphabetical Index of Pay Items	**Added item 418.10**	**10-22-2019**
Alphabetical Index of Pay Items	Deleted item 646.75.	7-23-2019

ERRATA

The table below shows changes made in the *Unofficial Specifications Book* to correct errata in the *2018 Standard Specifications for Construction*. Errata are small mistakes such as typographical errors, missing punctuation, formatting mistakes and other oversights which do not change the intent of the specification, but which nonetheless need to be corrected. Such changes are made administratively by the Pre-Contract and Specifications Unit. If you discover any errata while using the book, please contact the Pre-Contract and Specifications Unit at AOT.HWYPrecontractSpecifications@vermont.gov. Please note that some of the changes listed below may have been rendered irrelevant by later General Special Provisions.

Unlike the table of General Special Provision changes, this table is organized by the date of the change, with the most recent changes at the bottom.

Date of Change	Locations of Changes	Description of Changes
Ongoing	Throughout book	Replacing double spaces after a period with single spaces, consistently capitalizing specific words, specifying whether days are calendar or working days.
4-26-2018	Divisions 100, 400, 500, 600 and 700	Changed all uses of the degree symbol so the same symbol is used throughout the book.
4-26-2018	Table 107.12A	Adjusted line spacing, capitalization and text justification. Adjusted/clarified wording of text in the first column.
4-26-2018	Subsection 406.03(h)(2)	Adjusted capitalization in list.
4-26-2018	Subsection 406.03(h)(3)	Changed the phrase “the Project QC plan” to “the QC Plan.”
4-26-2018	Subsection 406.12	Capitalized the word “plans.”
4-26-2018	Subsection 406.14(a)	Uncapitalized (for lack of a better word) the phrase “Bituminous Concrete Pavement”.
4-26-2018	Subsection 407.03	Added the word “The” to the start of the note below the equation for weight of effective asphalt binder, added a period to the end of the note.
4-26-2018	Subsection 407.08(b)	Capitalized the word “plans” and added a period after the phrase “and Subsection 417.05(c)”.
4-26-2018	Subsection 631.06	Changed the phrase “percent slope from 0 to 100% in 0.1%” to “percent slope from 0% to 100% in 0.1%”.
4-26-2018	Tables 704.10D, 704.18B, 707.10A, 707.14A, 708.04A, 720.01A, 731.03A	Adjusted capitalization.
4-26-2018	Subsection 704.11(c)	Added a comma after “When crushed gravel is used”.
4-26-2018	Tables 704.18B, 704.18C, 708.04A, 708.05A, 729.05A, 755.05A	Modified column header text slightly for clarification.
4-26-2018	Table 707.14A	Deleted period after “hrs.”, replaced “@” with “at”.

Date of Change	Locations of Changes	Description of Changes
4-26-2018	Table 708.04A	Changed “Brown Green” to “Brown-green.” In the phrase “No. 2 before solvent evaporation and No. 5 after solvent evaporation.”, replaced “and” with a comma and deleted the period at the end.
4-26-2018	Index	Adjusted spacing around dashes in pay item ranges.
4-27-2018	Table 406.03E	Adjusted widths of columns 2 – 8 to be the same.
4-27-2018	Subsections 641.06 and 641.07	Changed “All Inclusive” to “All-Inclusive” to match pay item name.
4-27-2018	Division 400	Italicized all instances of the terms “IRI”, “PWL”, “RQL”, “PAM”, “ACEA”, “DC”, “PF_{AV}”, “PF_J” and “PF_D”. Capitalized “quality index” and all pay factor names.
4-27-2018	Subsection 406.03C(d)(8)a.	Uncapitalized “Standard Deviation” and “Pay Factor”.
4-27-2018	Subsection 406.03C(e)	Changed the subsection title from “Pay Factor Determination.” to “Air Voids Pay Factor (PF_{AV}) Determination.”
4-27-2018	Subsection 406.03C(h)(1)	Changed “The QC Plan” to “the QC Plan”.
4-27-2018	Subsection 406.19(c)	Changed the subsection name from “Longitudinal Joint Pay Factor” to “Longitudinal Joint Pay Adjustment”.
5-4-2018	Section 646	Deleted extra space and underline at the beginning of the section name.
5-8-2018	Subsection 102.02(a)(3)	Replaced semi-colon with comma and added semi-colon after “and”.
5-23-2018	Subsection 105.30(b)(2)g.	Changed “Subsection 105.30(c)” to “Subsection 105.30(c)(3)”.
5-23-2018	Subsection 105.30(b)(3)c.	Changed “Section 105.30(c)” to “Subsection 105.30(c)(3)”.
5-23-2018	Subsection 108.06(a)(2)a.	Unitalicized “is”.
5-23-2018	Subsection 105.20(e)(11)	Adjusted spacing to move “*31 U.S.C.*” onto one line.
5-23-2018	Subsection 540.04(e)	Changed “Section 540.08” to “Subsection 540.08”.
5-23-2018	Subsection 506.19	Changed “Column 3 of Table 506.19B” and “column 3 of Table 506.19B” to “Column 4 of Table 506.19B”.
5-24-2018	Subsection 543.06(j)	Corrected italicization of titles.
5-24-2018	Subsection 643.07(c)	Italicized “Executive Order 11246”.
5-29-2018	Subsections 678.03(a), 752.06(a), 752.07(b) and 752.10	Unitalicized “NEMA”.
5-29-2018	Subsection 679.10	Uncapitalized “Standards”.
5-29-2018	Subsection 679.12	Italicized “NEC”.
5-29-2018	Subsection 752.06(b)(6)	Changed “NEMA (3R)” to “*NEMA 3R*”.
5-29-2018	Subsection 752.07(c)	Changed “NEMA 3R” to “*NEMA 3R*”.

Date of Change	Locations of Changes	Description of Changes
5-29-2018	Subsection 651.04(a)	Removed underline from the space following "Subsection 651.04(b)".
5-29-2018	Subsection 725.02(a)(2)	Unitalicized "*Agency's*".
6-1-2018	Subsection 703.02	Unitalicized "Method C."
6-1-2018	Subsection 705.06(a)	Italicized "ASTM".
6-1-2018	Subsection 704.10(a)(3)b.	Changed "*AASHTO T 304, Method A, Standard Test Method for Uncompacted Void Content of Fine Aggregate*" to "*AASHTO T 304, Uncompacted Void Content of Fine Aggregate*, Method A".
6-1-2018	Table 707.14A	Deleted extra space from "*AASTHO T 42 /*"
6-1-2018	Subsection 708.06	Italicized "Porcelain Enamel Institute, Inc., Specification ALS-105."
6-1-2018	Subsections 709.01(b)(2) and 712.03(c)	Changed "*AWPA Standards*" to AWPA standards".
6-1-2018	Subsection 713.01(f)	Unitalicized "*S24100, S30400, S31603, S31653, S32101, S32201, S32205,* or *S32304.*"
6-1-2018	Subsection 715.01(a)	Unitalicized "*AASHTO*".
6-1-2018	Subsection 727.01(d)	Unitalicized "*or*".
6-1-2018	Subsection 728.01(a)	Changed "*AWPA Standards U1*" to "*AWPA Standard U1*".
6-1-2018	Subsection 728.03(b)	Added a comma after "*ASTM F 3125/F 3125 M*".
6-1-2018	Table 729.05A	Changed "*ASTM D 2256D 2256 M*" to "*ASTM D 2256/ D 2256 M*".
6-1-2018	Subsection 731.05	Deleted "of".
6-1-2018	Subsection 732.04(c)	Changed "Subsection 740.05" to "Subsection 740.05".
6-1-2018	Subsection 752.05(b)	Changed "*Traffic Control Signal Heads Standards*" to "*Traffic Control Signal Head Standards*".
6-1-2018	Subsection 752.12(a)	Changed "*Loading*" to "loading".
6-1-2018	Subsection 753.07(a)	Unitalicized "*Cycle No. 4*".
6-1-2018	Subsection 755.05	Changed "*CFR*" to "*C.F.R.*"
6-1-2018	Table 755.11B Note 2	Italicized "Mod."
6-1-2018	Subsection 780.02(c)	Unitalicized "*Procedure A*".
6-7-2018	Subsections 415.02, 415.08 and 704.10(a)	Italicized "(Modified)".
6-11-2018	Subsections 102.03 and 102.04	Italicized "Form CA-82".
6-11-2018	Subsection 103.03	Replaced "*No. 226-2* and *226-7*" with "*No. 226-2* and *No. 226-7*".
6-12-2018	Subsection 105.14	Corrected double lettering of subsections. Changed the second (c) to (d) and (d) to (e).

Date of Change	Locations of Changes	Description of Changes
6-12-2018	Subsection 105.28	Adjusted spacing so that the first sentence starts immediately after the subsection title.
6-12-2018	Subsection 105.30(c)(2)	Changed “if any; and” to “if any, and;”.
6-12-2018	Subsection 106.09(b)(5)	Replaced “Agency; and” with “Agency, and;”.
6-12-2018	Subsection 106.09(c)(1)	Replaced “acceptable; and” with “acceptable, and;”.
6-12-2018	Subsection 106.09(b)	Reduced indent of the last paragraph.
6-12-2018	Table of Contents, Division 100	Corrected spacing of header and footer, resulting in slight spacing changes throughout. Corrected Table of Contents to match new spacing.
6-12-2018	Subsection 105.20(e)(11)	Changed “*Federal False Claims Act, 31 U.S.C. § 3729* and/or the *Vermont False Claims Act, 32 V.S.A § 631*.” to “*Federal False Claims Act* (*31 U.S.C. § 3729*) and/or the *Vermont False Claims Act* (*32 V.S.A § 631*).”
6-12-2018	Subsection 103.03	Corrected the legal reference to Vermont Sales and Use Tax Regulations.
6-12-2018	Subsection 106.08	Unitalicized “*Vermont Statutes Annotated*”.
6-12-2018	Subsection 404.02	Changed “Application Temperatures” to “Application Temperature Ranges”.
6-12-2018	Subsection 702.04	Reworded and reorganized subsection to clarify the different requirements for regular and polymer-modified emulsified asphalt. Combined parts.
6-15-2018	Division 400	Adjusted footer spacing.
6-19-2018	Subsection 406.05(c)(3)	Changed “National Institute of Standards and Technology *Handbook 44*” to “National Institute of Standards and Technology, as given in *NIST Handbook 44*”. Added a comma after “*Measuring Devices*”.
6-19-2018	Subsections 406.13(b)(1) and 407.07(b)(1)	Adjusted list capitalization.
6-19-2018	Subsection 501.03(b)(6)	Uncapitalized “Testing”.
6-20-2018	Subsection 507.03	Unitalicized “*Concrete Reinforcing Steel Institute (CRSI)*”.
6-21-2018	Subsection 514.05	Changed “14 days old” to “14 Calendar Days old”.
6-21-2018	Subsection 528.05	Capitalized “rights-of-way”.
6-21-2018	Subsection 653.09(a)	Changed “rights-of-ways” to “Rights-of-Way”.
6-21-2018	Subsection 531.04(a)	Deleted extra space in “200° F”.
6-21-2018	Sections 543, 544, 546, 630 and 631	Fixed spacing between subsection numbers and titles.
6-21-2018	Subsection 522.15	Changed “1 foot increment” to “1-foot increment”.
6-21-2018	Subsection 522.15	Changed “If round timbers are specified” to “For round timbers”.

Date of Change	Locations of Changes	Description of Changes
6-21-2018	Subsection 522.15	Added "*BF* = Number of board feet in round timber".
6-21-2018	Subsection 633.05	Corrected lettering of parts (e) through (g) to be parts (d) through (f). Moved what was part (h) out to be part of the main body text.
6-22-2018	Subsection 675.07(b)	Changed "a State highways" to "a State highway".
7-2-2018	Table of Contents	Added "Table of Contents" header, increased text size of footer from size 10 to size 12.
7-10-2018	Subsection 105.14	Changed "in accordance with the *NCHRP Report*" to "in accordance with *NCHRP Report*".
7-10-2018	Subsection 105.16	Changed "*23 V.S.A. § 1391(a)*" to "*23 V.S.A. § 1391a*".
7-10-2018	Subsection 105.24(h)	Changed "shall comply with *Vermont Water Quality Standards*." to "shall comply with the *Vermont Water Quality Standards*."
7-12-2018	Subsections 107.07(a) and 108.09(e)	Changed "as specified in Subsection 104.04." to "as specified in Subsection 104.04A and Subsection 104.04B."
7-13-2018	Subsection 107.22(a)	Changed "and *C.F.R. 635.410*." to "and *23 C.F.R. 635.410*."
7-13-2018	Subsection 679.15	Capitalized "luminaire".
7-13-2018	Subsection 676.03	Uncapitalized "Bridge".
7-16-2018	Subsection 108.06(a)(1)	Changed "*The Fair Labor Standards Act (FLSA) of 1938*" to "*The Fair Labor Standards Act of 1938* (*FLSA*)".
7-17-2018	Subsection 407.02	Changed the subsection listing from "Performance Graded Asphalt Binder" to "Performance Graded Asphalt Binder (Prepared from Petroleum)". Changed subsection listing from "707.04" to "707.04(a)".
7-18-2018	Subsection 506.02	Changed the subsection listing from "Heat-Treated Structural Bolts" to "Heat-Treated Steel Structural Bolts".
7-19-2018	Subsections 510.12(b) and 540.11(b)	Changed "requirements of Subsection 707.03(c)(1) and Subsection 707.03(c)(3)." to "requirements of Subsection 707.03(a)(1) and Subsection 707.03(a)(3)."
7-19-2018	Subsection 516.02	Changed the subsection listing from "Asphalt Plug Bridge Joint" to "Asphaltic Plug Bridge Joint".
7-19-2018	Subsections 510.09(c)(1)a. and 540.09(c)(1)a.	Changed "time of set testing may be found" to "time of set may be found" and "temperatures at approximately 10°F apart" to "temperatures at intervals of approximately 10°F".
7-23-2018	Subsection 540.12	Changed "requirements of Subsection 510.12(b)." to "requirements of Subsection 540.11(b)."
7-24-2018	Subsection 726.10	Fixed underlining of subsection title.
7-24-2018	Subsection 580.07	Changed "Parts 1, 2, 3, 5, and 7 only." to "Parts (1), (2), (3), (5), and (7) only."

Date of Change	Locations of Changes	Description of Changes
7-24-2018	Subsection 580.07	Changed “Parts 1, 2, 5, and 7 only.” to “Parts (1), (2), (5), and (7) only.”
7-26-2018	Subsection 619.02	Changed subsection listing from “Wood Posts and Offset Blocks for Guardrail, Barriers, and Guide Posts” to “Wood Posts and Offset Blocks for Rail, Guardrail, Barriers, and Guide Posts”.
7-26-2018	Subsection 619.02	Capitalized “materials”.
7-26-2018	Subsection 620.02	Changed subsection listing from “Plank Rail” to “Plank Rail Fence”.
7-26-2018	Subsection 750.08(b)	Changed all instances of “TYPE” to “Type”.
7-26-2018	Subsection 107.11(a)	Changed “to *VOSHA Safety and Health Regulations for Construction, Subpart U, Blasting and the Use of Explosives.* to “to the VOSHA *Safety and Health Regulations for Construction, Subpart U, Blasting and the Use of Explosives.*”
7-26-2018	Subsection 631.02(a)(2)	Changed “the *VOSHA Safety and Health Standards for Construction.*” to “the VOSHA *Safety and Health Regulations for Construction.*”
7-26-2018	Subsection 641.02	Changed “as specified in Subsection 104.04.” to “as specified in Subsection 104.04A and Subsection 104.04B.”
7-27-2018	Subsections 525.06(d)(3) and 631.02(c)(4)	Changed “heavy-duty” to “heavy duty”.
7-30-2018	Subsection 755.11(a)	Changed “Rolled Erosion Control Product Type I.” to “Rolled Erosion Control Product, Type I.”
8-1-2018	Subsection 677.02	Changed subsection listing from “Caulking Compound” to “Aluminum-Impregnated Caulking Compound”.
8-1-2018	Subsections 752.06(b)(11) and 753.06	Italicized “National Electric Code”.
8-1-2018	Subsection 678.02	Changed subsection listings from “Pull Box” and “Junction Box” to “Pull Boxes” and “Junction Boxes”.
8-1-2018	Subsection 679.02	Changed subsection listing from “Finish” to “Finish of Highway Illumination Components”.
8-1-2018	Subsection 679.02	Changed “Street Lights” to “Street lights”.
8-1-2018	Subsection 704.02(a)	Added a comma after “Table 704.02B”.
8-1-2018	Subsection 711.02(a)(2)c.	Changed “requirements of Subsection 711.01(a)(2)c.” to “requirements of Subsection 711.01(a)(1)c.”
8-2-2018	Subsection 755.05	Changed “(also known as U.S. EPA *Part 503*)” to “(also known as *EPA Part 503*)”.
8-2-2018	Preface	Changed “as filed at the Vermont State Library” to “as filed at the Vermont State Archives and Records Administration”.

Date of Change	Locations of Changes	Description of Changes
8-7-2018	Subsections 501.17(b) and 501.17(c)	Added a sentence to part (b) and deleted a sentence from part (c) to correct meaning.
8-7-2018	Subsection 541.17	Deleted Subsection 541.17(b)(9) and added a new Subsection 541.17(c)
8-23-2018	Subsections 646.07(e)(1) and 646.07(g)(1)	Changed “paver-placed pavement” to “bonded wearing course”.
9-4-2018	Subsection 755.05	Italicized “Test Method for the Examination of Composting and Compost” and “TMECC”.
9-4-2018	Subsection 680.02	Changed “Signs Posts” to “Sign Posts”.
9-6-2018	Index	Changed “Hand-Placed Bituminous Concrete Pavement, Drives” to “Hand-Placed Bituminous Concrete Material, Drives”.
9-7-2018	Table 406.03I	Changed Note 4 from “more frequent” to “less frequent”.
9-7-2018	Subsection 700.01	Changed subsection title from “GENERAL” to “GENERAL REQUIREMENTS”.
9-7-2018	Table 707.14A, Subsections 713.04 and 713.05	Deleted references to “*AASHTO T 42*” and “*AASHTO M 221 M/M 221*”. Changed references that were to “*AASHTO M 32 M/M 32*” or “*AASHTO M 55 M/M 55*” to reference “*AASHTO M336 M/M 336*”.
10-1-2018	Subsection 501.03	Changed “*AASHTO M 194/M 194*” to “*AASHTO M 194 M/M 194*”.
10-4-2018	Subsection 510.09(a)	Changed “restressed concrete” to “prestressed concrete”.
10-10-2018	Table of Contents	Corrected page numbering to reflect deletion of Subsection 708.06.
10-10-2018	Index	Changed title from “Alphabetical Index of Pay Items” to “Index of Pay Items”. Changed header text to match.
10-22-2018	Subsection 546.04	Full justified parts (a) and (b).
12-10-2018	Subsection 630.04(a)	Changed “Flaggers meets” to “Flaggers meet”.
12-17-2018	Subsection 678.16(a)(1)	Changed “does not” to “do not”.
1-9-2019	Subsection 210.03(c)	Changed “applicable Cold Plane Contract Item.” to “applicable Contract Item for milling”.
1-24-2019	Subsection 621	Corrected order of items 621.218 and 621.219 in the list of pay items.
3-1-2019	Subsection 633.02(b)	Fixed spelling of “Gantt” in the name of part (b).
3-1-2019	Subsections 506.23(b), 531.04(d), 678.07(e) and 726.09(c)	Italicized and corrected spacing of SSPC specification numbers.
3-12-2019	Subsection 406.13	Changed “binder course” to “intermediate course”.
3-12-2019	Subsection 407.03	Changed “PG asphalt-binder grade” to “PG asphalt binder grade”.

Date of Change	Locations of Changes	Description of Changes
3-20-2019	Subsection 780.02	Changed “manufacturers specified limits” to “manufacturer’s specified limits.”
7-9-2019	Subsection 702.07(b)	Changed “*Test Procedures MRD-1* and *MRD-10*.” to “*Test Procedure MRD-1* and *Test Procedure MRD-10*.”
7-9-2019	Subsection 704.10(a)(3), 704.10(a)(4) and 708.05(c)	Deleted the titles of AASHTO and ASTM references, leaving just the numeric designation.
7-9-2019	Subsection 704.11(d)	Deleted the titles of AASHTO and ASTM references, leaving just the numeric designation.
7-9-2019	Subsection 708.03	Changed “listed on the Agency’s *Approved Products List*, listed on the *NEPCOAT Qualified Products List B*,” to “listed on both the Agency’s *Approved Products List* and on the *NEPCOAT Qualified Products List B*,”
7-9-2019	Subsection 708.07	Changed “*MPI #8, #9,* or *#94*.” To “*MPI #8, MPI #9,* or *MPI #94*.”
7-10-2019	Subsection 506.05	Changed “Vtrans” to “VTrans”.
7-10-2019	Subsection 601.03	Changed “Such coating be dry before installation.” to “Such coating shall be dry before installation.”
7-11-2019	Subsection 522.06	Capitalized the word “material” at the start of the first sentence.
7-11-2019	Subsection 541.04(e)(3)c.	Capitalized the word “aggregate” at the start of a sentence.
7-11-2019	Subsection 544.02	Listed out individual material subsections instead of referencing a range.
7-15-2019	Subsections 105.14(b), 501.03, 510.03(a), 510.04(a), 510.08(i), 540.03(a), 540.04(a), 540.07(f), 541.03, 543.06(j)	Deleted the names of the NCHRP, AASHTO, ACI and PCI references, leaving just the numbers.
7-16-2019	Subsections 406.03A(c), 406.05(a)(12), 506.23(d), 677.03, 678.07(e) and 755.12(c)	Deleted names of AASHTO, MREI, SSPC, and ANSI references, leaving just the number.
	Subsection 407.02	Changed “Aggregate for Bonded Wearing Course” to “Aggregate for Ultra-Thin Bonded Wearing Course”.
7-16-2019	Subsection 678.16(b)	Replaced “DTA’s” with “District Transportation Administrator’s”.
7-16-2019	Subsection 678.17	Deleted “(DTA)”.
7-16-2019	Subsection 728.01(a)	Changed “*AWPA Standards M2, M3, and M4*.” to “*AWPA Standard M2, AWPA Standard M3,* and *AWPA Standard M4*.”
7-18-2019	Subsection 203.11(c)	Replaced “rock or Granular Borrow” with “Rock Borrow or Granular Borrow”.

Date of Change	Locations of Changes	Description of Changes
7-18-2019	Subsection 203.11(e)	Changed “casing advanced drilling methods.” to “casing advance drilling methods.” Replaced “void(s)” with “voids”.
7-18-2019	Subsection 204.01(a)(1)	Replaced “4 foot and under” with “with a clear span of 4 feet and under”.
7-18-2019	Subsection 204.01(b)	Replaced “over 4 foot clear span” with “with a clear span of over 4 feet”.
7-18-2019	Subsection 213.03	Changed “become property of the Contractor.” to “become the property of the Contractor.”
7-18-2019	Subsections 310.09 and 310.10	Changed “FDR” to “Full Depth Reclamation (FDR)”.
7-25-2019	Division 200	Replaced all instances of “Contract Documents” with “Contract”.
7-26-2019	Subsection 510.04(a)(6)f.	Changed “56 days from the date specimen were cast ... provided for sample ages of 3 days, 5 days, 7 days, and 28 days.” to “56 calendar days from the date specimens were cast ... provided for sample ages of 3, 5, 7, and 28 calendar days.”
7-29-2019	Subsection 726.05	Deleted certification requirements.
8-2-2019	Table 108.12A	Modified table format.
8-6-2019	Subsections 406.03A(b), 406.05(a)(12), 406.05(c)	Deleted names of AASHTO and NIST references, leaving just the number.
8-9-2019	Table 651.06B	Changed “Liquid Lime” to just “Liquid”.
8-9-2019	Subsection 711.01	Changed “requirements of *AASHTO M 218*, *M 274*, or *M 289*.” To “requirements of *AASHTO M 218*, *AASHTO M 274*, or *AASHTO M 289*.”
8-9-2019	Subsection 755.06	Changed “Unless otherwise specified, the fertilizer shall contain...” to “If the Plans do not specify the composition of the fertilizer, it shall contain...” Reorganized paragraphs.
8-12-2019	Subsection 541.18	Removed erroneous label for part (c) and re-lettered part (d) as part (c).
10-7-2019	Subsections 101.02, 105.10, 108.11, 507.04, 541.03, 543.06(c), 544.06(f), 726.01	Replaced “Resident Engineer” with “Engineer”.

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Questions or Comments?

Should you have any questions, comments, or suggestions regarding the Specifications presented in this book, please contact the Vermont Agency of Transportation, Contract Administration by email at: AOT.ConstructionContractingInquiry@vermont.gov

Electronic Availability

Electronic copies of this publication may be viewed or downloaded at no charge from the Vermont Agency of Transportation Pre-Contract and Specifications Unit website at the following address: http://vtrans.vermont.gov/highway/construct-material/construct-services/pre-contractspecifications

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PREFACE

This edition of the Standard Specifications for Construction was adopted in April 2018 in compliance with *19 V.S.A. § 10*. The provisions of these Specifications shall apply on all construction Contracts entered into by the Vermont Agency of Transportation. Variations from these Specifications will not be permitted except as provided for by General Special Provisions or Project Special Provisions included in the specified Contract.

Plans and estimates are approved by the Agency with the understanding that the work covered by such Plans and estimates is to be performed or contracted in accordance with these Specifications and any General Special Provisions and Project Special Provisions included in the Contract. When preparing the Contract for execution, reference shall be made to these Specifications by title and date of adoption. The standard set of Specifications, as filed at the Vermont State Library and at the office of the Secretary, Vermont Agency of Transportation, shall cover all work approved. Copies of these Specifications may be obtained from the Vermont Agency of Transportation, Montpelier, Vermont 05633-5001.

Joe Flynn

Secretary of Transportation

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DIVISION 100

GENERAL PROVISIONS

SECTION 101 – DEFINITIONS AND TERMS

101.01 ABBREVIATIONS. Wherever the following abbreviations are used in these specifications or on the Plans, they are to be construed the same as the respective expressions represented:

A	Ampere(s)
A	Arch (Section 601)
ABS	Acrylonitrile-Butadiene-Styrene
ACL	VTrans Advanced Certification List
ADA	Americans with Disabilities Act
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
Amp(s)	Ampere(s)
AMRL	AASHTO Materials and Reference Laboratory
ANR	Vermont Agency of Natural Resources
ANSI	American National Standards Institute
APEL	AASHTO Product Evaluation List
APL	VTrans Approved Products List
AREA	American Railway Engineering Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASD	Allowable Stress Design
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASR	Alkali-Silica Reactivity
ASTM	American International Standards Worldwide

AWPA	American Wood Protection Association
AWS	American Welding Society
AWWA	American Water Works Association
BTU	British Thermal Unit
CAAP	Corrugated Aluminum Alloy Pipe
CCRL	Cement and Concrete Reference Laboratory
CF, FT^3, ft^3	Cubic Foot (Feet)
CFR or C.F.R.	Code of Federal Regulations
CIP	Cast Iron Pipe
CPEP	Corrugated Polyethylene Pipe
CPM	Critical Path Method
CPPP	Corrugated Polypropylene Pipe
CRSI	Concrete Reinforcing Steel Institute
CSP	Corrugated Steel Pipe
CVEP	Conceptual Value Engineering Proposal
CWHSSA	Contract Work Hours and Safety Standards Act
CWR	Continuous Welded Rail
CWT	Hundredweight (see Subsection 109.01(g)(1) for details)
CY, YD^3, yd^3	Cubic Yard(s)
DI	Drop Inlet
DIP	Ductile Iron Pipe
DN	Diameter Nominal for Metric Pipes
DL	Dollar
DTA	District Transportation Administrator
DVEP	Detailed Value Engineering Proposal
EA	Each
EPA	United States Environmental Protection Agency
EPSC	Erosion Prevention and Sediment Control
ES	End Section (Section 204 and Section 601)
FAA	Federal Aviation Administration, U.S. Department of Transportation
FHWA	Federal Highway Administration, U.S. Department of Transportation
FPQ	Final Pay Quantity
FRA	Federal Railroad Administration, U.S. Department of Transportation
FSS	Federal Specifications and Standards (General Services Administration)
FTA	Federal Transit Administration, U.S. Department of Transportation
g	Gram(s)
Gal or gal	Gallon(s)
GMRR	Green Mountain Railroad

HDPE	High Density Polyethylene
Hz	Hertz
in^2	Square Inch(es)
ISEA	International Safety Equipment Association
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
KG or kg	Kilogram(s)
kips	Thousand Pounds-Force
kPa	Kilopascal(s)
kW	Kilowatt(s)
lbf	Pound-Force
Lb(s) or lb(s)	Pound(s)
LF	Linear Foot (Feet)
LRFD	Load and Resistance Factor Design
LS	Lump Sum
LU	Lump Unit
LVRT	Lamoille Valley Rail Trail
MASH	Manual for Assessing Safety Hardware
Mbps	Megabits per second
MC	Medium Curing
MM	Mile Marker
mm	Millimeter(s)
MP	Mile Post
MS	Medium Set
MFBM	Thousand Feet Board Measure (see Subsection 109.01(i) for details)
MGAL	Thousand Gallons
MNL	Manual
MSM	VTrans Materials Sampling Manual
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
MVRT	Missisquoi Valley Rail Trail
N.A.B.I.	Not A Bid Item
NBFU	National Board of Fire Underwriters
NCHRP	National Cooperative Highway Research Program
NDS	National Design Specification
NDT	Nondestructive Testing
NEC	National Electric Code
NECR	New England Central Railroad
NEPCOAT	North East Protective Coating Committee

NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NETC	New England Transportation Consortium
NHS	National Highway System
NIST	National Institute of Standards and Technology
NPS	Nominal Pipe Size
NSBA	National Steel Bridge Alliance
NSPE	National Society of Professional Engineers
NTPEP	National Transportation Product Evaluation Program
OSPC	On-Site Plan Coordinator
OSA	Off-Site Activity
OSHA	Occupational Safety and Health Administration
OTM	Other Track Material
Pa	Pascal(s)
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCCSP	Polymeric Coated Corrugated Steel Pipe
PCF	Pounds per Cubic Foot
PCI	Precast/Prestressed Concrete Institute
PI	Paved Invert
PSI or psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
QA	Quality Acceptance
QAP	Quality Assurance Program
QC	Quality Control
RAP	Recycled Asphalt Pavement
RAS	Recycled Asphalt Shingles
RCP	Reinforced Concrete Pipe
RC	Rapid Curing
RS	Rapid Set
ROW or R.O.W	Right-Of-Way
SAE	Society of Automotive Engineers
SF, FT^2, ft^2	Square Foot (Feet)
SL	Smooth Lined
SSPC	The Society for Protective Coatings
SY, YD^2, yd^2	Square Yard(s)
TL	Test Level (*NCHRP Report 350*)

UL	Underwriters Laboratories, Inc.
USC or U.S.C.	United States Code
UTO	Uniformed Traffic Officer(s)
V	Volt(s)
VAOT, AOT or VTrans	Vermont Agency of Transportation
VCP	Vitrified Clay Pipe
VOSHA	Vermont Occupational Safety and Health Act
VSA or V.S.A.	Vermont Statutes Annotated
VTR	Vermont Railway
W	Watt
WACR	Washington County Railroad
WHD	Wage and Hour Division, U.S. Department of Labor
YD or yd	Yard(s)
°C	Degrees Celsius
°F	Degrees Fahrenheit
MΩ	Megaohm
µm	Micrometer
µW	Microwatt
Ω	Ohm

All standard recognized abbreviations may be used in connection with the Contract.

101.02 DEFINITIONS. Wherever in these specifications or in other Contract documents the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

AASHTO PRODUCT EVALUATION LIST - The APEL management system is the web database/central repository for evaluation reports from the testing of innovative patented and/or proprietary engineered transportation products, conducted either through APEL or by state departments of transportation.

ACCEPTANCE DATE - Date noted in the Completion and Acceptance Memorandum on which designated responsible Agency personnel have accepted the completeness and quality of all material incorporated in and work performed to complete the project(s).

ACT OF GOD - An act of God means an earthquake, flood, cyclone, or other cataclysmic phenomena of nature beyond the ability of a prudent Contractor to foresee and make preparation to defend against damage.

ADVANCED CERTIFICATION LIST - A list of products compiled by the Agency that have been approved for use based on an annual certification submitted by the manufacturer or supplier. Only materials that require a Type A Certification per the Agency's *Materials Sampling Manual* can be included on this list.

AGENCY - Agency of Transportation, State of Vermont (VAOT, AOT, or VTrans).

AGGREGATE - Inert material such as sand, gravel, crushed gravel, broken stone, crushed stone, or a combination thereof.

APPROVED PRODUCTS LIST - A listing of products and materials that have been evaluated by VTrans, for applicable specifications, and have been deemed satisfactory for use on Agency projects without additional certification requirements.

AUTHORIZATION TO PROCEED - Written notice confirming that the Contract has been successfully executed and the Contractor may progress Contract work.

AUTHORIZED REPRESENTATIVE

(a) Contractor's - An individual registered with the Office of Contract Administration having the legal authority to sign the Contract on behalf of the Contractor.

(b) Agency's - The Chief Engineer's authorized representative(s) responsible for engineering supervision of the construction project.

BASE COURSE - The layer or layers of specified or selected material of designed thickness on a subbase to support a surface course.

BITUMINOUS CONCRETE FIELD UNIT SUPERVISOR - The Agency's authorized representative of the Materials Testing and Certifications Section responsible for the evaluation and approval of various aspects of bituminous concrete pavement detailed in these specifications and supervision of plant Inspectors utilized at hot mix asphalt plants.

BIWEEKLY - Occurring once every two weeks.

BOARD - The Transportation Board of the State of Vermont or its successor.

BORROW AREA - All borrow pits, gravel pits, quarries, sand pits, and similar sources of materials used in the construction of the project.

BRIDGE

(a) Highway Bridge – A structure, including supports, erected over a depression or an obstruction such as water, a highway, or a railroad, having a passageway for carrying traffic or other moving loads and having a clear span of more than 20 feet (6 feet on non-federal-aid projects) measured along the center of the roadway between abutments, spring lines of arches, extreme ends of openings for multiple boxes, or multiple pipes where the clear distance between openings is less than 50% of the smaller contiguous opening.

(1) Highway Bridge Length – The dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between the ends of a bridge floor, whichever is greater.

(2) Highway Bridge Width – The clear dimension of a structure measured at right angles to the center of the roadway between the inner faces of parapet or railing.

(b) Railroad Bridge - Any structure with a deck, regardless of length, which supports one or more railroad tracks, or any other under grade structure with an individual span length of 10 feet or more located at such a depth that it is affected by live loads.

(1) Railroad Bridge Length - The dimension of a structure measured along the center of the railroad between backs of abutment backwalls or between the ends of a bridge floor, whichever is greater.

(2) Railroad Bridge Width - The clear dimension of a structure measured at right angles to the center of the railroad between the inner faces of parapet or railing.

CALENDAR DAY - Any day shown on the calendar, beginning and ending at midnight.

CHANGE ORDER - A written agreement made and entered into by and between the Contractor and the Agency covering work not otherwise provided for in the Contract, revisions in or amendments to the terms of the Contract, an increase to the original quantities as set forth in the original Contract, or conditions specifically described in these specifications as requiring a Change Order. Change Orders constitute amendments to the original Contract once properly signed and executed.

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CHANNEL - A natural or artificial water course.

CHIEF ENGINEER - See DIRECTOR OF THE HIGHWAY DIVISION.

CHIEF OF RIGHT-OF-WAY - The Agency's authorized representative to perform all liaison and negotiations between private property owners and utility companies to ensure the *Uniform Relocation Assistance and Real Property Acquisition Policies Act* is met and conflicting utility facilities are relocated to accommodate transportation projects.

CLAIM

(a) Contractor's Claim - A claim by the Contractor for adjustment or dispute under Subsection 105.20.

(b) Damage Claim - A claim by an individual or entity for damage to property or for personal injury.

(c) Labor and Materials Claim - A claim by a Subcontractor, supplier, or other entity covered by *19 V.S.A. § 10(9)* for monies claimed to be due and payable.

CLEAR ZONE - The roadside border area starting at the edge of the traveled way available for use by errant vehicles. Specified clear zones are as shown in the Plans.

COLLUSION - A secret agreement among two or more persons, companies, or organizations for a deceitful or fraudulent purpose.

CONCRETE ENGINEER - See STRUCTURAL CONCRETE ENGINEER.

CONDUIT - A tube used for carrying, holding, and protecting electrical or other utilities.

CONSTRUCTION AREA - The entire portion of a project site within the right-of-way and easement limits during construction.

CONSTRUCTION EASEMENT - See EASEMENT.

CONSTRUCTION ENGINEER - The authorized representative of the Agency responsible for engineering supervision once the Contract has been signed and until project completion and final acceptance.

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CONSTRUCTION ENVIRONMENTAL ENGINEER - The Agency's authorized representative of the Construction Section that provides guidance and technical assistance to the Engineer and Contractor on environmental compliance issues.

CONSTRUCTION MANAGER - See CONSTRUCTION ENGINEER.

CONSTRUCTION OPERATIONS - A visible presence at the project site that may impact traffic or environmental resources.

CONSTRUCTION SAFETY TECHNICIAN - The Agency's authorized representative of the Construction Section who provides guidance and technical assistance to the Engineer and Contractor on safety issues.

CONSTRUCTION SEASON - The period from April 15th through December 1st, inclusive.

CONSTRUCTION SERVICES ENGINEER - The authorized representative of the Construction and Materials Bureau who provides expertise in matters of specifications, policy, procedures, and Contract finals.

CONSTRUCTION STRUCTURES ENGINEER - The Agency's authorized representative of the Construction Section that provides guidance and technical assistance to the Engineer and Contractor on structural issues.

CONTRACT - The written agreement between the Agency and the Contractor setting forth the obligations of the parties relative to the performance of the work.

The Contract includes the Contract agreement, Contract bonds, project permits, Project Special Provisions, Contract Plans, General Special Provisions, Standard Drawings, the Standard Specifications for Construction, and any Supplemental Agreements or supporting documents that are required to complete the work in an acceptable manner.

CONTRACT BONDS - The approved forms of security, signed, notarized and furnished by the Contractor and the Contractor's surety or sureties, guaranteeing complete performance of the Contract, compliance with the Contract, and the payment of all legal debts pertaining to the construction of the project or work.

CONTRACT COMPLETION DATE - The calendar date specified in the Contract and as adjusted by Change Order when applicable, by which the Contractor shall achieve substantial completion .

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CONTRACT DOCUMENTS - See CONTRACT.

CONTRACT DURATION - The number of working days or calendar days prescribed in the Contract to complete the work.

CONTRACT ITEM - A specific unit of work for which a price is provided in the Contract.

CONTRACTOR - The individual, partnership, firm, corporation, any acceptable combination thereof, or a joint venture which is a party to the Contract with the Agency which is undertaking the performance of the work under the terms of the Contract and acting directly or through its agent(s) or employee(s). The term "Contractor" means the prime Contractor as differentiated from a Subcontractor. All Contractors must be registered with the Vermont Secretary of State. The Contractor will act in an independent capacity and not as officers or employees of the State.

CONTRACT PLANS - The Contract drawings that show the location, character, and dimensions of the work, including layouts, profiles, cross-sections, and other details.

CPM PROGRESS SCHEDULE - A schedule that must depict work activities in a time-based, logic diagram format showing the relationship with preceding and succeeding activities with the critical path clearly indicated.

CRITICAL PATH - The critical path is the sequence of project activities with the longest total duration, which must be completed on time for the project to be finished by the Contract completion date.

DETOUR - A temporary route to carry traffic.

DIRECTOR OF THE CONSTRUCTION AND MATERIALS BUREAU - The authorized representative of the Agency responsible for oversight of the Construction, Materials Testing and Certification, and Geotechnical Engineering Sections.

DIRECTOR OF THE HIGHWAY DIVISION - The authorized representative of the Agency, appointed by the Vermont Secretary of Transportation to administer the Highway Division.

DIRECTOR OF THE POLICY, PLANNING, AND INTERMODAL DEVELOPMENT DIVISION - The authorized representative of the Agency, appointed by the Vermont Secretary of Transportation to administer the Policy, Planning and Intermodal Development Division.

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DISTRICT TRANSPORTATION ADMINISTRATOR - The authorized representative of the Agency for a maintenance district subdivision of the State who is responsible for maintenance of state transportation facilities.

DRAINAGE - The system of pipes, drainage ways, ditches, and structures by which surface or subsurface waters are collected and conducted away from the project area or a transportation facility.

EARTH - See SOIL (EARTH).

EASEMENT - A right acquired to use or control property outside of the established right-of-way limits for a designated purpose.

EMBANKMENT - That portion of a filled area situated between the previously existing ground level and the subgrade (roadbed).

ENCROACHMENT - Use of highway or railroad right-of-way or easement unlawfully and/or without authority or permission.

ENGINEER - See RESIDENT ENGINEER.

ENGLISH - Other than when referring to the English language, the U.S. Customary Units of Measurement.

EQUIPMENT - All machinery, instruments, tools, vehicles, and apparatuses together with the necessary supplies for upkeep and maintenance, for the proper construction and acceptable completion of the work.

EXTRA WORK - An item of work not provided for in the Contract as awarded but determined to be essential to the satisfactory completion of the Contract. Extra work shall be performed at agreed upon prices or on a force account basis as provided in the Contract.

EXTRA WORK ORDER - A form used to provide for the performance of work or furnishing of materials involving extra work.

FEDERAL AVIATION ADMINISTRATION - The agency within the U.S. Department of Transportation, Washington, D.C., with authority concerning airports and aviation.

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FEDERAL HIGHWAY ADMINISTRATION - The agency within the U.S. Department of Transportation, Washington, D.C., with authority concerning highways.

FEDERAL RAILROAD ADMINISTRATION - The agency within the U.S. Department of Transportation, Washington, D.C., with authority concerning railroads.

FEDERAL TRANSIT ADMINISTRATION - The agency within the U.S. Department of Transportation, Washington, D.C., with authority concerning public transit.

FINAL ESTIMATE - A compilation of item quantities prepared upon completion of the Contract stating the whole amount of work done by the Contractor and the final amount to be paid under the Contract.

FINALS ENGINEER - The authorized representative of the Construction and Materials Bureau responsible for handling all issues related to finalizing a Contract.

FORCE ACCOUNT - Prescribed work paid for on the basis of actual costs, including appropriate extra work, as defined in Subsection 109.06.

FOULING - The condition arising when the location of an individual or an item of equipment is in such proximity to a railroad track that the individual or equipment could be struck by a moving train or on-track equipment, and as defined by the Operating Railroad.

GAGE - The distance between the heads of railroad rails, measured at a point 5/8 inches below the top of the railroad rail. Standard gage measures 4 feet 8-1/2 inches.

GENERAL SPECIAL PROVISIONS - Additions and revisions to the Standard Specifications for Construction approved pursuant to the specification approval process.

GEOLOGIST - The Agency's authorized representative who provides expertise pertaining to the field of geology, such as bedrock and unbound aggregates, as specified in the Contract.

GEOTECHNICAL ENGINEERING MANAGER - The Agency's authorized representative who provides guidance and technical assistance relating to soils and aggregates, and geotechnical and geological engineering.

GRADE SEPARATION - A crossing of two or more transportation facilities at different elevations.

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HAZARDOUS MATERIALS AND WASTE COORDINATOR - The Agency's authorized representative who provides guidance and technical assistance to the Engineer and Contractor on hazardous materials and waste issues.

HIGHWAY - See ROADWAY.

HOLIDAYS - The Contractor shall observe the following holidays:

New Year's Day	January 1st
Martin Luther King Jr. Day	Third Monday in January
Presidents' Day	Third Monday in February
Town Meeting Day	First Tuesday in March
Memorial Day	Last Monday in May
Independence Day	July 4th
Bennington Battle Day	August 16th
Labor Day	First Monday in September
Indigenous Peoples' Day	Second Monday in October
Veterans Day	November 11th
Thanksgiving Day	Fourth Thursday in November
Day After Thanksgiving	Day After Thanksgiving
Christmas Day	December 25th

If a holiday falls on a Sunday, the following Monday shall be considered the holiday; if a holiday falls on a Saturday, the Friday immediately preceding shall be considered the holiday.

INSPECTOR - An authorized representative of the Engineer assigned to make detailed inspections of Contract performance.

LABORATORY - The Agency's Materials Section Central Laboratory or any other testing laboratory which may be designated by the Engineer.

LIQUIDATED DAMAGES - The charge assessed to the Contractor pursuant to the Contract because the Contractor did not achieve substantial completion within the Contract time or by the Contract completion date. Liquidated damages are not a penalty but an assessment of damages that are impossible or difficult to determine with accuracy.

LOAD TICKET - A ticket accompanying a load of material and indicating the gross weight of the load, less the tare weight of the delivery vehicle, and other information as specified and/or as required by the Engineer.

MASS - The words mass and weight are used interchangeably. Mass must be converted to force before computing structural reactions, shears, moments, or internal stresses.

MATERIALS - Any substance(s) specified for use in the construction of the project and its appurtenances.

MATERIALS MANAGER - The authorized representative of the Agency responsible for the acceptance testing and certification of materials incorporated in Contracts.

MATERIALS SECTION - The section of the Agency of Transportation responsible for maintaining and administering the Agency's Quality Assurance Program, Materials Acceptance Program, and Independent Assurance Program. Officially named the Materials Testing and Certification Section.

MEDIAN - Unless different in context, the portion of a divided highway separating opposing traveled ways.

NATIONAL TRANSPORTATION PRODUCT EVALUATION PROGRAM - The national evaluation and auditing program for manufactured products.

NON-PARTICIPATING - Designates work in which the cost is not shared by the federal and/or state Government.

NOTICE TO PROCEED - Written notice to the Contractor stipulating the date on which the Contractor can begin construction operations subject to other Contract requirements.

OPERATING RAILROAD - The entity with operating rights on a public or privately owned railroad.

OTHER TRACK MATERIAL - Other railroad track material includes, but is not limited to, spikes, nuts, bolts, tie plates, tie plugs, railroad anchors, joint bars, and other ancillary components necessary for the construction of a track. OTM does not include ties or ballast.

PAY ITEM - See CONTRACT ITEM.

PAVEMENT STRUCTURE - The combination of subbase, base course, and wearing course placed on a subgrade to support the traffic load and distribute it to the roadbed.

PLANS - See CONTRACT PLANS.

PLANT INSPECTOR - An authorized representative of the Agency assigned to perform detailed inspections of methods and materials at plants, including bituminous, concrete, and structural steel assembly plants.

PROFESSIONAL ENGINEER - A qualified registered professional engineer licensed in the State of Vermont or eligible to practice engineering in the State of Vermont under the transient practice provisions of *26 V.S.A., Chapter 20*.

PROFILE GRADE - The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline. Depending on the context, profile grade means either the elevation at one or more points, or the gradient of such trace.

PROGRAM MANAGER - The Agency's authorized representative responsible for the design aspects of projects.

PROJECT - The specific portion(s) of the transportation facility infrastructure on which work is to be performed under one or more Contracts.

PROJECT MANAGER - The authorized representative of the Chief Engineer or the Director of the Policy, Planning and Intermodal Development Division responsible for the development of project design and management of project costs.

PROJECT SPECIAL PROVISIONS - Additions and revisions to the Standard Specifications for Construction and General Special Provisions applicable to the Contract, as well as other provisions specific to the Contract. Also referred to as Special Provisions.

PUNCH LIST - List of items which are minor adjustments, repairs, or corrections to work that shall be completed prior to the acceptance of the project.

QUALITY ASSURANCE PROGRAM - The program that prescribes the practices for acceptance of material in construction and maintenance.

RAILBANKING - A railbanked line is an inactive line (from which the tracks may or may not have been removed) which has been approved for railbanking and interim trail use by the Surface Transportation Board under the *Federal Trails Act* (*16 U.S.C. § 1247 (d)*) or by the Vermont Secretary of Transportation under Vermont's own railbanking statute (*5 V.S.A. § 3408*).

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RAILROAD - The area within the limits of construction that is used for the movement of trains and that may include track, ties, ballast, subbase, and OTM.

REGIONAL CONSTRUCTION ENGINEER - The authorized representative of the Agency for a construction regional subdivision of the State who is responsible for administering and overseeing construction Contracts.

RESIDENT ENGINEER - The authorized representative of the Agency and the Chief Engineer who is responsible for engineering supervision of one or more specific projects.

REVIEWED FOR CONFORMANCE - A review of a working drawing for compliance with the requirements of a specification.

RIGHT-OF-WAY - The land or property, or interests therein, devoted to transportation purposes.

ROADBED - See SUBGRADE.

ROADSIDE - The area adjoining the outer edge of the traveled way or shoulder of a highway. Extensive median areas between the roadways of a divided highway may also be considered roadside.

ROADWAY - The area within the limits of construction that is used for the movement of vehicular and pedestrian traffic and that may include the traveled way, shoulder, and sidewalk.

SAFETY OFFICER

(a) Contractor's - An individual designated by the Contractor charged to assure that all construction operations under the Contract are performed safely and according to all VOSHA regulations.

(b) Agency's - The Agency's authorized Occupational Safety Coordinator.

SECRETARY - The appointed head of the Agency of Transportation of the State of Vermont.

SHOULDER - The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

SIDEWALK - That portion of the roadway primarily constructed for the use of pedestrians.

SLOPES - The inclined areas extending from the shoulders to the previously existing surface of the ground.

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SOIL (EARTH) - Sediments or other unconsolidated accumulations of solid particles produced by the chemical and physical disintegration of rocks and which may or may not contain organic matter.

SPECIALTY ITEM - Work that requires highly specialized knowledge, ability, or equipment not ordinarily available in contracting organizations qualified to bid on the Contract as a whole; in general Specialty items are limited to minor components of the overall Contract.

SPECIFICATIONS - The compilation of provisions and requirements for the performance of prescribed work including the Standard Specifications for Construction, General Special Provisions, Project Special Provisions, and other requirements included in the Contract.

STAGING AREA - Any areas that the Contractor uses for storage of materials and equipment or for general use and access for Contract operations.

STANDARD DRAWINGS - Agency approved drawings used for typical repetitive use, showing details to be used where appropriate.

STANDARD SPECIFICATIONS or STANDARD SPECIFICATIONS FOR CONSTRUCTION - This book, entitled the *Standard Specifications for Construction*, as approved for general application and repetitive use in Agency construction Contracts.

STATE - Unless different in context, the State of Vermont acting through its Agency of Transportation and authorized representative(s).

STRUCTURAL CONCRETE ENGINEER - The Agency's authorized representative of the Materials Testing and Certification Section responsible for the evaluation and approval of various aspects of cast-in-place Portland cement concrete and pre-cast concrete as detailed in these specifications. Also responsible for supervision of plant Inspectors utilized at concrete plants and for the evaluation of Portland cement concrete mix designs.

STRUCTURAL EMBANKMENT AREA - The cross-sectional area of an embankment situated between the lines projected downward from the outer edges of the subgrade on a 1:1.5 (vertical to horizontal, or V:H) slope to the intersection with the previously existing ground.

STRUCTURAL STEEL FABRICATION ENGINEER - The Agency's authorized representative of the Structures Engineering Section responsible for the supervision of Inspectors utilized for steel fabrication and for the evaluation of field welding procedures and qualifications.

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STRUCTURES ENGINEER - The Agency's authorized representative responsible for structural engineering supervision of the project. Sometimes referred to as the Structures Program Manager.

SUBBASE - The layer or layers of specified or selected material of designated thickness placed to support a base and/or surface course.

SUBCONTRACTOR - An individual or legal entity to whom or which the Contractor sublets part of the work.

SUBGRADE - The graded surface prepared as a foundation for the pavement structure and shoulders of a transportation facility.

SUBSTANTIAL COMPLETION DATE - The date when, in the opinion of the Engineer, all Contract items, with the exception of the Contractor's demobilization and punch list type items, have been completed.

SUBSTRUCTURE - All of that part of a structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames; included are backwalls, wingwalls, and wing protection railings.

SUPERINTENDENT - The Contractor's authorized representative in responsible charge of the work.

SUPERSTRUCTURE - All that part of a structure supported by the substructure, except approach slabs.

SUPPLEMENTAL AGREEMENT - See CHANGE ORDER.

This definition deleted.

SURETY - The individual, partnership, firm, or corporation, or any acceptable combination thereof, other than the Contractor, executing the bond or bonds furnished by the Contractor. Surety companies must be authorized to do business in the State of Vermont (See *19 V.S.A. § 10(8)*).

SURFACE COURSE - See WEARING COURSE.

TRAVELED WAY - The portion of the roadway for the movement of vehicles, exclusive of shoulders, sidewalks, and auxiliary lanes.

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UNIT PRICE - The Contract price for one unit of work, as defined by the Contract.

UTILITY - The privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste stormwater not connected with highway drainage, and other similar commodities, including publicly owned fire and police signal systems and street lighting systems, which directly or indirectly serve the public or any part thereof. The term utility shall also mean the utility company, inclusive of any wholly owned or controlled subsidiary.

WEARING COURSE - The uppermost component of a pavement structure.

WASTE AREA - Any area where excess material or materials unsuitable for construction are disposed.

WEIGHT - See MASS.

WEIGHTS AND MEASURES - The Division of Weights and Measures of the Vermont Agency of Agriculture, Food, and Markets.

WORK - The furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and carrying out of the duties and obligations imposed by the Contract.

WORKING DAY - Weekdays during the construction season during which construction operations may proceed. If the Contractor works on Saturdays, Sundays, holidays, or during the seasonal closure period, those days will be considered working days.

WORKING DRAWINGS - Supplemental design sheets or similar data which the Contractor is required to submit to the Agency as stated in Subsection 105.03.

WRITTEN ORDER - A statement in writing from the Engineer to the Contractor that:

(a) Authorizes or directs work to be done that is not part of the Contract, including method of payment.

(b) Informs the Contractor of work that is not being accomplished according to the Plans and these specifications, and directs corrective action.

(c) Documents quantities to be paid for designated Contract items.

(d) Directs that safety, environmental, or other requirements or measures be followed.

(e) Directs that certain work or all work be stopped or discontinued.

(f) Brings to the Contractor's attention any other information or concerns that the Engineer may wish to emphasize.

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101.03 INTENTION OF TERMS.

(a) By/To the Engineer. In order to avoid cumbersome and confusing repetition of expressions in these specifications, whenever anything is, or is to be, done if, as, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be read and understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

(b) As Ordered/Directed by the Engineer. When the phrases "as ordered by the Engineer," "as directed by the Engineer," or similar phrases are used in the Contract, they shall be understood to provide the Engineer latitude to meet field conditions, but in no case shall these phrases be construed to permit changing the intent of the Contract.

(c) Furnish and Provide. "Furnish," "provide," and words of similar meaning, when used in relation to the "Contractor," shall mean at the Contractor's expense unless otherwise specifically provided in a Contract item.

(d) Headings and Captions of Sections, Subsections, and Paragraphs. All headings and captions are inserted for convenience and identification only and are in no way intended to define, limit, or expand the scope and intent of the Contract.

(e) Approval of/Ordered by/Consent of Engineer. As they appear in these specifications, phrases like "approval of the Engineer," "as ordered by the Engineer," "with the consent of the Engineer," and any similar phrase indicating the acceptance or direction by the Engineer shall not supersede any requirement of the Contract that the Contractor meet all Contractual obligations, including but not limited to, compliance with permit conditions and applicable laws, rules, regulations, ordinances, and bylaws.

(f) Construction/Interpretation of Contract Documents. The Contract and its provisions shall not be construed or interpreted for or against the Agency because the Agency drafted or caused its representative(s) to draft its provisions.

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SECTION 102 – BIDDER REQUIREMENTS AND CONDITIONS

102.01 INTERPRETATION OF QUANTITIES IN BID PROPOSAL. The estimates of quantities of work to be performed and/or materials to be furnished as shown on the proposal are approximate and are provided only as a basis of calculation upon which the award of the Contract is to be made.

Except as otherwise provided, the Agency disclaims responsibility, and shall not be held responsible, for the estimates of quantities, whether they be less than, equal to, or greater than the quantities used in the actual performance of the work.

The Contractor shall not plead misunderstanding or deception because of the estimates of quantities or of the character, location, or other conditions pertaining to the estimates of quantities.

The Agency, in its sole discretion, reserves the right to increase or decrease any or all of the estimated quantities of work or to omit any of them as deemed necessary.

102.02 EXAMINATION OF PLANS, SPECIFICATIONS, PROPOSAL FORMS, SITE OF WORK, AND SUBSURFACE INFORMATION.

(a) General. Each and every bidder shall examine carefully the site of the work contemplated and the relevant Plans, specifications, and proposal forms. It is the responsibility of each and every bidder to investigate and become aware of:

(1) The conditions to be encountered;

(2) The character, quality, and quantities of the work to be performed;

(3) The materials to be furnished, and;

(4) The requirements of the Plans, specifications, proposal, and all other proposal documents.

(b) Subsurface Investigations. To assist in the design for a project, the Agency normally investigates subsoils, foundation conditions, and potential sources of material for character, quality, and/or quantity by various means, including borings, test pits, samples, tests, and classifications. Information concerning any investigations normally appears on the Plans or in the proposal.

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(1) Disclaimer. Boring logs and other subsurface information on the Plans, in the proposal, or otherwise provided to bidders were obtained with reasonable care and recorded in good faith by the Agency. This subsurface information has been collected for the use of the Agency only, to assist the Agency in developing a design suitable for the subsurface conditions in the area of the foundation for the structure and/or for preparation of the Engineer's estimate. This subsurface information is made available to prospective bidders as a public document relating to a project. Such information is not intended to provide prospective bidders with a subsurface analysis for purposes of bid preparation. It is up to the prospective bidder to conduct whatever subsurface investigation may inform its bid preparation.

The Agency disclaims any liability for claims based upon a prospective bidder's reliance on the subsurface information provided by the Agency unless, following Contract award, the Contractor can establish by clear and convincing evidence that the subsurface information provided by the Agency was inadequate to support the structure as designed.

(2) No Responsibility or Warranty by the Agency. Soil classifications have been made from laboratory tests of soil samples extracted and/or collected. Rock and soil descriptions, engineering properties, or classifications are from visual inspection and tests of rock cores and/or soil samples. Observed water levels and/or water conditions indicated are as recorded at the time of exploration and may vary considerably with time according to the prevailing rainfall and other factors.

The information provided may not represent existing conditions. The Agency is not responsible for the information. The Agency does not warrant in any way the completeness or accuracy of the information. Disclosure of the information is not a substitute for personal investigations, interpretations, and/or judgments by each prospective bidder. It is the responsibility of each prospective bidder and/or Subcontractor to satisfy itself, through its own independent investigations, concerning the conditions and materials to be encountered.

(c) Contractors Obligation to Convey Information. It is the Contractors responsibility to convey any and all information relative to Contract requirements to any proposed suppliers, fabricators, or Subcontractors.

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102.03 FAMILIARITY WITH LAWS, ORDINANCES, AND REGULATIONS.

(a) General. By submitting a bid, an entity certifies that it is familiar with all federal, state and local laws, ordinances and regulations which affect in any way the materials, equipment, haul roads used in or upon the work, the conduct of the work, and the persons engaged or employed in performance of the work to be performed pursuant to a Contract.

(b) Duty to Report.

(1) Inconsistency or Conflict with Federal, State, or Local Law, Ordinance, or Regulation. By submitting a bid an entity certifies that it shall immediately report in writing to the Chief of Contract Administration any provision in the Plans, proposal, specifications or proposal that the bidder/Contractor believes is in conflict with or inconsistent with any federal, state or local law, ordinance, or regulation.

(2) Differing Site Conditions. By submitting a request for a proposal (*Form CA-82*) a prospective bidder certifies that if, during its investigation of the work in the process of preparing its bid, it discovers or encounters subsurface or latent physical conditions at a project site differing materially from those indicated in the proposal or unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the proposal, it shall notify in writing the Chief of Contract Administration of the specific differing conditions immediately upon discovering or encountering the differing site conditions.

(3) Failure to Notify. A prospective bidder further certifies that if it fails to notify the Chief of Contract Administration of any differing site conditions as described above, it shall waive any and all rights that it might have to additional compensation from the Agency for additional work as a result of the differing site conditions and that it shall not bring a claim for additional compensation because of the differing site conditions.

(c) No Claim or Defense of Ignorance or Misunderstanding. By submitting a Request for Contract Specific Prequalification (*Form CA-82*) a bidder certifies that no claim or defense of ignorance or misunderstanding concerning federal, state, or local laws, ordinances, or regulations will be employed by a bidder or considered by the Agency in claims, litigation, alternative dispute resolution procedures, or other matters concerning the proposal for which the bid is submitted.

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102.04 ERRORS AND/OR INCONSISTENCIES IN CONTRACT DOCUMENTS.

(a) Duty to Report. By submitting a request for proposal (*Form CA-82*) a bidder certifies that it shall report in writing to the Chief of Contract Administration any error or inconsistency discovered in the Plans, proposal, specifications, or proposal documents immediately upon discovery of the error or inconsistency.

(b) Errors and Inconsistencies Not Used Against the State. By submitting a request for proposal (*Form CA-82*) a bidder certifies that it shall assert no claim, cause of action, litigation, or defense against the State unless notice was provided to the State in writing of any error or inconsistency found in the Plans, proposal, specifications, or proposal documents immediately upon discovery of such error or inconsistency. Failure to provide such notice to the Agency's Chief of Contract Administration, in writing, within 48 hours of such discovery constitutes reasonable grounds for disallowance and/or waiver of any claim or demand by the prospective bidder based, in whole or in part, directly on the existence of such error or omission.

SECTION 103 – TAXES AND INSURANCE

103.01 CONSTRUCTION EQUIPMENT TAX. The Contractor shall pay all construction equipment tax assessed under *32 V.S.A. § 3603* for machinery and other personal estate.

103.02 WITHHOLDING OF TAXES. The Contractor shall comply with the requirements of *32 V.S.A., Chapter 151, Subchapter 4* relating to the withholding of taxes from employees, and all taxes withheld pursuant to *Subchapter 4* shall be reported and paid to the Commissioner of the Vermont Department of Taxes.

103.03 STATE SALES TAX. Contractors are not required to pay the Vermont sales tax for materials incorporated into a state funded project completed on property owned or held in trust for the benefit of any governmental body or agency and used exclusively for public purposes or owned or held in trust for the benefit of any organization holding a valid exemption certificate and used exclusively in the conduct of its business or purpose, or for materials incorporated in a rail line in connection with the construction, maintenance, repair, improvement, or reconstruction of the rail line (see *32 V.S.A. § 9743(4)*, *32 V.S.A. § 9741(30)*, *32 V.S.A. § 9741(44)*, and the *Vermont Sales and Use Tax Regulations*, *Reg. § 1.9741(34)-5* and *Reg. § 1.9743*).

Therefore, no sales tax shall be included in the cost of these materials.

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Contractors are responsible for maintaining records sufficient to justify eligibility for sales tax exemption. Forms for maintaining these records are available from the Vermont Department of Taxes.

103.04 INSURANCE REQUIREMENTS. Insurance obtained by the Contractor to cover the below-listed requirements shall be procured from an insurance company registered and licensed to do business in the State of Vermont. Before the Contract is signed and becomes effective, the Contractor shall file with the Agency a certificate of insurance, executed by an insurance company or its licensed agent(s), on a form satisfactory to the Agency, stating that with respect to the Contract awarded, the Contractor carries insurance in accordance with the following requirements. Renewal certificates for keeping the required insurance in force for the duration of the Contract shall also be filed as specified above.

No warranty is made that the coverages and limits listed herein are adequate to cover and protect the interests of the Contractor and any Subcontractor for the Contractor's and any Subcontractor's operations. These are solely minimums that have been established to protect the interests of the State.

(a) Workers' Compensation Insurance. With respect to all operations performed the Contractor shall carry workers' compensation insurance in accordance with the laws of the State of Vermont, *21 V.S.A. Chapter 9*. The Contractor shall also ensure that all Subcontractors carry workers' compensation insurance in accordance with *21 V.S.A. Chapter 9* for all work performed by them.

(b) Commercial General Liability Insurance. With respect to all operations performed by the Contractor and Subcontractors, the Contractor shall carry commercial general liability insurance on an occurrence form providing all major divisions of coverage, including but not limited to:

(1) Premises - operations

(2) Independent Contractor's protective

(3) Products and completed operations

(4) Personal injury liability

(5) Contractual liability applying to the Contractor's obligations under Subsection 107.16, broad form property damage

(6) Collapse and underground (CU) coverage

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(7) Explosion (X) coverage, unless this requirement is waived in writing by the Agency of Transportation

(8) Limits of coverage shall be not less than:

$2,000,000	Each occurrence
$4,000,000	General aggregate applying, in total, to this project only
$2,000,000	Products/completed operations

(c) Automobile Liability Insurance. The Contractor shall carry automobile liability insurance covering all motor vehicles including owned, hired, borrowed, and non-owned vehicles, used in connection with the project.

(1) Limits of coverage shall be not less than:

a. Bodily Injury:

$1,000,000	Each person
$1,000,000	Each occurrence

b. Property Damage:

$1,000,000 Each occurrence

(2) Or:

a. Combined Single Limit:

$1,000,000 Each Occurrence

(d) Railroad Protective Liability Insurance. When the Contract involves work on, over, or under the right-of-way of any railroad, the Contractor shall carry, with respect to operations performed by the Contractor and/or by the Contractor's Subcontractors, railroad protective liability insurance in a form and amount as required by the Operating Railroad and as specified in *23 C.F.R. 646.107*. If not available from insurance companies registered and licensed to do business in the State of Vermont, this insurance may be procured from Eligible Surplus Lines companies approved by the Vermont Department of Financial Regulation (DFR).

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The Contractor shall file the original railroad protective liability policy and one duplicate policy with the Agency. The Agency will transmit the original railroad protective liability policy to the Operating Railroad concerned.

The Contractor shall cooperate with and allow the Operating Railroad or its agents free and full access to the project during construction along with all materials and equipment necessary in order that their authorized employees or agents may do any and all railroad work, inspection, flagging, and watching.

The Contractor shall defend, indemnify, and save harmless the Operating Railroad and all of its officers, employees, and agents against any claim or liability arising from or based on any delay to the Contractor as a result of railroad construction or maintenance, whether by the Operating Railroad, its employees, or agents.

(e) General Insurance Conditions. The insurance specified under Subsection 103.04(a), Subsection 103.04(b), and Subsection 103.04(c) shall be maintained in force until acceptance of the project by the Agency.

Under Subsection 103.04(d), the liability protective policy shall remain in force until all work required to be performed on railroad property is completed to the satisfaction of the Operating Railroad and of the authorized representative of the Agency.

The contractual liability insurance requirements detailed in the Contract, including Subsection 107.16, are to indemnify, defend, and hold harmless the municipality(ies), the State, the Agency, and Operating Railroad(s), as applicable, and their officers, agents, representatives, and employees, with respect to any and all claims, causes of actions, losses, expenses, or damages that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on the project.

Each policy, except the workers' compensation policy, shall name the municipality(ies), the State, the Agency, and Operating Railroad(s), as additional insureds for actions, losses, expenses, or damages that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on the project.

Umbrella excess liability policies may be used in conjunction with primary policies to comply with any of the limit requirements specified above.

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"Claims-made" coverage forms are not acceptable without the prior written consent of the Agency.

The Contractor shall investigate and the Contractor and/or insurance company shall either adjust or defend all claims against the insured for damages covered, even if groundless.

Each policy furnished shall contain a rider or non-cancellation clause reading in substance as follows:

> *Anything herein to the contrary notwithstanding, no cancellation, termination, or alteration of this policy by the company or the assured shall become effective unless and until notice of cancellation, termination, or alteration has been given by registered mail to the Chief Engineer of the Vermont Agency of Transportation, 1 National Life Drive, Montpelier, Vermont 05633-5001, at least 30 calendar days before the effective cancellation, termination, or alteration date, unless all work required to be performed under the terms of the Contract is satisfactorily completed as evidenced by the formal, final acceptance of the project by the Agency.*

There shall be no directed compensation allowed the Contractor on account of any premium or other charge necessary to take out and keep in effect such insurance or bond; the cost thereof shall be considered included in the general cost of the work.

(f) Contract Insurance Requirements. In cases that a discrepancy between the stated insurance requirements of *Bulletin 3.5 Attachment C: Standard State Provisions for Contracts and Grants* and this section occurs, the higher limit shall govern.

SECTION 104 – SCOPE OF WORK

104.01 INTENT OF CONTRACT. The intent of the Contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the Contract.

104.02 ALTERATION OF PLANS OR CHARACTER OF WORK. To suit conditions disclosed as the work progresses, the Engineer may, without notice to the sureties on the Contractor's bonds, make alterations in the design, in type of materials, in the quantities or character of the work or materials required, in the cross-sections, in dimensions of structures, in length of project, in locations, and any other ways deemed appropriate. Alterations will not constitute a change in other parts of the Contract or a waiver of any condition of the Contract, and shall not invalidate any of the provisions of the Contract.

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Payment for work occasioned by changes or alterations will be made according to Subsection 109.04 and Subsection 109.05. If the altered or added work is of sufficient magnitude to require additional time in which to complete the project, a time adjustment will be made pursuant to Subsection 108.11.

104.03 EXTRA WORK. The Contractor shall perform extra or unforeseen work for which there is no quantity and price included in the Contract according to the Contract or as directed by the Engineer whenever it is deemed necessary or desirable by the Engineer in order to complete the work as contemplated; payment will be made pursuant to Subsection 109.06.

104.04A MAINTENANCE OF VEHICULAR TRAFFIC.

(a) All Facilities Safe and Passable. All facilities to be used by the traveling public, including temporary highways, bridges, sidewalks, and approaches as necessary to accommodate the vehicular or pedestrian traffic diverted from the facility undergoing improvements, shall be provided and maintained in a safe and passable condition. All traffic control plans and devices shall conform to the latest edition of the *MUTCD*.

(b) Service Shall Be Maintained. During working hours, the Contractor shall maintain, at a minimum, alternating one-way traffic unless otherwise shown on the Plans or directed by the Engineer. Working hours will be limited to the period between sunrise and sunset for daytime operations and the approved scheduled night shift for night work. Wherever one-way traffic is being maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes per operation or not more than 15 minutes cumulatively for the project. However, two-way traffic shall be re-established during all holiday periods, temporary shutdowns, and any other periods designated by the Engineer.

(c) Detours and Temporary Bridges. Detours necessary for public travel which are not contiguous to the work will be designated by the Agency unless otherwise provided. When contiguous to the work, detours shall be constructed and maintained by the Contractor and no compensation will be allowed to the Contractor except as provided in the Contract. If the Contractor elects to construct a temporary bridge on a detour contiguous to the work over which traffic is to be maintained while a culvert or bridge is being constructed, the temporary bridge shall be constructed according to Section 528. The expense of the construction, maintenance, and removal of a temporary bridge and its approaches, and all incidental work pertaining thereto, shall not be paid directly, but shall be incidental to all other Contract items. The Contractor shall be responsible to the public for the structural adequacy and safety of these structures and approaches. The Contractor shall provide, erect, and maintain all necessary barricades, lights, signs, signals, other traffic control devices, and flaggers required in accordance with the applicable subsections.

(d) Winter Maintenance on Active Projects. The highway condition on active projects shall be maintained such that snowplowing, sanding, and salting may occur without unduly burdening the properly designated entity from performing such tasks. If the condition of the highway, temporary highway, sidewalks, detours, or bridges, are such that ordinary winter maintenance activities cannot occur, the Contractor shall assume the responsibility to perform winter maintenance. The costs for snowplowing, sanding, and salting shall be considered incidental to the appropriate traffic control items.

(e) Winter Maintenance on Closed Projects. When a project is closed down for the winter season, the Contractor shall leave the project in a satisfactory condition for the traveling public and in a condition suitable for normal and satisfactory winter maintenance. The full depth of subbase shall be placed over portions of the road under construction and used by the traveling public unless otherwise shown on the Plans or directed by the Engineer. During the period that the project is officially closed down for the winter season, the State, a political subdivision thereof, or other properly designated entity will assume responsibility for snowplowing, salting, and sanding. This shall not relieve the Contractor of any other responsibilities regarding public convenience and safety as specified in this section, from the liabilities as specified in Section 107, or as specified elsewhere in the Contract.

If unsatisfactory travel conditions or ruts develop in the traveled way or other construction defects or conditions dangerous to the traveling public develop, whether arising from the execution or non-execution of the work, the Contractor may be directed to return to the construction work site and carry out necessary measures to satisfactorily remedy the situation. The cost for said work will be included as part of the cost of the items in the Contract, with no additional payment. If the Contractor fails to carry out the measures to satisfactorily remedy the situation immediately, the Engineer may cause the work to be performed and deduct the cost from any monies due or to become due to the Contractor. If the closing of a project is due to the Contractor's inability to complete the Contract before the Contract completion date, the Contractor shall bear all costs associated with making the project acceptable to the Engineer for winter shut down.

(f) Closed Projects; Temporary Traffic Control Measures. When a project is closed down for the winter season or for any other reason, the Contractor shall erect and maintain temporary guardrail, guide posts, barricades, warning signs, and other traffic control devices throughout the length of the project as shown on the traffic control plan or as directed by the Engineer. These temporary installations shall conform to requirements for the permanent items except that approved, used material may be substituted; they shall be removed when the Engineer indicates they are no longer required. The installation, maintenance and removal of temporary guardrail, guide posts, barricades, warning signs, and other traffic control devices will not be paid for directly, but will be incidental to all other items in the Contract.

(g) Closed Projects; Guardrail. When the Contract specifies that the base course or the intermediate course of pavement be placed prior to suspension of work for the winter season, permanent, rather than temporary, guardrail shall be installed in accordance with the Contract. No payments will be made for adjustments to these permanent installations in order to accomplish work when construction resumes in the spring.

(h) Suspension of Work; Contractor Responsibility. If, regardless of the cause, construction is suspended on the project before the completion, acceptance, and termination of the Contractor's responsibility as defined under Subsection 108.15, the Contractor shall take precautions against injury or damage to the work and shall repair and/or replace any damaged work as specified under Subsection 107.18.

(i) Traffic Control Devices. All traffic control devices shall be presented to the Engineer for approval prior to placement on the project. At no time will traffic control devices that do not have the specified reflectivity sheeting or are dirty, damaged, or unacceptable to the Engineer be placed or remain on the project.

All traffic control devices, including but not limited to signs, pavement markings, pavement marking removals, temporary traffic barrier, barricades, reflectorized plastic drums, cones, flashing arrow boards, and detours shall conform to the latest edition of the *MUTCD*, shall be installed to the satisfaction of the Engineer, and shall be functioning prior to the beginning of field work.

(j) Reflectorized Sheeting; Cleaning; Costs. All reflectorized sheeting on the project shall be cleaned on a biweekly basis unless more frequent cleaning is directed by the Engineer. The cost of this work will not be paid for directly, but will be incidental to all other Contract items.

(k) Traffic Control Devices During Construction; Costs. Costs involved in covering, uncovering, and otherwise adjusting the signing and traffic control devices during construction to conform to the changing requirements of traffic flow around and through various operations will not be paid for directly, but will be incidental to all other Contract items.

(l) Suspension of Work; Treatment of Signing; Costs. Costs involved in covering or removing signs at the beginning of a suspension of work, including winter shutdown, and in uncovering or re-installing the signs at the end of a suspension of work will not be paid for directly, but will be incidental to all other Contract items. Such signing adjustments shall be performed as directed by the Engineer.

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104.04B MAINTENANCE AND PROTECTION OF RAIL TRAFFIC AND INFRASTRUCTURE.

(a) General. Operating Railroad traffic shall be maintained at all times with safety and continuity, and the Contractor shall be responsible for conducting all operations on, over, or under the railroad right-of-way fully within the rules, regulations, and requirements of the Agency and the Operating Railroad.

The Contractor shall perform its work in such a manner that the tracks, traffic, and appurtenances of the Operating Railroad shall be safeguarded. The Contractor shall comply with the requirements of the Operating Railroad relative to the Contractor's work on or adjacent to the railroad, and shall make all efforts to prevent fouling of the tracks.

The Contractor must anticipate unscheduled trains.

(b) Railroad Clearances and Fouling. In the construction of any staging, falsework or forms, the Contractor shall not foul the tracks and shall coordinate with the Engineer.

(c) Contractor Equipment and Materials. Equipment of the Contractor to be adjacent to the tracks shall be in first-class condition so as to fully prevent any failure that would cause delay in the operation of trains or damage to railroad facilities. The Contractor shall not place or put into operation equipment adjacent to a track without first obtaining permission of the Operating Railroad.

Materials and equipment belonging to the Contractor shall not be stored adjacent to tracks without first obtaining permission from the Operating Railroad. The Agency and/or Operating Railroad will not be liable for damage to such materials and equipment from any cause. The Contractor shall keep the tracks and the site adjacent to the tracks clear of all refuse and debris and shall leave the property in the condition existing before the start of construction operations.

(d) Railroad Safety Personnel. The Contractor shall consult with the Operating Railroad to determine the type of protection required to ensure the safety and continuity of Operating Railroad traffic incidental to the particular methods of operation and equipment to be used in the work. Any construction inspectors, track foremen or track watchmen, signalmen, or other employees deemed necessary for protective services by the Operating Railroad, or its authorized representative, to ensure the safety of trains contingent upon the Contractor's operations, shall be obtained from the Operating Railroad by the Contractor. The providing of such watchmen and other precautionary measures shall not relieve the Contractor from liability for payment of damages caused by the Contractor's operations. Refer to Subsection 107.09(b) and Section 632 for information on railroad flaggers.

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(e) Damage to Railroad. During the execution of the Contract, if the trains, tracks or other facilities of the Operating Railroad are endangered, the Contractor shall immediately restore safe conditions. If the Contractor fails to make conditions safe, the Agency may take whatever steps necessary to restore safe conditions. All costs of restoring safe conditions or any damage to trains, tracks or other facilities due to the Contractor's operations shall be the sole responsibility of the Contractor.

(f) Fouling of Ballast. In performing construction operations, the Contractor shall prevent the fouling of railroad track ballast with earth, mud, silt, or other foreign matter. To prevent fouling of the ballast, it may be necessary for the Contractor to construct temporary erosion control measures or sheeting or provide other precautionary measures. The Contractor shall take preventive measures to protect the entire ballast section to the satisfaction of the Engineer. The protective measure shall remain in place until there is no further possibility of fouling the ballast and then shall be removed by the Contractor. In the event that the railroad track ballast does become fouled after the protective measures are taken, the Agency shall remove and replace the fouled ballast with clean ballast. All costs of restoring the ballast to the satisfaction of the Engineer shall be the sole responsibility of the Contractor.

(g) Existing Signage. All existing signs, markers, and other informational indicators associated with the Agency or the Operating Railroad that are removed by the Contractor shall be preserved. All signs shall be in place prior to the operation of any trains as directed by the Engineer. All costs associated with installing signs prior to train operations to the satisfaction of the Engineer shall be the sole responsibility of the Contractor.

104.05 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS. The Contractor shall remove any existing structure, parts of structure, or other obstructions which interfere in any way with the new work or which is shown on the Plans to be removed.

Unless otherwise provided, all salvageable material being removed shall become the property of the Contractor and shall be disposed of and/or recycled as authorized by the Engineer. Salvage generated by utility relocation shall remain the property of the applicable utility.

104.06 USE OF MATERIALS FOUND IN THE PROJECT LIMITS; AUTHORIZATION; PAYMENT.

(a) General. With the written approval of the Engineer the Contractor may use stone, gravel, sand, or other materials found in the excavation for other work items for the project provided the materials meet the requirements of the Contract.

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The Contractor will be paid for the removal of such materials used for the project at the proper Contract unit price for items of excavation.

The Contractor shall not excavate or remove any material that is not within the slope and grade lines of an excavation as shown on the Plans without written authorization from the Engineer. If the Engineer allows over-excavation for the use of the Contractor, the State will be compensated for the quantity of material removed, and the replacement of material, if necessary, shall be done at no additional cost to the Agency and shall conform to the requirements of embankment construction as specified in the Contract. The over-excavation, if allowed by the Engineer, shall only occur within the State's right-of-way.

(b) Quantities. Whenever any material, except Granular Borrow, is removed from excavation and used in the construction of other items in the Contract, the total quantity measured for payment of these items shall be multiplied by 1.15, and the resulting quantity deducted from the total quantity of the Contract item Earth Borrow. If the final quantity of Earth Borrow is zero, no deductions will be made for material used for other items.

Whenever material meeting the requirements for Granular Borrow is taken from excavation on the project and used for Contract item Granular Borrow, its removal and use shall be paid for by single payment under the appropriate excavation item in Section 203.

104.07 FINAL CLEANUP FOLLOWING COMPLETION OF PROJECT.

(a) Cleanup of Project. Upon completion of the work, before acceptance, and before final payment will be made, the Contractor shall satisfactorily and completely clean and remove from the right-of-way and grounds occupied by the Contractor in connection with the work all equipment, falsework, surplus and discarded materials, rubbish, temporary structures, buildings, tools, lumber, refuse, and other unsightly material.

(b) Restoration of Property. The Contractor shall restore in an acceptable manner satisfactory to the Engineer all property, both public or private, which has been damaged during the prosecution of the work; replace or renew any fences damaged; leave the waterways unobstructed; and leave the work area in a neat and presentable condition throughout the entire length of the work.

(c) Drainage Structures and Ditches. The removal and disposal of silt, debris, and other material from drainage structures and ditches, deposited during construction under the Contract, shall be accomplished prior to acceptance of the project as ordered by the Engineer.

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(d) Closure of Material Supply and Disposal Areas. Material supply and disposal areas shall be closed in accordance with Subsection 105.28.

(e) Costs. Costs involved with final cleanup following completion of the project will either be paid for under specific pay items or be incidental to all other Contract items.

104.08 DIFFERING SITE CONDITIONS.

(a) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those specified in the Contract or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

(b) Upon written notification, the Engineer will investigate to determine if the conditions materially differ and will cause an increase or decrease in the cost or time required for the performance of any work under the Contract. The Contractor will be notified of the Engineer's determination, whether or not an adjustment of the Contract is warranted. If an adjustment is warranted, the Contract will be modified in writing accordingly. Any adjustment made will exclude loss of anticipated profits.

(c) No Contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

(d) No Contract adjustment will be allowed under this clause for any effects caused on unchanged work.

SECTION 105 – CONTROL OF THE WORK

105.01 AUTHORITY OF THE ENGINEER.

(a) General. The Engineer shall decide all questions which arise concerning the quality and acceptability of materials furnished, the manner of performance of the work, the rate of progress of the work, and compliance with the requirements of the Contract. The Engineer shall decide all questions concerning interpretation of the Contract.

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(b) Quantities; Orders; Disputes; Rejection of Materials, Work; Suspension of Work. The Engineer shall determine the amount and quantity of the work performed and materials furnished that are to be paid for under the Contract. The Engineer shall have authority to enforce and make effective decisions and orders the Contractor fails to carry out promptly. In case of any dispute arising between the Contractor and the Engineer as to materials furnished or the manner of performing the work, the Engineer has the authority to reject the materials and/or to suspend the work until the dispute is decided by the Chief Engineer. The Engineer is not authorized to revoke, alter, enlarge, relax, or release any requirements of the Contract. The Engineer has authority to suspend the work or withhold payment of all estimates due the Contractor when necessary to secure proper compliance with the Contract.

(c) Performance of Work by Engineer; Setoff. If the Contractor fails to perform work ordered by the Engineer, the Engineer may, upon written notice, proceed to perform the work as deemed necessary; the cost of the work will be deducted from any monies due or which may become due the Contractor under the Contract.

(d) Advice by Engineer. Advice given the Contractor by the Engineer shall not be construed as binding the Agency in any way, or releasing the Contractor from any obligations under the Contract.

105.02 CHIEF ENGINEER TO BE REFEREE.

(a) General. The Chief Engineer shall act as referee in all questions of dispute arising under the terms of the Contract. If the Contractor is aggrieved by the decision of the Chief Engineer, the Contractor may appeal the decision in writing to the Transportation Board via the Chief Engineer. Included with the notice of appeal shall be a complete outline of the nature and extent of the question or questions appealed together with any supporting documentation.

(b) Limitation of Time to Appeal. Notwithstanding any other provision of law, case law, regulation, or the Contract, all appeals shall be made within 30 calendar days of the decision to which the Contractor is aggrieved, and not thereafter.

105.03 PLANS AND WORKING DRAWINGS. A complete description of the work requires the Contract, which are furnished to the Contractor by the Agency, and working drawings, which are submitted to the Agency by the Contractor or the Contractor's suppliers. The Contract and working drawings will be provided as follows:

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(a) Contract Documents. The Agency will make available the Contract in electronic format.

The Contractor shall keep the Contract available on the project at all times.

(b) Working Drawings.

(1) General. Certain items and work activities require Plans, drawings, procedures, and other information to document the Contractor's proposed actions to conform with Contract requirements.

Drawings and procedures shall be submitted sufficiently in advance of the anticipated work to allow for review(s), comment(s), correction(s), and if necessary, resubmittal.

In the event that any condition requires a change to the any previously approved or conforming working drawings, the Contractor is required to submit updated drawings prior to performing the work.

When a Contract item requires calculations to be submitted, the calculations shall be included with the submittal of the working drawings. Manufacturer's engineering data for prefabricated materials, including that for falsework and forms, shall be submitted with each set of working drawings.

All submittals shall be transmitted electronically to the Vermont Agency of Transportation unless prior approval has been granted by the Engineer. Submittals shall be "flattened" prior to transmitting so that information added to the submittal, becomes an integral part of the document rather than separate information "on top of" the document. The document shall have a "clean" appearance so that any comments or stamps placed as part of the submission cannot be mistaken as review comments. Resubmittals shall be free from previous review comments and have a clean appearance so that any comments or stamps placed cannot be mistaken as a review comment.

Drawing and detail sheets shall be provided as an ISO standard Portable Document Format (PDF) file. The PDF document properties shall be set up with an appropriate page size and engineering or architectural scale. The page size and scale shall be of sufficient size to permit to-scale plotting of the document(s) on paper for review, use in construction and shall include the following:

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a. Project name and number

b. Route number and location information

c. Prime Contractor's name and address

d. Fabricator or supplier's name and address

e. Sheet title or identification of details shown

f. The name of the detailer and the checker

g. Date and version of the drawings

h. Sheet number _____ of _____

(2) Required Submittals. Working drawings submitted to detail work that has been designed and detailed in the Contract Plans shall be submitted to the Agency for approval. Fabrication drawings are a type of working drawing that are submitted for approval.

Working drawings submitted to detail work that has not been designed in the Contract Plans shall be designed and detailed by a professional engineer and submitted to the Agency to be reviewed for conformance with the Contract. These working drawings shall ensure that the Contractor or Contractor's suppliers have correctly interpreted the intent of the Contract. Construction drawings and design drawings are types of working drawing that are submitted to be reviewed for conformance.

Exceptions to this guidance will be detailed by the specification for the individual pay item.

No work shall begin on any item associated with a working drawing(s) until all of the associated drawing(s) have been approved, approved as noted, marked as conforming, or conforming with comments by the Agency. The Contractor or fabricator shall assume all risk for materials ordered or work performed prior to written notification by the Agency.

a. Submittals for Approval. Approval of drawings and/or procedures does not relieve the Contractor or fabricator of compliance with all specifications and code requirements. The Agency assumes no responsibility for error(s) and/or omission(s) in the drawings and procedures.

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Drawings and procedures identified as being approved as noted indicate that specific clarification or conditional changes have been identified and take precedence over submitted information. Withholding of approval by the reviewer for selected details or procedures shall not constitute a basis for delay of performance of a non-related item of work that has approval to proceed.

After approval of the drawings and/or procedures, no changes shall be made without the written approval of the Agency.

b. Submittals to be Reviewed for Conformance. When the submittal is reviewed for conformance, the Agency will review the submittal for compliance with the requirements of the Contract. The Contractor shall submit the required drawings and/or procedures in advance of the proposed work. The Contractor is entirely responsible for the work associated with these submittals. The Agency will not be responsible for errors in dimensions, incorrect erection procedures, or design requirements.

If the drawings and/or procedures have misinterpreted the Contract Plans or specifications, the submittal will be returned as non-conforming. The submittal shall not be marked as conforming or conforming with comments until all of the required information has been received and reviewed.

After the drawings have been marked conforming or conforming with comments, no changes shall be made without the written approval of the Agency. The Contractor or fabricator shall assume all risk for materials ordered or work performed prior to the changes being marked as conforming by the Agency.

(3) Categories of Working Drawings.

a. Fabrication Drawings.

1. General. Fabrication drawings are required for work performed by or in conjunction with materials furnished by a fabricator or supplier. They shall consist of complete details developed from information in the Contract, and field measurements to define dimensions, sizes, procedures, and materials necessary to complete fabrication and installation or erection of the work specified.

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Once a complete submittal has been received for approval, the reviewer shall be allowed 28 calendar days for the initial review period and a 14 calendar day review period for each subsequent resubmittal unless stated otherwise in the pay item requirements. The Contractor is entirely responsible for the work associated with these submittals. The Agency will not be responsible for errors in dimensions, incorrect erection procedures, design requirements, or successful completion of the work.

2. Ownership; Delivery; Procedures. Fabrication drawings shall be the property of the Agency. Prior to processing the final estimate, the Engineer shall verify that all as-builts have been received by the Agency.

b. Construction Drawings. For an item or element of work that permits the Contractor optional details, procedures, and materials, the Contractor shall prepare and submit to be reviewed for conformance detailed drawings and procedures of how the Contractor proposes to perform and control the work. Construction drawings and procedures shall be stamped and signed by a qualified licensed professional engineer registered in the State of Vermont. The professional engineer is responsible for the design, performance of the designed element, and preparation of the construction drawings and procedures.

Once a complete submittal has been received, the reviewer shall be allowed 21 calendar days for the initial review period and 14 calendar days for review of a submittal returned as non-conforming unless stated otherwise in the pay item requirements. The Contractor is entirely responsible for the work associated with these submittals. The Agency will not be responsible for errors in dimensions, incorrect erection procedures, design requirements, or successful completion of the work.

c. Design Drawings. For an item or element of work to be permanently incorporated in the project which has not been designed and detailed in the Contract Plans, the Contractor shall prepare and submit to be reviewed for conformance detailed designs, procedures, and drawings for the item or element of work. Design drawings and procedures shall be stamped and signed by a licensed professional engineer registered in the State of Vermont.

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105.04 CONFORMITY WITH PLANS AND ALLOWABLE DEVIATIONS.

(a) General. The work shall be performed in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances, shown in the Contract. Any deviation from the Contract required will be determined by the Engineer and authorized in writing.

(b) Acceptance of Non-Conforming Materials/Work; Price Adjustment. If the materials or the finished product in which the materials are used do not conform to the Contract requirements, but reasonably acceptable work has been produced, the Engineer will determine if the work will be accepted and remain in place. If accepted, the Engineer will document the basis of acceptance, which may require a Contract modification and price adjustment.

(c) Rejection of Non-Conforming Materials/Work; Treatment of Rejected Materials/Work. If the materials or the finished product in which the materials are used do not conform to the Contract requirements, and the Engineer determines that the product is unsatisfactory, the Engineer will direct the work or materials be removed, replaced or otherwise corrected by the Contractor at the Contractor's expense.

105.05 COORDINATION OF CONTRACT DOCUMENTS.

(a) General. The project permits, Project Special Provisions, Contract Plans, General Special Provisions, Standard Drawings, Standard Specifications, and all supplemental documents are essential parts of the Contract. A requirement occurring in one is as binding as though occurring in all. The Contract documents are complementary and intended to describe and provide for a complete work. In case of discrepancy, precedence of the Contract documents will be determined in the following order:

(1) Contract Document Precedence.

a. Project Permits. In the event of a conflict between permit requirements, the more protective or stringent shall take precedence as determined by the Engineer.

b. Project Special Provisions.

c. Contract Plans.

1. Calculated dimensions

2. Scaled dimensions

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d. General Special Provisions.

e. Standard Design Detail Sheets.

1. Calculated dimensions

2. Scaled dimensions

f. Standard Drawings.

1. Calculated dimensions

2. Scaled dimensions

This subpart deleted.

g. Standard Specifications for Construction.

h. Other Specifications. Any other specifications adopted by reference.

(b) No Advantage from Errors or Omissions in Contract Documents. Neither the Contractor nor the Agency shall take advantage or be afforded any benefit as the result of apparent errors or omissions in the Contract. If either party discovers errors or omissions, it shall immediately notify the other.

(c) Corrections to Contract Documents. The Engineer will make corrections and interpretations deemed necessary and appropriate to fulfill the intent of the Contract. When there is an apparent absence or mention of a detail or an apparent omission of a detailed description in the Contract, the detail or description shall be interpreted/understood/determined using the best general engineering and construction practice.

(d) Effect of Other Specifications/Standards. Other specifications (e.g. ASTM, NDS, CRSI, ACI) cited by reference shall become effective only if the work or material covered by them is not included in the Contract. Specifications so referenced shall be the latest revision in effect on the date of advertisement for bids. Where any conflict shall arise between VTrans Standard Specifications and Contract requirements, the more stringent specification shall apply as determined by the Engineer.

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105.06 COOPERATION BY CONTRACTOR. The Contractor shall:

(a) Bid Documents. Promptly provide copies of all bid documents upon request by the Engineer, including but not limited to all information used to prepare the bid proposal. Failure to provide such documents may result in the waiver of any right to bring a claim for additional compensation under Subsection 105.20.

(b) Competent Contractor Superintendent. Have on the project at all times a competent and reliable English-speaking superintendent authorized to receive orders and to act for the Contractor. The Contractor shall make every effort to provide continuity in the position of superintendent. However, the Agency reserves the right to refuse or terminate the assignment of any superintendent on the project; this shall not be grounds for a claim under Subsection 105.20.

(c) Competent Safety Officer. Have available on the project at all times during the prosecution of the work a competent and reliable English-speaking employee designated as the safety officer. This person shall be authorized to receive orders and issue binding directions concerning safety to all persons associated with the project who are employed by the Contractor, Subcontractors or material suppliers. This individual shall be well versed in all applicable OSHA regulations, shall be capable of implementing a plan to conform to these regulations, and shall have the authority to stop operations on the project.

The safety officer shall maintain a complete copy of the safety plan(s) for the project, which shall be available at all times during the prosecution of the work for inspection and/or copying by the Engineer.

(d) Emergency Contacts. Furnish to the Engineer a list of addresses and telephone numbers of the Contractor's personnel who can be reached in an emergency. The Contractor shall alert certain personnel to stand by and shall inform the Engineer of all arrangements therefore.

(e) Facilities; Information; Assistance; Samples; Control Points. Provide all reasonable facilities and furnish the information, assistance, and samples required by the Engineer or Inspector to properly inspect and test materials and quality of work; and cooperate in setting and preserving stakes, benchmarks, and other control points used in laying out the work.

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105.07 COOPERATION WITH UTILITIES.

(a) General. The Agency will notify all utility companies, pipeline owners, and other known parties affected and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction made as soon as practical.

(b) Moving Utility Property; Owner's Expense. Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light poles, cableways, signals, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, unless otherwise provided in the Contract.

(c) Utility Interference; No Claim for Delays. The Contractor acknowledges and understands that, at the time of bid submission, it has considered all of the permanent and temporary utility facilities or appurtenances in their present and/or relocated positions as shown on the Plans and evident at the site. Notwithstanding any other provision of law, case law, regulation, or the Contract, no additional compensation will be allowed for any delays, inconvenience or damage sustained by the Contractor due to any interference from utilities, utility companies, utility facilities, appurtenances, or the operation of moving them.

(d) Utility Relocation for Contractor's Convenience. Should the Contractor desire temporary changes of location of any utility facilities or appurtenances for convenience in performing the work, the Contractor shall satisfy the Agency that the proposed relocation does not interfere with its own or other Contractors' operations or the requirements of the work and does not cause an obstruction or a hazard to traffic. The Contractor shall be responsible for requesting such relocation work of a utility and/or other affected parties. Such relocation work shall be made solely at the Contractor's expense.

105.08 COOPERATION BETWEEN CONTRACTORS.

(a) Agency Right to Contract. The Agency reserves the right to Contract for and perform other or additional work on or near the work covered by the Contract at any time.

(b) No Interference with Other Contractors. When separate Contracts are let within the limits of a project, each Contractor shall conduct its own work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as specified or ordered by the Engineer.

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(c) Liability, Indemnification, Defense. Each Contractor involved shall assume all liability, financial or otherwise, in connection with its own Contract and shall defend, indemnify, protect and save harmless the Agency from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by the Contractor because of the presence and operations of other Contractors working within the limits of the same project.

105.09 CONSTRUCTION STAKES.

(a) Initial Layout. Unless other methods of placing stakes are provided in the Contract, the Engineer will be responsible for setting sufficient points to establish the initial alignment and elevation of the proposed work. The Contractor shall check the proposed grades; any mistakes or errors identified shall be brought immediately to the attention of the Engineer, and adjustments will be made by the Engineer.

(b) Permanent Marking Layout. Once the wearing course has been placed, the Engineer will establish the layout for the permanent centerline traffic markings, including passing zones, breaks for town highways and side roads, and any other items required for the centerline markings. The Contractor shall be responsible for the layout of all non-centerline markings.

(c) Responsibility for Layout. The Contractor shall be responsible for the preservation of all stakes and markings, and shall replace any stakes or grades that are destroyed or disturbed. No claim shall be brought and no additional compensation will be paid on account of any alleged inaccuracies in the construction layout, including any additional layout that the Engineer may perform that is not covered in this subsection, unless the Contractor notifies the Engineer of the inaccuracies in writing at least 24 hours prior to commencement of the work.

(d) Qualified Personnel. All other stakes, templates, and other materials, either in addition to or in replacement of the original set, which may be required for the construction operations, shall be furnished, set, and properly referenced by qualified personnel employed by the Contractor.

(e) Contractor Layout. The Contractor shall stake out the work and make known the immediate plan or procedure of the next work contemplated sufficiently in advance of construction to permit the Engineer to take the necessary measurements for the computation of quantities and to check the Contractor's layout. The Contractor shall lay out in a timely manner and maintain a sufficient number of grade stakes so the Engineer can monitor and regulate all portions of the Contract work.

(f) Cost. The cost of this work shall be considered as incidental to the project as a whole, and shall be included in the unit price bid for the Contract items involved.

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105.10 AUTHORITY AND DUTIES OF RESIDENT ENGINEER (ENGINEER). As the direct representative of the Chief Engineer, the Resident Engineer (Engineer) on a project has immediate charge of the engineering details of the project; is responsible for the administration and satisfactory completion of the project(s); has the authority to reject defective material, to suspend any work that is being improperly performed, and to withhold payment until defective work has been corrected. The Engineer also has the authority to suspend work, or specific aspects of the work, if necessary to address a concern for safety of the workers or traveling public, or a serious environmental concern or violation. Notwithstanding any other provision of law, case law, regulation, or the Contract, no additional compensation shall be provided for any work suspensions of this sort.

105.11 AUTHORITY AND DUTIES OF INSPECTORS. Inspectors employed by the Agency are authorized to inspect all work done and materials furnished and to perform other duties as directed by the Engineer. Inspections can extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials used. An Inspector is not authorized to alter or waive the provisions of the Contract, to issue instructions contrary to the Contract, or to act for the Contractor.

105.12 INSPECTION OF WORK.

(a) General; Contractor to Help Engineer. The Engineer or designated representative shall be allowed access to all parts of the work at all times and shall be furnished by the Contractor all information and assistance necessary to make a complete and detailed inspection. The Contractor shall furnish such help as the Engineer desires and/or needs to ascertain whether or not the work is performed in accordance with the requirements and the intent of the Contract.

(b) Examination of Completed Work. If, before the acceptance of the work, the Engineer requests, the Contractor shall remove or uncover portion(s) of the finished work as the Engineer may direct. After the examination, the Contractor shall restore the portion of the work to the standard required by the Contract. If the work thus exposed or examined proves acceptable, the expenses of uncovering or removing and replacing the parts removed shall be paid for as extra work as defined in Subsection 109.06; but if the work exposed or examined is unacceptable, the expenses of uncovering or removing and replacing the parts removed shall be borne by the Contractor.

(c) All Work Requires Supervision or Inspection. The Agency will not be required to pay for any work done or materials used without supervision or inspection by the Engineer or an Inspector. Supervision/inspection includes project, mill, plant, or shop inspection of any work furnished under the Contract.

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(d) Inspection by Others. When any unit of government or of a public or private entity is to pay a portion of the cost of the work covered by the Contract, its respective representative(s) shall have the right to inspect the work. Such inspection shall not make any entity a party to this Contract and shall not interfere with the rights of either party hereunder.

105.13 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK.

(a) General. All work which does not conform to the requirements of the Contract will be considered unacceptable unless otherwise determined to be acceptable under the provisions of Subsection 105.04.

(b) Removal and Replacement of Unacceptable Work. Unacceptable work, whether the result of poor quality of work, use of defective materials, damage through carelessness or any other cause found to exist prior to the acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

(c) All Work Must Be Authorized. Work shall be performed only with lines and grades having been provided by the Engineer. Work performed contrary to the instructions of the Engineer, beyond the lines shown on the Plans, or without authority will be considered unauthorized and no payment therefore will be made. Work so done may be ordered removed or replaced at the Contractor's expense.

(d) Failure to Comply with Order of Engineer. Upon failure by the Contractor to comply forthwith with any order of the Engineer communicated under the provisions of this subsection, the Engineer will have authority to require unacceptable work to be remedied or removed and replaced and to require unauthorized work to be removed. In either case, the Engineer is authorized to deduct the costs from any monies due or to become due the Contractor.

(e) Responsibility for Agency Expense. Any expense incurred by the Agency in making removals, renewals, or repairs which the Contractor has failed or refused to make shall be paid for out of any monies due or which may become due the Contractor or may be charged against one or more Contract bonds.

(f) No Compensation for Additional Time. No additional Contract time shall be warranted for any of the work described in this subsection.

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105.14 SUNDAY, NIGHT, AND HOLIDAY WORK.

(a) Sundays. The Contractor shall not carry on construction operations on Sundays unless allowed by the Contract, or as authorized by the Engineer.

(b) Nights. Night work shall be performed in accordance with *NCHRP Report 476*.

Prior to beginning night work, the Contractor shall design a lighting plan and present it as an addition to the traffic control plan. The Contractor shall not perform any night work or activities within the project limits until the lighting system has been found to be in conformance and is in place on the project.

The designed lighting plan shall be mobile, shall be mounted separately from other construction equipment, shall illuminate the entire work area to daylight intensity with minimal glare, and shall be a surrounding design that minimizes shadows in the work area as much as possible.

All costs associated with the lighting plan will be considered incidental to the appropriate traffic control items.

(c) Holidays. Unless otherwise permitted in writing by the Engineer, the Contractor shall not work during holiday periods.

Designated holiday periods shall begin at 12:00 noon on the day before the weekend or holiday, whichever applies, and shall end at 7:00 a.m. on the day after the holiday or the weekend, as appropriate.

The Engineer may require the Contractor to cease construction operations for the entire day before if a holiday falls on Tuesday, or for the day after if a holiday falls on Thursday.

(d) Application. The limitations in this subsection shall not apply for the purposes of maintenance, emergency repairs, and proper protection of the work, including but not limited to the curing of concrete and the repair and servicing of equipment.

(e) Other Provisions Not Affected. The above limitations shall not relieve the Contractor of any responsibility for the work involved as set forth in Subsection 105.06, Subsection 107.18, or elsewhere in the Contract.

105.15 CONVICT LABOR. No incarcerated convict labor shall be employed on the project.

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105.16 LOAD RESTRICTIONS.

(a) General. All Contractors, Subcontractor, suppliers, or others involved in any project-related activities shall comply with all legal load restrictions specified in *23 V.S.A. § 1392* in the hauling of equipment or material on public roads, including that beyond the limits of the project. The application for and possession of any hauling or related permit will not relieve the Contractor or others involved in any project-related activities of any liability that may arise due to any damage resulting from the use or moving of equipment, vehicles, or any other project-related activity.

(b) Limitations on Use of Equipment and Vehicles. Use of equipment and vehicles is subject to the following:

(1) No vehicle or equipment exceeding the load restrictions cited in *23 V.S.A. § 1392* will be permitted on any structure as defined by the Engineer.

(2) The operation of any equipment or vehicle of such weight or any other project-related equipment loaded so as to cause damage to structures, the roadway, or to any other type of active construction will not be permitted, regardless of the limits set forth in *23 V.S.A.*

(3) Hauling or operation of said vehicles or equipment over any permanent course of any bituminous pavement or any structure during active construction will not be permitted.

(4) Notwithstanding those restrictions above, the Contractor shall be responsible for any and all damages incurred to any public roadway as defined in *23 V.S.A.* due to the use of any equipment or vehicles related to project activities.

(c) Penalty and Reduction for Overweight Operation. Each vehicle entering or leaving the project limits must be within the legal load limit or the load limit imposed by a current overload permit for the roadways and structures. Should any vehicle not meet these requirements, in addition to the appropriate penalty under *23 V.S.A. § 1391a*, the difference in weight between the legal load limit and the gross vehicle weight shall be converted to the appropriate measurement quantity for the item involved and treble this amount shall be deducted from the quantity of the item to be paid the Contractor. The Contractor shall not deduct this amount from the payment to its trucking Subcontractor(s)/supplier(s).

(d) Provision of Overweight Permit Copies. The Contractor shall provide copies of overweight permits to the Engineer prior to the commencement of hauling. Copies of permits provided after hauling has begun will not be considered to be in effect for the project prior to the time that the Engineer receives the copy.

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(e) Provision of Tare Weight. The Contractor shall provide the Engineer with tare weights for all vehicles carrying or delivering materials to be used on a project. A tare weight shall be the weight of the unloaded vehicle with full fuel tank and water tank as applicable.

(f) Application to All Vehicles Used for Project. These requirements, including the overload reduction, shall apply to the Contractor's vehicles as well as all other vehicles used in conjunction with the construction of this project, including the vehicles of Subcontractors and suppliers.

105.17 MAINTENANCE OF PROJECT DURING CONSTRUCTION.

(a) General. The Contractor shall maintain the work during construction and until the work is accepted. This maintenance shall constitute continuous and effective performance of the work day-by-day with adequate equipment and forces so that the project is kept in satisfactory condition at all times.

(b) Costs. All cost of maintenance work during construction and before acceptance of the work shall be included in the Contract unit prices for the various pay items, and the Contractor will not be paid an additional amount for such work.

(c) Maintenance During Shutdown. In the event the work is ordered shut down for failure to comply with the provisions of the Contract or for any other reason, the Contractor shall maintain the project as provided herein and provide such ingress and egress for local residents as necessary during the period of shutdown.

105.18 FAILURE TO MAINTAIN PROJECT; COST. Failure on the part of the Contractor to properly maintain the work will result in the Engineer immediately notifying the Contractor to comply with the required maintenance provisions. If, after receipt of such notice, the Contractor fails to remedy the situation to the Engineer's satisfaction, the Engineer will proceed with adequate forces and equipment to maintain the project; the cost of this maintenance will be deducted from monies due or which may become due the Contractor under the Contract.

105.19 FINAL INSPECTION AND ACCEPTANCE.

(a) General. The Contract shall not be accepted until all of the work required by the Contract has been satisfactorily completed.

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(b) Procedure. Upon notice from the Contractor of their intent to achieve substantial completion , the Engineer will review the work and issue a Written Order if the project has achieved substantial completion. The Written Order will document the date on which the project achieved substantial completion.

The Engineer will arrange a date for a final inspection of the work. As a result of the final inspection a final punch list will be developed and provided to the superintendent.

When the punch list is completed and all work provided for and contemplated by the Contract is found to be completed, the Contractor will be informed in writing that the project is complete and accepted.

105.20 CLAIMS FOR ADJUSTMENT.

(a) Claims Process – In General. Whenever the Contractor learns that a condition and/or issue may result in costs and/or delays that were not anticipated by the Contractor at the time of bid, the Contractor must provide the Engineer with notice of that fact immediately or as soon as reasonably possible. It is critical that VTrans be aware of potential claims at the earliest opportunity so that it can carefully monitor the potential additional costs and potentially assist the Contractor in taking steps to mitigate those additional costs. Thus, the Contractor must promptly file a Notice of Intent to File a Claim. If the Contractor later decides to file a claim for additional compensation under the Contract, that claim must provide certain key pieces of information to the Construction Engineer so that the claim can be evaluated expeditiously. If necessary, the Construction Engineer will contact the Contractor for additional information about the claim, and may request a meeting with the Contractor. The Construction Engineer typically does not invite legal counsel to such meetings unless the Contractor chooses to have its own legal representation at the meeting.

(b) Notice – Procedural Requirements. In order to bring a claim for additional compensation for costs and conditions not clearly covered under the Contract, the Contractor shall provide written notice ("Notice of Intent to File a Claim for Additional Compensation" or the "Notice") to the Engineer before incurring any costs or conducting any work that could in any way be included in any such claim for additional compensation under the Contract (the "Claim"). The Engineer's written acknowledgement of receipt of the Notice and the Contractor's daily reporting under this subsection, shall not be construed as an approval by the Agency of the merits of the Claim.

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(c) Notice – Substantive Requirements. The words "Notice of Intent to File a Claim" must appear in large print at the top of the document. The Notice must specify the basis for the Claim, including the nature of the Claim, the reason why the Contractor believes that the Agency is responsible for payment of the Claim, and a description of the additional compensation, including reference to each activity associated with the work and/or materials, including reference to any impacts to the Contractor's progress schedule, as defined in Subsection 108.03 or CPM schedule as defined in Section 633. If the Contractor fails to provide the Notice as specified herein, the Contractor waives its right to bring the Claim under the Contract and the Agency may deny the Claim on this basis alone.

(d) Notice Documentation Requirements. Upon providing the Notice of Intent to File a Claim, the project superintendent shall commence daily records for all labor hours, equipment hours (idle and operating), and materials involved with the work or materials at issue in the Notice and submit such records to the Engineer on a daily basis. ("Daily Records"). Such records must separate the work and/or materials subject to the Claim from the undisputed work, and include a written analysis of how the work and/or materials at issue in the Notice impact(s) the critical path. If the Contractor fails to provide such records to the Engineer as required herein, the Contractor waives its right to bring the Claim, and the Agency may deny the Claim on this basis alone.

(e) Claim Documentation Requirements. The Contractor shall provide the Construction Engineer with the following documentation in support of the Claim ("Claim Documentation"):

(1) A detailed statement of the Claim, including all necessary dates, location, and work and material items at issue in the Claim, including copies of the Daily Records;

(2) The date on which the Contractor first became aware of the actions or conditions giving rise to the Claim;

(3) A copy of the Notice of Intent to File a Claim;

(4) A list of the names of all Agency employees and agents, including consultants, the Contractor believes have knowledge or information concerning the facts giving rise to the Claim;

(5) A list of the names of all Contractor employees and agents, including Subcontractors, whom the Contractor believes have knowledge or information concerning the facts giving rise to the Claim;

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(6) A list of the specific provisions of the Contract that the Contractor believes support the Claim, and a description of why the Contractor believes those provisions support the Claim;

(7) A list of all documents and all written statements that the Contractor believes support the Claim, and copies of the same;

(8) A statement as to whether additional compensation and/or a time extension are being requested in the Claim;

(9) If a time extension is being requested in the Claim, a statement as to the specific number of days being requested, supported with reference to how the facts underlying the Claim affected the Contractor's performance schedule, including how such facts affected the critical path;

(10) If additional compensation is being requested, an itemized listing of the total amount of any and all costs being sought, in the Claim, listed by category of work, including but not limited to, work items, labor and materials costs, and costs relating to delays associated with performing the work. Such documentation shall include invoices for rented equipment, the *Rental Rate Blue Book* published by EquipmentWatch (the "*Blue Book*") analysis for owned equipment; and Subcontractor agreements.

(11) For every Claim seeking additional compensation in excess of $50,000, the Contractor must provide a separate document certifying that the documentation provided in support of the Claim and that the amount of additional compensation sought in the Claim is accurate and that the Contractor has a good faith basis for believing that the Agency is responsible for payment of the Claim (the "Claims Certification"). The Claims Certification shall be notarized and executed by a senior officer of the Contractor with legal authority to bind the Contractor, or if the Contractor is a sole proprietor, by the proprietor. The Claims Certification may be used in any proceeding under the federal *False Claims Act* (*31 U.S.C. § 3729*) and/or the *Vermont False Claims Act* (*32 V.S.A § 631*).

(f) Procedure for the Initial Adjudication of Claims. The initial determination of the merits of the Claim shall be made by the Construction Engineer.

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(1) Completeness Determination. Within 30 calendar days of receipt of the Claim, the Construction Engineer shall endeavor to determine whether the Claim Documentation provided by the Contractor meets the requirements of Subsection 105.20(e). Where this 30 calendar day period is unfeasible due to the volume and/or the complexity of the Claim, the Construction Engineer shall inform the Contractor what additional documentation is required and endeavor to keep the Contractor updated as to the status of the Completeness Determination, if necessary, on a quarterly basis. The review and analysis of the merits of the Claim may be postponed pending the Completeness Determination. The Construction Engineer will inform the Contractor, in writing, that the Completeness Determination has been issued.

(2) Claims Analysis. Once the Construction Engineer has issued the Completeness Determination, the Construction Engineer will begin a principled, merits-based analysis of the Claim ("Initial Claim Judgment" or "ICJ"). The Construction Engineer may seek additional documentation from the Contractor, including but not limited to a full set of the Contractor's original bid preparation package.

a. The Construction Engineer may interview employees of the Contractor and Subcontractors, and conduct other interviews or seek additional documents from other entities, including the Agency. The Construction Engineer may also hold an informal hearing with the Contractor to ask any follow-up and clarifying questions, and to give the Contractor a full and fair opportunity to present the merits of the Claim. The Construction Engineer will endeavor to keep the Contractor informed as to the status of the Claim, if necessary, on a quarterly basis.

b. The Construction Engineer will make all reasonable efforts to issue, in writing, the Initial Claim Judgment, allowing or denying the Claim, in whole or in part, within 180 calendar days of the Completeness Determination. The ICJ shall include findings of fact and conclusions of law with respect to the specific Contractual provisions governing the Claim.

(g) Appeal to the Chief Engineer. If the Contractor is aggrieved by the ICJ, an appeal may be made to the Chief Engineer.

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(1) Review. The Chief Engineer will review the ICJ and determine whether additional documents or interviews will be necessary to decide the appeal. The Chief Engineer may interview or re-interview employees of the Contractor and Subcontractors, and conduct other interviews or seek additional documents from other entities, including the Agency. The Chief Engineer may also hold an informal hearing with the Contractor to ask any follow-up and clarifying questions, and to give the Contractor a full and fair opportunity to present the merits of the Claim. The Chief Engineer will endeavor to keep the Contractor informed as to the status of the Claim, if necessary, on a quarterly basis.

(2) Decision-Making. The Chief Engineer will make all reasonable efforts to issue, in writing, the Agency's final determination on the merits of the Claim ("Final Claim Judgment" or "FCJ"), as required under paragraph nine of the construction Contract, "Dispute Resolution, Exclusivity of Administrative Remedies," within 180 calendar days of the date of the appeal. The FCJ may affirm the ICJ in whole or in part, or may allow or deny the Claim, in whole or in part, on other grounds. The FCJ shall include findings of fact and conclusions of law with respect to the specific Contractual provisions governing the Claim.

(3) Quasi-Judicial Appeal. If the Contractor is aggrieved by the FCJ, it may seek appellate review of the FCJ before the Transportation Board pursuant to Subsection 105.02. The Transportation Board shall defer to the factual findings of the FCJ and review the legal conclusions of the FCJ de novo.

(h) Time for Claims; Appeals. Notwithstanding any other provision of law, case law, regulation, or the Contract, all Claims by the Contractor shall be submitted in writing within 90 calendar days after the acceptance date of the project or within 90 calendar days of the Notice of Intent to File a Claim, whichever occurs first, and not thereafter (the "Claim Filing Period"). Such Claims must meet the requirements set forth above, including but not limited to complete documentation supporting the Claim. Any additional time granted by the Construction Engineer because the Claim was incomplete or for the time to produce supplemental information shall not be the subject of any demand for interest payments or for attorneys' fees and/or other costs.

If the Contractor fails to file the Claim within the Claim Filing Period, the Contractor waives its right to bring the Claim. If the disputed work continues to be performed beyond the Claim Filing Period, the Contractor must submit a written request to extend the Claim Filing Period prior to the expiration of the Claim Filing Period. The Contractor shall submit such requests for extension of the Claims Filing Period every 90 calendar days until the disputed work is completed. Once the disputed work is complete, the Contractor must submit the complete Claim within the latest approved Claim Filing Period, or 90 calendar days from the date the disputed work was completed, whichever is first, and not thereafter.

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105.21 PAYROLLS.

(a) General. The Contractor shall maintain and make available payroll records as required in the Contract. This requirement shall also apply to the work of any Subcontractor having a Subcontract for any part of the work performed on the job. Any costs associated with this work will not be paid for directly, but will be considered incidental to the Contract pay items.

(b) Examination, Authority. The Contractor hereby authorizes the Engineer or the Engineer's authorized representative to examine the Contractor's orders for construction workers on file with the local employment office of the Vermont Department of Employment and Training.

(c) Additional Contract Requirement. For construction and transportation projects over $250,000.00, a payroll process by which during every pay period the Contractor collects from the Subcontractors or independent Contractors a list of all workers who were on the jobsite during the pay period, the work performed by those workers on the jobsite, and a daily census of the jobsite. This information, including confirmation that Contractors, Subcontractors, and independent Contractors have the appropriate workers' compensation coverage for all workers at the jobsite, and similar information for the Subcontractors regarding their Subcontractors shall also be provided to the Department of Labor and to the Department of Financial Regulation (DFR), upon request, and shall be available to the public.

105.22 ENVIRONMENTAL REGULATION. The Contractor shall perform all project related operations so as to give adequate protection to the natural and cultural resources of the State.

The Contractor shall conduct the work in conformance with all regulations and permit conditions applicable to the project. If the Contractor proposes to perform the work differently than the manner provided in the Contract, the Contractor shall obtain approval from the appropriate regulating entities prior to performing the work. The costs associated with obtaining and complying with permits required to perform the work will not be paid for directly, but will be considered incidental to the Contract pay items.

105.23 EROSION PREVENTION AND SEDIMENT CONTROL.

(a) Submission of Plans. Unless otherwise required by Contract to comply with Subsection 653.03, the Contractor shall submit a plan in writing for the prevention of erosion and control of sedimentation and pollution on the project and on associated access roads, material waste and borrow areas, and staging areas. The plan shall be submitted no later than the preconstruction conference and a Notice to Proceed will not be issued until the plan has been found to be in conformance.

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(b) Erosion Prevention and Sediment Control Measures. Erosion prevention and sediment control measures shall be installed and maintained in conformance with the Contract. Unless otherwise specified in the Contract, this work shall be performed as described in this section and Section 653.

(c) Engineer's Authority; General. The Engineer has authority to limit the surface area of erodible earth material exposed by construction activities and to direct the Contractor to provide immediate permanent or temporary erosion prevention and sediment control measures to minimize adverse effects on resources. This may include restricting the area of clearing and grubbing, excavation, borrow, and embankment operations such that these activities are commensurate with the Contractor's capability to install erosion prevention and sediment control measures in accordance with the Erosion Prevention and Sediment Control Plan.

(d) Temporary and Permanent Erosion Prevention and Sediment Control. The Contractor shall incorporate all temporary and permanent erosion prevention and sediment control measures into the project at the earliest reasonable time. Temporary erosion prevention and sediment control measures shall be used to prevent erosion and to correct conditions that develop during construction prior to installation of permanent measures. As the earthwork proceeds, slopes shall be graded to finish grade whenever practical and all disturbed areas shall be stabilized by seeding and mulching or other acceptable methods within 48 hours of disturbance.

(e) Erosion; Clearing and Grubbing. Clearing and grubbing shall be performed so that the resulting exposed surfaces are stabilized with temporary or permanent measures within 48 hours.

(f) Conflicts. In the event of conflict between the requirements of this subsection and those of federal, state, or local agencies, the more restrictive provision(s) shall apply as determined by the Engineer.

(g) Suspension of Operations. If construction operations are suspended, areas of exposed earth shall be stabilized. If permanent stabilization is not possible, exposed areas shall be shaped and then covered with mulch or matting to intercept and divert runoff to locations where the least amount of erosion will result. During a suspension of construction operations, the Contractor shall act immediately to correct any deficiencies that develop with the erosion prevention and sediment control measures and/or stabilized areas.

(h) Maintenance of Temporary Erosion Prevention and Sediment Control Measures. Temporary erosion prevention and sediment control measures shall be acceptably maintained until both the permanent drainage facilities have been constructed and vegetation has been established throughout the project.

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105.24 POLLUTION CONTROL.

(a) General. The Contractor shall exercise every reasonable precaution to prevent pollution of the air, land and water of the State and shall comply with applicable statutes and regulations relating to the prevention and remediation of pollution.

(b) Bridge Operations. For projects with bridge activities including demolition, painting, cleaning, cutting, welding, or grinding operations, the Contractor shall include a description of any proposed containment measures as part of their Erosion Prevention and Sediment Control Plan, submitted in accordance with Subsection 105.23(a). When the bridge activities listed above are in progress where lead paint is known or suspected, the Contractor shall utilize containment devices to retain all generated materials. The Contractor shall also consult with the Vermont Department of Health Asbestos and Lead Regulatory Program to determine if a lead abatement permit is required. When required, the Contractor shall coordinate with the Agency Hazardous Materials and Waste Coordinator(s) to administer the permit request.

(c) Coated/Treated Materials. The Contractor shall comply with all pollution control, health, and transportation regulations when cleaning, handling, moving, repainting, cutting, welding, sanding, or grinding any coated or treated materials.

(d) Noise and Air Pollution. The Contractor shall employ standard methods to minimize noise and air pollution associated with construction operations. The method(s) employed shall be acceptable to the Engineer and compatible with the location of the work. The burning of tires or other manufactured products is prohibited.

(e) Contaminated Materials and Hazardous Waste. The Contractor shall provide documentation to the Engineer that any generated or found contaminated material or hazardous waste was characterized as necessary and disposed of in conformance with all applicable regulations.

In the absence of the Engineer, the Agency's Construction Safety Technician and the Agency's Hazardous Materials and Waste Coordinators shall each have the authority to suspend work when they determine that a serious safety or environmental violation exists on the job site. The period of time work is suspended due to a serious safety or environmental violation will not be justification for an extension of time.

(f) Limits on Use of Mechanized Equipment. Unless otherwise approved in writing and permitted by the appropriate federal or State regulating authority, mechanized equipment shall not be operated in waters of the State.

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(g) Water Quality. Pollutants, including but not limited to chemicals, paints, fuels, lubricants, bitumens, raw sewage, sediment or other waste, shall not be discharged into or alongside wetlands, waters of the State, or natural or constructed channels leading thereto. Any construction activity in or adjacent to regulated waters shall comply with the *Vermont Water Quality Standards*.

105.25 OFF-SITE ACTIVITY AREAS. Off-site activity (OSA) areas are those areas located outside of the project's defined construction limits that are necessary adjuncts used for supporting the construction activities, including access roads, waste, borrow, and staging areas. Compliance with environmental regulations described in Subsection 105.22 and pollution control described in Subsection 105.24 shall apply to all OSA areas.

105.26 OPENING OFF-SITE ACTIVITY AREAS.

(a) General. The Contractor shall demonstrate that the proposed OSA area is in accordance with all project permits and that the following are met:

(1) The final shape, slope, and contour of the land in and about the area will not be undesirable aesthetically or as it relates to drainage;

(2) Is consistent with any duly adopted development plan, land use plan or land capability plan, whether site specific, local, or regional;

(3) The entrance is at the most desirable angle or perspective from any nearby highways, residences, and other facilities;

(4) The Contractor shall remove, stockpile, and preserve topsoil, sod, and other suitable material from the surface of the area prior to proceeding with other operations, and;

(5) The Contractor has all erosion prevention and sediment control measures, as indicated in the conforming Erosion Prevention and Sediment Control Plan, in place prior to use of the area. At a minimum, *The Low Risk Site Handbook for Erosion Prevention and Sediment Control* published by ANR shall be used as best management practices for OSA areas.

(b) Clearances.

(1) Exempt Sites. Certain types of sites for certain activities are exempt from requiring further review of potential natural and cultural resource impacts. A list of these exemptions is part of the *Off-Site Activity Exemption Record* form that is available on the Vermont Agency of Transportation website. To use an exempt OSA area, the Contractor shall complete this form and then submit to the Engineer.

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(2) Non-exempt Sites. For non-exempt OSA areas, the Contractor shall complete an OSA submittal form that is available on the Vermont Agency of Transportation website. The completed form shall be submitted to the VTrans Environmental Section to review potential natural and cultural resource impacts. A copy of this form shall also be submitted to the Engineer. Within 21 calendar days, the Environmental Section will provide an OSA review form indicating conformance or non-conformance of the site, along with any specific conditions.

(c) Permits. The Contractor and/or the property owner shall be required to obtain or amend all necessary State, federal, and local permits and clearances, prior to using an area for an Agency project. Any fees related to applications for such permits shall be the responsibility of the Contractor.

105.27 MAINTAINING OFF-SITE ACTIVITY AREAS.

(a) General. The Contractor shall conduct operations at OSA areas so as to minimize air pollution. The Contractor shall keep in a condition acceptable to the Engineer the portions of an area where a pit or pits have been opened and shall maintain all access roads with sufficient dust control and proper drainage to prevent damage to adjacent properties. Area operations shall be restricted to normal working hours except with the express written approval of the Engineer and shall be in accordance with all permit conditions.

(b) Area Erosion Prevention and Sediment Control Measures. Installation and maintenance of erosion prevention and sediment control measures at OSA areas shall be consistent with the conforming Erosion Prevention and Sediment Control Plan for the specific area. The on-site plan coordinator (OSPC) shall review these areas as required in the Contract.

(c) Seasonal Shutdown. For areas that will be utilized for more than one construction season, the Contractor shall grade to no more than 1:3 (V:H), seed and mulch disturbed fill areas prior to shutting down for the season.

105.28 CLOSING OFF-SITE ACTIVITY AREAS. With the exception of those areas which will remain open for commercial use, the Contractor shall complete the following prior to the completion and acceptance of the project:

(a) Shape the entire area to leave banks in a neat and presentable condition, properly and thoroughly graded and drained.

(b) Establish vegetation on all disturbed areas.

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(c) All stones, boulders, stumps, and debris shall be removed or satisfactorily disposed of.

(d) Slopes shall not be left steeper than 1:3 (V:H) for earthen fills. Slopes shall not be left steeper than 1:2 (V:H) for fill made up of stone or concrete. The tops of slopes and toes of slopes shall be neatly rounded.

Stockpiled sod, topsoil, and other stripped material shall be evenly spread over the surface of the area. The complete area shall be seeded and mulched in accordance with Section 653.

105.29 PAYMENT FOR EROSION PREVENTION AND SEDIMENT CONTROL.

(a) General. Unless otherwise indicated in the Contract, all materials, installation, monitoring, maintenance and, where necessary, removal for those erosion prevention and sediment control measures required by the Plans and/or the Engineer that are not items in the Contract will not be paid for directly, but will be considered incidental to all other Contract items.

Environmental protection work in connection with erosion prevention and sediment control for the opening, maintaining, and closing of OSA areas and pollution control measures will not be paid for directly, but will be considered incidental to all other Contract items.

Costs for damages to OSA areas, to the owners thereof, or to adjacent property owners shall be the responsibility of the Contractor.

(b) Temporary Erosion Prevention and Sediment Control Measures. Required temporary erosion prevention and sediment control work not attributable to the Contractor's negligence, carelessness, or failure to install permanent controls will be performed and paid for as specified in Subsection 105.29(a), or as ordered by the Engineer.

Temporary erosion prevention and sediment control measures required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the scheduled work or as ordered by the Engineer shall be performed by the Contractor at the Contractor's expense.

(c) Failure to Control Erosion, Pollution, or Siltation. In case of repeated failures by the Contractor to control erosion, pollution, or siltation, the Engineer may employ outside assistance or use State forces to provide the necessary corrective measures. Such incurred direct costs, plus project engineering costs, will be charged to the Contract and appropriate deductions made from any money or monies due or to become due the Contractor.

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105.30 VALUE ENGINEERING.

(a) General. The intent of value engineering (VE) is to provide an incentive to the Contractor to initiate, develop, and present to the Engineer for consideration cost reduction proposals involving changes in the drawings, designs, specifications, or other requirements of the Contract. These provisions do not apply unless the proposal submitted is specifically identified by the Contractor as being presented for consideration as a VE proposal.

The change in cost proposals contemplated are those that would require a Change Order modifying the Contract and would produce an overall savings to the public by providing items or methods other than those specified in the Contract and/or reduce future maintenance costs without impairing or compromising essential functions and characteristics such as service life, safety, durability, reliability, economy of operation, ease of maintenance, and necessary standardized features. A VE proposal shall contain proven features that have been used under similar conditions, and is presented as such, and does not contain equivalent options already provided in the Contract.

The Agency will not be responsible for schedule delays that occur as a result of the Contractor's desire to pursue a VE proposal.

(b) Procedure.

(1) General. Unless mutually agreed otherwise, the VE proposal approval process will occur in three steps:

a. A conceptual VE proposal submission and review;

b. A detailed VE proposal submission and evaluation, and, if approved;

c. A Change Order modifying the Contract, including the amount of payment due to the Contractor and credit due to the Agency.

(2) Conceptual Value Engineering Proposal. To begin the VE proposal approval process, the Contractor shall submit a written Conceptual Value Engineering Proposal (CVEP) to the Engineer for consideration. The CVEP is not a formal and complete submittal based upon detailed technical analysis, but instead relays a conceptual idea based upon the Contractor's knowledge and expertise. The CVEP should include the following information based upon the Contractor's best knowledge and understanding:

a. General Description. A narrative that describes the proposed change in concept and includes the basic differences between the existing Contract and the proposed change.

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b. Advantages and Disadvantages. A listing and brief description of the comparative advantages and disadvantages of the CVEP including effects on the service life, safety, durability, reliability, economy of operation, ease of maintenance, and any other factors significantly altered by the CVEP.

c. Impacts to Permits and/or Third-Party Agreements. A description of steps necessary to address existing permits, new permits, or third-party agreements that may be impacted or required in order to initiate the proposed change(s). In addition, the Contractor shall describe its expectation of securing or modifying these documents, who is responsible for securing them, and required timeframe(s).

d. Identification of Prior Similar CVEPs. If the CVEP was submitted previously on another Agency project, the date, the project name and number, and the action taken by the Agency shall be indicated.

e. Known Use or Testing. A description of any previous use or testing of the concept(s) included in the CVEP that is known to the Contractor, including the tester, the conditions, and the results.

f. Estimate of Net Savings. An estimate of the Net Savings as defined in Subsection 105.30(c). This amount shall not include the cost to prepare and submit the CVEP.

g. Estimate of Development Costs. A scope of work and related cost estimate to develop and submit a Detailed Value Engineering Proposal (DVEP). This estimate should include a detailed estimate of both the engineering costs the Contractor will incur in preparing the DVEP (the "Internal DVEP Costs") and the cost the Contractor will incur to obtain specialty engineering services that the Contractor cannot perform and which are necessary to prepare the DVEP (the "External DVEP Costs") (collectively, the "DVEP Costs"). If the Contractor establishes, to the satisfaction of the Construction Engineer, that it does not have the financial resources to incur the DVEP Costs, the Agency may, in its sole discretion, decide to advance the Contactor up to 50% of the DVEP Costs. In no event will the Agency pay more than 50% of the DVEP Costs, nor will the DVEP Costs exceed 50% of the Net Savings amount, as defined in Subsection 105.30(c)(3).

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h. Savings and Schedule Impacts. An estimate of the time necessary for the Contractor to submit a DVEP and the time-sensitivity of the savings identified. Such estimate shall specify the date by which the Agency must approve the DVEP to obtain the maximum cost reduction, and the latest date by which the Agency must approve the DVEP for the Contractor to avoid significant impacts on the estimated Net Savings or the Contractor's schedule of work. If the Agency determines that the time for response is insufficient for review, the Contractor will be promptly notified. The Contractor shall identify the date by which if the DVEP is not approved the VE will be withdrawn and the original work can commence without delay to the project.

i. Plans and Specifications. A set of preliminary plans and specifications, prepared as construction drawings in accordance with Subsection 105.03, showing the proposed revisions relative to the original Contract features and requirements. VE proposals that require engineering design, computations, or analysis shall be prepared under the responsible charge of, and sealed and signed by, a professional engineer licensed in the State of Vermont. The plan, specification, and engineering changes should be progressed far enough along to clearly show the design intent and be able to provide a quality cost estimate.

j. CVEP Presentation. Within 7 calendar days of submitting a CVEP, the Contractor shall be available to attend a meeting scheduled by the Agency for the purpose of presenting and answering questions regarding the CVEP. The purpose of the meeting is to discuss possible risks, design implications, and schedule impacts associated with the VE proposal. If applicable, the Contractor shall be accompanied by their engineer responsible for the plan and specification revisions associated with the VE proposal.

k. Agency Review. The Engineer will use best efforts to review a conforming CVEP and respond to the Contractor within 14 calendar days of receipt. The Agency may, at its sole discretion:

1. Invite the Contractor to submit a DVEP;

2. Reject the CVEP for reasons that will be described briefly, or;

3. Request additional information.

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(3) DVEP. If invited by the Agency as provided in Subsection 105.30(b)(2)k.1., the Contractor may submit a DVEP. DVEPs will be processed in the same manner as prescribed for any other alterations of the Contract that require a Change Order and shall contain, as a minimum, the following information:

a. Description. A description of what is being changed, altered, or deleted, and why, and what is being proposed to improve upon the originally designed feature.

b. Itemization. An itemization of the requirements of the Contract (Plans, specifications, pay items, and unit prices) that must be changed and a recommendation of how to make each change, including a description of the advantages and disadvantages and where these items have been successfully used on other projects before or tested elsewhere.

c. Computation of Net Savings. A detailed computation of the estimated net savings to be generated as defined in Subsection 105.30(c)(3), actual DVEP development costs, and estimated savings and schedule impacts, including approval date(s) required. If the Agency determines that the time for response is insufficient for review, the Contractor will be promptly notified.

d. Prediction of Other Costs. A prediction of any effects the proposed changes would have on other costs to the Agency, including environmental effects, traffic impacts, and preventive action or treatment costs.

e. Plans and Specifications. A complete set of plans and specifications, prepared as construction drawings in accordance with Subsection 105.03, showing the proposed revisions relative to the original Contract features and requirements. All DVEPs that require engineering design, computations, or analysis shall be prepared under the responsible charge of and signed and sealed by a professional engineer licensed in the State of Vermont.

f. Contract Completion. A statement as to the effect the proposal would have on the time for the completion of the Contract. Extension to the original Contract completion date will generally not be approved.

(4) Evaluation of DVEP. The Agency will evaluate the DVEP and consider the following:

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a. The Agency may request any additional information that it determines is necessary to properly evaluate the DVEP. Where design changes are proposed, such additional information may include results of field investigations and surveys, design computations, specifications, and any field changes already incorporated into the project. The Contractor shall promptly provide any such requested information.

b. The Agency may require the Contractor to provide additional information to verify the Contractor's cost analysis.

c. When the Agency is acting as the contracting authority for a locally owned facility, the local governing body must also provide approval. The Contractor shall present their proposal to the local governing body and allow sufficient time to present the proposal and receive comments.

(5) Evaluation Response. The Agency will use its best effort to evaluate a conforming DVEP and provide the Contractor with a written response within 30 calendar days of receipt of all of the information it has determined was necessary to properly evaluate the DVEP. Such response will include a brief description of the Agency's reason(s) for its decision. The Agency, at its sole discretion, will either accept the DVEP, accept it with contingencies, or reject it.

(6) No Liability for Delay. The Agency shall not be liable for any delay in acting upon any VE proposal submitted. The Contractor may withdraw in whole or in part any VE proposal not accepted within the period specified in the proposal. The decision of the Engineer as to the acceptance or rejection of VE proposals will be final and will not be subject to the provisions of Subsection 105.02 or Subsection 105.20.

(7) Contingencies. The Agency may accept a DVEP with contingencies, which if not met by the Contractor, will prompt the Agency to reject the DVEP before the execution of a Change Order. Contingencies may include but not be limited to the necessary approvals of permits, amendments, execution or amendments to third-party agreements, specific deadlines for completion of submittals, or execution of permits, agreements, and/or amendments thereof.

(8) Rejection/Termination. If the Agency rejects the DVEP, the DVEP process will terminate. The Agency, in its sole discretion, will determine whether to reimburse the Contractor for DVEP Costs, and if so, what percentage of those costs. In no event will the Agency pay more than 50% of the DVEP Costs. These costs will not include the cost to prepare the CVEP.

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(c) Accepted Proposals; Change Order. If a DVEP is accepted, or if it is accepted with conditions and the Contractor wants to proceed, the necessary Contract modifications will be effected by execution of a Change Order which will provide for equitable price adjustments giving the Contractor and the Agency equal shares in the net savings. Unless and until a proposal is effected by such Contract modification, the Contractor shall remain obligated to perform in accordance with the terms of the existing Contract. In addition to the requirements of Subsection 109.04 and Subsection 109.05, the DVEP will set forth the credit due the Agency calculated as the difference between the cost of performing the work, as originally specified, and the amount payable to the Contractor for the revised work. The payment for this Contract modification will only include the following amounts:

(1) The cost of performing the work as revised by the DVEP at agreed upon unit or lump sum prices;

(2) The DVEP development costs that the Agency agreed to reimburse the Contractor as provided in Subsection 105.30(b)(2)g., if any, and;

(3) Fifty percent (50%) of the Net Savings (NS) generated by the DVEP as determined by the Agency, calculated as follows:

$$NS = EGS + CSP - CUDC - AVEC$$

where:

NS = Net Savings generated by the DVEP.

EGS = Estimated Gross Savings is an agreed upon difference between the cost of performing the work as originally specified in the Contract and the cost of performing the work as revised by the DVEP.

CSP = Cost Savings to the Public are those funds not expended by the public, including but not limited to reduced maintenance costs and reduced road user costs. CSP shall not include any cost savings attributable to a time period exceeding 10 years from the Contract completion date.

CUDC = Contractor's Unreimbursed Development Costs related to the preparation of the DVEP, including costs of the Contractor's design subconsultants and Subcontractors, but excluding all such costs already paid by the Agency under Subsection 105.30(b)(2)g.

AVEC = Agency's VE Costs related to review, approval, and implementation of the DVEP including design costs, field inspection, and the value of any Agency-provided property.

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The Change Order effecting the necessary Contract modifications shall establish the net savings agreed upon and shall provide for such adjustment in the Contract price as will divide the net savings equally between the Contractor and the Agency. All reasonably incurred costs of developing the cost reduction proposal and implementing the changes, including any increased costs to the Agency resulting from its application, will be deducted from the total estimated decrease in the Contractor's costs of performance to arrive at the net savings.

(d) Subsequent Payment Adjustments. Upon completion of the portion of the work revised by the DVEP, the Agency, on its own initiative or upon request by the Contractor, may review the actual net savings realized by the DVEP. The Contractor will be afforded an opportunity to review and comment on such a review. If the actual net savings were greater than set forth in the Change Order, the increased savings will be shared equally between the Agency and the Contractor. If the net savings were less than set forth in the Change Order, the reduction in savings will be borne equally by the Agency and the Contractor by a reduction of amounts otherwise due the Contractor.

(e) General Conditions.

(1) DVEPs will remain the property of the Contractor, provided that the Agency will have the unrestricted right to use any approved DVEP, or any DVEP in which the Agency has reimbursed the Contractor for any portion of the development costs, on other Agency projects without notice, cost, or liability to the Contractor.

(2) Only the Contractor may submit DVEPs. The Contractor shall review, be responsible for, and submit all proposals initiated by the Contractor's Subcontractors.

(3) The Contractor shall not anticipate Agency approval of a VE proposal when bidding or otherwise before approval of a DVEP. The Contractor is responsible for all delays caused by the VE proposal that were not negotiated in the Change Order.

(4) If a VE proposal is rejected by the Agency, the Contractor shall perform the work in accordance with the Contract.

(5) Except as otherwise provided in this subsection, the Contractor shall have no Claim against the Agency for additional compensation or time resulting from the delayed review or rejection of a DVEP, including but not limited to development costs, loss of anticipated profits, and increased material or labor costs.

(6) Cost sharing applies only to the Contract for which the DVEP was submitted.

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(7) Upon acceptance of a cost reduction proposal, any restrictions imposed by the Contractor on its use or on disclosure of the information submitted shall be void, and the Agency shall thereafter have the right to use, duplicate, and disclose in whole or in part any data necessary to the utilization of the proposal on this project or other projects.

(8) Any time savings realized by implementation of VE proposals may result in a corresponding adjustment in the Contract completion time. No incentive pay will be provided for early completion days resulting from time savings of any approved VE proposals.

(9) Because the Agency has no obligation to change the terms of the original Contract, all VE proposal decisions by the Agency are final and are not subject to the dispute resolution provisions provided in this Contract or otherwise available in law.

(10) The Contractor may withdraw any DVEP prior to the time the Contractor signs the Change Order. If the Contractor elects to withdraw the DVEP in accordance with this provision, the Contractor waives its right under Subsection 105.30(b)(2)g. for reimbursement of DVEP costs, including any costs advanced to the Contractor. If such costs have been advanced, the Contractor shall reimburse the Agency for those costs within 30 calendar days of withdrawing its DVEP.

(11) Acceptance of a DVEP by the Agency does not indicate any assumption of liability by the Agency for any design errors and/or omissions associated with the DVEP implementation.

SECTION 106 – CONTROL OF MATERIAL

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS. The material used in the work shall meet the requirements of the Agency's Quality Assurance Program (QAP). The QAP, including the *Materials Sampling Manual* (*MSM*), has been developed to clearly articulate the processes for acceptance of materials in construction and maintenance. In order to expedite the inspection and testing of materials, the Contractor shall notify the Engineer of the proposed approved sources of materials at least 96 hours prior to delivery. Sources not previously approved by the Agency will require a minimum of four weeks advanced notification to complete the necessary inspection and testing of materials.

At the option of the Engineer, materials may be approved at the source of supply before delivery is started. If it is found during acceptance that supplied materials from previously approved sources do not meet specifications, the Contractor shall take action to supply materials that meet specifications.

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106.02 LOCAL MATERIAL SOURCES. The Contractor shall determine potential sources of material and the amount of equipment and work required to produce material meeting the specifications. The Agency's Geologist maintains a list of material sources that have previously produced materials meeting specifications. The ability to purchase from the owner(s) of the source(s) and the quality of the material are not guaranteed by the Agency. The Contractor acknowledges that it is not possible to ascertain from samples the limits of a deposit and that variations in quality in a material source are normal and to be expected. Exploration for new material sources will be the responsibility of the Contractor. The Engineer may order procurement of material from any portion of a material source and may reject portions of the material sources as unacceptable.

It shall be the responsibility of the Contractor to acquire the right to take materials from any source together with the right to use such property as required for whatever purpose, including plant sites, stockpiles, and hauling roads. The Contractor shall pay all costs related thereto together with any costs resulting from exploring and developing these sources.

106.03 SAMPLES AND TESTS. All materials will be inspected, sampled, tested or accepted by the Engineer as incorporated into the work. Under any applicable Quality Acceptance (QA) specifications, the Contractor shall perform all process quality control testing with the Engineer performing all quality acceptance testing. Any work in which untested and/or unaccepted materials are used without the approval or written permission of the Engineer shall be performed at the Contractor's risk. Any work determined to be unacceptable and unauthorized will not be paid for. All testing will conform to the most recent cited standard methods of AASHTO or ASTM, including AASHTO Provisional Standards or the ASTM Tentative Specifications that are current on the date of the advertisement for bids, unless otherwise specified. In the case of conflict between the ASTM and the AASHTO methods of sampling and testing, the AASHTO method shall govern. When modified AASHTO or ASTM test methods or Vermont Agency of Transportation test methods are designated, the test method will be available at the office of the Agency's Materials Testing and Certification Section. Tests for compliance with specification requirements will be made by and at the expense of the Agency.

Samples will be taken by authorized representatives of the Agency in accordance with the requirements of the latest edition of the Agency's *Materials Sampling Manual*. The Contractor shall provide such facilities, as specified in these specifications, or as the Engineer may require, for collecting and/or forwarding samples. In all cases, the Contractor shall furnish the required samples without charge.

All materials used are subject to inspection, testing, and acceptance/rejection at any time during the Contract period. Materials contaminated by the Contractor's operations shall be removed. No work or materials shall be deemed approved until accepted by the Engineer. Copies of all test results will be furnished to the Contractor's representative upon request.

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106.04 PLANT INSPECTION. The Engineer may undertake the inspection of materials at the source.

In the event plant inspection is undertaken the following conditions shall be met:

(a) The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.

(b) The Engineer shall have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.

(c) When required by the Contract, the Contractor shall arrange for an approved building or trailer with the necessary equipment for testing for the use of the Inspector; such building or trailer shall be located conveniently near the plant.

(d) Adequate safety measures shall be provided and maintained.

The Agency reserves the right to retest all materials that have been tested and accepted at the source of supply prior to incorporation into the work after delivery and to reject all materials that do not meet the requirements of the Contract when retested.

106.05 STORAGE OF MATERIALS. Materials shall be stored so as to ensure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may be inspected prior to their use in the work; they shall meet the requirements of the Contract at the time of use. Stored materials shall be located so as to facilitate inspection. Upon approval, portions of the right-of-way not required for public travel may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required shall be at the Contractor's expense. The Contractor may not store materials under any bridge without written approval from the Engineer. Private property shall not be used for storage purposes without written permission of the owner and/or lessee. All storage sites shall be restored to their original condition at the Contractor's expense; this shall not apply to the stripping and storing of topsoil, or to other materials salvaged from the work or specifically prescribed in the Contract.

106.06 HANDLING MATERIALS. All materials shall be handled so as to preserve their quality and fitness for the work.

106.07 UNACCEPTABLE MATERIALS. At the discretion of the Engineer, all materials not in conformance with the requirements of the Contract shall be considered unacceptable and all such materials, whether in place or not, shall be rejected and removed immediately from the site of the work unless otherwise instructed by the Engineer. Rejected materials that have been subsequently corrected shall not be used unless and until approval has been given.

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106.08 EXPLOSIVE AND FLAMMABLE MATERIALS. The Contractor's attention is directed to the provisions of the Vermont Statutes Annotated, as amended, which (1) authorize the State Fire Marshal to make, publish, enforce, and from time to time to alter, amend, or repeal rules and regulations pertaining to fire prevention and public safety concerning the safekeeping, storage, use, manufacture, sale, handling, transportation, or other disposition of blank cartridges, gun powder, dynamite, nitroglycerine, crude petroleum or any of its products including liquefied petroleum gas, explosives, flammable gases and flammable fluids, compounds or tablets, any other explosive, or any substance that may spontaneously or acting under the influence of any contiguous chemical or physical agent ignite, inflame, or generate inflammable or explosive vapors or gases to a dangerous extent, and (2) may prescribe the location, materials, and construction of buildings and other facilities to be used for storage of such products. Attention is further directed to the regulations applying to explosives while being transported by carriers in motor vehicles, railroad cars, or vessels in conformity with the regulations adopted by the U.S. Department of Transportation, the U.S. Coast Guard, or the Vermont Secretary of Transportation under the provisions of *5 V.S.A. § 2001* and Subsection 107.11.

106.09 STOCKPILING OF MATERIALS.

(a) Ordering Materials; Stockpiling Authority. The Contractor is urged to place orders for materials with producers and suppliers as early as practicable.

The Contractor may submit a written request to the Agency to pay for stockpiled material.

The Engineer may authorize payment for the Contractor's cost of materials, including freight.

The Agency may deny any and all requests to stockpile materials and to make stockpile payments.

(b) Request and Procedure; Criteria. To request stockpiling, the Contractor shall submit the following for consideration by the Agency:

(1) Listing of material(s) by specific Contract pay item and quantity to be stockpiled;

(2) Invoice for all materials, or a receipt for delivery;

(3) Drafts of documents that show that ownership of the material(s), without encumbrances, will be in the name of the Contractor and will be for the benefit of the Agency;

(4) Appropriate certifications and/or passing samples as required for the specific material(s);

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(5) Statement that the material shall be clearly marked so as to easily identify the project in which the material will be incorporated and shall be available for inspection by the Agency, and;

(6) The location where and condition(s) under which the material will be stockpiled.

The storage location and security of the stockpiled material(s) shall be the responsibility of the Contractor.

(c) Raw Materials. In addition to the criteria set out above for other materials, raw material stockpiles shall be approved by the Construction Engineer and meet the following additional criteria:

(1) The various components of the finished product shall include all of the appropriate certifications, passing samples, passing tests, and any other documentation that may be required to certify that the materials are acceptable.

(2) For stockpiles of structural steel, invoices or quotes from the fabricator shall include supporting documentation such as mill invoices or quotes that show actual dimensions, quantities, and costs to the fabricator for the raw materials. The intent of this raw material payment is to reimburse the actual amount it cost the fabricator to purchase the raw materials for the specific Contract item. There will be no allowance for mark up of any type by the Contractor or fabricator. Stockpile payments will be limited to one payment per 6 months, per Contract item. There will be no raw material stockpile payment allowed for materials that do not meet the dimensions provided on the mill invoices.

(3) Any other criteria the Engineer deems necessary to allow for payment.

(d) Cap; Payment to Supplier; Charge Back; Minimum to Stockpile. Payment will be made for the invoiced amount, not to exceed 75% of the total Contract bid amount for each specific item for which stockpiling is allowed; the quantity of stockpiled material shall not exceed the Contract quantity for the specific item. The Contractor shall furnish the paid invoice within 28 calendar days after the cutoff date for the estimate in which the stockpile amount is paid. If the Contractor fails to furnish the paid invoice within this time limit, the amount of the stockpile payment will be deducted from one or more subsequent payments. Under no circumstances shall stockpiling be allowed for an item with a Contract bid amount totaling less than $25,000.

The stockpile credit amount shall be reduced once installation of the item begins, and the reduction shall correspond with the installation and payment of the specific stockpiled item.

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The Contractor may request an exception to the 75% cap; any such request shall be included in the original request for stockpile and shall include all information to support the request.

(e) Finished Product. Payment for stockpiled materials shall not relieve the Contractor from providing an acceptable finished product or from its responsibility for the condition of the materials as specified elsewhere in the Contract. Any defects, flaws, or poor craftsmanship shall be the responsibility of the Contractor and shall be corrected to the Agency's satisfaction at the Contractor's expense.

SECTION 107 – LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED.

(a) General; Defense and Indemnification. The Contractor shall observe and comply with all federal and state laws and local bylaws, ordinances, and regulations in any manner affecting the conduct of the work and the action or operation of those engaged in the work, including all orders or decrees as exist at present and those which may be enacted later by bodies or tribunals having jurisdiction or authority over the work, and the Contractor shall defend, indemnify, and save harmless the State and all its officers, agents, and employees against any Claim or liability arising from or based on the violation of any such law, bylaws, ordinances, regulations, order, or decree, whether by the Contractor in person, by the employees of the Contractor, or by a Subcontractor or supplier.

(b) Contract Contrary to the Law. If the Contractor discovers any provisions in the Contract that are contrary to or inconsistent with any law, ordinance, regulation, order, or decree, the Contractor shall immediately report it to the Engineer in writing.

(c) U.S., VOSHA, and Environmental Protection Regulations. The Contractor's attention is directed to the various regulations promulgated and enforced by the United States and VOSHA and the environmental protection agencies.

(d) Fair Employee Practices Act. The Contractor shall comply with all of the requirements of *21 V.S.A. Chapter 5, Subchapter 6*, relating to fair employment practices to the extent applicable. A similar provision shall be included in any and all Subcontracts.

(e) Hazardous Wastes. The Contractor's attention is directed to regulations regarding the management of hazardous wastes such as waste crankcase and hydraulic oils, and waste paint generated by construction operations (ref: Agency of Natural Resources' Department of Environmental Conservation and *10 V.S.A. Chapter 159*).

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(f) Americans with Disabilities Act. The Contractor shall comply with the *Americans with Disabilities Act of 1990* and shall ensure that individuals with disabilities have equal access to the services, programs and employment activities/opportunities offered by the Contractor under the Contract.

(g) Prompt Payment Act. The Contractor shall fully comply with the provisions of *9 V.S.A. § 4002*, also referred to as *Act No. 74 of 1991* or the *Prompt Payment Act*, as amended.

(h) Subcontractor Payments; Reporting; Violations; Inclusion in Subcontracts. On all federal-aid and State funded Contracts, the Contractor, during the life of the Contract and on a monthly basis, shall submit electronically, a listing of payments to Subcontractors on the form specified by the State and made available on the Agency Office of Civil Rights and Labor Compliance website. Electronic reports shall be filed with the Agency Office of Civil Rights and Labor Compliance by an authorized representative and received in the Agency Office of Civil Rights and Labor Compliance on or before the tenth working day after month end. Contractors without access to the Prompt Pay reporting site shall submit manual reports to the Office of Civil Rights and Labor Compliance using the *Prompt Pay Manual Reporting Form*. The form can be found on the Agency Office of Civil Rights and Labor Compliance website. Manual reports shall be signed by an authorized representative, sent to the Agency Office of Civil Rights, and postmarked on or before the tenth working day after month end. There shall be no direct compensation allowed the Contractor for this work, but the cost thereof shall be included in the general cost of the work.

In accordance with *9 V.S.A. § 4003*, notwithstanding any contrary agreement, payments made to Subcontractors after 7 calendar days from receipt of a corresponding progress payment by the State to the Contractor, or 7 calendar days after receipt of a Subcontractor's invoice, whichever is later, violate this agreement.

Violations shall be reported to the Agency Office of Civil Rights and Labor Compliance for review. Failure to resolve disputes in a timely manner may result in a complaint made to the Agency Prequalification Committee. In this Committee's judgment, appropriate penalties may be involved for failure to comply with this specification. Penalties may include suspension, reduction or revocation of the Contractor's prequalification rating.

This clause shall be included in the prime Contractor's Contract made with all of its Subcontractors.

(i) Cargo Preference Requirement. All Contractors and Subcontractors are required to follow the requirements of *46 C.F.R. 381.7(a)-(b)*. Guidance on the requirements of *Part 381 – Cargo Preference – U.S. Flag Vessels* can be found on the FHWA website.

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107.02 PERMITS, LICENSES, AND TAXES. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES. If any design, device, material, or process covered by letters of patent or copyright is used by the Contractor, whether required or not, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner; a copy of this agreement shall be filed with the Agency. The Contractor and the Contractor's surety shall defend, indemnify, and save harmless the State, any affected third party, or political subdivision from any and all Claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages including reasonable attorney's fees which it may be obliged to pay by reason of any infringement at any time during the prosecution or after the completion of the work.

107.04 FEDERAL-AID PROVISIONS. The Contractor acknowledges that pursuant to the provisions of *23 U.S.C.*, and acts amendatory thereto, as well as any and all other federal legislation appropriating funds to the State, the federal government may pay a portion of the cost of this project. The above act of Congress provides that the construction work and labor on any federal-aid project in Vermont shall be done in accordance with its laws and under the direct supervision of the State of Vermont, Agency of Transportation, subject to the inspection and acceptance of the U.S. Department of Transportation or appropriate federal agency and in accordance with the rules and regulations made pursuant thereto. Therefore, the construction work will be subject to such inspection by the U.S. Department of Transportation or appropriate federal agency or its agent as deemed necessary to meet the above requirements. Such inspection will in no sense make the federal government a party to this Contract and will in no way interfere with the rights of either party hereunder.

107.05 SANITARY PROVISIONS. The Contractor shall provide and maintain, in a neat and sanitary condition, such accommodations for the use of its employees as necessary to comply with the requirements and regulations of the State or local Boards of Health at no expense to the Agency.

107.06 PLANT PEST CONTROL REQUIREMENTS. Soil and soil moving equipment are subject to plant quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from a project. Complete information may be secured from the Agency of Agriculture, Food, and Markets and the United States Department of Agriculture plant and pest control inspectors.

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107.07 PUBLIC CONVENIENCE AND SAFETY.

(a) General. The Contractor shall conduct all work so as to ensure the least possible obstruction to all types of traffic. The safety and convenience of the general public and the residents within the construction area and the protection of persons and property shall be provided for by the Contractor as specified in Subsection 104.04A and Subsection 104.04B.

(b) Dust Control. The Contractor shall use all necessary dust control on haul road(s) and maintenance yard(s) in the same manner as required for material sources and disposal areas in Subsection 105.27 and shall be performed in accordance with Section 609 or as directed by the Engineer. Unless otherwise provided, dust control will not be paid for directly, but will be considered incidental to all other Contract items.

The Engineer will direct the use of all necessary dust control within the limits of the work performed under the Contract. Under those Contracts which contain pay items for dust control, the dust control within the construction area shall be performed in accordance with the requirements of Section 609 and will be paid for under the appropriate Contract item(s). Under those Contracts which do not contain pay items for dust control, the necessary dust control shall be performed in accordance with the requirements of Section 609 and the cost will not be paid for directly but will be considered incidental to all other Contract items.

(c) Stored Materials. Materials stored within the construction area shall be placed so as to cause a minimum obstruction to the traveling public and snow removal operations.

(d) Fire Hydrants. Fire hydrants located within the construction area shall be kept accessible to fire apparatuses at all times and no material or obstruction shall be placed within 15 feet of any such hydrants.

(e) Adjoining Ways. Sidewalks, gutters, drainage inlets, and portions of highways adjoining the roadway under construction shall be obstructed only when necessary. If a sidewalk is obstructed, temporary pedestrian access meeting the requirements of the *ADA* and the *MUTCD* shall be provided around the obstructed area.

(f) Lane Restrictions. When the total useable width of a traveled way will be decreased to 14 feet or less for a period longer than one working day, the Contractor shall notify the Engineer of the date of the first day and the anticipated period of time such a lane restriction will be in effect. This notification shall be provided at least 14 calendar days prior to the beginning of the lane restriction so that the Engineer may provide proper notification to the Oversized/Overweight Section of the Commercial Vehicle Enforcement Unit of the Department of Motor Vehicles and the Agency's Public Outreach Section. When the date of the removal of the restriction becomes known, the Contractor shall notify the Engineer so that notification can be provided to these entities.

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(g) Parking Restrictions. Only such trucks and equipment as are necessary for the construction of this project will be permitted to stop or park on the travel lane or shoulders of the highway or intersecting highways. All trucks or equipment so stopped or parked shall be at least 4 feet from the edge of the through traffic lanes. Parking or stopping on the traveled portion of the roadway will not be permitted unless authorized by the Engineer to meet field conditions.

Private automobiles of workers will not be permitted to stop or park on the travel lane or shoulders of the highway or intersecting highways.

Each of the Contractor's trucks or equipment used for the construction of this project and permitted to park or stop as provided above shall be equipped with flashing light signals on the front and rear and the signals shall be operating at all times when parked or stopped on the highway unless otherwise authorized by the Engineer. equipment, materials, or vehicles must be parked or placed a minimum of 30 feet from the edge of pavement in all directions or a minimum of 10 feet behind guardrail when not being utilized.

The flashing light signals shall be visibly distinct from and physically separate from the hazard warning system required by federal and State motor vehicle laws and regulations. At least one of these flashing light signals shall be visible to traffic approaching from any angle at all times.

The procedure shown on the traffic control plan shall be strictly adhered to whenever the Contractor's vehicles or equipment (including that belonging to the individual workers) enter or leave the traffic flow. All movement, in or out of the traffic flow, shall be with the flow of traffic.

107.08 TRAFFIC CONTROL DEVICES.

(a) General. All approach signs shown on the Plans shall be installed prior to beginning other work. Additional traffic control devices necessary for work on any portion of the project shall also be installed prior to beginning work on that portion. All traffic control devices shall conform to the latest version of the *MUTCD*. The Contractor shall have available on the project the current editions of both the *MUTCD* and the *Standard Highway Signs and Markings* (*SHSM*) book.

The Contractor shall furnish, erect, and maintain all signs, barricades, lights, signals, and other traffic control devices necessary for the protection of the work and safety of the traveling public.

(b) Existing Pavement Markings. Whenever existing pavement markings conflict with desired traffic patterns within a construction or detour area or otherwise create a potentially misleading, confusing, or hazardous condition for the traveling public, the markings will be completely removed or obliterated by the Contractor to the satisfaction of the Engineer. Painting over the existing lines is not acceptable. Unless otherwise specified in the Contract, no direct payment will be made for this work, which will be considered incidental to all other Contract items.

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(c) Warning Signs. The Contractor shall erect warning signs in advance of any location on the project where operations interfere with the use of the road by traffic and all locations where the new work crosses or coincides with an existing road.

(d) Detour Signs. The Contractor shall provide and maintain throughout the project acceptable warning, direction, and detour signs at all closures and intersections; along the construction and detour routes, the Contractor shall provide and maintain acceptable warning, direction, and detour signs directing traffic around the closed portion or portions of the highway so that the temporary detour routes shall be indicated clearly throughout their entire length.

(e) Closed Highways or Sidewalks. Highways closed to traffic shall be protected by barricades and/or other approved barriers, which shall be reflectorized or illuminated.

When a section of an existing sidewalk is closed to pedestrians, suitable barricades and warning signs conforming to the *ADA* and the *MUTCD* shall be installed. If channelizing devices are used to establish a temporary pedestrian route, those devices shall conform to the *MUTCD*.

(f) Delineation. Delineation will be required through the construction area as shown on the Plans or as directed by the Engineer.

(g) Warning Lights. Warning lights may be required by the Engineer for use on signs and barricades to call attention to special or hazardous conditions. If warning lights are used those devices shall conform to the *MUTCD*.

(h) Costs Incidental. The cost of furnishing, fabricating, installing, maintaining, and removing traffic control devices shall be considered incidental to all other items in the Contract unless otherwise specified.

(i) Failure to Install, Maintain, Remove. If the Contractor fails to satisfactorily install, maintain or remove traffic control devices, the Engineer may have such installations made, maintained, or removed, and the cost thereof shall be deducted from the monies due the Contractor.

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107.09 RESPONSIBILITY FOR USE OF FLAGGERS.

(a) Highway Flaggers. As conditions warrant, the Contractor shall employ one or more highway flaggers at any location on the project where equipment or construction operations will interfere with the movement or safety of the traveling public. This includes operations where equipment enters, leaves or crosses normal traffic lanes being used or set aside for the traveling public and locations where heavy equipment is operating adjacent to areas where traffic is moving. Highway flaggers may not be required at locations manned by uniformed traffic officers assigned for the protection of the traveling public as a pay item of the Contract. Attention is directed to the provisions of Section 108 as they may apply to the use of highway flaggers. Where needed to assure safe ingress and egress for activities associated with the construction of the project, the Engineer may require the use of highway flaggers at locations off the project site.

The dress, equipment, and procedures of all highway flaggers shall conform to the requirements in the *MUTCD* and Section 630.

(b) Railroad Flaggers. The Contractor shall request flagging protection from the Operating Railroad where equipment or construction operations will interfere with the movement or safety of the trains in advance of entry into the Operating Railroad right-of-way. This includes any operation where equipment enters, leaves or crosses the Operating Railroad right-of-way. Attention is directed to the provisions of Section 108 and Section 632 as they may apply to the use of railroad flaggers. Where needed to assure safe ingress and egress for activities associated with the construction of the project, the Engineer or the Operating Railroad may require the use of railroad flaggers at locations outside of the project site.

107.10 THIS SUBSECTION RESERVED.

107.11 USE OF EXPLOSIVES.

(a) General. The Contractor shall use the utmost care to protect life and property and, whenever directed by the Engineer, shall reduce the number and size of explosive charges. Blasting mats shall be used when required by regulation or deemed necessary. The Contractor shall notify each person, company, corporation, or public utility that owns, leases, or occupies property or structures near the site of the work, of plans to use explosives; notice shall be given sufficiently in advance to enable people to take such steps to protect their property or structure from injury as they may deem necessary. Provision of notice shall not relieve the Contractor of responsibility for any damage resulting from the Contractor's blasting operations. All persons within the danger zone of blasting operations shall be warned, a warning whistle shall be sounded, and the zone cleared just prior to blasting. A sufficient number of flaggers shall be stationed outside the danger zone to stop all approaching traffic during blasting operations.

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Explosives shall be used only during daylight hours and shall be handled only by competent, trained workers; particular care shall be taken to ensure that no unexploded charges remain in the work area unattended and when constructions operations cease for the day. All explosives shall be stored securely, all storage locations shall be clearly marked "DANGER – EXPLOSIVES," and all storage locations shall be supervised and controlled by a competent, trained person at all times. All explosives and highly flammable materials shall be stored and used in strict conformity with all federal, state, and local laws, rules, and regulations. Attention is directed to the VOSHA *Safety and Health Regulations for Construction, Subpart U, Blasting and the Use of Explosives*.

(b) Liability. Each of the insurance policies required for a project shall include coverage for injury to persons and injury or destruction of any property arising out of the storage and use of explosives.

(c) Insurance. The Contractor acknowledges full responsibility and assumes full liability for any and all damage or injury to persons or property caused either directly or indirectly by the Contractor's or a Subcontractor's use of explosives. The liability of the Contractor shall apply equally to damages or injury to persons or property whether said injury or damage occurs within or outside of the right-of-way. The cost of all precautionary measures shall not be paid for directly, but all costs therefore shall be included in the bid prices for the pay items under the Contract.

(d) Blasting Cap Danger. The Contractor and/or the Contractor's agents shall take all precautions necessary to prevent premature explosions of electric blasting caps either individually or when they are connected into a circuit. If blasting is within 200 feet of a railroad, a notification shall be provided to the Agency.

The Contractor and/or the Contractor's agents acknowledge and are hereby advised of the potential hazard of a premature explosion of electric blasting caps due to propagation of radiofrequency energy by transmitters of radio and the related radio services such as television and radar. Mobile and fixed radio, cellular telephone, radar, television, and related transmitters are in general use in the State of Vermont, including police departments, fire departments, political subdivisions, utility companies, commercial carriers, private and public enterprises, and individuals.

(e) Warning Signs; Costs Incidental. Prior to blasting operations, the Contractor shall install warning signs in conformance with the *MUTCD*. Warning signs shall be located in prominent positions at least 1,200 feet from the point of blasting and visible to any person approaching the blasting point. Payment for furnishing, erecting and maintaining warning signs shall be considered incidental to all other items in the Contract.

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(f) Documentation of Structure Condition. It shall be the responsibility of the Contractor to document the existing condition of all structures that have potential for damage. This documentation shall be in the form of a video or pictures, with sufficient description, and shall be supplied to the Engineer prior to any blasting on the project. The costs of preparing this documentation will not be paid for directly, but shall be considered incidental to all Contract items.

(g) Blast Surveys. The Contractor shall monitor all blasts and provide a report to the Engineer that shall indicate the Peak Particle Velocity (PPV) of the blast. The PPV sensitivity as reported shall range from less than 0.02 in/s to more than 5.0 in/s. The Engineer reserves the right to request more than one instrument to monitor the blasting if there is a need for monitoring in more than one direction from the blasting area. The costs of the monitoring and preparing the reports will not be paid for directly, but shall be considered incidental to all Contract items.

107.12 PROTECTION AND RESTORATION OF PROPERTY.

(a) General. The Contractor shall:

(1) Not enter upon private property for any purpose without obtaining written permission;

(2) Be responsible for the preservation of all public and private property along and adjacent to the work;

(3) Use every precaution necessary to prevent damage or injury to public and private property;

(4) Protect from disturbance or damage all land monuments and property markers until an authorized agent has witnessed or otherwise referenced their locations, monuments, and property markers;

(5) Not move any land monuments and property markers until directed by the Engineer, and;

(6) Protect all trees, shrubs, and other plants not marked by the Engineer for removal from damage by construction operations.

(b) Protection of Existing Infrastructure. The Contractor shall make sure that any portions of the existing roadway and existing structures which are to be retained for public travel are left in as good condition as when the Contractor commenced work. The Contractor shall not move or use equipment on any pavement or structure in a manner that may or does cause damage.

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(c) Contractor's Responsibility. The Contractor shall be responsible for all Claims involving damage or injury to, or destruction of, property of any type resulting from any act, omission, neglect, or misconduct of the Contractor's manner or method of executing the work, due to the Contractor's non-execution of said work, or due to defective work or materials. The Contractor's responsibility shall not be released until the work has been completed and accepted and the applicable statute of limitations has expired.

(d) Restoration of Damaged Property. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the non-execution thereof on the part of the Contractor, such property shall be restored at the Contractor's expense to a condition similar or equal to that existing before such damage or injury was done or the Contractor shall make good such damage or injury in an acceptable manner.

(e) Cleaning Traffic Signals and Street Lighting. When the Contractor's operations compromise the functionality of existing traffic signals and/or street lighting equipment, the Engineer may require the Contractor to clean said equipment prior to project completion. Cleaning of traffic signals shall include all vehicle and pedestrian signal face lenses (inside and outside). Further, the inside of the controller cabinet shall be vacuumed and any vent filter shall be replaced; cleaning of streetlights shall include both the lens (inside and outside) and the reflector. The cleaning of electrical equipment shall be done by a traffic signal/electrical Contractor. Any equipment that is damaged in the cleaning process shall be repaired or replaced at the Contractor's expense. The costs for cleaning will not be paid for directly, but will be considered incidental to all other items in the Contract.

(f) Ground Vibration Limits. The maximum Peak Particle Velocity (PPV) of ground vibration in any of the three mutually perpendicular components of particle velocity for the following structure types shall be limited as shown in Table 107.12A.

TABLE 107.12A – MAXIMUM PEAK PARTICLE VELOCITY

Type of Structure	Frequencies < 40 Hertz	Frequencies ≥ 40 Hertz
Modern homes (drywall interior, maximum PPV limit in inches/sec.)	19	50
Older homes (plaster on wood or lath, maximum PPV limit in inches/sec.)	13	50

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The Agency reserves the right to lower the PPV limit in areas where there may be structures or elements with a higher sensitivity to ground vibration. Adherence to this specification does not waive the Contractor's responsibility for damage as specified in this subsection and in Subsection 107.16.

107.13 PROTECTION AND RESTORATION OF UTILITIES AND SERVICES.

(a) General. The Contractor shall take proper precaution during construction to avoid damage to public and private services. These services include, but are not limited to, gas, water, sewer and drainage pipes, springs, wells, septic tanks, cesspools, telephone, telegraph, television, and other communication and electrical services. Services may be located on or adjacent to the project, above, on, or under the ground, and may not be shown on the Plans.

(b) Dig Safe. The Contractor shall comply with the requirements of Dig Safe, per *30 V.S.A. § 7001 - § 7008*.

(c) Notice of Work. At commencement or resumption of construction, the Contractor shall notify the owners, operators, occupants, or lessees of all the public or private services of any work to be done on, over, under, adjacent to, or in proximity to said utilities during the construction of the project. Further, the Contractor shall again notify the aforesaid parties 7 to 14 calendar days in advance of starting such work to enable them to take steps as they may deem necessary to protect their property or structures from damage. Provision of notice shall not relieve the Contractor of its responsibility for any damages resulting from the Contractor's work.

(d) Owner Access. Owners, employees, or agents of public or private services located within the project limits shall be allowed free and full access with the tools, materials, and equipment necessary to install, operate, maintain, place, replace, relocate, and remove service facilities. No compensation will be paid to the Contractor for any inconvenience caused by working with these parties or around or with their services.

(e) Service Relocation. The exact location of any service facility relocated within the project limits shall be as shown in the Contract or directed by the Engineer.

(f) Cooperation. The Contractor shall cooperate with the owners of any of the aforementioned services in order that the service removal and/or relocation operation will progress in a reasonable manner, that duplication or temporary relocation work may be reduced to a minimum, and that services rendered by the concerned parties will not be unnecessarily interrupted.

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(g) Service Interruption. If in connection with the work interruption in service occurs, the Contractor shall promptly notify the owner or the owner's authorized representative and cooperate with the owner to promptly restore service. In no case shall interruption to water or sewer service be allowed to exist without the substitution of acceptable alternate service.

(h) Fire Hydrants. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

(i) Responsibility for Damage. The Contractor shall be responsible for all damages done to services from the beginning of construction to the satisfactory completion of the project, including all damages to water supplies and sewage systems, including but not limited to damage to springs and wells, septic tanks, cesspools, and underground pipes, whether located within or outside the project right-of-way or whether or not shown on the Plans, except as otherwise provided in the Contract.

(j) Restoration of Service by Agency. If the Contractor fails to restore a service or to make good on a damage or injury to service(s), the Engineer may proceed to repair, rebuild, or otherwise restore the service as deemed necessary and the cost thereof will be deducted from any monies due, or which may become due, the Contractor under the Contract.

107.14 PROTECTION OF HISTORICAL AND ARCHAEOLOGICAL SITES. When the Contractor's excavation operations encounter sites or artifacts of historical or archaeological significance, the operations shall be immediately discontinued. The Engineer will contact the VTrans Archaeology Officer for instructions.

107.15 FOREST PROTECTION. When working within or adjacent to forests or other plant growth, the Contractor shall satisfactorily chip or otherwise dispose of all valueless trees and logs, stumps, roots, brush, weeds, grass, and other objectionable material. Disposal of such material shall be in conformance with the laws, rules, and regulations of the State of Vermont pertaining thereto and other authority having jurisdiction governing the protection of forests and in carrying out work within forests.

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107.16 RESPONSIBILITY FOR DAMAGE CLAIMS.

(a) General. The Contractor shall defend, indemnify and save harmless the municipality(ies), the State, the Agency, and Operating Railroad(s) and all of their officers, agents, and employees from all suits, actions, or Claims of any character, name, and description brought for or on account of any injuries or damages received or sustained by any person, persons, or property that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on the project; or by or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or by or on account of any act of omission, neglect, or misconduct of the Contractor; or by or on account of any claims or amounts recovered for any infringement of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the *Workers' Compensation Act*, or any other law, bylaw, ordinance, order, or decree. The State shall notify the Contractor in the event of any such claim or suit, and the Contractor shall immediately retain counsel and otherwise provide a complete defense against the entire claim or suit.

After a final judgment or settlement, the Contractor may request recoupment of specific defense costs and may file suit in Washington County Superior Court requesting recoupment. The Contractor shall be entitled to recoup costs only upon a showing that such costs were entirely unrelated to the defense of any claim arising from an act or omission of the Contractor.

The Contractor shall indemnify the State and its officers and employees in the event that the State, its officers or employees become legally obligated to pay any damages or losses arising from any act or omission of the Contractor.

(b) Right to Retention of Funds. Money due the Contractor under and by virtue of the Contract as shall be considered necessary by the Agency for such purpose may be retained for the use of the State. If no money is due, the Contractor's surety shall be held until such suit or suits, action or actions, or claim or claims for injuries or damages shall have been resolved and suitable evidence to that effect furnished by the Agency.

(c) Submission of Damage Claims. With regard to each and every damage claim, the Contractor shall:

(1) Provide the claimant with a damage claim form for the submission of damage claims to the Contractor;

(2) Submit the claim to the insurance carrier;

(3) Pay, settle, or otherwise resolve the claim;

(4) Treat all claimants with respect;

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(5) Maintain a record of all claims submitted against the Contract. This record shall be available to the Agency and provided immediately upon request. The record shall contain at least the following information: name of the claimant, description of the claim, claim date, amount claimed, date that the claim was sent to the insurance company (if applicable), date resolved, amount paid, indication of how the claimant was notified of the resolution and notation of how the resolution was determined.

107.17 OPENING SECTIONS OF PROJECT TO TRAFFIC.

(a) General. Opening of a section of a project to traffic prior to substantial completion of the entire Contract may be desirable in some instances. Discussions concerning such an opening shall involve, but are not limited to, the Regional Construction Engineer, Project Manager, District Transportation Administrator, and, when appropriate, local municipal officials. Such an opening shall be made when directed by the Engineer and documented in a Written Order. Such an opening shall not constitute acceptance of the work or a part thereof or a waiver of any provisions of the Contract.

(b) Maintenance; Expense. On any section opened by direction of the Engineer prior to substantial completion of the Contract, the Contractor shall not be required to assume any expense entailed in maintaining the road for traffic beyond that required of a Contractor when opening a section of roadway to traffic. When extraordinary work is required to open a section of work prior to substantial completion of the Contract, the Engineer in his/her sole discretion may determine that compensation for any additional expense incurred by the Contractor to maintain traffic and allowance of additional time needed to complete the work will be made to the Contractor.

(c) Delayed Completion of Project. If the Contractor delays completion of shoulders, drainage structures, or other features of the work, the Engineer will notify the Contractor in writing and establish a reasonable period of time in which the work shall be completed. If the Contractor fails to complete the work by the time specified, the Engineer may order all or a portion of the project opened to traffic at no additional cost to the Agency. On sections that are ordered to be opened, the Contractor shall conduct the remainder of construction operations so as to cause the least obstruction and disruption to the traveling public, including vehicular and pedestrian traffic, adjacent landowners, and commercial businesses. The Contractor shall not receive any additional compensation due to the added cost caused by opening such section(s) to traffic.

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(d) Opening Project to Traffic for Winter Season. As specified in Subsection 104.04A, the Contractor shall open the roadway for the winter shutdown period from December 2nd to April 14th inclusive. However, when work is being done because the Contractor did not complete the work before the Contract completion date, any work that is not covered by a pay item in the Contract shall be considered incidental to the original Contract items and shall be performed at no additional cost to the Agency. This shall include any work required by the Agency's District Transportation Administrator(s) and/or municipal highway or public works officials to aid in the performance of winter maintenance activities. None of the time associated with the performance of this work shall be considered for an extension of time under Subsection 108.11. Furthermore, the Contractor shall not be entitled to any additional compensation for the completion of remaining work that has to be performed under the influence of pedestrian and/or vehicular traffic.

(e) Compensation for Work on Opened Sections. Except as provided for in this subsection, notwithstanding any other provision of the Contract, the Contractor shall receive no additional compensation for work on a section of the project that has been opened to traffic as described herein.

107.18 CONTRACTOR'S RESPONSIBILITY FOR WORK.

(a) General. Until acceptance of the project by the Engineer, the Contractor shall be responsible therefore and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work before acceptance and shall bear the expense thereof, except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God, of a public enemy, or governmental authorities. For purposes of this paragraph the term "work" shall exclude Contractor owned, rented, or leased materials, equipment, and incidentals.

(b) Suspension of Work. When work is suspended for any reason, the Contractor shall be responsible for the project and shall take precautions to prevent damage to the project, provide for normal drainage, and erect any necessary temporary structures, signs, or other facilities solely at the Contractor's expense. During a period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under the Contract and take adequate precautions to protect new tree growth and other important vegetative growth against injury.

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(c) Winter Maintenance. The performance by the State, a subdivision thereof, or other authorized agent of any snowplowing, salting, and/or sanding shall not relieve the Contractor of its responsibility as outlined herein or elsewhere in the Contract.

107.19 NO PERSONAL LIABILITY OF PUBLIC OFFICIALS. It being understood that in all such matters relative to the Contract that they act solely as agents and representatives of the State, neither the Vermont Secretary of Transportation, Deputy Secretary, the Chief Engineer, Engineer, or their authorized representatives shall be liable, either personally or as officials of the State, for their actions pursuant to authority granted to them by the Contract.

107.20 NO WAIVER OF LEGAL RIGHTS.

(a) General. Upon completion of the work, the Agency will expeditiously make final inspection and notify the Contractor of acceptance. Acceptance of the project, however, will not preclude or prevent the Agency from correcting any measurement, estimate, or certificate made before or after completion of the work; and the Agency will not be precluded or prevented from recovering from the Contractor, the Contractor's surety, or both any overpayment it may have made by failure on the part of the Contractor to fulfill the Contractor's obligations under the Contract. A waiver on the part of the Agency of any breach of any part of the Contract shall not be held to be a waiver of any other or subsequent breach.

(b) Latent Defects, Fraud, and Gross Mistakes. Without prejudice to the terms of the Contract, the Contractor shall be liable to the Agency for latent defects, fraud, and such gross errors, omissions, or mistakes as may amount to fraud, and as regards the Agency's rights under any warranty or guaranty.

107.21 FURNISHING RIGHT-OF-WAY. It will be the responsibility of the Agency or appropriate political subdivision to secure all of the permanent rights-of-way which may be necessary for a construction Contract and to make said rights-of-way completely and physically available to the Contractor. Any additional rights-of-way and/or additional rights to use land outside of the right-of-way as shown on the Plans which the Contractor desires for its own convenience shall be obtained and paid for by the Contractor.

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107.22 BUY AMERICA PROVISIONS.

(a) General. All steel or iron products permanently incorporated into federal-aid projects shall be products that have been entirely manufactured within the United States as per *23 U.S.C. 313* and *23 C.F.R. 635.410*. All manufacturing processes of the steel or iron material in a product (i.e., smelting and any subsequent process which alters the steel material's physical form or shape or changes its chemical composition) must occur within the United States to be considered of domestic origin. This includes processes such as rolling, extending, machining, bending, grinding, and drilling. If an item is utilized and in the opinion of the Contractor it is impossible, impractical, or undesirable to remove the item, then Buy America provisions apply.

(b) Use of Foreign Materials. This requirement does not prevent a minimal use of foreign materials, provided the cost of foreign materials used does not exceed 0.1% of the total Contract price or $2,500, whichever is greater. The cost of foreign steel or iron is defined as its value delivered to the project. The Contractor shall notify the Engineer if it intends to use any foreign materials on the project.

(c) Coatings on Steel/Iron. In accordance with *23 C.F.R. 635.410*, iron has been added to the materials now subject to the Buy America requirements, and the action of applying a coating to a covered material (i.e., steel and iron) is now deemed a manufacturing process subject to Buy America. Coating includes epoxy coating, galvanizing, painting, and any other coating that protects or enhances the value of a material subject to requirements of Buy America.

(d) Temporary Items. Temporary items are not subject to Buy America provisions where the Contract specifications provide that the steel or iron products used on the project are to be removed at the end of the project or may be removed at the Contractor's convenience. Where the State can document that steel or iron products will be removed in subsequent near-term stages as part of phased construction, such products are considered temporary and not subject to Buy America. Where steel or iron products will remain in place at the end of the Contract and where phased construction is not imminent, such products are considered permanent and Buy America shall apply.

107.23 DEFENSE OF LAWSUITS – CHALLENGE TO JURISDICTION AND WAIVER OF IMMUNITY. When defending any claim that may arise under the Contract, the Contractor shall not raise or impose any defense involving the jurisdiction of the tribunal before which said claim is pending, the immunity of the State of Vermont, governmental nature of the State, or the provision of any statutes respecting suits against the said State of Vermont without obtaining the express advance permission of the Vermont Attorney General's Office.

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107.24 INTEREST. Notwithstanding any statutory or other provisions to the contrary, interest on monies owed pursuant to the Contract shall be paid as follows:

(a) Claims for Adjustment or Dispute – Pre-Decision or Judgment. Interest shall be allowed the Contractor on a decision or judgment for money in a claim for adjustment or dispute. Pre-decision or judgment interest shall be calculated for 21 calendar days after the date of the claim, but for the failure of the Agency to make the payment to the date of decision or judgment, at a simple rate equal to the weekly average 1-year constant maturity Treasury yield, as published by the Board of Governors of the Federal Reserve System, for the calendar week preceding the date of the decision or judgment.

(b) Claims for Adjustment or Dispute – Post-Decision or Judgment. Interest shall be allowed the Contractor on a decision or judgment for money in a claim for adjustment or dispute. Post-decision or judgment interest shall be calculated from the date of decision or judgment to the date of payment at a simple rate equal to the weekly average 1-year constant maturity Treasury yield, as published by the Board of Governors of the Federal Reserve System, for the calendar week preceding the date of the decision or judgment.

SECTION 108 – PROSECUTION AND PROGRESS

108.01 SUBLETTING OR ASSIGNMENT OF CONTRACT.

(a) General. The Contractor shall not sublet, assign, sell, transfer, or otherwise dispose of the Contract or any portion thereof, or of its right, title, or interest therein to any individual, firm, corporation, or other entity without the written consent of the Engineer. The Contractor must file with the Agency copies of all executed Subcontracts and other documents. An approved Subcontractor shall not in turn sublet or assign any of the work pertaining to the Subcontract without the Contractor obtaining further permission from the Agency. In no event shall Agency approval release the Contractor from responsibility and liability under the Contract and bonds.

(b) Performance of the Contract Work. The Contractor shall perform Contract work with its own organization amounting to at least 50% of the total Contract work amount, minus "specialty items." The Contractor's own organization includes only workers employed and paid directly by the Contractor and equipment owned, leased, or rented by it from a non-debarred individual or entity, with or without operators. The term "own organization" does not include employees or equipment of a Subcontractor, assignee, agent, or supplier of the Contractor. When determining whether the Contractor is in compliance with this 50% requirement, the following shall apply:

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(1) The cost of materials and manufactured products to be purchased or produced under the Contract shall be included in the amount upon which the 50% requirement is computed.

(2) The percentage of Subcontracted work shall be based on the Contract, rather than Subcontract, unit prices. If only a part of a Contract item is to be sublet, its proportional value shall be determined on the same basis.

(3) When a firm sells materials to a Contractor and performs the work of incorporating the materials into the project, these actions must be considered in combination and as constituting a single Subcontract.

(c) Specialty Items. The cost of specialty items may be deducted from the total Contract price before computing the amount of work required to be performed by the Contractor's own organization. Specialty items will be designated as such in the Project Special Provisions and may be performed by Subcontract.

(d) Performance Requirements. The Contractor and its Subcontractor(s) shall, in the staffing and administration of the Contract, comply with the following performance requirements:

(1) Commercially Useful Function. The Contractor and Subcontractor(s) must each perform a "commercially useful function." This means that the Contractor/Subcontractor is responsible for the execution of a distinct element of the work of a Contract and carries out its responsibilities by actually performing, managing, and supervising the work involved. The Contractor/Subcontractor must have the latitude to independently:

a. Select Contracts to be bid;

b. Determine prices to be quoted;

c. Select material suppliers;

d. Hire, fire, supervise, and pay employees, and;

e. Direct or cause the direction of the management and policies of the firm.

The Contractor/Subcontractor may not broker work for another firm or act as a bidding conduit.

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(2) Contractor to Furnish Competent Representative; Safety Officer; Others. To ensure that any Subcontracted work is performed in accordance with the Contract requirements, the Contractor shall be required to furnish:

a. A competent, reliable English-speaking representative employed by the Contractor who has full authority to direct performance of the work in accordance with the Contract requirements and who is responsible for all construction operations on the project regardless of who performs the work.

b. A competent, reliable English-speaking employee designated as the safety officer who is authorized to receive orders and to issue binding directions concerning safety to all persons except Agency representatives associated with the project, whether employed by the Contractor, Subcontractors, or material suppliers.

c. Such other individuals from the Contractor's organization as the Agency's Construction Engineer determines are necessary to ensure the performance of the Contract, e.g., supervisory, managerial and engineering personnel.

(3) Employees on Payroll. The Contractor/Subcontractor is not permitted to place on the payroll the employees of another firm for the purpose of avoiding federal or state regulations or the provisions of the Contract.

108.02 NOTICE TO PROCEED. The Contractor shall not commence construction operations until the written Notice to Proceed has been issued.

108.03 PROSECUTION AND PROGRESS OF THE WORK.

(a) Progress Schedule. The progress schedule shall be submitted a minimum of 7 calendar days prior to the preconstruction conference. The progress schedule shall show the proposed sequence of work and when the Contractor proposes to complete the various items of work within the times established in the Contract. During the progress of the work, the Contractor shall confer with the Engineer concerning performance of the work in accordance with the conforming schedule. The conforming schedule shall be used as a basis for establishing major construction operations and for checking the progress of the work. A Notice to Proceed will not be issued until the progress schedule has been found to be in conformance.

(b) Performance of the Work. The work shall be performed from as many points, in as many parts, at times, in a manner, and with sufficient materials, equipment, and labor so as to ensure its completion within the times set forth in the Contract.

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(c) Resumption of Work After Discontinuance with Consent. Should the performance of the work be discontinued by the Contractor for any reason, the Contractor shall notify the Engineer at least 24 hours before resuming operations.

108.04 LIMITATIONS OF OPERATIONS. The Contractor shall conduct the work at all times in a manner and sequence that will ensure the least interference with traffic. The Contractor shall have due regard to the location of detours and to the provisions for handling traffic. The Contractor shall not commence work to the prejudice or detriment of work previously started. The Engineer may require the Contractor to complete an area on which work is in progress before work is commenced on other areas if the opening of the area in progress is essential to public convenience.

108.05 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT.

(a) General. The Contractor shall at all times employ sufficient labor and equipment to perform the several classes of work to full completion in the manners and times required by the Contract.

(b) Worker Skill and Experience. All workers shall have sufficient skill and experience to properly perform the work assigned to them. Workers engaged in specialty or skilled work shall have sufficient skill, experience and experience with equipment required to perform such work properly and satisfactorily.

(c) Electrical Work. All electrical work shall be performed by or under the supervision of a licensed electrician (master or journeyman). Electrical work shall be defined as any work which involves making connections to electrical components or splices in wiring that are, or will be, carrying 100 volts or more. "Under the supervision of" means that the licensed electrician employed on the project shall be physically present on the project and must be actively supervising the work.

(d) Removal of Workers from Project. Any person employed by the Contractor or a Subcontractor who in the opinion of the Engineer does not perform work in a proper and skillful manner or is intemperate or disorderly shall, at the Written Order of the Engineer, be removed forthwith by the Contractor or Subcontractor employing such person and shall not be employed again in any portion of the work without the approval of the Engineer.

(e) Failure to Remove Worker from Project. If the Contractor fails to remove a person or persons as required above, or fails to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may withhold all monies which are or may become due and/or may suspend the work by written notice until the Contractor complies with the order.

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(f) Equipment Sufficiency. All equipment used to perform the work shall be of sufficient size and mechanical condition to meet requirements of the work and to produce work of satisfactory quality. Equipment used on the project shall not cause injury to the roadway, adjacent property, or other highways.

(g) Methods and Equipment Not Prescribed. When the methods and equipment to be used by the Contractor are not prescribed in the Contract, the Contractor is free to use any methods or equipment that it demonstrates to the satisfaction of the Engineer will accomplish the work in conformity with the requirements of the Contract, and provided they pose no safety risk to the workers, inspection staff, traveling public, or general public.

(h) Methods and Equipment Prescribed. When the Contract specifies that the work be performed by the use of certain methods and equipment, those methods and equipment shall be used unless otherwise authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the Contract, the Contractor shall request approval from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with Contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet Contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved or in Contract time as a result of authorizing a change in methods or equipment. The changing of methods and equipment prescribed shall not be justification for a Claim.

108.06 WAGES AND CONDITIONS OF EMPLOYMENT.

(a) General. The Contractor and all Subcontractors shall comply with the provisions and requirements of all federal and state labor laws and with the wage requirements set forth in detail in the Contract. In case of conflicts between wage determinations made by the U.S. Department of Labor and the minimum wage established by statute, the larger of the two amounts shall be the minimum wage for that classification.

(1) Fair Labor Standards Act. *The Fair Labor Standards Act of 1938* (*FLSA*), as amended, *29 U.S.C. 201*.

a. General. No law requires federal or state agencies to insert in their Contracts a clause to ensure compliance by the Contractor with the *FLSA*. However, the *FLSA* most likely applies to work under a construction Contract with the federal government or that is financed with the aid of the federal government. The *FLSA* requires payment of a minimum hourly rate as well as overtime pay for work in excess of 40 hours in each workweek. Moreover, the overtime provisions of the *FSLA* and of the "Eight-Hour Law" are not mutually exclusive. Therefore, a Contractor's employees covered by the *FLSA* are most likely also covered by the overtime provisions of other, applicable laws.

The *FLSA*, sometimes known as the "Wage-and-Hour-Law," applies to individual workers who are engaged in commerce or in the production of goods for commerce as defined in the *FLSA*. Workers on virtually all Agency construction jobs are included under these terms. If a worker carries materials or moves equipment across state lines, unloads or guards materials or equipment arriving from other states, or performs other functions in commerce in the course of performing work, that worker is covered under the *FLSA*. Also, if the job is one to repair, reconstruct, enlarge, or improve an existing instrumentality of commerce such as a highway, bridge, or road, the worker is likewise covered under the *FLSA* while working on the job, including municipal streets if they are available to and are regularly used by interstate traffic.

New construction is covered by the *FLSA* when the project(s) is (are) part of and directly related to the functioning of an existing instrumentality of commerce. Coverage is therefore extended to construction workers on highways in the "Interstate System" or on other roads built to serve as part of a network carrying interstate traffic. In this regard, workers engaged in work preparatory to actual construction such as surveying, clearing, or grading are also covered.

b. Minors. Under the *FLSA*, the minimum age for general employment in the construction industry is 16 years. The minimum age is 18 years for employment in occupations declared to be hazardous by the U.S. Secretary of Labor. Included in this category are the occupations of motor-vehicle driver and helper. Children 14 and 15 years old may be employed for a limited number of hours and under certain conditions in office work; they may not be employed in any manner at covered construction sites.

c. Contacts for More Information. The above is general information concerning the applicability of the *FLSA* to the highway construction industry. More information can be found on the U.S. Department of Labor website or:

U.S. Department of Labor
Wage and Hour Division
Manchester District Office
1155 Elm Street, Suite 501
Manchester, NH 03101
Phone: (603) 666-7716
1-866-4-USWAGE (1-866-487-9243)

(2) Contract Work Hours and Safety Standards Act.

a. General. The *Contract Work Hours and Safety Standards Act* (*CWHSSA*) is administered by the Wage and Hour Division (WHD). The act applies to Contractors and Subcontractors with federal service contracts and federally funded and assisted construction contracts over $100,000. Covered contracts include those entered into by the United States, any agency or instrumentality of the United States, any territory of the United States, or the District of Columbia.

The *CWHSSA* also extends to federally assisted construction contracts subject to *Davis-Bacon and Related Acts* wage standards where the federal government is not a direct party, except those contracts where the federal assistance takes the form only of a loan guarantee or insurance.

b. Basic Provisions and Requirements. The *CWHSSA* requires Contractors and Subcontractors with covered Contracts to pay laborers and mechanics employed in the performance of the Contracts one and one-half times their basic rate of pay for all hours worked over 40 in a workweek.

(3) Davis-Bacon Act. Where the Contract includes *Davis-Bacon* wage rate requirements, the following also applies.

a. General. The wage rate determination of the U.S. Department of Labor which has been incorporated in the proposal may not contain all job classifications necessary for the work contemplated under the project. The Contractor is independently responsible for ascertaining area practice with respect to the necessity, or lack thereof, for the use of any job classifications in the prosecution of the work contemplated by the project; no inference concerning prevailing area practices relative to their use may be drawn from the omission of these job classifications. Further, the omission of a job classification shall not be construed as establishing governmental liability for increased labor cost.

b. Missing Job Classifications and Wage Rates. The Contractor shall submit to the Agency any requests for missing job classifications and proposed wage rates.

c. Vermont Labor Laws. The Contractor's attention is directed to the provisions and requirements of the *Vermont Workers' Compensation Act* and to Vermont statutes regulating employment of minors.

108.07 LABOR AND RENTAL PREFERENCE. In accordance with *19 V.S.A § 17*, the Contractor shall give preference to Vermont labor and trucks owned in Vermont. This requirement shall not apply to any highway project, or any part thereof, financed with federal funds.

108.08 MEETING PERSONNEL REQUIREMENTS. Contractors are encouraged to use the services of the local offices of the state Department of Employment and Training to meet their personnel requirements. Recruitment of workers in all occupations and skills is conducted by the state Employment and Training Services, initially from the immediate labor market areas, and when workers with the required skills are not available locally, through the nationwide workforce clearance system of the U.S. Employment Service.

Available workers may be obtained from the Vermont Department of Employment & Training and from the VTrans Office of Civil Rights and Labor Compliance.

108.09 TEMPORARY SUSPENSION OF THE WORK.

(a) General. The work may be suspended by the Engineer, wholly or in part, for such period or periods as necessary on account of:

(1) Unsuitable weather conditions.

(2) Failure on the part of the Contractor to carry out instruction or a Written Order, to perform satisfactory work, or to perform one or more provisions of the Contract.

(3) Any other conditions which, in the judgment of the Engineer, make work impractical, dangerous, harmful to the environment, or in violation of a permit or other authorization for the project.

(b) Authority of Agency Safety Officer. In the absence of the Engineer, the Agency Safety Officer, or person acting in that role, shall have authority to suspend work when they determine that the suspension of work is warranted for a safety violation on the job site. The period of time work is suspended due to a safety violation will not be justification for an extension of time under Subsection 108.11 or for additional compensation.

(c) Authority of Agency Hazardous Materials and Waste Coordinator. In the absence of the Engineer, the Agency Hazardous Materials and Waste Coordinator, or person acting in that role, shall have authority to suspend work when they determine that the suspension of work is warranted for an environmental violation on the job site. The period of time work is suspended due to an environmental violation will not be justification for an extension of time under Subsection 108.11 or for additional compensation.

(d) Seasonal Closure. From December 2nd to April 14th, inclusive, no construction work of any kind shall be done except by written permission from the Regional Construction Engineer, and only under such conditions as specified therein. Permission will only be granted for work which will result in a direct benefit to the State or the traveling public. Items which may be considered as a benefit include but are not limited to shorter Contract duration, a cost savings, increased safety for the traveling public, and an ability to ensure the quality of work. The Contractor shall request permission in writing, detailing what Contract items may be affected, a schedule of work, and the benefits to the State or traveling public. The Agency reserves the right, at its sole discretion to rescind permission to work during the seasonal closure period. The rescission will not be justification for additional compensation.

(e) Seasonal Closure Procedure. Construction procedure prior to closing down the project for seasonal closure shall be as specified in Subsection 104.04A or Subsection 104.04B.

(f) Contractor Suspension of Work. The Contractor shall not suspend the work without permission of the Engineer. Such permission will not be unreasonably withheld.

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(g) Contract Applicable. If the work is suspended for any reason, all appropriate requirements of the Contract shall continue.

108.10 SUSPENSIONS OF WORK ORDERED BY THE ENGINEER.

(a) Additional Compensation/Time Request; Time Limit. If the performance of all or any portion of the work is suspended or delayed by the Engineer for an unreasonable period of time not originally anticipated, customary, or inherent to the construction industry, and the Contractor believes that additional compensation and/or Contract time is due, or will become due as a result of the suspension or delay, the Contractor shall immediately submit to the Engineer in writing a Notice of Delay. The Notice of Delay shall set forth the reasons and potential impacts to the work and the schedule.

The Contractor must submit a Request for Adjustment to the Contract, to include additional costs and schedule impacts with all supporting documentation to the Engineer within 7 calendar days of receipt of the Notice to Resume Work or the Conclusion of the Delay and not thereafter. The Request will be evaluated in accordance with Subsection 108.16.

No Contract adjustment will be allowed unless the Contractor has submitted the required Notice of Delay and the Request for Adjustment within the time prescribed.

(b) Evaluation of Request. Upon receipt of the Request for Adjustment, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the Contract has increased as a result of the suspension/delay and the suspension/delay was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or Subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the Contract accordingly. The Engineer will notify the Contractor whether or not an adjustment of the Contract is warranted. To the extent that performance would have been suspended or delayed by any other cause or an adjustment is provided for or excluded under some other term or condition of the Contract, no Contract adjustment will be allowed under this subsection.

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108.11 DETERMINATION OF EXTENSION OF CONTRACT TIME FOR COMPLETION.

(a) General; Request for Extension of Contract Completion Date. When a definite date or a fixed number of days for completion is specified in the Contract, and when the Contractor fails to substantially complete the work within the Contract time specified due to unforeseen conditions beyond the control and without fault or negligence of the Contractor, the Contractor will be credited additional Contract completion time on a full day basis as provided in Subsection 108.11(b). The Finals Engineer will submit to the Contractor a "Request for Extension of Time Form" containing a preliminary review of extension of time in accordance with Subsection 108.11(b). If the Contractor concurs with the preliminary review, the Contractor shall sign and return the form to the Finals Engineer within 60 calendar days of the date of presentation (the "60 calendar day period").

If the Contractor disputes the preliminary review, the Contractor shall notify the Finals Engineer within the 60 calendar day period and provide supportive documentation regarding the dispute. Upon notification of a dispute, the Construction Section will research and provide a decision to the Contractor. The Contractor may appeal this decision within 30 calendar days to the Chief Engineer as provided in Subsection 105.02. Notwithstanding Subsection 105.02 and Subsection 105.20, failure to notify the Finals Engineer of a dispute within the 60 calendar day period shall constitute concurrence with the preliminary review and be deemed a waiver of the Contractor's right to appeal, in which case the extension of time will be processed without the Contractor's signature.

The Contractor may request an extension of time to the Engineer during the course of the project.

No extension of time will be required when a substantial completion date is established prior to the Contract completion date, as modified by applicable Change Orders.

(b) Determination of Contract Completion Date Extension. Whenever the work is delayed or suspended through no fault of the Contractor, a Contract completion date extension may be made by the Engineer in the following circumstances:

(1) Delay by the Agency in awarding the Contract and/or in issuance of the Authorization to Proceed with Submittals or the Notice to Proceed.

(2) Federal or state laws passed subsequent to the date of the Contract adversely affecting progress of the work.

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(3) Acts of God, including but not limited to unusually severe storms of extended duration or impact which could not generally be anticipated by the Contractor, either during the bidding process or during construction, and catastrophic weather events such as floods, droughts, fires, hurricanes, tornadoes, earthquakes, or landslides.

(4) Suspension of work by order of the Engineer. In such cases, the time for completion will be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(5) Differing site conditions pursuant to Subsection 104.08.

(6) Significant changes in the character of the work pursuant to Subsection 109.04.

(7) Extra work ordered by the Engineer pursuant to Subsection 104.03.

(8) Delays in the issuance of permits, approvals, or other government regulatory action that are not attributable to the Contractor.

(9) Court orders, including but not limited to temporary restraining orders, preliminary and permanent injunctions, or judgments that are not attributable to the Contractor.

(10) Industry-wide labor unrest.

(11) The days from April 15th to December 1st, inclusive, on which the weather or condition of the ground caused suspension of the work.

(12) Industry-wide material or supply shortages not reasonably anticipated by the Contractor at the time the Contract was entered. Delays caused by a shortage of materials, but only when the Contractor furnishes to the Engineer documentary proof that a diligent effort has been made to obtain the materials from all known sources and the inability to obtain the materials when originally planned did in fact cause a delay in final completion of the entire work, and the delay could not be avoided by revising the sequence of the Contractor's operations. The Contractor shall notify the Engineer in writing of the causes of delay caused by material shortages no later than 15 calendar days from the beginning of any such delay and not thereafter.

(13) Any other conditions which in the opinion of the Chief Engineer warrants consideration for an extension of time.

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108.12 FAILURE TO COMPLETE WORK ON TIME.

(a) Time Essential Element. Time is an essential element of the Contract. The Contractor shall plan its progress schedule and progress the work in order to complete the Contract on or before the completion date or duration set forth in the Contract.

(b) Liquidated Damages; General; Days Charged. For each working day on which any work remains incomplete after the completion date or duration specified in the Contract for completion of the work involved, there shall be deducted from any monies due the Contractor the amount shown in Table 108.12A, unless otherwise specified in the Contract. The deduction is not a penalty, but is liquidated damages to defray the cost to the Agency to administer the Contract, including but not limited to the cost of engineering, inspection, supervision, inconvenience to the public, obstruction of traffic, and interference with business. Due account shall be provided for any adjustment of the Contract time for completion of the work under the provisions of Subsection 108.11.

TABLE 108.12A – DAILY LIQUIDATED DAMAGES CHARGE PER WORKING DAY OF DELAY

Original Contract Amount		Daily Charge per Working Day of Delay
From More Than	To and Including	
$0	$300,000	$1,600
$300,000	$500,000	$1,700
$500,000	$1,000,000	$1,800
$1,000,000	$1,500,000	$2,000
$1,500,000	$3,000,000	$2,300
$3,000,000	$5,000,000	$2,800
$5,000,000	$10,000,000	$4,000
$10,000,000	$20,000,000	$6,500
$20,000,000	--	$11,400

Should the Contractor elect to work on Saturdays, Sundays, holidays, or days from December 2nd to April 14th, inclusive, after the Contract completion date, the Contractor will be charged liquidated damages for such days worked.

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(c) No Waiver. Permitting the Contractor to continue to finish the work or any part of the work after the time fixed for its completion or after the date to which the time for completion may have been extended shall not operate as a waiver on the part of the Agency of any of its rights under the Contract.

(d) Liability for Liquidated Damages. The Contractor covenants and agrees that should the amount of monies due or that may become due the Contractor be less than the amount of ascertained liquidated damages, the Contractor and the Contractor's surety shall be liable to the State for the deficiency.

(e) Liquidated Damages Cutoff Date. No liquidated damages will be charged after the establishment of a substantial completion date.

108.13 TERMINATION OF CONTRACT.

(a) General; Notice. Upon written notice from the Engineer or other proof satisfactory to the Secretary, the Secretary will give notice in writing to the Contractor and the Contractor's surety of delay, neglect, or default if the Contractor:

(1) Fails to begin the work under the Contract within the time specified in the Notice to Proceed;

(2) In the opinion of the Engineer, fails to perform the work with sufficient workers and equipment or with sufficient materials to ensure the prompt completion of said work;

(3) In the opinion of the Engineer, performs the work unsuitably or neglects or refuses to remove materials or to redo or replace work rejected as defective and unsuitable;

(4) Discontinues the prosecution of the work without authorization of the Engineer;

(5) Fails to resume work that has been discontinued within a reasonable time after notice to do so;

(6) Becomes insolvent, is declared bankrupt, or commits any act of bankruptcy or insolvency;

(7) Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 calendar days;

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(8) Makes an assignment for the benefit of creditors, or;

(9) In the opinion of the Engineer, fails, for any cause whatsoever, to carry on the work in an acceptable and timely manner.

(b) Failure of Contractor to Proceed; Termination. If the Contractor or the Contractor's surety does not proceed in accordance with the notice within a period of 10 calendar days after notice, the Agency may, without violating the Contract, terminate the Contract by taking performance of the work out of the hands of the Contractor. The Agency may appropriate and use any or all materials and equipment on the project as are suitable and acceptable and may enter into an agreement for the completion of the Contract, according to the terms and provisions thereof or use such other methods as, in the discretion of the Engineer, will be required for the completion of the Contract in an acceptable manner and in the best interest of the Agency.

(c) Agency's Costs. All costs and charges incurred by the Agency, together with the costs of completing the work under Contract, shall be deducted from any monies due or which may become due the Contractor. If the expense incurred by the Agency is less than the sum which would have been payable under the Contract had it been completed by the Contractor, the Contractor shall be entitled to receive the difference; if the expense exceeds the sum which would have been payable under the Contract, the Contractor and the Contractor's surety shall be liable and shall pay to the Agency the amount of the excess.

108.14 TERMINATION OF CONTRACT FOR CONVENIENCE.

(a) General. The Agency may, by Written Order to the Contractor, terminate the Contract or any portion thereof when such termination would be in the best interest of the Agency.

Any such termination shall be effected by delivery to the Contractor an Order of Termination specifying the termination is for the convenience of the Agency, the extent to which performance of work under the Contract is terminated, and the effective date of the termination.

In the event such termination occurs, without fault and for reasons beyond the control of the Contractor, all completed items of work as of the date of termination will be paid for at the Contract bid price. Payment for partially completed work will be made either at agreed prices or by force account methods provided elsewhere in the Contract.

Pursuant to Subsection 109.07, no compensation will be allowed for items eliminated from the Contract.

Upon request the Contractor shall make all Contract-related records available to the Agency.

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(b) Contractor Obligations. After receipt of the Order of Termination and except as otherwise directed by the Engineer, the Contractor shall immediately proceed to:

(1) To the extent specified in the Order of Termination, stop work under the Contract on the date specified.

(2) Place no further orders or Subcontracts for materials, services, and/or facilities except as may be necessary for completion of such portion(s) of the work under the Contract as is (are) not terminated.

(3) Terminate and cancel all orders or Subcontracts for materials, services, and/or facilities except as may be necessary for completion of such portion(s) of the work under the Contract as is (are) not terminated.

(4) Submit to the Engineer a material inventory list, certified as to quantity and quality of materials in its possession or in transit to the project.

(5) Transfer to the Agency all completed or partially completed plans, drawings, information, and other property which, if the Contract had been completed, would be required to be furnished to the Agency in electronic format.

(6) Take other action as may be necessary or as directed by the Engineer for the protection and preservation of the property related to the Contract which is in the possession of the Contractor and in which the Agency has or may acquire any interest.

(c) Claim by Contractor. After receipt of the Order of Termination from the Agency, the Contractor shall submit any claim for additional damages or costs not covered herein or elsewhere in the Contract within 60 calendar days of the effective termination date, and not thereafter.

Should the Contractor fail to submit a claim within the 60 calendar day period, the Agency may, at its sole discretion, based on information available to it, determine what, if any, compensation is due the Contractor and pay the Contractor the determined amount.

(d) Materials. At the option of the Agency, acceptable materials included in the material inventory in Subsection 108.14(b)(4) above that have been obtained by the Contractor for the work but which have not been incorporated into the work may be purchased from the Contractor at actual cost and delivered to a location prescribed by the Engineer or otherwise disposed of as mutually agreed.

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Payment for materials included in the material inventory chosen to be purchased by the Agency will be made at actual cost delivered to the project or storage site designated by the Engineer, including transportation charges, to which 10% overhead and profit will be added.

(e) Idle Equipment. Idle equipment time claimed by the Contactor will be paid as follows:

(1) Contractor Owned Equipment. For the portion of any Claim relating to idle equipment time for equipment owned by the Contractor, the Contractor will be entitled to recover equipment rates based on the Contractor's internal ownership costs. Recovery for idle equipment time shall not be based on published rental rates.

(2) Rented or Leased Equipment. For the portion of any Claim relating to idle equipment time for equipment rented or leased by the Contractor, the Contractor will be entitled to recover the lesser of the actual rental costs or fair market rental costs, and the amount shall not exceed 30 calendar days rental.

(3) Limitations on Recovery for Idle Equipment. Claims for idle equipment time, whether for Contractor owned equipment or leased/rented equipment, following termination of the Contract pursuant to this subsection are limited to a maximum of 30 calendar days and may not include any operating expenses.

(f) Negotiation; No Anticipated Profit. Negotiation to settle a timely claim shall be for the sole purpose of reaching a settlement equitable to both the Contractor and the Agency. Settlement shall be based on actual costs incurred by the Contractor plus overhead and profit as specified in Subsection 109.06. Consequential damages, loss of overhead, loss of overhead contribution of any kind, and/or loss of anticipated profits on work not performed shall not be included in the Contractor's Claim and will not be considered, allowed, or included as part of any settlement.

(g) Records. The Contractor shall make available to the Agency all cost records relevant to a determination of an equitable settlement.

(h) Contractual Responsibilities Continue. Termination of the Contract, or portion thereof, shall not relieve the Contractor of its contractual responsibilities for work completed and shall not relieve the Contractor's surety of its obligation for and concerning any just claim arising out of the work performed.

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108.15 TERMINATION OF CONTRACTOR'S RESPONSIBILITY.

(a) Completion and Acceptance. Whenever the projects provided for by the Contract have been completely performed by the Contractor, all parts of the work have been approved and accepted by the Engineer, and all Contract complied with, the Contractor will then be released from further obligations except as set forth in the bonds provided, and the Agency will provide the Contractor with a Completion and Acceptance Memorandum.

(b) Limited Completion and Acceptance. If the Contract includes work at more than one location as separate projects or as separate locations on a single project, the Agency may accept the work at any location when the work at that location is completely finished and all responsible parties agree to acceptance in the same manner as a normal final inspection. If a portion of the Contract is accepted by the Engineer, and all Contract related thereto are complied with, the Contractor shall remove all construction warning signs from that portion and the Contractor will then be released from further obligations as to that portion except as set forth in the bonds provided. If substantial completion of the work is accomplished, but additional work is required to achieve final acceptance, the Agency may accept the work under the Contract with exceptions and/or reservations.

108.16 DELAYS – COMPENSABLE AND NON-COMPENSABLE.

(a) Compensable Delays. The Engineer may allow additional compensation for the time-related issues specifically enumerated in this subsection only if the delays and other time-related issues result from:

(1) Differing site conditions pursuant to Subsection 104.08, or;

(2) Significant changes in the character of the work pursuant to Subsection 109.04, or;

(3) Suspensions of work ordered by the Engineer pursuant to Subsection 108.10.

(b) Recoverable Costs. Only the following costs may be recovered for Compensable Delays under Subsection 108.16(a):

(1) Labor, Materials, and Equipment. The costs provided for in Subsection 109.06 and properly documented and maintained pursuant to that subsection.

(2) Field Office Overhead. The actual cost paid by the Contractor to third parties for field office rental, utilities, and routine cleaning, plus 5% for Contract supervision, overhead, and profit.

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(3) Home Office Overhead. Unabsorbed home office overhead is only recoverable pursuant to Subsection 108.14.

(c) Non-Recoverable Costs. The following costs are not recoverable under the Contract:

(1) Home office overhead in excess of that provided in Subsection 109.06.

(2) Loss of profit in excess of that provided in Subsection 109.06.

(3) Loss of productivity and/or inefficiencies in labor.

(4) Consequential damages, such as loss of interest or investment with respect to funds at issue in the dispute.

(5) Attorneys' fees, mediation expenses, Claims analysis, or preparation expenses.

(6) Costs attributable to the Contractor's failure to advance the work in a reasonable manner.

(d) Non-Compensable Delays. The Engineer may allow an extension of the Contract completion date or the interim completion date but may not allow additional compensation except for those situations specifically enumerated in Subsection 108.16(a).

(e) Failure to Perform Adequately. Failure to perform the work continuously and effectively with adequate work force and as scheduled for the full time allowed will be cause for denial of a time extension that might otherwise be allowed.

SECTION 109 – MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES.

(a) General. All work completed under the Contract will be measured by the Engineer according to U.S. customary or SI units, as required by the Contract.

The measurement and determination of the number of units of each pay item will be made as specified in this section and as are specifically described under the Method of Measurement and Basis of Payment subsections for each item.

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(b) Area. Unless otherwise specified in the Contract area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of 10 square feet or less; measurements for area computations will be to the neat dimensions shown on the Plans or authorized in writing by the Engineer.

(c) Structures. Structures will be measured according to neat lines shown on the Plans or as altered to fit field conditions in accordance with the method of measurement stated in the Contract.

(d) Volumes. Volumes of excavation and borrow pits will be calculated from cross-sections, the use of average end area formulae, 3-dimensional models created by survey or by another approved method. Volumes of other work, e.g. Cement Masonry or Removal of Concrete or Masonry, will be calculated by using arithmetical formulae. Where the volume is bounded by varying dimensions and there is no simple volumetric formula applicable, frequent cross-sections will be taken and the volume computed from average end area formulae. Other methods of measurement for small quantities may be authorized when approved in writing by the Engineer.

(e) Length Measurement. All items measured by the linear foot will be measured parallel to the base or foundation upon which the item is placed, unless otherwise shown on the Plans.

(f) Ton. The term ton means the U.S. customary unit of the short ton consisting of 2,000 pounds. All materials that are measured, or proportioned by weight, shall be done so on accurate, approved scales by competent, qualified personnel.

(g) Bituminous Materials Measurements.

(1) General. Bituminous materials will be measured by the gallon or hundredweight (CWT). Wherever used, the term hundredweight and the abbreviation CWT shall refer to the U.S. customary unit of the short hundredweight, equal to 100 pounds.

Volumes of bituminous materials will be measured at 60°F or will be corrected to the volume at 60°F using *ASTM D 1250* for asphalt.

(2) Shipping of Bituminous Materials; Correction. When liquid bituminous materials are shipped by truck or transport, net certified weight or volume subject to correction for loss or foaming may be used for computing quantities.

(h) Cement. Portland cement will be measured by the pound.

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(i) Timber. Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the work. Measurement will be based on nominal widths and thicknesses and the in-place length of each piece. An MFBM shall be equal to one thousand board feet. A board foot is defined as a board that is 12 inches long by 12 inches wide by 1 inch thick, or a volume of 144 cubic inches. One MFBM is therefore equal to 144,000 cubic inches or exactly 83-1/3 cubic feet.

(j) Lump Sum.

(1) General. The term lump sum when used as a unit of measurement for an item of payment means complete payment for the work described in the item description.

(2) Everything Included. When a complete structure or structural unit (in effect, lump sum work) is specified as the unit of measurement, the unit will be construed to include all labor, tools, equipment, material, necessary fittings, accessories and incidentals necessary to complete the work.

(k) Rental. Rental of equipment will be measured by time in hours of actual work time and the necessary travel time of the equipment within the limits of the project.

(l) Final Bridge Quantities. In order to save engineering resources and expedite payment of the final estimate, the Agency will pay for the original plan quantities, exclusive of estimated overrun allowances, for all bridge quantities if the Agency and the Contractor agree to the acceptance of the plan quantities by the time the final survey is made. However, if either the Contractor or the State challenges the quantities, final quantities will be computed in accordance with the Contract. When one or more changes in design generate changes in quantities, final quantities shall be based on final measurements.

109.02 PURCHASES OF MATERIALS BASED UPON AGENCY MEASUREMENTS.

(a) Estimates Are Not Guarantees. The Agency does not furnish or guarantee estimates of measurements of borrow, gravel, sands, soils, fill, and other construction materials to be used on the project for the benefit and/or convenience of the Contractor either in dealings with sellers of those materials or any other purpose.

(b) Purchase of Materials. Except by written agreement, with a copy of the agreement furnished to the Agency prior to removal of materials for the project, the Contractor shall not purchase materials on terms that require payment on the basis of the estimates of measurement made by the Agency.

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109.03 SCOPE OF PAYMENT.

(a) General. The Contractor shall receive and accept the compensation provided in the Contract as full payment:

(1) For furnishing all materials, labor, tools, and equipment and performing all work contemplated and required under the Contract;

(2) For all loss or damage arising out of the work from the actions of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work until its acceptance by the Agency;

(3) For all risks of every description connected with the prosecution of the work, and;

(4) For all expenses incurred by or in consequence of the temporary suspension or discontinuance of the work for any infringement of patent, trademark, or copyright, and for completing the work in an acceptable manner according to the Contract.

(b) Payment of Estimates; Obligations of Contractor. The payment of any current or final estimate shall not prejudice or affect the obligation of the Contractor under the Contract, at its own cost and expense, to repair, correct, renew, or replace any defects or imperfections in the project and its appurtenances or the strength of or quality of materials used on the project; payment of an estimate, including a final estimate, shall not relieve the Contractor from the payment of any and all damages due or attributed to defects or imperfections..

(c) Damage Claims and Liabilities; Payment by Agency. Relative to damage, labor and materials, and other claims against the Contractor or project, no monies payable under the Contract or any part thereof shall become due and payable if the Agency so elects until the Contractor satisfies the Agency that the Contractor has fully settled or paid all damage, labor, or materials Claims and all liabilities incurred in connection with the work; if it so elects, the Agency may pay any or all Claims or liabilities wholly or in part and deduct the amount or amounts so paid from any biweekly or final estimates.

(d) Written Evidence of Releases. If it so elects, the Agency may require the Contractor to furnish written evidence of release from all claims and obligations connected with the work.

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109.04 SIGNIFICANT CHANGES IN THE CHARACTER OF WORK.

(a) General. At any time during work the Engineer reserves the right to make, in writing, changes in quantities and alterations in the work as are deemed necessary or desirable to satisfactorily complete the project. Changes in quantities and alterations in the work will not invalidate the Contract or release the Contractor's surety, and the Contractor shall perform the work as altered.

(b) Significant Alteration/Change to Character of Work; Adjustment to Contract. If the alterations or changes in quantities significantly change the character of the work under the Contract, whether or not changed by different quantities or alterations, a monetary adjustment will be made to the Contract; loss of anticipated profits shall not be included. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, an adjustment will be made as the Engineer determines to be fair and equitable.

(c) Alterations/Changes Not Significant. If the alterations or changes in quantities do not significantly change the character of the work to be performed under the Contract, the altered work will be paid for as provided elsewhere in the Contract.

(d) Significant Change Defined. The term significant change shall be construed to apply only to the following circumstances:

(1) When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or

(2) When a major item of work, as defined, is increased in excess of 25% above or decreased below 75% of the original Contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125% of the original Contract item quantity; any allowance for a decrease in quantity below 75% shall apply to the actual amount of work performed.

(e) Major Item Defined. A major item of work is any bid item that has a total bid value greater than 20% of the total bid amount of the Contract.

109.05 COMPENSATION FOR ALTERED PLANS OR QUANTITIES.

(a) General. When alterations in the Plans or quantities of work are ordered and performed as provided in Subsection 104.02 and when such changes or alterations result in an increase or decrease of not more than 25% of the total original Contract amount, or the length of the project is not increased or decreased more than 25% of the original length shown in the Contract, the Contractor shall accept payment in full at the Contract unit price for the actual quantities of work done.

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(b) Adjustment When Exceeded. When changes or alterations result in a sum total change of more than 25% of the total cost of the Contract calculated from the original bid quantities and the original Contract unit prices, or a length increased or decreased more than 25%, and a demand is made by the Contractor or the Agency, a negotiated Supplemental Agreement shall be signed by both parties setting forth the necessity for the change and an adjustment of unit prices agreed upon as satisfactory to both parties. Agreement shall be signed by both parties setting forth the necessity for the change and an adjustment of unit prices agreed upon as satisfactory to both parties.

In order to bring a claim for additional compensation, the Contractor shall meet all applicable requirements of Subsection 105.20.

(c) No Further Allowance. No further payments will be made for changes/alterations, including the changes/alterations or indirectly from unbalanced allocation of overhead expense among the Contract items by the Contractor and subsequent loss of expected reimbursements therefore or from any other cause.

109.06 EXTRA AND FORCE ACCOUNT WORK. Extra work ordered and accepted as specified in Subsection 104.03 will be paid for on a unit price or lump sum basis under a Supplemental Agreement. The agreement will be made before the work is started. When the Engineer deems it impractical to handle any extra work ordered on a unit price or lump sum basis, a Supplemental Agreement will be made and the work will be ordered done and paid for on a force account basis as follows:

(a) Labor. For all machine or equipment operators, other workers, and supervisors in direct charge of the specific operation, the Contractor shall receive the actual wages agreed upon before beginning the work and were paid to the workers performing the work, to which shall be added an amount equal to 10% for profit. If the Contractor elects to use employees more skilled than required to perform the extra work, the Agency reserves the right to allow compensation for said employees to be capped at 125% of the applicable *Davis-Bacon* wage rate of the base skill level required to perform the work.

Workers' compensation insurance, unemployment compensation insurance, and Social Security charges on labor items as paid by the Contractor will be allowed. Other employee insurances (health, disability, e.g.) being paid by the Contractor just prior to the work being ordered will also be allowed, provided the Contractor submits an applicable notarized insurance rate schedule from its insurance agent. The Contractor shall submit an Agency form indicating all applicable insurances and overhead items for each employee involved in the extra work.

The Contractor will be allowed an additional 10% of the actual wages paid to the employee as compensation for administration charges and any other additional costs. Additional cost or charge for the superintendent shall not be allowed.

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(b) Materials. The Contractor shall receive the actual cost, including freight charges (both as submitted on original receipted bills), for all materials furnished and used. Ten percent shall be added thereto for overhead, profit and any other costs incurred in supplying the materials. Vermont sales tax shall not be included.

(c) Equipment. The Contractor will be reimbursed as described below. Equipment that is used shall be specifically described by year, manufacturer, model number, and any other information required to identify the appropriate hourly rate in the *Blue Book*. In the event the Contractor elects to use equipment of a higher rental value than equipment suitable for the work, payment will be made at the rate applicable to suitable equipment.

(1) Contractor Owned Equipment.

a. Ownership Costs. The Contractor will be reimbursed for its ownership costs for self-owned equipment at the rates agreed to before the work begins. These rates shall be on an hourly basis and shall not exceed the monthly ownership rates listed in the current *Blue Book* divided by 176. The rates will be adjusted for depreciation as computed and published in the *Blue Book* rate adjustment tables, but will not be adjusted as recommended on the *Blue Book* regional adjustment maps. The rates for ownership costs will be total reimbursement to the Contractor for all non-operating costs of the equipment, including depreciation, insurance, taxes, interest, storage, overhead, repairs, and profit.

The maximum duration for reimbursement in a day shall not exceed eight hours unless the equipment actually is operated for more than eight hours on a particular day, in which case the rate shall be paid for all hours the equipment actually worked on that day.

b. Operating Costs. The rates for operating costs include fuel, lubricants, other operating expendables, and preventative and field maintenance. The Contractor will be reimbursed the amount derived as the product of the number of hours of actual use multiplied by the *Blue Book* estimated operating cost per hour. Operating costs do not apply to equipment idle time. Operating costs do not include the operators' wages.

Except as otherwise provided, the rates to be used for computation shall be those in effect at the time the force account work is performed as reflected in the applicable publication of the *Blue Book*.

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c. Establishing New Rates. In the event that an ownership cost rate and/or an operating cost rate is not established in the *Blue Book* for a particular piece of equipment, the Engineer shall establish a rate for that piece of equipment consistent with its costs and expected life. The Contractor shall make no charge for small tools that are considered as having a replacement value of less than $1,000.

(2) Rented Equipment. In the event the Contractor does not own a specific type of equipment and must rent, the Contractor will be reimbursed the actual cost for the equipment, as submitted by invoice, for the time that the equipment is used to accomplish the work. Vermont sales tax shall not be included.

The Agency reserves the right to limit the hourly rate to the maximum amount allowed by *Blue Book* in the event that the prime Contractor is a subsidiary of, or has a close affiliation to, the firm supplying the rented equipment.

(3) Maximum Amount Payable. The maximum amount of reimbursement for the ownership cost of Contractor owned equipment or the rental cost of rented equipment is limited to the original purchase price of the equipment.

(4) Equipment Downtime. No rental cost or operating cost will be paid for downtime for either rented equipment or Contractor owned equipment.

(5) Transportation Costs. The Contractor will be paid for the reasonable documented cost of transporting both Contractor owned and rented equipment to the work location and back to its original location or a new location if the cost is less.

(d) Subcontracted Work. The Contractor shall receive the actual cost, as submitted on original receipted bills, for all extra work and force account work Subcontracted to others. Ten percent shall be added thereto for overhead, profit and any other costs incurred to perform the Subcontracted work. However, the Agency reserves the right to use the force account procedures as depicted previously in this subsection in the event that the cost of reimbursable Subcontracted work is deemed excessive.

The compensation as herein provided shall be received by the Contractor as payment in full for extra work done on a force account basis. The Contractor's representative and the Engineer shall compare records of extra work on a force account basis at the end of each day. Copies of these records shall be made on Agency forms provided for this purpose and shall be signed by both the Engineer and Contractor's representative.

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All requests for compensation for extra work done on a force account basis, including original receipted bills to verify cost and freight charges for all materials, shall be submitted to the Agency as soon as possible; however, if the required request, invoices, and other documentation are not filed before 90 calendar days have lapsed following final acceptance of the project, the costs associated with such extra work and force account work shall not be reimbursable.

(e) Additional Costs. Any additional costs for public liability insurance and property damage insurance that are required in the Contract will be allowed and reimbursed at the actual cost to the Contractor.

109.07 ELIMINATED ITEMS. Should any items contained in the Contract be found unnecessary for proper completion of the work, the Engineer may, upon Written Order to the Contractor, eliminate the items from the Contract. Such action shall have no effect on the other provisions of the Contract and shall in no way invalidate the Contract. No compensation will be allowed for items eliminated from the Contract.

109.08 PARTIAL AND FINAL PAYMENTS.

(a) General. Partial payments, computed upon the basis set forth in the Contract, will be made by the Engineer. On or before the Saturday of each alternate week during satisfactory progress of the work, the Engineer will make a biweekly estimate of the amount of work performed and will compute and report the value thereof under the Contract. Such estimates may be approximate only and not be based on actual measurements. All biweekly and partial estimates will be paid in full except as set forth below, and no payment will be made when the total value of the work done since the last estimate amounts to less than $1,000.

(b) Tax Compliance. If the Contractor is found to not be in good standing with respect to, or in full compliance with a plan to pay, any and all taxes due the State as required in *32 V.S.A. § 3113*, money otherwise owed to the Contractor will be withheld from one or more biweekly estimates and the final estimate.

(c) Claims and Withholdings. For the protection of the State, creditors and other claimants of the Contractor, payment for all or part of one or more biweekly estimates and/or the final payment as determined by the final estimate may be held for the use of the State, if the Agency so elects, until the Contractor has fully settled for or paid for all materials and equipment used in or upon the work and labor done in connection therewith and fully settled for or paid for all damage Claims or liabilities incurred in connection with said work. Upon satisfactory settlement of all such accounts, the final estimate will be paid to the Contractor.

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(d) Final Payments. Payment of the final estimate will be made when an agreement is reached between the Agency and the Contractor regarding the final quantities of all Contract pay items, the acceptance date as defined in Subsection 101.02 is established, all materials and certifications are accepted, and all other project requirements have been met. The Finals Engineer will present the Agency's determination of final quantities to the Contractor for their concurrence. If the Contractor wishes to dispute the final quantities, the Contractor shall notify the Finals Engineer within 60 calendar days of the date of presentation (the "60 calendar day period") of final quantities. The Contractor shall indicate which specific quantities are being disputed and provide supportive documentation regarding the disputed quantities. The Contractor may request a 30 calendar day extension to review the quantities by notifying the Finals Engineer within the 60 calendar day period.

Upon notification of a dispute, the Construction Section will research and provide a decision to the Contractor. The Contractor may appeal this decision within 30 calendar days to the Chief Engineer as provided in Subsection 105.02. Notwithstanding Subsection 105.02 and Subsection 105.20, failure by the Contractor to notify the Finals Engineer of dispute of final quantities within the 60 calendar day period (or 90 calendar days from the date of presentation if a 30 calendar day extension is granted) will be deemed as agreement to the final quantities as presented, and deemed a waiver of the Contractor's right to appeal.

Following the resolution of final quantities, the Finals Engineer will present the Contractor with close-out documents consisting of the final estimate for signature and a Status of Claims form. Failure by the Contractor to sign the final estimate and Status of Claims form within 20 calendar days will result in closure of the Contract, provided that there are no claims on file with the Agency.

At the discretion of the Finals Engineer, the Contractor may be presented with close-out documents concurrent with the final quantities. In such case, notwithstanding Subsection 105.02 and Subsection 105.20, failure by the Contractor to notify the Finals Engineer of dispute of final quantities within applicable time durations specified in this subsection will be deemed as agreement to the final quantities as presented, and closure of the Contract without the Contractor's signature will result.

In cases when presentation of final quantities to the Contractor indicates that the Agency has overpaid the Contract, the Contractor shall remit payment to the Agency by the end of the 60 calendar day period, unless the Contractor is disputing final quantities. Failure to make payment may result in notification to the Agency's Prequalification Committee by the Construction Engineer, and/or may result in set off pursuant to the *Bulletin 3.5* compliance requirements in the Contract.

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(e) Retainage. The Agency shall not withhold retainage on the Contract; the Contractor shall not withhold retainage on any Subcontract; and Subcontractors shall not withhold any retainage on any of their Subcontracts.

109.10 FINAL PAY QUANTITY. When a Contract item is designated in the Contract as (FPQ), then this item shall be considered a final pay quantity item. The Contract quantity shall be considered the final pay quantity for the item, unless the Plan dimensions of any portion for measurement of the item or the Contract quantity of that item are revised by the Engineer, or the Contract quantity of the item or any portion of the Contract quantity of the item is eliminated.

If the dimensions of any portion for measurement of the item or the Contract quantity of the item is revised, and the revision results in an increase or decrease in the Contract quantity of the item, the final pay quantity for the item will be revised in the amount represented by the changes in the dimensions or by the imposed revision. If the item is eliminated, the Contract quantity for the item will be eliminated. If a portion of the item is eliminated, the Contract quantity will be revised in the amount represented by the eliminated portion of the item.

No adjustment will be made to the Contract quantity for an FPQ pay item, except as allowed under this subsection.

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DIVISION 200

EARTHWORK

SECTION 201 – CLEARING

201.01 DESCRIPTION. This work shall consist of performing all clearing, grubbing, thinning, and trimming within the limits of the project.

201.02 GENERAL CONSTRUCTION REQUIREMENTS. The Contractor shall protect all trees, shrubs, and vegetation as identified in the Contract or as directed by the Engineer, in accordance with Subsection 656.09. The Contractor shall take care to avoid damaging trees, shrubs, and vegetation that is to remain standing and that is otherwise unprotected or outside of the limits of clearing items. Where any trees that are to be left standing have been damaged through the Contractor's operations, the Contractor shall be responsible for repairing all damage caused to trees in accordance with the current *VTrans Technical Landscape Manual* and its latest revisions, at no additional compensation.

The Contractor shall protect public utilities, buildings, or other property in accordance with Section 107, Subsection 104.04A, and Subsection 104.04B.

All branches of trees overhanging the paved roadway surface shall be removed to a minimum height of 20 feet above finished grade. This work will not be paid for directly but will be considered incidental to other clearing items.

Where only branches are to be removed, from trees that are to remain standing, branches shall be removed in accordance with the current *VTrans Technical Landscape Manual* and its latest revisions. Work associated with the removal of branches shall be considered incidental to other clearing items.

Where stumps are not to be removed, they shall be cut flush with existing ground, or as close as practical.

201.03 CLEARING AND GRUBBING.

(a) Clearing. Clearing shall consist of cutting and disposing of all trees, down timber, brush, bushes, and debris from all areas extending from the centerline to 10 feet beyond the limits of all cut or fill sections, or to applicable right-of-way limits, whichever is less. Clearing areas shall also include any other areas shown in the Contract. Any trees designated for removal under another Contract item are excluded from this work.

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Where structures are to be constructed, clearing shall include the area within the structure limits and 20 feet beyond the structure limits.

Except for trees, shrubs and vegetation that are to remain standing, all trees, shrubs, down timber, brush and other objectionable material shall be removed and disposed of prior to grading operations beginning, in the respective areas.

If it is deemed impractical to fell the tree as a whole, it shall be removed in sections according to standard practices of professional tree removal.

(b) Grubbing. Grubbing shall consist of removing and disposing of all stumps, roots, grass, turf, debris, or other objectionable material within the construction limits, and within fill limits where the embankments are to be made to a depth less than 5 feet below subgrade. Grubbing areas shall also include any other areas shown in the Contract. The grubbing shall progress in such a manner to prevent erosion as required in Subsection 105.23.

Any voids left through grubbing operations shall be backfilled with approved excavated material or borrow and compacted to conform to the surrounding area.

201.04 REMOVING TREES AND STUMPS. Removing trees and stumps shall consist of removing and disposing of single trees and stumps as shown in the Contract or as directed by the Engineer. Removing trees shall include the removal and disposal of the entire tree including the stump, limbs, and brush. A stump is designated as that portion of the tree remaining after the trunk has been severed.

Tree and stump size will be determined by circumferential measurement at a height 4.5 feet above the ground line or at the point of cutoff, whichever applies. Small trees and stumps will be classified as having a circumference 40 inches or less (approximately 12 inches in diameter). Medium trees and stumps will be classified as having a circumference greater than 40 inches (approximately 12 inches in diameter) and less than 120 inches (approximately 38 inches in diameter). Large trees and stumps will be classified as having a circumference 120 inches (approximately 38 inches in diameter) or greater.

The work shall be in accordance with Subsection 201.02 and Subsection 201.03.

201.05 THINNING AND TRIMMING.

(a) General. Thinning and Trimming shall consist of selective cutting and trimming beyond the limits of clearing and grubbing to clear brush; remove undesirable growths, dead trees, vegetation, and stumps; thin out trees; trim branches; allow for passage of overhead wires; or improve visibility at locations shown on the Plans or directed by the Engineer.

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(b) For Signs. Thinning and Trimming for Signs shall consist of selective cutting and trimming to provide full visibility for a sign at a single designated sign location.

The Contractor shall remove all woody stemmed growth including brush, saplings, trees, and tree limbs growing within or projecting into the required clear viewing area for the designated sign to the minimum horizontal and vertical dimensions shown on the Plans or as directed by the Engineer.

The dimensions are for the standard area of sign visibility, however, the Contractor shall not cut, trim or clear any vegetation outside the right-of-way limits. The Engineer will designate the right-of-way limits.

In performing this work, the Contractor shall not use any chemical growth retardants, poisons, or defoliants.

201.06 DISPOSAL. Unless otherwise specified in the Contract or herein all trees, limbs, stumps and other vegetation removed through this work shall become property of the Contractor.

On National Forest lands, the Contractor shall comply with the requirements included in the Contract for the specific project and in accordance with Subsection 107.15.

Whenever elm trees are trimmed or removed, all portions removed shall be chipped and remain on site.

201.07 METHOD OF MEASUREMENT. The quantity of the Clearing and Grubbing, Including Individual Trees and Stumps will be on a lump sum basis for providing clearing and grubbing in the complete and accepted work. If limits are changed an adjustment for the increased or decreased area will be measured in acres. No adjustment will be made for changes involving less than 0.1 acre. Clearing and grubbing completed for the convenience of the Contractor will not be considered for adjustment.

When specified to be measured by area, the quantity of the Clearing and Grubbing, Including Individual Trees and Stumps to be measured for payment will be the number of acres cleared and grubbed in the complete and accepted work. Clearing and grubbing completed for the convenience of the Contractor will not be included in the measurement for payment.

The quantity of Removing Medium Trees, Removing Large Trees, Removing Medium Stumps, and Removing Large Stumps to be measured for payment will be for the number of each removed, for the various classes, in the complete and accepted work.

The quantity of Thinning and Trimming to be measured for payment will be the number of acres thinned and trimmed in the complete and accepted work, as determined by using horizontal measurements.

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The quantity of Thinning and Trimming for Signs to be measured for payment will be the number of each sign's viewing area cleared in the complete and accepted work.

201.08 BASIS OF PAYMENT. The accepted quantity of Clearing and Grubbing, Including Individual Trees and Stumps will be paid for at the Contract lump sum price or Contract unit price per acre. Progress payments will be made based on the percentage of total area cleared. When the clearing and grubbing limits are changed, an adjustment for the increased or decreased area will be made by Change Order.

The accepted quantity of Removing Medium Trees, Removing Large Trees, Removing Medium Stumps, and Removing Large Stumps will be paid for at the Contract unit price for each. Small trees and stumps will not be paid for directly but will be considered incidental to other Contract items.

The accepted quantity of Thinning and Trimming will be paid for at the Contract unit price per acre.

The accepted quantity of Thinning and Trimming for Signs will be paid for at the Contract unit price for each location designated in the Contract.

If the Contract does not contain a quantity for a Contract item listed in this Section, but such work is required, the work will not be paid for directly but will be considered incidental to all other Contract items.

Payment as indicated will be full compensation for performing the work specified, including disposal, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
201.10 Clearing and Grubbing, Including Individual Trees and Stumps	Lump Sum
201.11 Clearing and Grubbing, Including Individual Trees and Stumps	Acre
201.15 Removing Medium Trees	Each
201.16 Removing Large Trees	Each
201.20 Removing Medium Stumps	Each
201.21 Removing Large Stumps	Each
201.30 Thinning and Trimming	Acre
201.31 Thinning and Trimming for Signs	Each

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SECTION 202 – DEMOLITION AND DISPOSAL OF BUILDINGS

202.01 DESCRIPTION. This work shall consist of the removal, wholly or in part, and the satisfactory disposal of all buildings, including accessories and appurtenances, erosion prevention and sediment control, and the backfilling of holes and pits when required.

202.02 GENERAL CONSTRUCTION REQUIREMENTS. Basements shall be completely cleared of all unsuitable materials, debris, partition walls, and supports. Concrete or masonry floors or foundations shall be removed to a depth not less than 2 feet below subgrade or 1 foot below final ground level. Floors below these levels shall be broken or holes approximately 1 foot × 1 foot shall be provided at 10 foot intervals to provide vertical drainage.

Septic tanks, cesspools, or appurtenant pipes shall be emptied of their contents and filled with suitable material or removed. Underground fuel storage tanks shall be removed, unless otherwise approved by the Engineer and the Agency's Hazardous Materials and Waste Coordinator. All work related to all underground storage tanks shall be in accordance with all local, state, and federal regulations. The removal of any underground storage tank shall be coordinated through the Agency's Hazardous Materials and Waste Coordinator prior to commencing the removal of any underground storage tank.

Basements or cavities left by building removal shall be either filled with suitable material to the level of the existing ground and thoroughly compacted, or the area shall be regraded to present a smooth, free-draining surface. A combination of filling and regrading methods may be used. Where filling and regrading operations occur within the limits of construction, manipulation, and placement of material shall conform to Subsection 203.11. All regraded areas shall be seeded and mulched in accordance with Section 651 and to the satisfaction of the Engineer.

All debris shall be removed from the parcel, and the area shall be cleaned up and graded to the satisfaction of the Engineer.

All materials resulting from the demolition shall become the property of the Contractor and shall be disposed of or recycled in accordance with all applicable laws, rules, regulations, and protocols.

If applicable, the Contractor shall provide for the discontinuance of all utility services including, but not limited to, electricity, telephone, sewer, water, and gas lines and utility meters. The Contractor shall be held responsible for any Claim arising from failure to provide for the discontinuance of such utility services. If permission has been given to the previous owner to occupy a building until a specified date, the previous owner shall not be required to pay rent to the Contractor or to move on a date earlier than that specified. The Contractor shall provide for the discontinuance of all utility services after the specified date.

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The Agency shall not be responsible for any changes in the condition of the buildings, or for loss of fixtures or equipment, at any time.

Once work has commenced, the Contractor shall complete the demolition and disposal of each Contract item in a continuous manner to the satisfaction of the Engineer.

The Contractor shall erect barriers around the site in accordance with all applicable safety guidelines.

The Contractor shall be responsible for finding, opening, and maintaining all disposal areas and shall comply with all applicable regulations.

When identified in the Plans the Contractor shall be responsible for the removal and disposal of lead and/or asbestos. The removal and disposal of lead and/or asbestos shall be done in accordance with all applicable local, state, and federal regulations. The Contractor shall submit, to the Engineer and the Agency's Hazardous Materials and Waste Coordinator, all applicable certifications, licenses, permits, and plans for approval prior to the commencement of this work.

202.03 METHOD OF MEASUREMENT. The quantity of Demolition and Disposal of Building to be measured for payment will be on a unit basis for each building, as shown on the Plans

202.04 BASIS OF PAYMENT. The accepted quantity of Demolition and Disposal of Building will be paid for at the Contract unit price for each building specified in the Contract. Payment will be full compensation for removing, disposing and/or recycling of buildings; for excavating, backfilling, removal of hazardous materials and regrading incidental to their removal; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. When seed, mulch, other turf establishment items, and/or erosion prevention and sediment control items are not part of the Contract, they shall be considered incidental to the Demolition and Disposal of Building item.

Payment will be made under:

Pay Item	Pay Unit
202.10 Demolition and Disposal of Building	Each

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SECTION 203 – EXCAVATION AND EMBANKMENTS

203.01 DESCRIPTION. This work shall consist of excavating and grading roadways, runways and railways, slides, borrow pits, waterways, channels, intersections, approaches, and steps in hillside embankments and excavating unsuitable material from the construction area and beneath embankment areas, surfaces, and pavements. This work shall consist of excavating selected material found in the construction area for specific use in the construction; constructing and removing detours shown on the Plans or directed by the Engineer; trimming and shaping of slopes; performing test borings for the purpose of determining areas of roadway and embankment subsurface voids; and disposing of all unsuitable or surplus excavated material. The work shall also consist of placing material in embankments and the grading of all material placed up to subgrade to the tolerance specified in the Plans.

The work is classified as follows:

(a) Common Excavation. Common Excavation shall consist of the removal of all material, which can be accomplished with normal excavating machinery, encountered in grading the project and not classified to be removed as Solid Rock Excavation, Muck Excavation, Channel Excavation, Excavation of Surfaces and Pavements, or Excavation for Structures.

Excavation required beyond the finished slope neat lines for slope stabilization, removal of sod and unsuitable material other than muck located in embankment areas, removal and stockpiling of topsoil, and removal of unsuitable material existing at or below subgrade elevation in excavation areas is also classified as Common Excavation.

(b) Solid Rock Excavation. Solid Rock Excavation shall consist of the removal of hard igneous, metamorphic, or sedimentary rock that requires blasting or the use of rippers; detached rock; boulders; mortared stone masonry; or concrete each having a volume of 2 cubic yards or more; and Portland cement concrete pavement including any bituminous surface overlay material, encountered in the limits of excavation.

(c) Unclassified Excavation. Unclassified Excavation shall consist of Common Excavation and Solid Rock Excavation as classified above and not measured separately.

(d) Muck Excavation. Muck Excavation shall consist of the removal, disposal, and backfill of a saturated or unsaturated mixture of soils and organic matter encountered below the original ground line in an embankment area that is not suitable to be used as foundation material regardless of its moisture content.

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(e) Channel Excavation of Earth. Channel Excavation of Earth shall consist of the removal of all material, which can be accomplished with normal excavating machinery, encountered in the excavation, except as classified as Channel Excavation of Rock, for widening, deepening, and straightening of existing channels and waterways, or in the construction of new channels; and any other excavation designated to be removed as channel excavation as shown on the Plans or as directed by the Engineer.

(f) Channel Excavation of Rock. Channel Excavation of Rock shall consist of the removal of rock in definite ledge formation that requires blasting or the use of rippers; and detached rock, boulders, stone masonry, and concrete each having a volume of 2 cubic yards or more encountered in the excavation for widening, deepening, and straightening of existing channels and waterways, or in the construction of new channels.

(g) Unclassified Channel Excavation. Unclassified Channel Excavation shall consist of Channel Excavation of Earth and Channel Excavation of Rock as classified above and not measured separately.

(h) Excavation of Surfaces and Pavements. Excavation of Surfaces and Pavements shall consist of the removal and disposal of existing surfaces and pavements that are located outside other excavation and embankment limits.

(i) Borrow. Borrow shall consist of material required for the construction of embankments or for other portions of the work and shall be obtained from approved sources located outside the limits of the right-of-way, unless otherwise shown on the Plans or directed by the Engineer.

Borrow is further classified as Earth Borrow, Sand Borrow, Granular Borrow, or Rock Borrow.

(j) Test Borings. Test Borings shall consist of an investigative and planned approach to determining areas of roadway and embankment subsurface voids and repairing bored areas.

(k) Gravel Filter for Slope Stabilization. Gravel Filter for Slope Stabilization shall consist of an approved graded material placed against slopes and any other places designated for use of this material.

(l) Shoulder Berm Removal. Shoulder Berm Removal shall consist of removing the berm of debris and sand resulting from guardrail that is to be retained. The removal may be performed by hand labor or mechanical means. The Contractor shall remove the berm down to the proper line and grade for the shoulder from which the berm is being removed.

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The removed sand and fine debris may be scattered into the turf on the roadway slope outside the point of shoulder unless otherwise directed by the Engineer. Larger debris such as stones in excess of 2 inches in diameter, automobile parts, wood, glass, and other bulky items shall be disposed of properly by the Contractor.

203.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Classification of Soils 703.01
Earth Borrow.....703.02
Sand Borrow and Cushion 703.03
Granular Borrow 703.04
Rock Borrow.....703.05
Gravel Filter for Slope Stabilization.....704.07
Backfill for Muck Excavation.....704.09

Concrete for backfilling subsurface voids shall meet the requirements of Controlled Density (Flowable) Fill of Section 541.

Bituminous concrete pavement shall conform to the requirements of Section 406, as applicable for the Contract, with the exception that the mix design submittal and plant inspection requirements set forth in Section 406 will not apply.

203.03 GENERAL CONSTRUCTION REQUIREMENTS. Prior to beginning excavation, grading, and embankment operations in any area, all necessary clearing and grubbing in that area shall have been completed in accordance with Section 201.

All slopes in cut and embankment sections, ditches, and waterways, whether old or newly constructed, shall be satisfactorily cleaned and cleared of obstructions and left in a neat and trim condition. Excavation shall be performed in accordance with the Contract or as directed by the Engineer.

The construction area shall always be maintained to ensure proper drainage. Where traffic is maintained, care shall be exercised to keep the portion of the roadway or the traveled way open to traffic in a satisfactory condition as per Subsection 104.04A and Subsection 104.04B.

All suitable material removed by excavating shall be used in the formation of embankments as shown on the Plans or as directed by the Engineer. Any excavation that cannot be incorporated in embankments shall be disposed of as directed by the Engineer. No material shall be wasted without permission of the Engineer.

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The Contractor shall be responsible for the stability of all constructed embankments and shall replace, at no cost to the Agency, any portions that have become displaced and that are not attributable to the unavoidable movement of the natural ground upon which the embankment is made or to an act of God.

Unless directed by the Engineer, borrow material shall not be placed until all suitable material has been excavated and placed in the embankments, except when Sand Borrow or Granular Borrow is shown on the Plans or when Granular Borrow is required by the Engineer for use under embankments or used with material from excavation in making embankments. Should a surplus of excavated material result from the Contractor placing more borrow than required, the amount of this surplus will be measured by the Engineer and 115% of the total surplus will be deducted from the total quantity removed from the borrow source.

When not otherwise shown in the Contract, at all bridge approaches in excavation areas excavation for additional subbase shall be made to a depth of 4 feet below finish grade for a distance not less than 50 feet from the end of the bridge. The transition depth from normal subgrade level to any extra depth level shall be at a rate of 1:25 (V:H).

Prior to the construction of test borings and the placement of Controlled Density (Flowable) Fill, the Contractor shall submit to the Engineer site-specific plans, detailing the schedule of work (for these two items), type and location of drilling, sleeve installation, pumping system, confirmatory boring operation, method of filling bore hole (with or without voids being encountered), and repair of the roadway section (sand, gravel, and pavement).

All work performed under this Section shall conform to Section 105. Construction drawings shall be submitted in accordance with Section 105 whenever OSHA or VOSHA regulations require a design by a professional engineer.

203.04 EXCAVATION. Any loose material resulting from breakage and slides shall be removed and disposed of as directed by the Engineer.

Excavated material shall be sorted so that the best material is placed in embankments beneath the traveled way.

The Contractor shall not excavate or remove any material outside the limits of the excavation slope and grade lines shown on the Plans unless authorized in writing by the Engineer. Grading shall be to full cross-section width at subgrade before placing of any type of subbase or pavement, except that partial-width construction is permissible where necessary for the maintenance of traffic, and shall be done within the allowable tolerances as indicated on the Plans.

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The Contractor shall strip ledge and then notify the Engineer that the area is ready for cross-sectioning prior to making any rock excavation. Any ledge removed prior to the taking of cross-sections will be paid for as Common Excavation. The Contractor may use other means of locating the rock line with the approval of the Engineer.

When excavating solid rock by the blasting method, the Contractor shall drill slope holes to the full depth of the rock lift along the line and plane of inclination of the slope, as shown on the Plans or as otherwise directed by the Engineer. Spacing for the slope holes shall not exceed 3 feet, center to center of holes. The diameter of the slope holes shall be not greater than 3 inches. The line of blast holes shall be drilled parallel to the plane of the slope holes. No portion of any blast hole in this line shall be closer than 4 feet to the proposed finished slope. No portion of any blast hole larger than 3 inches in diameter will be permitted closer than 12 feet to the proposed finished slope.

When it is shown on the Plans that concrete shall be placed on or against the limits of rock excavation, care shall be taken to avoid disturbing, shattering, or removing rock outside such limits. Any costs incurred due to the unauthorized removal, shattering, or disturbing of the material outside the indicated limits shall be at the Contractor's expense.

The explosives used in the slope holes along the line of the finished slope and the adjacent slope holes shall be explosives for pre-splitting use only, prepared and packaged by explosives manufacturing firms and approved by the Engineer.

The slope holes along the line of the finished slope shall be loaded with approved explosives containing not more than 0.5 pounds of explosives per foot of hole depth. The spaced charges on a detonating cord shall be equal in length to the full depth of the hole. If spacers are used, the holes shall be completely stemmed so that uniform breakage of the rock will result from top to bottom of the hole. A bottom charge of not more than 8 pounds of explosive may be used. No explosive charge shall be placed within 30 ± 6 inches of the collar of the finished slope holes.

The Contractor shall complete the drilling, loading, stemming, and blasting of the slope holes at least 25 feet in advance of any other blasting.

In areas other than along the proposed finished rock cut slopes and adjacent slope holes, the spacing of holes, distribution of explosives, the methods of relief, and fractional second delay blasting shall be adjusted by the Contractor. The Contractor shall make adjustments according to the characteristics and structure of the rock encountered in order to obtain the required finished slopes with a minimum of overbreak.

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The depth of the rock lift within any one excavation area will be approved by the Engineer and shall be reduced by the Contractor if the proper alignment of the slope holes cannot be maintained.

203.05 MUCK EXCAVATION. The material shall be excavated to the widths and depths shown on the Plans or as required to give a stable foundation for the placement of necessary backfill, embankment, or subbase material. The excavation of this material shall be handled in a manner that will prevent the entrapment of muck within the backfill.

Unless otherwise specifically shown in the Contract, the material that has been excavated under this Contract item shall be spread on the fill slopes as shown on the Plans or as directed by the Engineer. If provision is not shown in the Contract for the disposition of the Muck Excavation, or if, in the opinion of the Engineer, its use on the slopes is impractical, then the excavated material shall be disposed of by the Contractor, in accordance with Subsection 203.09.

The backfilling of the excavated area shall immediately follow the excavation of the muck so that any soft material that is pushed ahead of the backfill can be removed.

The material used for backfilling the excavated area up to the ground line or water level, whichever is higher, shall be rock or other granular material selected from the excavation, if available. When this material is not available, it shall be obtained as Granular Borrow from an approved source.

After removal of the muck and prior to backfilling, the Contractor shall allow the Engineer adequate time to take all necessary measurements for determining the volume removed.

203.06 CHANNEL EXCAVATION. The area where the channel is to be excavated shall be cleared and grubbed as required. The work involved shall be considered as incidental work to Channel Excavation when Clearing and Grubbing, Including Individual Trees and Stumps is not a Contract item.

The channel shall be excavated to the lines, grades, and cross-sections shown on the Plans or as ordered by the Engineer. All suitable material excavated shall be used in the formation of roadway embankments or for other construction purposes as shown on the Plans or as directed by the Engineer. Unsuitable material or waste material, when directed by the Engineer, shall be wasted and disposed of by the Contractor at no additional compensation in accordance with Subsection 203.09.

203.07 EXCAVATION OF SURFACES AND PAVEMENTS. All excavation shall be made strictly to the required alignment, grade, and cross-sections shown on the Plans, or as directed by the Engineer for areas located outside of the limits of roadway excavation and embankment.

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All suitable materials removed shall be used, as far as practical, in the formation of embankments and at other locations as directed by the Engineer.

The completed excavation shall be properly graded and shaped prior to receiving any cover or top dressing.

203.08 BORROW. Opening, maintaining, and closing borrow pits shall be in accordance with Section 105. The simultaneous extraction of more than one borrow item from a given pit will require the written permission of the Engineer.

203.09 DISPOSAL OF SURPLUS EXCAVATION AND WASTE MATERIAL. All surplus excavation and waste material shall be deposited as shown on the Plans or as authorized in writing by the Engineer. Excavated material shall not be wasted unless authorized by the Engineer. Compaction requirements for surplus or waste material used to flatten slopes outside the embankment limits shown on the Plans may be waived; however, placement procedures shall ensure a stable fill slope.

Disposal of all surplus or waste material shall be in accordance with Section 105.

Disposal of surplus or waste material will not be paid for directly but shall be considered as incidental work pertaining to the grading or excavation Contract item from which the material was obtained.

When sufficient on-site disposal areas are not shown on the Plans, it shall be the responsibility of the Contractor to locate disposal areas in accordance with Section 105 and any applicable permits.

203.10 HAUL ROADS. Particular care shall be taken in the locating of haul roads. In wooded areas, haul road width shall be minimized and placed at approximate right angles or angled away from the view of oncoming traffic and, where feasible, shall incorporate one bend to eliminate the tunnel effect. Large and well-shaped trees shall be preserved.

203.11 EMBANKMENTS.

(a) Preparation of Embankment Area. When embankments are to be made on a hillside, the slope of the original ground on which the embankments are to be constructed shall be stepped and properly drained as the fill is constructed in accordance with the Plans or as directed by the Engineer.

(b) Use of Materials. The excavated rock, ledge, boulders, and stone, except where required in the construction of other items or otherwise directed, shall be used in the construction of embankments to the extent of the project requirements and, generally, shall be placed to form the base of an embankment. When shown on the Plans, certain portions of rock excavation may be reserved for special use such as rock fill, for embankment construction at locations below high water, or at locations susceptible to erosion.

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Frozen material shall not be used in the construction of embankments. The embankments or successive layers of the embankments shall not be placed upon frozen material. Placement of material other than rock shall stop when the sustained ambient air temperature, below 32°F, prohibits attainment of the required compaction. If the material is otherwise acceptable, it shall be stockpiled and reserved for future use when its condition is acceptable to the Engineer for use in embankments.

(c) Procedure for Placing and Spreading. When an embankment is to be constructed across open water or across swampy, wet ground, the first layer of the fill shall be Rock Borrow or Granular Borrow.

The first layer of the embankment may be constructed in one thickness of rock or Granular Borrow, to the minimum elevation at which equipment may be operated, as directed by the Engineer. Above this elevation, the embankment shall be constructed as specified below. Material from excavation on the project shall be used to the extent available and when not available shall be obtained from sources of Granular Borrow or Rock Borrow when authorized in writing by the Engineer.

When trucks are used to place earth from excavation or borrow, the material shall be deposited on the layer of embankment being constructed, bladed or dozed into place, and shaped and compacted. Dumping directly onto previously constructed layers will not be permitted.

Embankments of either earth or rock material shall be placed in horizontal layers of uniform thickness and across the full section width. When it is impractical to construct a full width layer across an embankment, partial width layers may be authorized, provided the full width procedure is resumed as soon as practical.

Logs, stumps, waste material, and oversized cobblestones or boulders shall not be placed within the structural embankment area. They may be placed outside the structural embankment area at locations directed by the Engineer or, when authorized, disposed of as surplus material. Initial layers shall begin at the deepest part of the fill. Except for the first layer of fill over swampy ground and cleared areas, the loose layer thickness shall be limited to 8 inches.

When conditions necessitate, the Engineer may authorize layers in excess of 8 inches but not more than 24 inches. The Contractor shall make all necessary excavations up to 24 inches deep so that the Engineer can determine moisture, density, and stability, solely at the Contractor's expense.

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Effective spreading equipment shall be used on each layer to obtain uniform thickness. Cobblestones or boulders having their least dimension greater than the loose layer thickness being placed shall be removed prior to compaction. Each layer shall be compacted as specified, and, if necessary, stabilized prior to a successive layer being placed. Each layer shall be kept crowned to shed water. As the compaction of each layer progresses, continuous leveling and manipulating will be required to ensure uniform density, a uniform and satisfactory moisture content, and acceptable stability. The last lift constructed each working day shall be graded, crowned, and rolled to ensure adequate drainage.

When A4, A5, A6, or A7 cohesive soils, as identified in Table 703.01A, have excess moisture and cannot effectively be air dried or dried by manipulation, the Contractor may layer or mix the material with dry A1, A2, or A3 granular soils to obtain acceptable compaction and stability. The Contractor is responsible for making prudent use of available granular excavation from the project prior to being authorized the use of Granular Borrow. The combined loose thickness of mixed or layered materials prior to compaction shall not exceed 16 inches.

During the construction of the embankments, if bulging, cracking, or unstable movement occurs, the placing of the fill material shall be stopped, retarded, or corrected to allow the material to stabilize as directed by the Engineer. Rutting, rolling, shoving, or other displacement in excess of 6 inches under the action of construction equipment may be considered evidence of stability problems.

When soft or wet clay or silt excavation is being used between layers of reasonably clean stable rock fill, the rock embankment layers shall not exceed 24 inches in loose measurement. The clay or silt layers shall not exceed 8 inches in loose measurement.

If embankments are to be constructed by using rock excavation, all reasonable precaution must be taken to ensure a solid embankment. The fill shall be made in uniform layers consistent with the size of the rock being used, but not to exceed 24 inches in thickness. Individual pieces of rock or boulders with their least dimension exceeding the thickness of the layer being placed shall either be reduced to an acceptable size or placed outside the structural embankment area in such a manner that all voids are filled.

Rock shall not be dumped over the end of a fill. Rock shall be deposited on the fill and distributed by blading or dozing to ensure proper placement in the embankment so that voids, pockets, and bridging are reduced to a minimum.

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(d) Compaction. Each layer between the design embankment limits shown on the Plans shall be uniformly compacted using compaction equipment to not less than 95% of the material's maximum dry density as determined by *AASHTO T 99*, Method C. Field density determination will be made in accordance with *AASHTO T 191*, Sand Cone Method; *AASHTO T 310,* Nuclear Method; or other approved procedures. Field moisture determination will be made in accordance with *AASHTO T 99* or measured in accordance with *AASHTO T 310*, Nuclear Method. Locations within the embankment limits where waste materials have been placed shall be compacted to the extent that stability is ensured.

All fill material shall be compacted at a moisture content determined by the Engineer to be suitable for obtaining the required density. The moisture content in each layer under construction shall not exceed 2% above the optimum moisture content, and it shall be less than that quantity that will cause the embankment to become unstable during compaction. The Engineer will consider sponginess, shoving, or other displacement under heavy equipment sufficient evidence of a lack of stability under this requirement, and the Contractor shall stop or retard further placement of material in the area affected to allow the material to stabilize.

When the moisture content of the material in the layer under construction is less than the amount necessary to obtain the required compaction by mechanical compaction methods, water shall be added by pressure distributors or other approved equipment. Water may also be added in excavation or borrow pits. The water shall be uniformly and thoroughly incorporated into the soil by discing, harrowing, blading, or other approved methods. This manipulation may be omitted for sand and gravel.

When the moisture content of the material is in excess of 2% above the optimum moisture content, dry material shall be thoroughly incorporated into the wet material, or the wet material shall be aerated by disking, harrowing, blading, rotary mixing, or other approved method; or compaction of the layer of wet material shall be deferred until the layer has dried to the required moisture content by evaporation.

The density requirements do not apply to those portions of embankments constructed of material so coarse that it cannot be properly tested with a conventional density testing apparatus. Instead, the material shall be compacted to the satisfaction of the Engineer.

In areas inaccessible to power rolling, the embankment material shall be placed in uniform horizontal layers of not more than 6 inches in depth and compacted by means of approved mechanical tampers to the density requirements specified above. The use of hand tamps will not be permitted.

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Additionally, the following requirements apply to airport compaction:

(1) Under all areas to be paved, the top 9 inches of the embankment shall be compacted to a density of not less than 95% of maximum density for cohesive soils, and 100% for noncohesive soils, unless otherwise shown in the Contract.

(2) In areas designed for the use of aircraft, the determination of maximum density and optimum moisture content will be performed per *AASHTO T 180*, Method D.

(e) Test Borings. Test borings shall be performed at the approximate locations indicated in the Plans and/or as directed by the Engineer.

When used adjacent to culverts, test borings shall extend to a depth equal to the bottom of the culvert using casing advance drilling methods. Alternate drilling equipment that provides a suitably clean, open hole may be submitted to the Engineer for approval.

If voids are encountered, Controlled Density (Flowable) Fill shall be placed to completely fill the voids. Confirmatory borings shall be performed in these locations as directed by the Engineer.

The roadway surface at boring hole locations shall be backfilled and then patched using bituminous concrete pavement.

203.12 SUBGRADE. The subgrade shall be constructed to the lines, grades, and cross-sections shown on the Plans. After all drainage structures have been installed and the subgrade has been shaped correctly, the subgrade shall be brought to a firm, unyielding surface compacted to attain at least 95% of the maximum dry density. This density will be determined by *AASHTO T 99,* Method C.

A power grader or other approved equipment shall be used during the placement and compaction to obtain the specified cross-section.

Areas of soft, yielding, or otherwise unsuitable material that will not compact readily shall be removed, replaced with a suitable material, and properly compacted as directed by the Engineer.

All loose rock or boulders encountered at subgrade in the earth excavation shall be removed or broken off to a depth not less than 12 inches below the subgrade.

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In excavation areas, the ground shall not be excavated or disturbed below the subgrade except as shown in the Contract or as directed by the Engineer. All ditches and drains shall be constructed so they will effectively drain the construction area before the placement of any subbase or surface course material. In handling materials, tools, and equipment, the Contractor shall protect the subgrade from damage. Vehicles should not travel in a single track and form ruts. If ruts are formed, the subgrade shall be reshaped and compacted. Any pockets of clay, sand, or soft material that may have been left in the subgrade shall be removed and replaced with approved material and properly compacted at the Contractor's expense.

The subgrade shall be kept in a condition that it will drain. Subbase, base, or surface material shall not be deposited on the subgrade until the subgrade has been checked and approved by the Engineer. After the subgrade has been approved, the Contractor shall not perform hauling or move equipment that will distort the cross-section over the subgrade.

A tolerance of 1/2 inch above or below the finished subgrade will be allowed provided that this tolerance is not maintained for a distance longer than 50 feet and that the required cross-section is maintained. Grading shall be done with a power grader or other approved equipment to conform to the requirements as specified above.

For airport construction, the field density will be determined in accordance with Subsection 203.11(d). In fill sections, stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 6 inches below subgrade.

203.13 METHOD OF MEASUREMENT.

(a) Excavation. The quantity of all excavation items to be measured for payment will be the number of cubic yards of the material removed from the areas shown on the Plans or as directed by the Engineer. The quantity will be measured in its original position by cross-sections and computed by the method of average end areas. When impractical, other acceptable methods involving three-dimensional measurement may be used to determine the quantity. The limits shall not exceed those shown on the Plans or authorized in writing by the Engineer.

The method of mass centers for computing volumes will be allowed only when the method has been used in the original design computations. Excavation requiring more than one handling prior to final placement in embankments will not be measured for payment for the additional handling unless specifically stated in the Contract.

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(1) Common Excavation. Excavation for stepping of original ground under hillside embankments will not be measured for payment.

Excavation for removal of soft spots in the subgrade of embankment areas and the material required for replacement will not be measured for payment. Any costs will be considered included in the Contract items involved.

However, where the embankments were constructed as part of another contract, the quantities of excavation for removal of soft spots and the material for replacement will be measured for payment.

(2) Solid Rock Excavation. The measurement limits for Solid Rock Excavation will coincide with the depth shown on the Plans or as directed by the Engineer. Excavation below subgrade will not be measured. Measurement limits for determining the amount of Solid Rock Excavation will be that amount actually removed up to a limit 12 inches outside of and parallel to the slope lines shown on the Plans or as directed by the Engineer. Measurement for payment will not be made for rock removed beyond these limits unless authorized. If natural fissures or faults exist making removal of rock beyond these limits necessary, the Engineer will authorize removal in writing, and the limits of excavation will be adjusted accordingly.

(3) Unclassified Excavation. The quantity of Unclassified Excavation to be measured for payment will be the number of cubic yards of material excavated as shown on the Plans or as directed by the Engineer. There shall be no differentiation made between common or solid rock excavation for this item.

(4) Muck Excavation. The quantity of Muck Excavation to be measured for payment will be the number of cubic yards of material excavated as shown on the Plans or as directed by the Engineer.

(5) Channel Excavation of Earth. The quantity of Channel Excavation of Earth to be measured for payment will be the number of cubic yards of material excavated from its original position. No differentiation will be made between the channel excavation of dry or wet material.

Where excavation (Common, Solid Rock, or Unclassified) and Channel Excavation occur jointly or separately at the same location, measurement for Channel Excavation will be made only below the lower limits of Common, Solid Rock, or Unclassified Excavation.

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(6) Channel Excavation of Rock. Measurement limits for determining the amount of Channel Excavation of Rock will be as specified in Subsection 203.13(a)(2).

Where excavation (Common, Solid Rock, or Unclassified) and Channel Excavation occur jointly or separately at the same location, measurement for Channel Excavation will be made only below the lower limits of Common, Solid Rock, or Unclassified Excavation.

(7) Excavation of Surfaces and Pavements. The quantity of Excavation of Surfaces and Pavements to be measured for payment will be the number of cubic yards of material removed and disposed of, measured in its original position. The measurement limits of excavation will not exceed those shown on the Plans or directed by the Engineer.

(b) Borrow. The quantity of borrow to be measured for payment of the type indicated, except Sand Borrow, will be the number of cubic yards of the material removed and used in the complete and accepted work from approved borrow sources measured in its original position. The quantity of Granular Borrow used to replace solid rock excavated below subgrade will be allowed and measured for payment to a depth not to exceed 3 inches. Any solid rock excavated below this depth shall be replaced by the Contractor with material from Solid Rock Excavation or Granular Borrow, furnished and placed at the Contractor's expense.

For small quantities of borrow, with the written permission of the Engineer, the quantity to be measured for payment of the type of borrow indicated will be the number of cubic yards of material used in the complete and accepted work, as determined by the vehicle loads using three-dimensional measurements. A load ticket including truck identification and date of delivery shall be furnished to the Engineer upon delivery for each load delivered to the site. All vehicles shall be loaded to at least their water level capacity, and any load designated shall be leveled at the point of delivery when directed by the Engineer. All quantities computed from vehicle load measurement will be divided by a factor of 1.15 and the resulting volume paid at the Contract unit price for those Contract items.

Stripping of pits to obtain borrow will not be paid for separately but will be considered incidental to the various borrow Contract items.

Any material removed or excavated from a borrow pit before cross-sections and measurements have been taken will not be paid for. No borrow quantity will be allowed that is not taken from measured borrow pits, unless otherwise agreed upon in writing by the Engineer and the Contractor.

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Should more borrow be placed than required, resulting in a waste of excavated material, or should embankments be constructed beyond the neat lines shown on the Plans, unless otherwise authorized in writing by the Engineer, 115% of the amount of such waste or excess will be deducted from the total amount of specified borrow being used.

When requested by the Contractor and authorized in writing by the Engineer, material specified to be measured by the cubic yard may be measured by mass (weighed) and the weight converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before the method of measurement of pay quantities is used.

The simultaneous extraction of more than one borrow item from a given pit will require the written permission of the Engineer, and the method of measurement shall be as specified by the Engineer.

(1) Earth Borrow. With the written permission of the Engineer, the method of measurement for Earth Borrow may be changed to the number of cubic yards in place in the complete and accepted work multiplied by a factor of 1.15.

When material from excavation is removed and either used for payment under another Contract item or diverted for the Contractor's use, such as the construction of haul roads, the quantity measured for these uses will be multiplied by a factor of 1.15. The resulting quantity will be deducted from the total quantity of Earth Borrow.

(2) Sand Borrow. The quantity of Sand Borrow to be measured for payment will be the number of cubic yards placed in the complete and accepted work, as determined by the Plan dimensions of the compacted material. No allowance will be made for material placed to a greater depth or width than shown on the Plans unless authorized in writing by the Engineer.

(3) Granular Borrow. With the written permission of the Engineer, the method of measurement for Granular Borrow may be changed to the number of cubic yards in place in the complete and accepted work multiplied by a factor of 1.15.

(4) Rock Borrow. When obtained from previously blasted or stockpiled sources, the quantity of Rock Borrow to be measured for payment will be the number of cubic yards of blasted material measured in the pile before removal divided by a factor of 1.35.

(c) Gravel Filter for Slope Stabilization. The quantity of Gravel Filter for Slope Stabilization to be measured for payment will be the number of cubic yards placed in the complete and accepted work. Measurements will be confined to the limits shown on the Plans or as directed by the Engineer.

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(d) Shoulder Berm Removal. The quantity of Shoulder Berm Removal to be measured for payment shall be the number of linear feet of shoulder from which the berm was properly removed, measured from the beginning point of removal to the end point of removal.

(e) Test Borings. The quantity of Test Borings to be measured for payment will be the number of linear feet of test boring performed in the complete and accepted work.

203.14 BASIS OF PAYMENT. The accepted quantities as measured will be paid for at the Contract unit price per cubic yard for the specified items, except for Shoulder Berm Removal and Test Borings, which will be paid for at the Contract unit price per linear foot. Payment will be full compensation for performing the work specified, submitting site-specific plans as required, performing test borings, installing sleeves, backfilling, patching with bituminous concrete pavement, including any drilling and blasting required, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

No added compensation will be made for any special manipulation or delay resulting in the drying or wetting of soils necessary to obtain the required compaction. The entire cost of such manipulation and delay will be considered included in the Contract unit price for the excavation item involved.

Compensation for the construction of embankments, as defined in Subsection 203.11, shall be considered incidental to the various excavation items. Water added to embankment material to aid in compaction will not be paid for directly but will be considered incidental to the Contract items involved.

All work and material required to grade, loam, seed, and mulch waste areas, borrow pits, and haul roads, as specified, to eliminate unsightly conditions and prevent erosion will not be paid for directly but will be considered incidental to the various types of excavation and borrow.

Material used for backfilling voids created by the removal of unsuitable material below subgrade and on slopes will be paid for at the Contract unit price per cubic yard for the particular Contract item used in making the backfill. If the particular item required for backfill is not included in the Contract, a Change Order for this item will be negotiated, with the exception of backfilling for Muck Excavation, which shall be incidental to the item.

The work specified in Subsection 203.12 will not be paid for directly but will be considered as incidental work pertaining to the excavation and borrow items.

On borrow projects, solid rock removed beyond the authorized limit, as specified for solid rock measurement, may be paid at the Contract unit price for other excavation or borrow items in the Contract, whichever unit price is the least, provided the material is used in constructing approved embankments.

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When the subgrade has been prepared by others under another contract, the excavation necessary to bring the subgrade to the required grade and cross-section or for the removal of soft spots in the subgrade will be paid for as Common Excavation.

All grading and shaping required after removing material paid for as Excavation of Surfaces and Pavements will not be paid for directly but will be considered incidental to this item.

Filling of subsurface voids encountered in performing test borings will be paid for under item 541.45.

Payment will be made under:

Pay Item	Pay Unit
203.15 Common Excavation	Cubic Yard
203.16 Solid Rock Excavation	Cubic Yard
203.17 Unclassified Excavation	Cubic Yard
203.20 Muck Excavation	Cubic Yard
203.25 Channel Excavation of Earth	Cubic Yard
203.26 Channel Excavation of Rock	Cubic Yard
203.27 Unclassified Channel Excavation	Cubic Yard
203.28 Excavation of Surfaces and Pavements	Cubic Yard
203.30 Earth Borrow	Cubic Yard
203.31 Sand Borrow	Cubic Yard
203.32 Granular Borrow	Cubic Yard
203.33 Rock Borrow	Cubic Yard
203.35 Gravel Filter for Slope Stabilization	Cubic Yard
203.40 Shoulder Berm Removal	Linear Foot
203.45 Test Borings	Linear Foot

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SECTION 204 – EXCAVATION FOR STRUCTURES

204.01 DESCRIPTION. This work shall consist of the excavation and backfill or disposal of material removed.

All excavation for structures below the designated slope or subgrade line as shown on the Plans shall be included in this work.

The work is classified as follows:

(a) Trench Excavation. Trench Excavation shall consist of excavation for the construction of new culverts and pipes of 4 foot clear span and under, conduits, culvert headwalls, drop inlets, manholes, catch basins, leaching basins, underdrains, concrete steps, and other minor structures, and drainage ditches at the inlet and outlet of drainage structures with a clear span of 4 feet and under; excavation for the removal of all existing drainage structures; exploratory excavation for locating underground utility services and/or other structures; and any other excavation designated to be removed under this Contract item.

(1) Trench Excavation of Earth. Trench Excavation of Earth shall consist of all material excavated within the limits shown in the Contract, except boulders measuring 18 cubic feet or more, solid rock, mortared stone masonry, and concrete; and the removal of all existing pipes with a clear span of 4 feet and under, regardless of material.

(2) Trench Excavation of Earth, Exploratory. Exploratory excavation to locate underground utility services and/or other structures shall be conducted where directed by the Engineer and shall be classified as Trench Excavation of Earth, Exploratory. The Contractor shall utilize protective measures during this excavation to avoid damage to any underground service or structure. When necessary, the Contractor shall cooperate with representatives of the utility companies to avoid damage to the utilities by permitting the utility companies to erect suitable supports, props, shoring, or other means of protection.

(3) Trench Excavation of Rock. Trench Excavation of Rock shall consist of all solid rock in formation, or boulders measuring 18 cubic feet or more, excavated within the limits shown in the Contract. All mortared stone masonry and concrete irrespective of the size of its components, excavated within the above limits, shall likewise be considered as rock.

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(b) Structure Excavation. Structure Excavation shall consist of excavation for the construction of foundations and substructures of all structures with a clear span of over 4 feet, pipe culverts and storm sewers of over 4 foot clear span, grade separation structures, retaining walls, cribs, and any other excavation designated to be removed under this Contract item. If temporary bracing, sheeting, or other means of supporting the excavation is required, construction drawings shall be submitted in accordance with Section 105.

(c) Granular Backfill for Structures. Granular Backfill for Structures shall consist of approved material placed within the limits shown on the Plans or directed by the Engineer.

204.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Coarse Aggregate for Concrete.....704.02(a)
Crushed Gravel for Subbase, Fine Graded .....704.05(a)
Granular Backfill for Structures.....704.08

Concrete shall have a minimum 28-calendar day compressive strength of 3,000 psi and shall conform to the requirements of Section 541.

When approved in writing by the Engineer, material meeting the gradation requirements for Coarse Aggregate for Concrete may be substituted for Granular Backfill for Structures under footings.

When approved in writing by the Engineer, material meeting the gradation requirements for Crushed Gravel for Subbase, Fine Graded may be substituted for Granular Backfill for Structures.

204.03 GENERAL CONSTRUCTION REQUIREMENTS. The locations and elevations for excavation shown on the Plans shall be considered as approximate only. The Engineer may order removal of poor foundation material below the designed elevation and replacement with an approved material.

All suitable excess excavated material shall be used in the formation of embankments, at other locations shown on the Plans, or as directed by the Engineer. The Contractor shall haul and dispose of the material at no additional compensation.

All work performed under this Section shall conform to Section 105. Construction drawings shall be submitted in accordance with Section 105 whenever OSHA or VOSHA regulations require a design by a professional engineer.

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204.04 PREPARATION OF FOUNDATION. The foundation pits shall be excavated so that the footings are the full lengths and widths shown on the Plans. The footings shall be constructed with full horizontal beds. Unless otherwise specified or authorized in writing, foundations shall be constructed in the dry. The site shall be dewatered to or below the footing elevation or lowest elevation of a structural component.

The excavation shall continue to either bedrock or the elevation specified for footings on soil. All loose material shall be removed, and all seams in the rock shall be cleaned out and filled with concrete or as directed by the Engineer. No excavation shall be done below the elevations shown on the Plans unless authorized in writing by the Engineer. Any material excavated without authority shall be replaced with concrete or as directed by the Engineer at the Contractor's expense.

When the footing is to be constructed on an excavated surface other than rock, particular care shall be taken not to disturb the bottom of the excavation. No excavation shall be done below the elevations shown on the Plans, unless authorized in writing by the Engineer. Any material excavated without authority shall be replaced with approved backfill and thoroughly compacted in accordance with Subsection 204.05(a) at the Contractor's expense.

When poor foundation material is encountered at the designed foundation level, it shall be removed as Structure Excavation or Trench Excavation and replaced with Granular Backfill for Structures or other suitable material as shown on the Plans or as directed by the Engineer, and thoroughly compacted in accordance with Subsection 204.05(a).

204.05 BACKFILL.

(a) General. All spaces excavated and not occupied by structures or select backfill shall be backfilled with material from excavation, unless otherwise specified. The Contractor shall backfill up to the elevation of existing ground or 2 feet over the pipe, whichever is less, as shown on the Plans or as directed by the Engineer.

All backfill material shall be placed in 6 inch maximum (loose measure) horizontal layers, and each layer shall be thoroughly compacted by means of air or mechanical tampers. Backfill material placed within the limits of Trench Excavation or Structure Excavation shall have a maximum stone size less than 3 inches.

Compaction by means of hand tamping will not be permitted.

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Where backfill is to be placed on both sides of a structure, the layers on both sides shall be brought up simultaneously and at approximately the same level to avoid unbalanced pressure. Care shall be taken to prevent wedging action against the structure.

(1) Backfill of Trenches. The backfill shall be carried to the upper-most level of the trench or subgrade. No stones or blasted bedrock exceeding 3 inches in diameter shall come in contact with pipes during backfill operations.

(2) Backfill of Structures. No backfill material shall be placed against a newly completed structure until the concrete has cured for 7 calendar days or until it has obtained 85% of the designed compressive strength, and then only with the permission of the Engineer.

Evidence of satisfactory compaction of the backfill adjacent to structures will consist of the attainment of the density required for the adjacent embankment material by testing at least every third layer in accordance with Subsection 203.11(d).

204.06 METHOD OF MEASUREMENT.

(a) Trench Excavation. The quantity of Trench Excavation of Earth, Trench Excavation of Earth, Exploratory, or Trench Excavation of Rock to be measured for payment will be the actual number of cubic yards excavated up to the maximum dimensions as follows:

(1) The horizontal dimensions for excavation for culverts and pipes (excluding underdrain and carrier pipe) shall be the distance between vertical planes 18 inches outside of the interior lines of the culvert or pipe.

(2) The horizontal dimensions for drop inlets, manholes, end sections, and other minor structures shall be 18 inches outside the exterior lines of the structure.

(3) The width dimensions for underdrain shall be shown on the Plans.

(4) The depth dimension for culverts, pipes, underdrain, drop inlets, manholes, and other minor structures shall be the vertical dimension from the original ground surface or bottom limits of other excavation to the bottom of authorized excavation. Unless otherwise specified in the Plans, or directed by the Engineer, limits of excavation shall extend 1 foot below the pipe or structure.

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(5) When culverts, pipes, underdrains, drop inlets, manholes, and other minor structures are in embankment areas, the natural ground line as cross-sectioned shall be the uppermost level of computation, unless otherwise specified. Vertical measurements will be used for the depth in making computations of Trench Excavation as follows:

a. 100% of the volume for the first 5 feet of vertical depth.

b. 150% of the volume below the first 5 feet of vertical depth.

(6) When Trench Excavation of Rock and Drilling and Blasting of Solid Rock Subgrade occur at the same location, the quantity of Trench Excavation of Rock will be measured for payment below the subgrade.

(7) The quantity of any material that the Engineer directs to be removed after the embankments have been placed will be included in the total amount for Trench Excavation.

(8) In measuring masonry or concrete as Trench Excavation of Rock, for all openings having cross-sectional areas of 4 square feet or less, the volume will be included as part of the rock. For all openings having cross-sectional areas greater than 4 square feet, the volume will be deducted and not allowed as either Trench Excavation of Rock or Trench Excavation of Earth.

(9) The quantity of Trench Excavation of Earth, Exploratory to be measured for payment will be the number of cubic yards of excavation, regardless of depth, for locating underground utility services and/or other structures where directed by the Engineer.

(b) Structure Excavation. The quantity of Structure Excavation to be measured for payment will be the number of cubic yards measured and computed by average end area method as follows:

(1) Vertically. Between the original ground surface or the bottom limits of any other excavation item, whichever is the lower elevation, and the bottom of the structure excavation.

Where excavation (Common, Solid Rock, or Unclassified), Channel Excavation, and Structure Excavation occur at the same location, measurement for Channel Excavation will be made only below the lower limits of excavation and measurement for Structure Excavation will be made only below the lower limits of Channel Excavation.

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The removal of authorized material below the elevation of the bottom of the excavation as shown on the Plans will be measured in accordance with Table 204.06A.

TABLE 204.06A – STRUCTURE EXCAVATION MULTIPLIERS

Vertical Depth Below Bottom of Excavation Indicated on the Plans (feet)	Volume of Structure Excavation Multiplied By
0 – 1	100%
> 1 – 5	150%
> 5 – 10	450%
> 10 – 15	750%
> 15	Paid as extra work

Where a foundation or component of a structure is designed or directed to be placed on bedrock, an average 6 inch maximum allowance for overbreakage will be allowed for measurement. Additional overbreakage shall be at the Contractor's expense.

(2) Horizontally. Between vertical planes 18 inches outside the neat lines of footings, beams, or other structural components, and parallel thereto except for the following:

a. The horizontal measurements of the Structure Excavation for reinforced concrete boxes shall be the overall width of the box, plus 18 inches on each side, and the length of the structure, plus 18 inches on each end.

b. The horizontal measurements for corrugated plate arches shall be the width of each abutment, plus 18 inches on each side, and the length of the arch, plus 18 inches on each end.

c. The horizontal measurements for pipes and pipe arches having a diameter or span over 48 inches shall be between vertical planes 3 feet outside the exteriors of each side, and the length of the pipes or pipe arches plus 18 inches on each end.

When footings are not used, the neat lines shall be the junction line between the new concrete and the old masonry or bedrock.

(c) Granular Backfill for Structures. The quantity of Granular Backfill for Structures to be measured for payment will be the number of cubic yards placed in the complete and accepted work within the confines of the limits shown on the Plans or as directed by the Engineer.

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When Coarse Aggregate for Concrete or Crushed Gravel for Subbase, Fine Graded is substituted for Granular Backfill for Structures, it will be measured and paid for as Granular Backfill for Structures.

204.07 BASIS OF PAYMENT. The accepted quantities for Trench Excavation, Trench Excavation of Earth, Exploratory, Structure Excavation, and Granular Backfill for Structures will be paid for at the Contract unit price per cubic yard for each of the Contract items specified in the Contract. Payment will be full compensation for performing the work specified, including placement and compaction of backfill, disposal or placement in embankments of all surplus material, and the cleaning up of the site following completion of construction areas, and for furnishing all labor, materials, tools, equipment, sheeting, bracing, and incidentals necessary to complete the work.

Unless otherwise specified, Structure Excavation will include all sheeting, bracing, dewatering, and siltation control, preparing and submitting construction drawings where required, and incidentals necessary for properly constructing, in the dry, a foundation or structural component.

All material removed beneath a vertical depth of 15 feet below the bottom of Structure Excavation limits shown on the Plans, or changes in sheeting, bracing, or dewatering necessitated by excavating below the 15-foot limit, will be paid for as extra work.

No differentiation will be made in Structure Excavation between the excavation of wet or dry material, earth, gravel, boulders, rock, old masonry, or reinforced concrete.

When exploratory excavation is conducted exclusively for the purpose of locating existing underground utility services and/or other structures when directed by the Engineer, the costs of such excavation, regardless of depth, will be paid for at the Contract unit price bid per cubic yard for Trench Excavation of Earth, Exploratory. Payment will be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work, including locating and protecting existing underground utility services and/or other structures, and for restoring the work area to the satisfaction of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
204.20 Trench Excavation of Earth	Cubic Yard
204.21 Trench Excavation of Rock	Cubic Yard
204.22 Trench Excavation of Earth, Exploratory (N.A.B.I.)	Cubic Yard
204.25 Structure Excavation	Cubic Yard
204.30 Granular Backfill for Structures	Cubic Yard

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SECTION 205 – DRILLING AND BLASTING

205.01 DESCRIPTION. Except as otherwise specified, this work shall consist of the drilling and blasting of rock to remain in place.

205.02 DRILLING AND BLASTING OF SOLID ROCK. Holes shall be drilled to the approximate depth and at the approximate spacing shown on the Plans or as directed by the Engineer.

Following the drilling, explosives shall be placed in each hole and then detonated. The amount of explosive shall be sufficient to shatter and rearrange the rock for the full depth of the drill holes. Blasting shall be done progressively from the lower level to the top level. The removal of the blasted rock is not required under the work in this Section.

205.03 DRILLING AND BLASTING OF SOLID ROCK SUBGRADE. Subgrade areas shall be shattered to the dimensions shown on the Plans or directed by the Engineer.

The area of blasted rock subgrade shall extend sufficiently beyond the beginning and end of cut areas to ensure the shattering of all rock to a depth of 4 feet below the bottom of subbase material elevation to eliminate water pockets.

After detonation, any rock protruding above the bottom of subbase shall be removed. When directed by the Engineer, the Contractor shall excavate a trench across the blasted rock to determine if the rock is broken and rearranged to a depth of 4 feet below the bottom of subbase. Afterwards, the trench shall be backfilled with the rock removed.

205.04 METHOD OF MEASUREMENT. The quantity of Drilling and Blasting of Solid Rock to be measured for payment will be the number of linear feet of drill holes drilled and detonated in accordance with this Section.

The quantity of Drilling and Blasting of Solid Rock Subgrade to be measured for payment will be the number of square yards of subgrade plan area drilled and detonated in accordance with this Section, measured at the bottom of subbase.

The number of cubic yards of excavation required by the Engineer to inspect the depth of shattered and rearranged rock, computed at a maximum width of 30 inches, will be measured for payment as Trench Excavation of Earth.

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Any area designated as Trench Excavation of Rock will not be included in the measurement and payment for Drilling and Blasting of Solid Rock Subgrade.

205.05 BASIS OF PAYMENT. The accepted quantities as measured will be paid for at the Contract unit price per linear foot or square yard, as applicable, for the specified Contract items. Payment will be full compensation for performing the work specified including any necessary stripping of rock below the bottom of subbase and refilling with approved material to the bottom of subbase, the removal of blasted subgrade rock that may swell above subgrade, and its disposition on the project as shown in the Plans or as directed by the Engineer.

Excavation and backfill required to inspect the depth of broken rock below subgrade will be paid for at the Contract unit price per cubic yard for Trench Excavation of Earth.

Payment will be made under:

Pay Item	Pay Unit
205.10 Drilling and Blasting of Solid Rock	Linear Foot
205.20 Drilling and Blasting of Solid Rock Subgrade	Square Yard

SECTION 208 – COFFERDAMS

208.01 DESCRIPTION. This work shall consist of the construction, material excavation within, dewatering, maintenance and removal of cofferdams in accordance with the Contract.

The work will be classified as follows:

(a) Cofferdam. This item shall consist of providing a method for constructing, in the dry, a specific foundation or other component of a structure in accordance with Contract requirements. This may involve the design, construction, maintenance, and removal of a watertight structure or may involve alternate methods of de-watering and stabilizing the specific site.

Construction of foundation seals per Contract or as required per Contractor plans and schedule of operations is also within the scope of work for the Cofferdam item. The Contractor shall obtain any and all necessary permits or clearances for alternate methods.

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(b) Cofferdam Excavation, Earth. This item shall consist of all material excavated within the pay limits as set forth in these specifications or indicated on the Plans except solid rock, mortared stone masonry, concrete, and boulders measuring 0.5 cubic yards or more.

(c) Cofferdam Excavation, Rock. This item shall consist of all solid rock material excavated within the pay limits as set forth in these specifications or indicated on the Plans, including all solid rock, mortared stone masonry, concrete, and boulders measuring 0.5 cubic yards or more.

208.02 MATERIALS. Concrete used in a cofferdam foundation seal or for replacing overbreakage shall have a minimum 28-calendar day compressive strength of 3,000 psi and shall conform to the requirements of Section 541.

208.03 GENERAL CONSTRUCTION REQUIREMENTS. The locations and elevations for excavation shall be as indicated on the Plans. The Engineer may order removal of poor foundation material below the normal designated elevation and replacement with an approved material.

All suitable excess excavated material shall be used in the formation of embankments as indicated on the Plans, or as directed by the Engineer. Unsuitable material shall be hauled and disposed of with no additional compensation to the Contractor.

208.04 PRESERVATION OF CHANNEL. Unless otherwise indicated on the Plans or ordered by the Engineer, the Contractor, in performing the excavation, shall confine excavating operations to the site of the proposed structure and to the limits of the cofferdam. The natural stream bed shall not be disturbed without permission of the Engineer.

208.05 PREPARATION OF FOUNDATION. The foundation pits shall be excavated so that the footings will be the full lengths and widths indicated on the Plans. The footings shall be constructed with full horizontal beds. Unless otherwise specified or authorized by Written Order, foundations shall be constructed in the dry. In the dry means foundations and other structural components being constructed are not in or under water. The site shall be dewatered to, or below, the bottom of footing elevation or lowest elevation of a structural component.

The excavation shall continue to either bedrock or the elevation specified for footings on soil. All loose material shall be removed and all seams in the rock shall be cleaned out and filled with concrete or as directed by the Engineer. No excavation shall be done below the elevations indicated on the Plans unless directed by the Engineer in writing. Any material so excavated without authority shall be replaced with concrete or as directed by the Engineer at the Contractor's expense.

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When the footing is to be constructed on an excavated surface other than rock, particular care shall be taken not to disturb the bottom of the excavation. No excavation shall be performed below the elevations indicated on the Plans unless directed by the Engineer in writing. Any material excavated without authority shall be replaced with approved backfill, which shall be thoroughly compacted in accordance with Section 204, at the Contractor's expense.

When poor foundation material is encountered at the foundation design elevation, it shall be removed as Cofferdam Excavation, Earth or Cofferdam Excavation, Rock and replaced with Granular Backfill for Structures or other suitable material, as indicated on the Plans or as directed by the Engineer, and thoroughly compacted in accordance with Section 204.

208.06 COFFERDAMS. The Contractor shall prepare detailed plans and a schedule of operations for each cofferdam specified in the Contract. Construction drawings shall be submitted in accordance with Section 105.

(a) The professional engineer is responsible for ensuring that the proposed cofferdam meets the following criteria:

(1) The design is structurally stable for all conditions to be encountered (e.g., soils, water, forces, and loadings)

(2) The design and details conform with the Contract and the applicable requirements in the current *AASHTO Standard Specifications for Highway Bridges* or the current *AASHTO LRFD Bridge Design Specifications* and their latest revisions

(3) The design and details are in conformance with applicable safety codes

(4) Adequate size and shape to construct the foundation and structural components specified

(5) The cofferdam is adequately watertight for proper performance of the work

(6) The foundation seals are adequate to achieve their design function

(b) The submittal shall include plan, elevation and section details indicating the following:

(1) The waterway

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(2) Information regarding the cofferdam and any indication that a foundation seal is required to ensure the structural integrity of the cofferdam during dewatering and foundation construction and inspection

(3) Substructure location

(4) Dimensions of any temporary restrictions that are to be placed in the waterway (e.g., barges, lines, earth dams, causeways, temporary diversion channels, and access bridging)

(5) The location, dimensions, clearances, and other relevant information for any temporary scaffolding or netting

(6) Dewatered heads, taking into consideration water level fluctuations

(7) Details for screening, pumping, and filtering discharges from the cofferdam

(8) A statement stipulating whether any equipment will be removed at night

(9) A schedule or sequence of operations that includes placement of the foundation seal, time from placement to dewatering, and foundation construction and inspection

The Contractor shall be responsible for performing the work in accordance with the submitted details and schedule of operations. All welding shall be performed per Subsection 506.10.

Cofferdam construction shall conform to the current *AASHTO LRFD Bridge Construction Specifications*, and its latest revisions.

Cofferdams shall be constructed so as to protect freshly placed concrete against damage from sudden rising of the water level and to prevent damage to the foundation or other structural component by erosion. The cofferdam shall be constructed so that no timber, bracing, or forms will extend into the foundation or other structural component.

In the event the Contractor elects to place fill material in the stream to facilitate access to, or be part of, a cofferdam operation, it shall be clean stone fill.

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208.07 PUMPING. Pumping from or dewatering of the interior of any cofferdam enclosure shall be performed so that disturbance of the subsoil or freshly placed concrete will not occur. Dewatering of a sealed cofferdam will be in conformance with the Contractor's sequence or schedule of operations. Pumping during the construction of a foundation or other structural component shall be from a suitable sump separated from the concrete work.

The discharge from any pumping operation, filtration system, or settling basin shall conform to the requirements of Section 105 and the Contract.

208.08 INSPECTION OF FOUNDATION PIT. Immediately following the completion of each foundation pit, the Contractor shall notify the Engineer, who shall approve the depth of the pit and the nature of the bearing surface before the placement of the concrete.

208.09 BEDDING FOR STRUCTURES. Excavation and preparation of the bed for a structure shall conform to the specifications for the specific structure being installed.

208.10 METHOD OF MEASUREMENT.

(a) Cofferdam. The quantity to be measured for payment will be on a lump sum basis for each cofferdam specified on the Plans or in the Contract.

(b) Cofferdam Excavation, Earth. The quantity to be measured for payment will be the number of cubic yards of earth excavated from within the pay limits of the cofferdam as set forth in these specifications or as shown on the Plans.

The removal of earth excavation authorized by the Engineer below the elevation of the bottom of the excavation, as indicated on the Plans, will be factored in accordance with Table 208.10A.

TABLE 208.10A – COFFERDAM EXCAVATION MULTIPLIERS

Vertical Depth Below Bottom of Excavation Indicated on the Plans (feet)	Volume of Cofferdam Excavation Multiplied By
0 – 1	100%
> 1 – 5	150%
> 5 – 10	450%
> 10 – 15	750%
> 15	Paid as extra work

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(c) Cofferdam Excavation, Rock. The quantity to be measured for payment will be the number of cubic yards of rock excavated from within the pay limits of the cofferdam as set forth in these specifications or as shown on the Plans.

The removal of rock excavation authorized by the Engineer below the elevation of the bottom of the excavation, as indicated on the Plans, will be factored in accordance with the list shown above.

Where a foundation or component of a structure is designed or directed to be placed on bedrock, a maximum of 6 inches average allowance for overbreakage will be allowed. Additional overbreakage will be at the Contractor's expense.

(d) Bottom of Excavation. The bottom of excavation shall be as indicated on the Plans.

When a foundation seal is specified in the Contract, the bottom of excavation shall be considered to be the bottom of the excavation required for the foundation seal. For a seal proposed by the Contractor, no excavation shall be measured for payment below the bottom of excavation as indicated on the Plans.

208.11 BASIS OF PAYMENT. The accepted quantity of Cofferdam will be paid for at the Contract lump sum price, which price shall be full compensation for the preparation of detailed plans and schedule of operations, performing the work specified, and the furnishing of all labor, tools, equipment, materials, and incidentals necessary to complete the work, including the cost of altering the cofferdam, foundation seals, sheeting, bracing, dewatering, installation and maintenance of siltation and sedimentation control measures for treating cofferdam discharge, incidentals necessary for properly constructing the foundation or structural component, maintaining the cofferdam in a dewatered condition, and removing the cofferdam when no longer required.

The accepted quantities of Cofferdam Excavation, Earth and Cofferdam Excavation, Rock will be paid for at the Contract unit price per cubic yard for each of the pay items in the Contract, which price shall be full compensation for performing the work specified and the furnishing of all labor, materials, tools, equipment, disposal of surplus material, and any other incidentals necessary to complete the work.

Payment for Cofferdam will be made as follows:

(a) A payment of 75% of the lump sum bid price will be made when excavation within the limits of the structural unit is completed, and the cofferdam has been successfully dewatered.

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(b) The remaining 25% of the lump sum price will be paid when the cofferdam is completely removed; or if the Contract requires the cofferdam to be left in place, when the associated foundation or other component of a structure is completed.

If the Engineer (by Written Order) requires that the cofferdam be left in place and this requirement is not specified in the Contract, a supplemental agreement will be processed in accordance with Section 109.

Payment will be made under:

Pay Item	Pay Unit
208.30 Cofferdam Excavation, Earth	Cubic Yard
208.35 Cofferdam Excavation, Rock	Cubic Yard
208.40 Cofferdam	Lump Sum

SECTION 210 – COLD PLANING

210.01 DESCRIPTION. This work shall consist of the removal, disposal and clean-up of bituminous pavements by coarse-milling or fine-milling.

210.02 EQUIPMENT AND OPERATION. The equipment shall be power-driven, self-propelled and of a size and shape to allow traffic safe passage through areas adjacent to the work. The equipment shall have grade and slope controls capable of operating from a ski and based on mechanical or sonic operation. It shall be able to remove bituminous pavement to an accuracy of 1/8 inch with conveyors capable of side or front loading to transfer the removed material from the roadway to a truck.

A lighting system shall be furnished for night work as necessary. The equipment shall have a positive means for controlling cross slope elevations. The equipment shall have sufficient weight to perform milling without lifting, and sufficient and positive down pressure on the drum assembly at all times when milling. The equipment shall also have an effective means of preventing dust from escaping into the air.

(a) Coarse-Milling Equipment. Equipment used for coarse-milling shall have a properly maintained cutting head that ensures that the depth of cut does not vary by more than 1/8 inch throughout the width of the head.

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(b) Fine-Milling Equipment. Equipment used for fine or micro-milling shall meet the following requirements:

(1) Equipment shall deploy a cutting head with a carbide- or PCD (polycrystalline diamond)-tipped cutting teeth designed for micro-milling bituminous pavement to close tolerances.

(2) The cutting head shall be properly maintained so that the depth of cut is within a tolerance of 1/8 inch throughout the width of the head with a center to center transverse pattern of 5/16 inch between strike areas.

(3) The grinding and texturing mandrel shall have multiple wraps of flighting with a weld on or quick change block system that accepts carbide or PCD tipped cutting bits. The carbide or PCD bits shall be arranged in a manner that is capable of producing a final pavement surface having a transverse pattern of 5/16 inch center to center of each strike area and a target difference between ridge and valley (RVD) measurement of the mat surface shall not exceed 1/5 inch. Tips of the carbide or PCD teeth are to be spaced at a maximum 5/16 inch axial distance between the tips of each tooth.

Bituminous surfaces adjacent to objects such as drop inlets and curbs that are inaccessible to milling equipment shall be milled with equipment designed for that purpose and approved by the Engineer.

210.03 GENERAL CONSTRUCTION REQUIREMENTS. The bituminous surface shall be removed to the depth, width and cross-slope as shown on the Plans or as directed by the Engineer. The milling depth shall not vary from the typical cross-section depth by more than 1/8 inch. The milling operation shall produce a uniform surface and maintain a constant cross slope between extremities in each lane and shoulder.

Unless otherwise specified, all milled material, including dust and other material remaining on the milled surface after milling, shall become the property of the Contractor and shall be removed from the roadway immediately and disposed of properly. A Power Broom, Type II shall be used to clean-up the milled surface after coarse-milling and a Power Broom, Type III shall be used to clean-up the milled surface after fine-milling. The milled surface shall be cleaned prior to allowing traffic onto the milled surface and to the satisfaction of the Engineer.

The Contractor shall use caution when milling operations occur on bridge decks. Should any damage occur to the deck or membrane as a result of milling operations the Engineer will contact the VTrans Construction Structures Engineer to provide an assessment of the damage and recommend any necessary repairs. All damages determined to be the fault of the Contractor shall be repaired by the Contractor at no cost to the state.

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When traffic shall be maintained for any period of time on a milled area, the following conditions apply:

(a) All butt joints 3/4-inch deep or greater shall have a temporary taper or wedge of bituminous concrete pavement installed at a minimum slope of 1:30 (V:H). Tapers and/or wedges shall be in place prior to allowing traffic on the butt joint.

Longitudinal edges greater than 2 inches in depth and located at ramp areas shall be tapered a minimum of 10 feet.

The Contractor shall be responsible for maintaining and repairing wedges and/or tapers throughout their use, to the satisfaction of the Engineer. Tapers and/or wedges shall be totally removed prior to placing permanent pavement at the respective butt joint. All costs associated with installing, maintaining and removing temporary tapers and/or wedges will not be paid for directly, but will be considered incidental to the applicable milling Contract item.

(b) The Contractor shall repave any coarse-milled areas within 14 calendar days and any fine-milled areas within 28 calendar days of milling, or when directed by the Engineer. Should the area remain unpaved for a period longer than specified herein, without the approval of the Engineer, no payment whatsoever will be made for the milled areas left exposed in excess of the 14 or 28 calendar day periods. If the Contractor lays down temporary pavement to avoid the above non-payment for milling, temporary pavement and subsequent milling shall be at the Contractor's expense.

(c) Milled areas susceptible to ponding of water shall be drained by cutting slots through the adjoining non-milled area. The slots shall then be filled with materials satisfactory to the Engineer. All costs of cutting and filling the slots will not be paid for directly but will be considered incidental to the applicable Contract item for milling.

210.04 FINE-MILLING. Fine-milling operations shall be performed as per design with each travel lane being milled full width in a maximum of two passes of the fine-milling equipment.

Substantially all of the pavement surface shall be textured. Extra depth fine-milling of isolated low spots will not be necessary if it requires lowering of the overall profile of the pavement. The accumulated total of excluded areas shall not exceed 5% of the total area to be milled. In all cases, the maximum depth of bituminous pavement removal shall be 2 inches. The operation shall result in a surface cross slope that conforms to existing or as shown on the Plans.

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210.05 METHOD OF MEASUREMENT. The quantity of Coarse-Milling, Bituminous Pavement and Fine-Milling, Bituminous Pavement to be measured for payment will be the number of square yards of surface from which bituminous pavement has been removed on the Plans.

210.06 BASIS OF PAYMENT. The accepted quantity of Coarse-Milling, Bituminous Pavement and Fine-Milling, Bituminous Pavement will be paid for at the Contract unit price per square yard. Payment will be full compensation for furnishing all labor, tools, and equipment, including the Power Broom, Type II and Power Broom, Type III, necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
210.10 Coarse-Milling, Bituminous Pavement	Square Yard
210.12 Fine-Milling, Bituminous Pavement	Square Yard

SECTION 211 – THIS SECTION RESERVED

SECTION 212 – THIS SECTION RESERVED

SECTION 213 – MILLED RUMBLE STRIPS

213.01 DESCRIPTION. This work shall consist of texturing bituminous concrete pavement to construct rumble strips, disposing of waste millings, and cleaning up the pavement.

213.02 EQUIPMENT. The equipment for milling rumble strips shall consist of a power operated machine with a rotary type cutting head of a size that will provide milled depressions to the dimensions as shown on the Plans. The cutting heads shall have cutting tips arranged to provide a smooth cut.

The cutting heads shall be on a suspension independent from that of the power unit to allow the tool to self-align with the slope, and/or any irregularities, of the surface being milled. The cutting tool shall be equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity and consistency throughout the project. Equipment that tears, distorts, or otherwise damages the pavement adjacent to the milled depressions will not be allowed.

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213.03 GENERAL CONSTRUCTION REQUIREMENTS. Rumble strips shall be milled to the finished dimensions, locations, and tolerances shown on the Plans, in accordance with these specifications or as directed by the Engineer.

Unless otherwise specified, the milled material shall become the property of the Contractor. All material shall be removed from the roadway immediately with a Type II Power Broom and shall become the property of the Contractor.

213.04 METHOD OF MEASUREMENT. The quantity of Milled Rumble Strips to be measured for payment will be the longitudinal length in linear feet of treated surface measured. The measurement will include the non-milled lengths between adjacent strips. Gaps or breaks greater than 10 feet will not be measured for payment.

213.05 BASIS OF PAYMENT. The accepted quantity of Milled Rumble Strips will be paid for at the Contract unit price per linear foot. Payment shall be full compensation for furnishing all labor, tools, and equipment, including the Type II Power Broom, necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
213.10 Milled Rumble Strips	Linear Foot

SECTION 215 – THIS SECTION RESERVED

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DIVISION 300

SUBBASE AND BASE COURSES

SECTION 301 – SUBBASE

301.01 DESCRIPTION. This work shall consist of furnishing and placing one or more courses of approved gravel, crushed gravel, dense graded crushed stone, or other proportioned material on a prepared surface or at other locations.

301.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Coarse Aggregate for Concrete.....704.02
Gravel for Subbase.....704.04
Crushed Gravel for Subbase 704.05
Dense Graded Crushed Stone for Subbase 704.06

Certifications required shall be submitted in conformance with the Agency's *Materials Sampling Manual.*

At the option of the Contractor, unless otherwise specified in the Contract, processed glass aggregate (PGA) or recycled concrete aggregate (RCA) may be used to partially replace natural aggregate in materials specified to meet the requirements of Subsection 704.04, Subsection 704.05 and Subsection 704.06. In no case shall PGA and RCA be blended together.

PGA shall be a crushed and screened material with 95% passing a 1 inch (25.0 mm) sieve. Not more than 3% of the material passing the No. 4 (4.75 mm) sieve shall pass a No. 200 (0.075 mm) sieve.

Materials used to produce PGA shall consist of recycled glass food or beverage containers. Small amounts (less than 5% total) of china dishes, ceramics, plate (window or mirror) glass, or other glass products will be allowed in PGA. The PGA material shall not contain more than trace amounts of screw tops, plastic cap rings, or other contaminants. Amounts of contaminants greater than 1% by weight shall be grounds for rejection of the entire PGA batch. Glass containers containing, or having contained, toxic or hazardous materials will not be allowed, and when present, shall be grounds for rejecting the entire stockpile of PGA or PGA subbase blends.

Materials used to produce RCA shall consist of recycled concrete that has been crushed to aggregate dimensions of 6 inches or less. Small amounts of brick, block or mortar may be present in the RCA at a level not to exceed a total of 5% by weight. The RCA material shall not contain more than trace amounts of wire, steel or plastic that were associated with the original placement of the concrete, bituminous material, or unreacted cementitious materials. No additional wire, steel or plastic may be added to the RCA. No discernable amounts of oils, fats, soaps, surfactants, or organic contaminants shall be present in the RCA.

Hazardous materials or concrete structures used to contain hazardous materials will not be allowed and when present shall be grounds for rejection of the entire stockpile of RCA or RCA subbase blends.

PGA and RCA materials shall be subjected to process control testing. PGA subbase blends shall not contain more than 10% by weight of PGA. RCA subbase blends shall not contain more than 25% RCA. The final blend shall conform to the specified gradation for the subbase material. The blending process shall be complete to ensure that as thorough a distribution and as uniform a mixture as practicable has been obtained. Process control tests shall be performed at a minimum frequency of one test per 2,500 cubic yards of material produced by a stable process. A copy of each test result shall be given to the Engineer.

Prior to the use of any PGA subbase blend, the Contractor shall submit in writing, for preliminary approval by the Engineer, information identifying the sources and locations from which PGA material to be used on the project will be obtained. The Contractor shall also submit certified test results verifying that the PGA material will be in compliance with the Contract requirements. Once the sources of PGA are approved, quality assurance samples may be taken by the Engineer.

PGA subbase blends must be approved for use on the project by the Engineer in writing prior to being placed on a project. In-place blending of PGA with other materials will not be permitted.

The supplier of PGA shall certify in writing to the Engineer that the crushed glass material to be used does not contain toxic or hazardous substances. The supplier of RCA shall certify in writing to the Engineer that the concrete to be used does not contain toxic or hazardous substances.

The blended subbase material shall meet all specified gradation and cleanliness requirements.

When specified for use on the project or as directed by the Engineer, Subbase, RAP shall include cold-planed grindings which have been screened or crushed by the Contractor such that 100% pass the 1-1/2 inch (37.5 mm) sieve prior to blending.

The grindings shall be blended in equal proportions (50% by weight) with material meeting the requirements of Subbase of Crushed Gravel, Fine Graded as specified in Table 704.05B.

301.03 GENERAL CONSTRUCTION REQUIREMENTS. The subbase material shall be placed on a prepared surface with an approved spreader box or by use of other approved mechanical spreading equipment. Dumping directly on the subgrade will not be permitted. A bulldozer may be used instead of a spreader box, provided that the subbase material is first placed on the previously laid subbase and then completely removed from the area where it was first deposited.

Should segregation of the subbase occur, the Contractor shall remove and replace the material or rework it until uniform grading is obtained.

If material below subgrade becomes intermixed with the subbase, resulting in an unacceptable product, the mixture shall be removed and replaced with new subbase material.

The maximum compacted layer thickness for all subbase materials is 12 inches. Where the finished depth of the subbase is to be greater than 12 inches, it shall be placed and compacted in two or more layers of approximately equal thickness. In the placement of layers, all joints shall be staggered at least 12 inches.

After each layer of subbase material is placed, it shall be graded to obtain a smooth, even surface as specified in Subsection 301.05. Following grading operations, the subbase shall be thoroughly compacted as specified in Subsection 301.06. If required, water shall be uniformly applied over the subbase materials during compaction in the amount necessary for proper consolidation.

Materials containing PGA or RCA shall be compacted in the same manner as materials that do not contain recycled materials. Care will be taken to prevent excessive moisture contents in subbase materials prior to compaction. If needed, the Contractor may use material meeting the requirements of Table 704.02B as filler to achieve the design grade when the variation of the surface is less than 1 inch.

When it is necessary to maintain traffic over the subbase, 50% of the width of the roadway shall be constructed at a time. The portion under construction shall have the subbase material placed, graded, and compacted before opening to traffic. Subsequent traffic damage to the material shall be entirely the Contractor's responsibility. If the subbase loses its shape, the Contractor shall loosen, regrade, and compact as necessary.

When it is necessary to maintain traffic over the subbase, or where construction hauling occurs over the subbase, the upper 2 inches of subbase shall be scarified (to restore permeability in the subbase surface), compacted, and regraded as required, or replaced just prior to the placement of any pavement.

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If roadway shoulders are to remain unpaved, subbase or other designated material to be placed in the shoulder area after final roadway paving shall be placed and compacted in accordance with Subsection 402.03.

301.04 SPECIFIC CONSTRUCTION REQUIREMENTS.

(a) Subbase of Gravel. Only uniformly graded gravel from the pit shall be used. The Contractor shall manipulate the material in the pit to eliminate non-uniformly graded pockets of material.

(b) Subbase of Crushed Gravel. When stockpiling, care shall be taken to prevent segregation in the pile.

(c) Subbase of Dense Graded Crushed Stone. When stockpiling, care shall be taken to prevent segregation in the pile.

301.05 SURFACE TOLERANCE. The surface of the compacted subbase will be tested by the Engineer at selected locations. The variation of the surface shall at no point exceed 1 inch. This variation shall not be maintained for a distance longer than 50 feet. The required crown and superelevation shall be maintained. All humps or depressions exceeding the specified tolerances shall be corrected by reshaping or removing defective work and replacing it with new material as directed by the Engineer. Any new material used to replace removed material shall meet the applicable gradation in Subsection 301.02.

301.06 COMPACTION. Compaction of each layer shall continue until a density of not less than 95% of the maximum dry density has been achieved.

When 1,000 cubic yards or more of subbase material is to be placed as part of the Contract, the maximum dry density shall be determined by the Contractor in accordance with *AASHTO T 180*, Method D, as modified by the Agency's Materials Section. Laboratory moisture-density tests shall be performed to ensure a standard error of the mean maximum dry density of less than one pound per cubic foot. This will necessitate at least five, but no more than ten, replications of the test. The Contractor shall provide the Engineer with all test results and calculations for determining the maximum dry density, at least 10 calendar days prior to subbase placement

The maximum dry density shall be determined after any change in source, regardless of quantity, and confirmed by repetition of the selected test method at a frequency of 1,000 cubic yards when the prescribed standard error can be attained by five or less replicate tests. If more than five replicate tests are required to meet the prescribed standard error, the maximum dry density shall be confirmed at a frequency of every 5,000 cubic yards. The Engineer may reduce this frequency with the approval of the Geotechnical Engineering Manager after the initial two maximum dry density determinations.

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When fewer than 1,000 cubic yards of subbase material are to be placed as part of the Contract, the maximum dry density will be determined by the Agency in accordance with *AASHTO T 180*, Method D, as modified by the Agency's Materials Section.

Field density testing will be performed by the Agency in accordance with *AASHTO T 310* at locations determined by the Engineer. Compaction operations shall proceed such that the target field density as determined in accordance with this subsection is achieved.

301.07 METHOD OF MEASUREMENT. The quantity of Subbase to be measured for payment will be the number of cubic yards of the type specified for use in the complete and accepted work, as determined by the plan dimensions of the compacted material, including any filler material used to achieve the design grade.

When specified to be paid by weight, the quantity of Subbase of Crushed Gravel, Fine Graded to be measured for payment will be the number of tons of material in place in the complete and accepted work, as determined from the load tickets.

The quantity of Subbase, RAP to be measured for payment will be the number of tons of material in place in the complete and accepted work, as determined from the load tickets.

When subbase material is required for extra depth at bridge approaches, the quantity to be measured for payment will be the number of cubic yards measured in place for this purpose between the lines shown on the Plans.

Materials containing PGA or RCA will be measured in the same manner as subbase materials that do not contain PGA or RCA.

301.08 BASIS OF PAYMENT. The accepted quantity of Subbase will be paid for at the Contract unit price per cubic yard or ton for the type specified. Payment will be full compensation for furnishing, blending, transporting, testing, placing, grading, and compacting the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

No additional payment will be made for filler material used as a replacement for the specified Subbase material.

No payment will be made for the following:

(a) Material forced into or mixed with the subgrade material.

(b) Material placed to a depth greater than shown on the Plans.

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(c) Water used to obtain required compaction.

(d) Removal and replacement of subbase material.

(e) Scarifying, recompacting, or regrading of subgrade or subbase layers, when required.

Payment will be made under:

Pay Item	Pay Unit
301.15 Subbase of Gravel	Cubic Yard
301.25 Subbase of Crushed Gravel, Coarse Graded	Cubic Yard
301.26 Subbase of Crushed Gravel, Fine Graded	Cubic Yard
301.28 Subbase of Crushed Gravel, Fine Graded	Ton
301.35 Subbase of Dense Graded Crushed Stone	Cubic Yard
301.40 Subbase, RAP	Ton

SECTION 303 – THIS SECTION RESERVED

SECTION 310 – FULL DEPTH RECLAMATION (FDR)

310.01 DESCRIPTION. This work shall consist of pulverizing the existing pavement together with underlying base course material to the depth and width specified on the Plans or in the Contract, adding aggregate materials as required or as ordered by the Engineer, adding the stabilizing agent indicated on the Plans, mixing the components thoroughly and shaping and compacting the stabilized material to the desired grade and density.

310.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Crushed Gravel for Subbase	704.05
Water	745.01
Calcium Chloride	746.01

The pulverized material shall consist of the existing pavement blended with underlying subbase material and/or additional aggregate material and shall conform to the gradation requirements of Table 310.02A.

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TABLE 310.02A – FDR GRADATION REQUIREMENTS

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
3 inch (75.0 mm)	100
1-1/2 inch (37.5 mm)	80 – 100
No. 4 (4.75 mm)	30 – 60

Additional aggregate material added to make up grading deficiencies and/or to correct roadway geometry shall meet the requirements of Subsection 704.05.

310.03 EQUIPMENT. Pulverization shall be accomplished with a machine having positive depth control adjustments and capable of reducing the pavement material to the specified size. The pulverizing equipment shall meet the approval of the Engineer. Equipment such as a milling machine or a rock crushing plant will not be permitted.

The mixer shall be a self-propelled mixer. The mixing rotor, or rotors, shall have positive depth control to ensure a uniform depth of mixing. When stabilization asphalt is designated as the stabilizing agent, the mixer shall also be a combined mixer and liquid distributor. The mixer shall meet the approval of the Engineer.

The equipment for distributing the designated stabilizing agent shall be uniformly adjustable and shall be equipped to accurately verify the rate of application of the stabilizing agent at any time.

The rollers used to compact the FDR material shall be as specified in Subsection 310.07.

The power grader and any replacement graders shall have grade control automation.

310.04 CONSTRUCTION. The moisture content of the pulverized materials shall be uniform and within the range approved by the Agency's Geotechnical Engineering Manager prior to the addition of the stabilizing agent. If necessary, the materials shall be manipulated with equipment approved by the Engineer to decrease the moisture content or moisture shall be added to increase the moisture content to bring it into an approved range.

The pulverized reclaimed base material shall be stabilized by thoroughly mixing the stabilizing agent with the pulverized material and regrading and compacting the resulting mixture.

When a stabilizing agent is not exclusively specified on the Plans, water shall be used as that agent to meet all requirements of this section. When a dust control agent is not exclusively specified on the Plans, water and/or calcium chloride shall be used as that agent to meet all requirements of this section.

Stabilization with water shall not be performed during rainstorms nor when the ambient air temperature is below 40°F. The Contractor shall pulverize only that area of pavement that can be stabilized during the same working day.

310.05 TESTING. The Contractor shall perform all process control and quality control sampling and testing.

Process control sampling and testing shall involve taking a set of four representative excavated samples from the test section, after the test section has been pulverized. The four samples shall be taken at random, representing the four-quarter segments of the test section. The four samples shall be sieved to determine if the process can produce the required gradation or if additional materials must be added. Following the completion of the sieve analysis, using the *AASHTO T 27* procedure modified to include air drying of the material only, the materials shall be physically combined to produce a representative sample.

A moisture/density curve, representing the combined sample, shall be generated in accordance with *AASTHO T 180,* Method C, using a minimum of five different moisture contents to determine the maximum density and optimum moisture.

The Contractor shall perform quality control tests for density using a nuclear gauge in accordance with *AASHTO T 310*, Method B (per compacted lift of stabilized material).

A minimum of 10 nuclear gauge tests per lane mile of compacted reclaimed base material shall be performed. Additional tests shall be performed as necessary or as directed by the Engineer. The Contractor shall verify that the minimum target density is maintained prior to resurfacing. The Contractor shall also perform quality control tests for uniform gradation of the pulverized material at a minimum rate of two tests per lane mile.

The Contractor shall provide the Engineer with written copies of all process control and quality control results, including test locations. These test results will not be used to determine acceptance of the FDR material.

Acceptance testing will be performed by Agency personnel.

310.06 TEST SECTION. The Contractor shall construct a test section to assure the Engineer that the Contractor's equipment and procedure(s) are suitable for the work specified and capable of achieving the minimum target density approved by the Engineer.

The test section shall be full roadway width and of a length approved by the Engineer. No further recycling shall be performed until all aspects of the test section and the target density are approved by the Engineer. The Contractor shall use the same equipment for building both the accepted test section(s) and performing the FDR work on the project unless equipment substitution is approved by the Engineer.

The Engineer may require an additional test section and additional process control sampling to investigate the suitability of substituted or changed equipment.

If the test section does not meet the requirements of this specification, or the density achieved does not meet the minimum target density, then the Contractor shall modify the procedure and either construct another test section or reconstruct the original test section until suitable results are obtained.

310.07 SHAPING AND COMPACTING. Shaping and compacting shall be done immediately after pulverizing. The base material shall be finished within a grade tolerance of ± 3/8 inch, provided that this deviation is not maintained for a distance longer than 50 feet and provided that the required crown or superelevation is maintained.

When additional aggregate material is added to the previously reclaimed roadway to correct geometric deficiencies, said material shall be subject to a second pass of the reclamation equipment to achieve a homogenous subbase and shall be shaped, graded, and compacted.

The Contractor shall maintain the centerline location of the roadway. The Contractor shall also be responsible for the necessary survey required to re-establish banking as shown on the Plans or as directed by the Engineer.

Compaction of the FDR shall be accomplished by successive passes of a vibratory sheepsfoot or padfoot roller of at least 25 tons of dynamic force. Final rolling shall be accomplished by a smooth steel wheel vibratory roller of at least 13 tons of dynamic force. The material shall be compacted to achieve at least the minimum target density approved by the Engineer.

The optimum moisture content shall be maintained throughout the duration of the project stabilizing and compaction process. The minimum target density during construction shall be 95% of the maximum density, upon approval by the Engineer, in accordance with Subsection 310.05 and Subsection 310.06.

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310.08 CURING AND STABILITY. The completed and cured FDR may be opened to traffic as approved by the Engineer. Required density and moisture content of the finished base shall be maintained until it is paved over. Any imperfections discovered shall be repaired by the Contractor as directed by the Engineer at no additional cost to the Agency.

The stabilized material shall be allowed to cure to a condition such that the free moisture content is reduced to 1.0% or less before bituminous concrete pavement is placed on it.

310.09 METHOD OF MEASUREMENT. The quantity of Full Depth Reclamation (FDR) to be measured for payment will be the number of square yards constructed to the depth specified, complete in place in the accepted work. No allowance will be made for overlapping areas.

The quantity of additional aggregate material used to correct gradation or geometric deficiencies to be measured for payment will be the number of tons of Subbase of Crushed Gravel, Fine Graded complete in place in the accepted work as determined by weigh tickets.

If the depth of base to be stabilized must be adjusted in the field, the first 2 inches of additional or decreased depth will not be paid for directly, but will be considered incidental to the Full Depth Reclamation (FDR) item. If the change in depth is greater than 2 inches, the number of square yards pulverized at the revised depth will be multiplied by the result of dividing the total depth actually pulverized by the original depth designated on the Plans to create an equivalent number of square yards for which payment will then be made.

310.10 BASIS OF PAYMENT. The accepted quantity of Full Depth Reclamation (FDR) will be paid for at the Contract unit price per square yard. Payment shall be full compensation for furnishing, handling, transporting, and placing the necessary materials; pulverizing; adding, or removing moisture; shaping, placing, and compacting the designated materials; constructing tests strips; conducting tests; maintaining the finished base until it is paved over and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

No additional compensation will be provided for multiple passes of the reclamation equipment and additional shaping, grading, and compacting.

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Water used to adjust the moisture content prior to stabilization, for stabilization when water is used as the stabilizing agent, for compacting the pulverized material, and for dust control after the reclamation will not be paid for directly but will be considered incidental to the Full Depth Reclamation (FDR) item. Calcium chloride used for dust control after the reclamation will not be paid for directly but will be considered incidental to the Full Depth Reclamation (FDR) item.

The accepted quantity of Subbase of Crushed Gravel, Fine Graded used to correct gradation or geometric deficiencies will be paid for under the appropriate Contract item.

Payment will be made under:

Pay Item	Pay Unit
310.20 Full Depth Reclamation (FDR)	Square Yard

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DIVISION 400

SURFACE COURSES AND PAVEMENT

SECTION 401 – AGGREGATE SURFACE COURSE

401.01 DESCRIPTION. This work shall consist of furnishing and placing a wearing course of approved aggregate on a prepared surface.

401.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Aggregate for Surface Course and Shoulders 704.12

401.03 PLACING. The aggregate shall be placed and properly shaped using equipment that allows the typical cross-section and design grade to be attained. Should aggregate segregation occur, the Contractor shall remove and replace the segregated material or manipulate it until uniform gradation is obtained.

The maximum layer thickness for placement of any aggregate surface material shall be 6 ± 2 inches after compaction. All layers shall be placed and compacted at approximately equal thickness. In the placement of layers, all joints shall be staggered at least 12 inches.

After each layer of surface material is placed, it shall be thoroughly compacted to a uniform density of not less than 95% of the maximum dry density as determined by *AASHTO T 99*, Method C. Suitable and effective equipment, meeting the approval of the Engineer, shall be used to obtain a true and even surface during compaction. All holes or depressions found during the compacting shall be filled with additional material, reworked, and compacted.

If required, water shall be uniformly applied over the aggregate material during compaction in an amount necessary to produce proper consolidation. The aggregate shall be thoroughly compacted by an approved power roller with a minimum weight of 8 tons, by an approved rubber-tired roller, or by other approved methods.

401.04 METHOD OF MEASUREMENT. The quantity of Aggregate Surface Course to be measured for payment will be the number of cubic yards used in the complete and accepted work, as determined by the Plan dimensions of the compacted material or as ordered by the Engineer. No allowance will be made for material placed to a depth greater than that shown on the Plans unless ordered by the Engineer.

401.05 BASIS OF PAYMENT. The accepted quantity of Aggregate Surface Course will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the item Aggregate Surface Course.

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Payment will be made under:

Pay Item	Pay Unit
401.10 Aggregate Surface Course	Cubic Yard

SECTION 402 – AGGREGATE SHOULDERS

402.01 DESCRIPTION. This work shall consist of furnishing, placing, and compacting material for Aggregate Shoulders on a prepared surface.

402.02 MATERIALS. Materials for Aggregate Shoulders and Aggregate Shoulders, RAP, shall meet the requirements of the following subsections:

Aggregate for Surface Course and Shoulders 704.12

402.03 PLACEMENT. Aggregate Shoulders shall be placed with equipment capable of placing the material in accordance with the Plans. The Contractor shall demonstrate to the Engineer the proposed placement procedures. If deemed necessary by the Engineer, the procedures shall be adjusted to avoid damage to the wearing course. It shall be the Contractor's responsible to repair any damage to the wearing course to the satisfaction of the Engineer, at no additional cost to the Agency.

Unless otherwise directed by the Engineer or shown on the Plans, Aggregate Shoulders shall be placed in one course and shall not be placed until the adjacent wearing course has been completed. The maximum layer thickness for placement of material shall be 6 ± 2 inches after compaction. When multiple layers are required, all layers shall be placed in approximately equal thicknesses.

All layers of Aggregate Shoulders shall be compacted to 95% of the maximum dry density determined by *AASHTO T 99*, Method C or to the satisfaction of the Engineer. This provision shall apply in such cases that the shoulder material has a 1:4 (V:H) slope or flatter and a minimum of a half width of a roller drum can traverse the material. Otherwise the material shall be compacted as directed by the Engineer.

The Contractor shall correct any segregated material, to the satisfaction of the Engineer, at no additional cost to the Agency.

All material shall have a true and even surface as shown in the Plans. All holes or depressions found prior to acceptance of the project shall be filled with additional material, reworked and compacted as necessary.

A printed load ticket, indicating truck identification, date and time of delivery, and weight shall be furnished to the Engineer with each load delivered to the project.

402.04 METHOD OF MEASUREMENT. The quantity of Aggregate Shoulders and Aggregate Shoulders, RAP to be measured for payment will be the number of tons used in the complete and accepted work, as determined from load tickets. Partial loads shall be paid for on a prorated basis.

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402.05 BASIS OF PAYMENT. The accepted quantity of Aggregate Shoulders and Aggregate Shoulders, RAP will be paid for at the Contract unit price per ton. Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the Aggregate Shoulders item in the Contract.

Payment will be made under:

Pay Item	Pay Unit
402.12 Aggregate Shoulders	Ton
402.13 Aggregate Shoulders, RAP	Ton

SECTION 403 – AGGREGATE SHOULDERS, RAP WITH RAS

403.01 DESCRIPTION. This work shall consist of furnishing, placing and compacting material for Aggregate Shoulders, RAP with RAS on a prepared surface.

403.02 MATERIALS. Materials for Aggregate Shoulders, RAP with RAS, shall meet the requirements of the following subsections:

Aggregate for Surface Course and Shoulders 704.12
Water 745.01

Aggregate Shoulders, RAP with RAS shall contain 15%, by weight, of Recycled Asphalt Shingles (RAS).

RAS shall be produced at a properly permitted facility and meet the requirements of *AASHTO MP 23*.

403.03 EQUIPMENT. Aggregate Shoulders, RAP with RAS shall be placed and compacted with equipment capable of meeting the maximum dry density requirements as specified in Subsection 403.05. For compaction around mailboxes, driveways, and other obstacles, equipment designed for that purpose shall be used and approved by the Engineer.

403.04 PRELIMINARY CONSTRUCTION REQUIREMENTS. The Contractor shall submit documentation to the Engineer verifying that the gradation requirements specified herein have been satisfied for each source of material intended for use.

403.05 CONSTRUCTION. The Contractor shall demonstrate to the Engineer the proposed placement procedures. If deemed necessary by the Engineer, the procedures shall be adjusted to avoid damage to the wearing course. It shall be the Contractor's responsibility to repair any damage to the wearing course to the satisfaction of the Engineer, at no additional cost to the Agency.

Unless otherwise directed by the Engineer or shown on the Plans, Aggregate Shoulders, RAP with RAS shall be placed in one course and shall not be placed until the adjacent wearing course has been completed. The maximum layer thickness for placement of material shall be 6 ± 2 inches after compaction. When multiple layers are required, all layers shall be placed in approximately equal thicknesses.

All layers of Aggregate Shoulders, RAP with RAS shall be compacted to 95% of the maximum dry density as determined by *AASHTO T 99*, Method C, or to the satisfaction of the Engineer. This provision shall apply in such cases that the shoulder material has a 1:4 (V:H) slope or flatter and a minimum of a half width of a roller drum can traverse the material. Otherwise the material shall be compacted as directed by the Engineer.

The Contractor shall correct any segregated material to the satisfaction of the Engineer, at no additional cost to the Agency.

All material shall have a true and even surface as shown in the Plans. All holes or depressions found prior to acceptance of the project shall be filled with additional material, reworked and compacted as necessary.

A printed load ticket indicating truck identification, date and time of delivery, and weight shall be furnished to the Engineer with each load delivered to the project.

403.06 QUALITY CONTROL PROGRAM. The work to be completed by the Contractor under this item shall be governed by a Quality Control Program completed by the Contractor. The quality control program shall have a Quality Control (QC) Plan, process control measures, and qualified personnel to record and act on the results of the program. The Contractor shall submit the QC Plan a minimum of 14 calendar days prior to commencing placement of the material.

The QC Plan shall address each phase of the construction including surface preparation, manufacture of the RAP, manufacture of the RAS, blending of the RAS and RAP, placement and compaction of the material. QC tests included in the QC Plan shall include moisture content, maximum dry density, gradation, and blend verification. The QC Plan shall address all reasonably anticipated factors including but not limited to weather, materials quality, material availability, traffic, equipment availability, and materials delivery.

The Contractor shall define an appropriate sampling and testing frequency for quality control purposes. The Contractor is responsible for field confirmation of lab conditions and revision of the mix design to achieve maximum dry density condition of the in-place product.

(a) QC Plan Administrator. The QC Plan Administrator shall be identified in the QC Plan as being qualified by way of past experience with aggregate shoulder placement coupled with NorthEast Transportation Technician Certification Program (NETTCP) certification for aggregate technician or aggregate field technician, or have it be alternately demonstrated that field staff, through supervision and under responsible charge of the plan administrator, has such qualifications or equivalent credentials.

(b) Quality Control Records. Quality control records shall include all sampling events, testing results, and process changes with accurate time and location data and available upon request by the Engineer. All QC records shall be bound and submitted at the completion of the project.

(c) Minimum Process Control Parameters. Minimum process control parameters are:

(1) Material sampling process and frequency.

(2) Gradation results.

(3) Moisture content prior to placement.

(4) RAS percentage, by weight.

(5) Final density after compaction.

403.07 METHOD OF MEASUREMENT. The quantity of Aggregate Shoulders, RAP with RAS to be measured for payment will be the number of tons used in the complete and accepted work, as determined from load tickets.

403.08 BASIS OF PAYMENT. The accepted quantity of Aggregate Shoulders, RAP with RAS will be paid for at the Contract unit price per ton. Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to Aggregate Shoulders, RAP with RAS.

Payment will be made under:

Pay Item	Pay Unit
403.12 Aggregate Shoulders, RAP with RAS	Ton

SECTION 404 – SURFACE TREATMENT MATERIALS

404.01 DESCRIPTION. This work shall consist of furnishing and applying bituminous treatment when required on an approved surface.

404.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Bituminous Material 702.01
Emulsified Asphalt 702.04
Application Temperature Ranges 702.06

All additives for emulsified asphalts must be approved prior to their use.

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404.03 WEATHER LIMITATIONS. Bituminous material shall be applied only when the following conditions prevail.

(a) The air and surface temperature upon which the bituminous material is to be applied is at least 35°F in the shade and rising.

(b) The road surface is sufficiently dry.

(c) Weather conditions or other conditions are favorable and are expected to remain so for the performance of satisfactory work.

404.04 EQUIPMENT. The equipment used by the Contractor shall include transporting equipment, a bituminous distributor, and equipment for heating bituminous material.

(a) Distributor. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surfaces up to 15 feet at the specified rate for the item being placed. Distributor equipment shall include suitable hand spray nozzle and hose, a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

Distributors may be required to apply a 24-foot wide strip at one time.

The weight of the loaded distributor shall not exceed the legal load limit.

Each pressure distributor shall be equipped with a measuring stick.

Traveling or stationary plants or other equipment of proven performance may be used by the Contractor instead of the specified equipment if approved.

(b) Transporting Equipment. Tanks for motor transport trucks shall be made of either steel or aluminum with a minimum capacity of 1,500 gallons, insulated, equipped with baffle plates to prevent surging, and equipped with the necessary units to heat the bituminous content in accordance with these Specifications. Heating of motor transport truck tanks by distributors to bring the material to the proper temperature will not be permitted. The Contractor shall furnish the necessary heating units for the motor transport trucks and the operators for the heating units.

404.05 PREPARATION OF SURFACES. All surfaces to be treated shall be patched, cleaned of loose or objectionable material, and free of irregularities to provide a reasonably smooth and uniform surface.

404.06 APPLICATION OF BITUMINOUS MATERIALS. The application rates of bituminous material shall be as defined in the Contract.

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The application shall not be made on more than 50% of the width of the road surface at a time, unless all traffic is detoured, in which case the application may be full width.

(a) Emulsified Asphalt. Emulsified asphalt shall be applied between the temperature ranges specified in Subsection 702.04 by pressure distributors or other methods approved by the Engineer.

404.07 TRAFFIC CONTROL. To control traffic during bituminous surface treatment operations, flaggers shall be used in accordance with Section 630.

404.09 THIS SUBSECTION RESERVED.

404.10 PROTECTION OF STRUCTURES AND TREES. The Contractor shall use care in applying bituminous material and protecting surfaces of adjacent structures and trees from being spattered with the material.

404.11 METHOD OF MEASUREMENT. The quantity of Emulsified Asphalt to be measured for payment will be the number of hundredweight (CWT) used in the complete and accepted work.

404.12 BASIS OF PAYMENT. The accepted quantity of Emulsified Asphalt will be paid for at the Contract unit price per hundredweight (CWT). Payment will be full compensation for furnishing, transporting, and placing the Emulsified Asphalt and for furnishing all materials, signs, traffic control, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
404.65 Emulsified Asphalt	CWT

SECTION 406 – BITUMINOUS CONCRETE PAVEMENT

406.01 DESCRIPTION. This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these Specifications and the specific requirements of the type of surface being placed and in conformance with the lines, grades, thicknesses, and typical cross-sections shown on the Plans or established by the Engineer.

406.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Performance-Graded Asphalt Binder 702.02
Emulsified Asphalt 702.04
Aggregate for Bituminous Concrete Pavement ..... 704.10(a)

The grade of performance-graded (PG) asphalt binder used to produce bituminous concrete pavement shall be as specified in Table 406.03C or Table 406.03F unless otherwise specified in the Contract.

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406.03A COMPOSITION OF MIXTURE – MARSHALL.

(a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in Table 406.03A.

TABLE 406.03A – MATERIAL SPECIFICATION RANGES (MARSHALL)

Mix Type	Type I	Type II	Type III	Type IV	Type VI
Percentage by Mass (Weight) Passing Square Mesh Sieves (Minimum – Maximum)					
1-1/4 inch (31.5 mm)	100	--	--	--	--
1 inch (25.0 mm)	95 – 100	100	--	--	--
3/4 inch (19.0 mm)	74 – 86	95 – 100	100	--	--
1/2 inch (12.5 mm)	60 – 80	64 – 88	95 – 100	100	--
3/8 inch (9.50 mm)	--	50 – 82	70 – 90	95 – 100	100
No. 4 (4.75 mm)	35 – 60	32 – 62	42 – 75	48 – 78	85 – 100
No. 8 (2.36 mm)	25 – 45	22 – 45	28 – 56	28 – 56	66 – 88
No. 16 (1.18 mm)	--	13 – 35	14 – 41	14 – 41	45 – 67
No. 30 (0.600 mm)	10 – 25	8 – 27	7 – 31	7 – 31	27 – 53
No. 50 (0.300 mm)	--	3 – 20	3 – 22	3 – 22	13 – 40
No. 200 (0.075 mm)	2.0 – 6.0	2.0 – 6.0	2.0 – 6.0	2.0 – 6.0	2.0 – 7.0
Material Composition of Total Mix (Minimum – Maximum)					
Total Aggregates (% of Total Mix)	94 – 97	93 – 97	92 – 97	92 – 95	91 – 93
Bitumen (% of Total Mix)	3.0 – 6.0	3.0 – 7.0	3.0 – 8.0	5.0 – 8.0	7.0 – 9.0

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(b) Design Criteria. The materials shall be combined and graded to meet the criteria specified in Table 406.03B.

TABLE 406.03B – DESIGN CRITERIA (MARSHALL)

Marshall Bituminous Concrete Pavement Blow Count	Medium Duty Bituminous Concrete Pavement (50 blows/side)	Bituminous Concrete Pavement (75 blows/side)
Air Voids (%)	3.0 – 5.0	3.0 – 5.0
VMA [1] (%), Type I	13.0 min.	13.0 min.
VMA [1] (%), Type II	14.0 min.	14.0 min.
VMA [1] (%), Type III	15.0 min.	15.0 min.
VMA [1] (%), Type IV	16.0 min.	16.0 min.
Stability (Pounds)	1,200 min.	1,800 min.
Flow (0.01 inches)	8.0 – 18.0	8.0 – 16.0
Stone Screenings (fine aggregate portion) Passing the No. 8 (2.36 mm) Sieve (%)	60.0 min.	75.0 min.

[1] Voids in Mineral Aggregate

TABLE 406.03C – PG BINDER GRADE SELECTION (MARSHALL)

RAP Content	Binder Grade
RAP ≤ 20.0%	PG 70-28
20.0% < RAP ≤ 25.0%	PG 70-34
25.0% < RAP ≤ 50.0%	TBD [1]

[1] The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grade meets the requirements of PG 70-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 70°C (158°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials Section Central Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan to implement when test results verify that the grade of PG binder does not meet the requirements of PG 70-28.

(1) Air Voids (V_A). The percent of air voids in the mixture shall be calculated by the following formula:

$$V_A = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$

where:

V_A = Percent air voids

G_{mm} = Maximum specific gravity of uncompacted mixture (*AASHTO T 209*)

G_{mb} = Bulk specific gravity of compacted mixture (*AASHTO T 166*, Method A)

The mix design shall have a filler/asphalt ratio ranging between 0.50 and 0.90.

(c) Mix Design. The Marshall Method of Mix Design will be used to develop a mix that will meet the specified Design Criteria. A copy of all test data used in developing the mix design, including graphs, may be required with the submittal of the mix design.

The job-mix formula for each mixture shall establish a single percentage of aggregate passing each sieve and a single percentage of bituminous material to be added to the aggregate. No change in the job-mix formula may be made without the written approval of the Engineer. The job-mix formula must fall within the master range of the Specification as shown in Subsection 406.03A(a).

No work shall be started until the Contractor has submitted and the Engineer has approved a mix design including cold feed gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required in the Marshall Method of Mix Design. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined to be unsatisfactory by the Engineer.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of 10 working days will be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source or PG asphalt binder grade. If a change is made in aggregate source or PG asphalt binder grade, a new mix design shall be submitted and a minimum 10 working day evaluation period will be allowed prior to resuming production. If a change is proposed to be made in the PG asphalt binder supplier, it shall be from an approved supplier and be in accordance with the most current VTrans mix design submittal policy.

406.03B COMPOSITION OF MIXTURE – SUPERPAVE.

(a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in Table 406.03D.

TABLE 406.03D – MATERIAL SPECIFICATION RANGES (SUPERPAVE)

Mix Type and Nominal Maximum Aggregate Size (in.)	Type MS (1-1/2)	Type IS (1)	Type IIS (3/4)	Type IIIS (1/2)	Type IVS (3/8)	Type VS (1/4)	Type VIS (3/16)
Percentage by Mass (Weight) Passing Square Mesh Sieves (Minimum – Maximum)							
2 inch (50.0 mm)	100 – X	--	--	--	--	--	--
1-1/2 inch (37.5 mm)	90 – 100	100 – X	--	--	--	--	--
1 inch (25.0 mm)	X – 90	90 – 100	100 – X	--	--	--	--
3/4 inch (19.0 mm)	--	X – 90	90 – 100	100 – X	--	--	--
1/2 inch (12.5 mm)	--	--	X – 90	90 – 100	100 – X	--	100 – X
3/8 inch (9.50 mm)	--	--	--	X – 90	90 – 100	100 – X	95 – 100
1/4 inch (6.30 mm)	--	--	--	--	--	90 – 100	--
No. 4 (4.75 mm)	--	--	--	--	X – 90	X – 90	90 – 100
No. 8 (2.36 mm)	15 – 41	19 – 45	23 – 49	28 – 58	32 – 67	37 – 70	--
No. 16 (1.18 mm)	--	--	--	--	--	--	30 – 60
No. 200 (0.075 mm)	0.0 – 6.0	1.0 – 7.0	2.0 – 8.0	2.0 – 10.0	2.0 – 10.0	2.0 – 10.0	6.0 – 12.0
Asphalt Cement Content (Minimum)							
Minimum Asphalt Cement Content (%)	--	--	--	--	--	6.0	--

All Superpave mixes shall meet the requirements of *AASHTO M 323*.

(b) Design Criteria. The number of Gyrations at N_{design} (for example, 50, 65, or 80 gyrations) is determined by the Agency and shall be as detailed on the Plans. Design criteria for Superpave mixtures shall be as specified in Table 406.03E and Table 406.03F.

TABLE 406.03E – DESIGN CRITERIA (SUPERPAVE)

Mix Type and Nominal Maximum Aggregate Size (in.)	Type MS (1-1/2)	Type IS (1)	Type IIS (3/4)	Type IIIS (1/2)	Type IVS [1] (3/8)	Type VS (1/4)	Type VIS (3/16)
Voids in Mineral Aggregate (%)	12.5 min.	13.5 min.	14.5 min	15.5 min.	16.5 min.	16.0 min.	17.5 min.
Dust Proportion Range (filler/asphalt ratio, dry sieve)	--	0.50 – 1.20	0.50 – 1.20	0.50 – 1.00	0.50 – 1.00	0.50 – 1.00	0.50 – 1.00
Air Voids (%) [1]	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0
Compaction Parameters by Traffic Level							
Traffic Level (ESALs, any mix type)	< 300,000		300,000 – 3,000,000			> 3,000,000	
Compaction Parameters	$N_{initial} = 6$ $N_{design} = 50$ $N_{max} = 75$		$N_{initial} = 7$ $N_{design} = 65$ $N_{max} = 115$			$N_{initial} = 8$ $N_{design} = 80$ $N_{max} = 160$	

[1] Where Type IVB bituminous material is included in the Plans, it shall be defined as Type IVS Superpave bituminous concrete as specified herein, with the exceptions that Type IVB material shall have a target air voids value of 3.0% and shall not contain any recycled asphalt materials.

TABLE 406.03F – PG BINDER GRADE SELECTION (SUPERPAVE)

RAP Content	Binder Grade
RAP ≤ 20.0%	PG 70-28
20.0% < RAP ≤ 25.0%	PG 70-34
25.0% < RAP ≤ 50.0%	TBD [1]

[1] The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grade meets the requirements of PG 70-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 70°C (158°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials Section Central Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan to implement when test results verify that the grade of PG binder does not meet the requirements of PG 70-28.

The following relationships are used to derive the various design criteria test properties. Refer to *AASHTO R 35* for more information.

(1) Air Voids (V_A). The percent of air voids of the mixture shall be calculated by the following formula:

$$V_A = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$

where:

V_A = Percent air voids

G_{mm} = Maximum specific gravity of uncompacted mixture (*AASHTO T 209*)

G_{mb} = Bulk specific gravity of compacted mixture (*AASHTO T 166,* Method A)

(2) Dust Proportion (*DP*). The proportion of dust in the mixture shall be calculated by the following formulae:

$$DP = \frac{P_{0.075}}{P_{be}}$$

where:

DP = Dust Proportion

$P_{0.075}$ = Percent, by mass, of the material passing the No. 200 (0.075 mm) sieve

P_{be} = Percent, by mass, of effective asphalt binder content of mix

and,

$$P_{be} = P_b - \left[(P_s \times G_b) \times \frac{G_{se} - G_{sb}}{G_{se} \times G_{sb}} \right]$$

where:

P_b = Asphalt content (percentage of total mass of mixture)

P_s = Aggregate content (percentage of total mass of mixture)

G_b = Specific gravity of asphalt cement

G_{se} = Effective specific gravity of aggregate

G_{sb} = Bulk specific gravity of aggregate

(3) Voids in Mineral Aggregate (*VMA*). Voids in mineral aggregate shall be calculated by the following formula:

$$VMA = 100 - \left(\frac{G_{mb} \times P_s}{G_{sb}}\right)$$

where:

VMA = Voids in Mineral Aggregate

G_{mb} = Bulk specific gravity of compacted mixture (*AASHTO T 166*, Method A)

P_s = Aggregate content (percentage of total mass of mixture)

G_{sb} = Bulk specific gravity of aggregate

(c) Mix Design. For Superpave bituminous concrete pavement mixes, *AASHTO R 35* will be the method used to develop a mix that will meet the specified Design Criteria in accordance with *AASHTO M 323,* unless otherwise specified. A copy of all design test data used in developing the mix design, including graphs, may be required with the submittal of the mix design or anytime following as directed by the Engineer.

The five principal parts of the Superpave Mix Design Method are:

(1) Select materials (aggregate and PG asphalt binder).

(2) Select design aggregate structure.

(3) Select design asphalt binder content.

(4) Evaluate moisture sensitivity and rutting susceptibility using *AASHTO T 324*. Test specimens for Hamburg Wheel-Track (HWT) testing shall be 150 mm (6.0 inches) in diameter with a 60 ± 1 mm (2.36 ± 0.04 inch) thickness and shall be short term conditioned in accordance with Section 7.2 of *AASHTO R 30*. HWT specimens shall be tested at 45 ± 1° C (113 ± 1.8° F), with the machine pre-set to end the test once a maximum rut depth of 12.5 mm (0.50 inches) is reached. If the difference in the rut depth between the two pairs of specimens is 6 mm (0.24 inches) or more, and/or only one pair of specimens has a final rut depth of 12.5 mm (0.50 inches), the test results will be deemed invalid and not acceptable for mix design qualification. Slab specimens shall not be used.

(5) Determine cracking susceptibility using *AASHTO TP 124*. Test specimens for the FIT shall be fabricated in a Superpave Gyratory Compactor and short term conditioned in accordance with Section 7.2 of *AASHTO R 30*. Specimens that are fabricated to a height of 50 mm (2.0 inches), in lieu of fabricating 160 mm (6.30 inch) or 115 mm (4.50 inch) specimens as part of the test specimen preparation procedures outlined in *AASHTO TP 124*, will be allowed.

The job-mix formula (JMF) for each mixture shall establish a single percentage of aggregate passing each sieve, a single percentage of bituminous material to be added to the aggregate, and a single percentage for VMA. No change in the job-mix formula may be made without the written approval of the Engineer.

The JMF must fall within the master range of the Specification as shown in Subsection 406.03B(a) and Subsection 406.03B(b). The JMF shall include values for the following sieves: 2 inch (50.0 mm), 1-1/2 inch (37.5 mm), 1 inch (25.0 mm), 3/4 inch (19.0 mm), 1/2 inch (12.5 mm), 3/8 inch (9.50 mm), 1/4 inch (6.30 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (0.600 mm), No. 50 (0.300 mm), No. 100 (0.150 mm), and No. 200 (0.075 mm).

Mix designs shall be submitted in accordance with the most current version of the VTrans HMA mix design submittal policy. No work shall be started until the Contractor has submitted and the Engineer has approved a mix design including cold feed gradations, mixing times, the percentage of each ingredient including bitumen, the JMF from such a combination, and the optimum mixing and compaction temperatures as required by *AASHTO M 323*.

The stockpile gradation data shall be derived by wet sieve analysis. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined unsatisfactory by the Engineer.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of three weeks shall be allowed for the testing and evaluation of the submitted mix design. Once a mix design is approved, the JMF is valid until a change is made in aggregate source or PG binder grade. If a change is made in aggregate source or PG asphalt binder grade, a new mix design shall be submitted and a minimum three-week evaluation period shall be allowed prior to resuming production. If a change is proposed to be made in the PG asphalt binder supplier, it shall be from an approved supplier and be in accordance with the most current VTrans mix design submittal policy.

406.03C REQUIREMENTS FOR BOTH MARSHALL AND SUPERPAVE BITUMINOUS MIXTURES.

(a) Control of Mixtures. The plant shall be operated so that no intentional deviations are made from the job-mix formula. The production of the actual mixture shall not vary from the job-mix formula by more than tolerances specified in Table 406.03G.

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TABLE 406.03G – JOB-MIX FORMULA PRODUCTION TOLERANCES

Job-Mix Formula Property	Tolerance	
Aggregate retained on the No. 8 (2.36 mm) sieve and above	±	6.0%
Aggregate passing the No. 8 (2.36 mm) sieve and retained on the No. 200 (0.075 mm) sieve	±	4.0%
Aggregate passing the No. 200 (0.075 mm) sieve	±	1.0%
Temperature of mixture	±	20°F
Air voids (All mixes except Type IVB)	=	4.0 ± 1.0%
Air voids (Type IVB)	=	3.0 ± 1.0%
Voids in mineral aggregate	±	1.0%

The quantity of PG asphalt binder introduced into the mixer shall be that quantity specified as a percentage in the accepted JMF for batch plants and will be accepted based on the mass (weight) on the printed weigh slip. For the use of drum-mix and continuous mixing plants, the quantity of PG asphalt binder shall be specified as a percentage in the accepted JMF and will be accepted based on the percentage printed on the demand ticket from the approved automatic digital recording device in the plant.

The Contractor shall provide Quality Control adequate to produce work of acceptable quality. The Contractor shall perform Quality Control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the Contract requirements and the minimum guidelines specified.

The Engineer will not sample or test for Quality Control or assist in controlling the Contractor's production operations. The Contractor shall provide personnel and testing equipment capable of providing a product which conforms to specified requirements. Continual production of non-conforming work at a reduced price, in lieu of adjustments to bring work into conformance, shall not be allowed.

(b) Method Specifications Acceptance Testing. For those Contracts having 2,000 tons or fewer of any individual mix type/design of bituminous concrete mixture, control of those mixtures will be analyzed using the following parameters:

(1) If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. A second consecutive failing test sample will be cause for the facility to immediately cease production. In this event, additional adjustments shall be made and tested by the Contractor on a trial basis until the deficiency is corrected.

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(2) With the permission of the Engineer, the plant may continue production pending results of these tests, but if the Engineer deems that it is in the best interest of the project, they may at any time order plant production stopped.

(3) It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program.

(c) Quality Assurance (QA) Acceptance Testing. For those Contracts having more than 2,000 tons of any individual mix type/design of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the procedure below. For those Contracts having multiple individual projects not meeting the 2,000-ton threshold, QA testing protocol may be waived by the Engineer.

Bituminous materials designated for acceptance under QA provisions will be randomly sampled and tested in accordance with the recommended acceptance guidelines specified for the applicable Contract item. Samples may also be taken any time the material appears defective or when the Engineer determines that a change in the process or product has occurred. Acceptance tests will govern in all cases for determination of pay factors without regard to quality control tests.

(1) General. Bituminous concrete mixtures will be sampled once per sublot on a statistically random basis, tested, and evaluated by the Agency for each mix design for the Contract in accordance with the acceptance criteria specified in Table 406.03H.

TABLE 406.03H – ACCEPTANCE CRITERIA

Property	Point of Sampling	Lot Size	Sublot Size	Test Methods
Air voids [1]	Truck at plant	3,000 tons	500 tons	*AASHTO T 269, AASHTO T 166, AASHTO T 209*

[1] For Marshall mixtures, air voids will be determined by the methods defined in Chapter 5 of the *Asphalt Institute MS-2 Manual*.

(2) Lot Size. For evaluating acceptance test properties, the representative tonnage of bituminous material within each lot will be 3,000 tons. The final resultant partial lot will be processed as a full lot if it consists of four or more acceptance samples. If the final resultant partial lot consists of fewer than four acceptance samples, it will be combined with the previous lot.

(3) Sublot Size. A sublot will be 500 tons, except for the final sublot of a partial lot, which will consist of the quantity of material required to complete the partial lot.

If fewer than four samples have been obtained at the time a lot is completed, excluding terminated lots as defined in Subsection 406.03C(h)(1)j., the material in the shortened lot will be included as a part of an adjacent lot and a pay factor computed for the combined lots. Generally, this involves combining results of the shortened lot with the results of the subsequent lot's test results.

However, if this occurs on the last lot of production, these results will be combined with the most recent lot's results for a revised determination.

The Engineer may reject material which appears to be obviously defective based on visual inspection. Such rejected material shall not be used in the work.

(d) Evaluation for Acceptance. Items specified to be sampled and tested for QA purposes will be evaluated for acceptance in accordance with the guidelines specified for those Contract items. All acceptance test results for a lot, as defined in the Specification, will be analyzed collectively and statistically by the Quality Level Analysis – "Percent Within Limits" Method using the procedures listed below to determine the total estimated percent of the lot that is within Specification limits.

Quality Level Analysis – "Percent Within Limits" is a statistical procedure for estimating the percent compliance with a Specification and is affected by shifts in the Arithmetic Mean ($\bar{x}$) of the test results and by the Sample Standard Deviation (s). The steps in the procedure are as follows:

(1) Compute the Upper Quality Index (Q_u) using the following formula:

$$Q_u = \frac{USL - \bar{x}}{s}$$

where:

Q_u = Upper Quality Index

USL = Upper Specification Limit

$\bar{x}$ = Arithmetic mean of the test results

s = Sample standard deviation

(2) Compute the Lower Quality Index (Q_L) using the following formula:

$$Q_L = \frac{\bar{x} - LSL}{s}$$

where:

Q_u = Lower Quality Index

$\bar{x}$ = Arithmetic mean of the test results

LSL = Lower Specification Limit

s = Sample standard deviation

(3) Determine the Percent Within the Upper Specification Limit (PWL_U) which corresponds to a given Upper Quality Index (Q_U) from references available through the Engineer.

Note: If a *USL* is not specified, the PWL_U will be 100.

(4) Determine the Percent Within the Lower Specification Limit (PWL_L) which corresponds to a given Lower Quality Index (Q_L) from references available through the Engineer.

Note: If an *LSL* is not specified, the PWL_L will be 100.

(5) Determine the Total Percent Within Specification Limits (*PWL*) using the following formula:

$$PWL = PWL_U + PWL_L - 100$$

(6) Compare the Total Percent Within Specification Limits (*PWL*) to the applicable Rejectable Quality Level (*RQL*). The *RQL* is the *PWL* value below which the material is deemed unacceptable.

(7) Determine the Pay Factor (*PF*) for the lot from the process or equation applicable to the specific Contract item.

(8) Results from the above calculations shall be reported to the decimal precision and rounded per the following procedures:

a. For decimal precision, report all standard deviation calculations to 0.01, all pay factor calculations to 0.1%, and use the "Precision as Displayed" option when working with Excel spreadsheets.

b. For rounding, the use of AASHTO "Rounding Rule D" shall be discontinued. Instead, when rounding, if the first digit to the right of the number to be rounded is greater than or equal to 5, then the number shall be rounded away from zero to the next number with larger magnitude. If the digit to the right of the number to be rounded is less than 5, then the number shall remain the same.

For example, for rounding to the nearest one decimal (1.0):

5.35 rounds to 5.4 -5.35 rounds to -5.4

5.34 rounds to 5.3 -5.34 rounds to -5.3

(e) Air Voids Pay Factor (PF_{AV}) Determination. Where the air voids *PWL* value, as defined in Subsection 406.03C(d), equals or exceeds the Rejectable Quality Level (*RQL*) for air voids of 50%, the PF_{AV} for each lot of bituminous concrete mixture, based on test results, will be determined using the following equation:

$$PF_{AV} = \frac{(0.28 \times PWL) + 75}{100} - 1.0$$

where:

PF_{AV} = Air Voids Pay Factor

PWL = Total Percent Within Specification Limits

(f) Rejectable Material.

(1) The Contractor may at any time elect to remove any defective material and replace it with new material at no expense to the Agency. Any such new material will be sampled, tested, and evaluated for acceptance.

(2) For those lots with an air voids *PWL* less than 50% and greater than or equal to 25%, the PF_{AV} for each lot of bituminous concrete mixture, based on air voids test results, will be determined using the following equation:

$$PF_{AV} = \frac{(2.16 \times PWL) - 29}{100} - 1.0$$

where:

PF_{AV} = Air Voids Pay Factor

PWL = Total Percent Within Specification Limits

(3) For those lots with an air voids *PWL* less than 25%, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency.

(g) Boxed Samples. If Inspectors are not available to perform their daily inspection duties, then box samples will be taken by the Engineer at the project site to afford verification of mixture properties. Boxed samples will be processed at the Agency's Materials Section Central Laboratory.

(h) Contractor Quality Control Plan. If Quality Assurance Specifications apply, the Contractor shall provide, maintain, and operate in accordance with a project Quality Control Plan, hereinafter referred to as the "QC Plan," sufficient to ensure a product meeting the Contract requirements. The QC Plan shall include all personnel, equipment, supplies, and facilities necessary to obtain samples, perform tests, and otherwise control the quality of the product to meet specified requirements.

The QC Plan shall be a single document in two parts and address all elements that affect the quality of plant mix and laydown operations. An example outline is available through the Agency's Materials Section Central Laboratory, Bituminous Concrete Section.

(1) General. Both parts of the QC Plan shall meet the following requirements:

a. The Contractor shall be prepared to present and discuss, at the preconstruction conference, quality control responsibilities for the specific Contract items. The Contractor shall submit the QC Plan to the Engineer for approval at least 10 working days prior to the start of related work. The Contractor shall not start work on the subject items without an approved QC Plan.

b. All Contractor Process Quality Control testing under the QC Plan shall be performed by qualified technicians in laboratories approved by the Materials Manager. Technician qualifications shall be as described in Subsection 406.03C(h)(2).

c. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. Major pieces of equipment shall be calibrated and/or verified in accordance with the schedule provided by Subsection 406.03C(i). Records indicating equipment condition and calibration status shall be maintained in the laboratory.

d. The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility. The Engineer will advise the Contractor of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stop to incorporating materials into the work until deficiencies are corrected.

e. The individual administering the QC Plan must be a full-time employee of, or a consultant engaged by, the Contractor. The individual shall have full authority to institute any and all actions necessary for the successful operation of the Plan.

f. The QC Plan shall contain a system for sampling that assures all material being produced has an equal chance of being selected for testing. The Engineer shall be provided the opportunity to witness all sampling.

When directed by the Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or the resulting deficiency otherwise corrected by the Contractor. All sampling and testing shall be in accordance with Agency, AASHTO, or ASTM procedures.

g. All testing shall be performed in accordance with the acceptance test procedures applicable to the specified Contract items or other methods specified in the approved QC Plan. Should acceptance test procedures not be applicable to quality control tests, the QC Plan shall stipulate the test procedures to be utilized. Upon request, the Contractor shall provide copies of all test results on forms meeting the approval of the Engineer.

h. The Contractor shall maintain complete records of all Process Quality Control tests and inspections. Quality control tests that are initiated but not run to completion shall be incorporated into the records with all available information that was derived. The records shall be available to the Engineer for review and copies furnished upon request. A complete set of all such documents shall be provided upon completion of the Contract.

Control Charts acceptable to the Engineer shall be maintained and kept current at a location satisfactory to the Engineer. At a minimum, the Control Charts shall identify the project number, the Contract item number, the test number(s), each test parameter, and the upper and lower Specification limits that triggers either action or production suspension activities. These limits shall be identified and applicable to each QC test parameter.

i. The Engineer may stop work or production operations at any time that the QC Plan is not being followed by the Contractor.

j. Under such conditions where two sublot test results indicate that the lot will result in a sub-standard Percent Within Limits (*PWL*), the Contractor may request that a third test, herein termed a "Lot Termination Test," be taken. If a lot is terminated via a lot termination test, the lot shall be closed and evaluated based on the three available test results and not combined with any adjacent lots. After performing a lot termination test, all production operations shall immediately be terminated for that day. The Contractor shall secure the Engineer's approval and concurrence prior to performing said test. This test shall not be cause for switching to "low production activities" as defined in Subsection 406.03C(h)(1)k.

k. Upon an advance request of 24 hours and subsequent approval by the Engineer, the Contractor may perform production activities outside of the requirements of the QC Plan in the instance those activities involve "low production activities." For this section, low production activities are defined as those not associated with mainline activities and up to a maximum daily production of 300 tons of bituminous mixture.

Materials being produced for low production activities will be tested under the Method Specification provisions of Subsection 406.03C(b) and shall comply with all applicable Specifications for the mix type being produced.

(2) Part I. The Plant Mix QC Plan shall include, but not be limited to, the following:

a. Job-mix formula(s)

b. Bituminous concrete mix plant details

c. Stockpile management

d. Name of the QC Plan Administrator

e. Name of Process Control Technician(s)

f. Mixing

g. Frequency and tests for Quality Control

h. For mix designs containing more than 25% RAP, indicate the RAP percentage, PG Grade of virgin binder determined, testing frequency of mix to verify composite PG Grade, and actions to be taken when test results are outside of PG Grade limits.

i. The QC Plan shall identify the following personnel with the specified minimum requirements and qualifications:

1. QC Plan Administrator. This individual shall be a Quality Assurance Technologist certified by the New England Transportation Technician Certification Program (NETTCP).

2. Process Control Technician (PCT). This individual shall be certified as a Hot Mix Asphalt (HMA) Plant Technician by NETTCP. The PCT may have an interim certification from NETTCP as an HMA Plant Technician. Alternatively, the PCT may be a trainee performing duties under the direct supervision of a NETTCP certified technician, as specified in the VTrans approved QC Plan. In this case, the QC Plan should address the following:

i. A training period shall continue for a minimum of 30 working days, at which point the supervising certified technician shall sign off on the trainee.

ii. Upon completion of the training period and having been validated (signed off), the trainee will be qualified to work on QA projects without direct supervision for the remainder of the current construction season.

iii. The PCT shall utilize test results and other quality control practices to ensure the quality of aggregates and other mix components and control proportioning to meet the job-mix formula(s). The PCT shall periodically inspect all equipment used in mixing to ensure it is operating properly and that mixing conforms to the mix design(s) and other Contract requirements.

iv. The QC Plan shall specify how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is

required. The QC Plan shall include the criteria utilized by the PCT to correct or reject materials not meeting Contract requirements.

The QC Plan shall detail the coordination of the activities of the QC Plan Administrator and the PCT. The QC Plan Administrator shall be available to respond to the Engineer within one hour of a request.

v. Bituminous concrete pavement shall be sampled, tested, and evaluated by the Contractor for each mix type/design for each project on a continuous production basis in accordance with the minimum quality control guidelines specified in Table 406.03I.

Upon approval of the Engineer, the Contractor may utilize innovative equipment or techniques not included in the Specifications to produce or monitor the production of the mix.

(3) Part II. Mix Laydown Field Control shall conform to the requirements of Subsection 406.13 and be incorporated into the QC Plan.

TABLE 406.03I – MINIMUM QUALITY CONTROL CRITERIA

Test Action	Frequency	Test Method
Temperature of mix	1 per 250 tons at plant (truck)	Verified thermometer
Air voids [8]	1 per 500 tons	*AASHTO T 269, AASHTO T 166, AASHTO T 209*
Cold feed gradation	1 per day	*AASHTO T 27*
Cold feed percentage fractured face and thin and elongated particles [1]	Day of initial paving and 1 per week [4]	*AASHTO T 335*
PG asphalt binder content	1 per 500 tons	Batch slip
Extracted gradations	1 per 500 tons	*AASHTO T 30, AASHTO T 164, AASHTO T 308*
Fine aggregate and coarse aggregate moisture content [2]	2 times daily minimum [3]	*AASHTO T 255*
Recycled asphalt pavement (RAP) moisture content	2 times daily minimum [3]	*AASHTO T 255*
Fine aggregate, coarse aggregate, and RAP specific gravities	Day of initial paving and one per week [4, 5, 6]	*AASHTO T 84, AASHTO T 85*
RAP PG asphalt binder content	1 per day	*AASHTO T 164, AASHTO T 308*
Determine composite PG binder grade [7]	1 per 5,000 tons	*AASHTO R 29*

[1] Fractured faces for gravel sources only. Thin and elongated percentage for all particles retained on the No. 4 (4.75 mm) sieve and above.

[2] This requirement is for drum-mix and continuous mixing plants only.

[3] Evenly spaced intervals throughout the day and when new material is being added to the stockpiles and utilized in the mix.

[4] Or 1 per every 5,000 tons, whichever is less frequent.

[5] Current (within the previous 2 to 10 days) specific gravities will need to be supplied prior to beginning paving operations.

[6] New specific gravities will be required when either absorbed asphalt is determined to be zero, a negative value, or at the request of the Engineer.

[7] For mix containing more than 25% RAP.

[8] For Marshall mixtures, air voids will be determined by the methods defined in Chapter 5 of the *Asphalt Institute MS-2 Manual*.

(i) Bituminous Concrete Lab Calibration and Verification Procedures. This subpart, Table 406.03J and Table 406.03K, provide a summary of procedures for both required internal laboratory calibration and verification and required external (independent) laboratory calibration services.

TABLE 406.03J – INTERNAL CALIBRATION AND VERIFICATION REQUIREMENTS

VTrans Procedure Number	Calibration (C)/Verification (V) Item	Frequency (months)
4	General Purpose Drying Oven (V)	12
10	Temperature Measuring Devices (V)	12
10c	Temperature Measuring Devices - *ASTM E 1, ASTM E 77, ASTM E 230/E 230 M* (C)	12
10f	Temperature Measuring Devices - Reference *ASTM E 1, ASTM E 77, ASTM E 230/E 230 M* (C)	12
11	Sieves (V)	12
20	Marshall Compaction Molds – *AASHTO T 245* (V)	12
21	Superpave Gyratory Compaction Molds and Gyratory Compactor – *AASHTO T 312* (V)	12
23	Vacuum System – *AASHTO T 209* (V)	12
32	Timers	12
45	Mechanical Sieve Shaker (C)	12
54m	Marshall Stability/Flow Apparatus – *AASHTO T 245* (C)	12
58	Marshall Molds, Manual Hammer, Breaking Heads, Pedestal – *AASHTO T 245* (V)	12

TABLE 406.03K – EXTERNAL CALIBRATION AND VERIFICATION REQUIREMENTS

Calibration (C) / Verification (V) Item	Frequency (months)
Scales (C)	12

For the purposes of this subsection, calibrations are performed on equipment that can be adjusted into compliance. Verifications are completed on fixed-condition equipment or equipment that requires outside calibration (typically by a manufacturer or calibration service). Laboratory records that include the date, service person, equipment calibrated or verified, and the procedure used for calibration and/or verification, and equipment condition shall be maintained in the laboratory.

Equipment determined unsuitable for use will be marked "out of service." Tests performed on equipment marginally meeting Specifications shall include a note on the results sheet indicating such.

Example calibration and verification procedures noted above are available from the Agency's Materials Section. Alternate procedures approved in advance by the Materials Manager are allowable and anticipated.

406.04 WEATHER AND SEASONAL LIMITATIONS. Bituminous material shall not be placed when the ambient air temperature and existing surface temperature at the paving site in the shade and away from artificial heat is below 40°F for courses 1-1/4 inches or greater in compacted thickness or below 50°F for courses less than 1-1/4 inches in compacted thickness. The minimum delivery, placement and compaction temperatures must be reviewed to accommodate the reduced temperature of Warm Mix Asphalt (WMA). The minimum ambient air and existing surface temperature limitations may be lowered to 35°F for WMA.

Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

For paving operations, including placement of temporary pavements, the year shall be divided into two seasons: "In-Season" and "Extended-Season." The dates of those seasons shall be as follows:

(a) Temporary, Leveling, Base, and Intermediate Courses.

(1) In-Season paving is defined as occurring from May 1st to November 1st, inclusive.

(2) Extended-Season paving is defined as occurring from November 2nd to April 30th, inclusive.

(b) Final Wearing and Surface Courses.

(1) In-Season paving is defined as occurring from May 15th to October 15th, inclusive.

(2) Extended-Season paving is defined as occurring from October 16th to May 14th, inclusive.

The following requirements shall apply unless otherwise authorized or directed by the Engineer:

Should paving operations be scheduled during the Extended-Season, the Contractor must submit an Extended-Season Paving Plan for the project that addresses minimum delivered mix temperature considering WMA, PMA, or other additives, maximum paver speed, enhanced rolling patterns, and the method to balance mixture delivery and placement operations. Paving during Extended-Season shall not commence until the Engineer has approved the plan.

406.05 BITUMINOUS MIXING PLANT AND TESTING. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained in a neat and orderly state and the separate stockpiles shall be readily accessible for sampling.

All existing plants shall be inspected and obtain approval each construction season by an authorized representative of the Agency. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Agency may inspect and approve said plant prior to any mixing operation for Agency projects. A minimum of 10 working days shall be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

Scales shall meet all Specifications, tolerances, and regulations which have been or may be adopted periodically by the Secretary of the Vermont Agency of Agriculture, Food, and Markets, and shall be subject to approval by the Engineer. The scales shall be checked and sealed as deemed necessary to ensure accuracy.

Producers located outside Vermont shall conform to all annual hopper scale mass, measurement, and seal requirements of their respective State or location.

Plants used for the preparation of bituminous mixtures shall conform to all requirements specified in Subsection 406.05(a), except that scale requirements shall apply only where mass (weight) proportioning is used. In addition, batch mixing plants shall conform to the requirements specified in Subsection 406.05(b), and drum-mix and continuous mix plants shall conform to the requirements specified in Subsection 406.05(c).

(a) Requirements for All Plants. The Contractor shall give the Engineer and Bituminous Concrete Field Unit Supervisor a 2 working day notice of intent to produce bituminous mixture so that arrangements can be made for plant inspection and control.

The plants shall be so designed, coordinated, and operated as to produce a uniform mixture within the mix design approved for the project.

The Contractor shall indemnify and hold the State harmless for any hazardous waste generated from plant operations in producing materials for use in Agency Contracts. The Contractor shall be responsible for properly disposing of such waste at no additional cost to the State.

All plants shall have automatic controls which coordinate the proportioning, timing, and discharge of mixture by the operation of a single switch or button. In addition to these controls, the plant shall have an approved recording system.

The recording system shall be capable of printing the total net weight of the load. Each weigh slip shall be automatically printed with the date and time of batching, shall show project and truck identification, and shall indicate the approved mix design number being produced.

All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recording, shall become the property of the Agency.

(1) Truck Scales. Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

These scales may be used for spot checking the accuracy of the recording equipment. Any variance exceeding 0.5% of the net weight shall result in immediate corrective action by the Contractor.

A weatherproof building of sufficient size to house the scale operator and the Inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

(2) Equipment for Preparation of Bituminous Material. Tanks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the Specifications. The heating system shall provide uniform heating of the entire contents of the tanks.

Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between the storage tank and the proportioning units during the entire operating period.

The discharge end of the circulating pipe shall be maintained below the surface of the bituminous material in the storage tank to prevent the discharging of hot bituminous material into the open air.

All pipe lines and fittings shall be steam- or oil-jacketed or otherwise properly insulated to prevent heat loss.

(3) Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that the proper uniform production and uniform temperatures will be obtained.

(4) Dryer. The dryer shall be capable of heating and drying the mineral aggregates to Specification requirements without leaving any visible unburned oil or carbon residue on the Aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to an amount which the dryer is capable of drying.

(5) Screens. Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the Specifications.

(6) Cold Storage Bins. The plant shall have cold storage bins of sufficient capacity to ensure a uniform and continuous operation.

The bins shall be so constructed as to prevent any intermingling of aggregate from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin shall not be permitted.

For all bituminous concrete supplied for use on Agency projects, uniform feeding of all fine aggregates shall be accomplished using a variable-speed continuous belt feeder on each cold storage bin of fine aggregate.

(7) Hot Storage Bins. The plant shall have hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage system shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

Each hot storage bin shall be provided with a free-flowing overflow pipe of such size and at such a location as to prevent backing up of material into other bins or into contact with the screen. This overflow material shall not be fed back into the system or into any accepted stockpiles.

All hot storage bins shall be equipped with a sensor device to indicate the position of the aggregate in the bins at the lower quarter point.

Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percentage required. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

Adequate and convenient facilities shall be provided to obtain representative aggregate samples from each bin. Hot bins are not applicable to drum-mix or continuous mix plants.

(8) Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall be accurate to within plus or minus 2% of the amount of bitumen delivered when tested for accuracy.

The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual weight.

Suitable means shall be provided, either by steam, oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

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(9) Thermometric Equipment. An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit for accurately indicating the temperature of the bitumen.

The plant shall also be equipped with an approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

The Engineer may reject questionable thermometric instruments, may direct replacement of any instrument with an approved temperature recording apparatus, and may further require that daily temperature charts be filed with the Engineer.

(10) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time.

(11) Dust Collectors. The plant shall be equipped with adequate dust collectors so that exhaust will not be dispersed into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

The introduction of baghouse fines into bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which uniformly introduces the fines.

The Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contractor is unsatisfactory as determined by the Engineer.

(12) Testing Facilities. The Contractor shall provide a weatherproof building, with at least 240 square feet of floor space, in which to house and use the testing equipment. The construction of the facility shall be such that while in use, the operation, sensitivity, and accuracy of testing equipment is not affected. If not all testing equipment can be housed in this space, the use of a supplemental workspace may be allowed. Supplemental workspace and its location must be approved by the Engineer.

Any testing facilities being constructed, renovated, or relocated shall have a minimum floor space of 320 square feet and accommodate all testing equipment. Construction plans and designs for facilities shall be provided to the Materials Manager prior to construction for review and feedback regarding the location, layout, and adequacy of the building.

Testing facilities shall be maintained for the use of the Agency Engineers or Inspectors, and shall be located so that details of the Contractor's plant are plainly visible from at least one window of the building. Adequate lighting, heating, ventilation, and electrical connections shall be provided 24 hours per day.

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The method of heating shall be such that a minimum temperature of 70°F will always be maintained. Sanitary toilet facilities with lavatory and proper sewage disposal shall be furnished for the use of Agency personnel. Cleaning supplies shall be furnished by the Contractor.

Private telephone service, dedicated for the use of Agency personnel, shall be provided in the laboratory. An internet connection that delivers a minimum download speed of 3 Mbps, without utilizing compression algorithms, shall be provided in the laboratory and dedicated for the use of Agency personnel. The connection bandwidth speed shall be verifiable using an online speed test.

The Contractor must have its office space separate from the office space used by Agency personnel. The Contractor's office space shall be located to afford privacy to Agency personnel.

The laboratory shall be equipped with a monitoring system readout that provides real-time access to active Agency project(s) production status. The system shall accumulate and provide the following information via digital display: project name and number, truck number, ticket number, product description, and accumulated project daily quantity and load quantity accurate to the nearest ton. The display shall be continually updated by the plant's recording system. Waivers may be considered for plants with production capacities not capable of exceeding 150 tons per hour.

Facilities shall be equipped with the following standard commercial equipment, with substitutes allowed upon approval of the Engineer:

1 Air conditioner sized for the volume of the building capable of maintaining a maximum temperature below 77°F

2 5-pound minimum capacity fire extinguishers, either ABC Dry Chemical or Carbon Dioxide, of standard commercial quality

1 First aid kit, adequately stocked

1 Standard office desk, 4 feet × 2-1/2 feet (minimum dimensions)

1 Adjustable office chair

2 Bench sections and storage compartments; benches shall be approximately 36 inches high, 24 inches wide, and 10 feet long

1 Exhaust fan and hood approved for the adequate removal of silica; exhaust fan shall be a high-volume axial flow type with a minimum diameter of 12 inches

1 Water cooler, supplied with potable water

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1 Sink with faucet, located within the office and supplied with continuous pressurized clean hot and cold water for the duration of the project; sink shall drain to the exterior

1 Forced draft oven, thermostatically controlled, capable of maintaining any desired temperature setting from room temperature to 500°F, to within 6°F, and capable of holding two SGC specimen molds and two Marshall specimen molds upright

1 Electronic balance with weigh below capability, 22 pound (10 kg) minimum capacity, sensitive/readable to 0.0002 pounds (0.1 g)

1 Ignition oven that conforms to the apparatus requirements of *AASHTO T 308*, with two full sets of sample baskets, two catch pans, and one set of safety equipment that conforms to the requirements of *AASHTO T 308*

1 Full set of 12-inch diameter full height sieves, pans, and covers necessary for testing all bituminous items required on the project

1 Motorized sieve shaker with either rocking and tapping action or circular and tapping action capable of holding at least ten sieves and one pan

1 16-inch diameter (minimum) stainless steel bowl

1 Mechanical aggregate shaker with 1.0 cubic foot capacity and necessary screens; shaker may be placed in a separate enclosure outside of the testing facility with the approval of the Engineer

1 Sample splitter with 2-1/2 inch chutes

1 Sample splitter (riffles) with 3/4 inch chute width or smaller

2 Square-pointed shovels; one long-handled and one short-handled

1 12-inch wide taping knife

4 Metal pans, approximately 20 inches long, 10 inches wide, and 2-1/2 inches deep (minimum dimensions)

1 Flat, triangular trowel

1 Rectangular trowel, approximately 2 inches wide

2 Hand scoops, Size #1, 1/2 quart capacity, measuring approximately 3-1/2 inches × 6 inches

1 Brass wire bristle brush

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1 Standard floor brush

1 Standard table brush

2 1-1/2 inch soft bristle paint brushes

2 Flexible spatulas with 6-inch long blades

2 Automatic timers with intervals from 0 - 30 minutes

1 Pail, 5-gallon capacity

2 Pairs of gloves, lined and heat resistant

2 Digital or mechanical metal stem thermometers with a range of 50°F to 500°F (10°C to 260°C), approximately 8 inches long; mechanical head shall be approximately 1-3/4 inches wide

2 Laboratory thermometers, glass or digital, capable of reading at least 140°F (60°C) in 2°F (1°C) increments

1 Proportional Caliper meeting the requirements of *ASTM D 4791*

2 Vacuum containers, meeting the apparatus requirements of *AASHTO T 209*

1 Vacuum pump and vacuum measurement device with bleeder valve, meeting the apparatus requirements of *AASHTO T 209*

1 Water bath meeting the apparatus requirements of *AASHTO T 166*, Method A, with adequate means to maintain constant water level and temperature as deemed satisfactory by the Engineer

In addition to the standard commercial equipment specified above, a facility producing Superpave mixtures shall be equipped with the following:

1 Superpave Gyratory Compactor (SGC) as specified in *AASHTO T 312,* with a minimum of two specimen molds specifically designed for use with the SGC provided; calibration of the SGC shall be done at the initial setup, whenever the unit is disrupted or moved, at the start of each construction season, and as directed by the Engineer

In addition to the standard commercial equipment specified above, a facility producing Marshall mixtures shall be equipped with the following apparatuses meeting the requirements of *AASHTO R 68* and *AASHTO T 245:*

1 Automatic Marshall Compaction Hammer

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2 Marshall compaction molds with base plates

1 Marshall stability mold

1 Marshall flow meter

1 Motorized compression and testing machine

1 Water bath capable of maintaining a temperature of 140°F ± 2°F

For drum-mix and continuous mix plants, the facility shall be equipped with the following additional test equipment and supplies, with substitutes provided upon approval of the Engineer:

1 Microwave oven with a minimum interior volume of 1.0 cubic foot, with defrost as well as normal modes of operation

6 Oven-proof glass dishes, measuring approximately 12 inches × 12 inches × 1-1/2 inches

All of the foregoing testing equipment shall be in good condition, calibrated and/or verified per the Contractor's QC Plan schedule and/or the Agency provided schedule as applicable. Testing equipment shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The above-mentioned equipment is for a one-plant operation only. In the event the Contractor chooses to use more than one plant, the Contractor shall provide adequate laboratory facilities as deemed necessary by the Engineer for making tests.

(13) Safety Requirements. Adequate and safe stairways to the mixer platform shall be provided, and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

All heated pipe lines adjacent to work areas, gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall always be maintained in and around the truck loading space. This space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

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(14) Surge or Storage Bins. Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Engineer. A surge or storage bin shall be capable of storing the mix without any degradation of its properties. The surge or storage bins shall be covered during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Agency will not be obligated to purchase mix remaining in a surge or storage bin.

For drum-mix and continuous mix plants, an approved recording weigh system shall be used on all surge bins.

When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for the applicable Contract item shall be in accordance with the following procedure:

a. The plant will produce mix with the printer operating in accordance with the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.

b. As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck driver will then deliver the ticket to the paving Inspector upon reaching the paving site.

c. The weight shown on the ticket will not be the actual weight of the mix contained in the truck since the truck was loaded from the surge bin. The bin shall be completely emptied at the end of every day, circumstances permitting, and all tickets delivered to the Paving Inspector.

d. Any rejected or held-over material shall be weighed on the platform truck scales. This quantity shall be deducted from the daily totals.

e. When paving ramps or other areas where a definite quantity is desired, the material required will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These weights will be entered on the ticket or a separate ticket provided.

f. The Plant Inspector will sign the first slip of each day instead of initialing it. If the Inspector changes during the day, this procedure will be followed for each change. At the end of each day, the Plant Inspector will inspect the storage bin to determine that it is empty and note that on the last ticket.

g. The Paving Inspector will acknowledge receipt of the material at the paving site by initialing the lower right-hand corner of the ticket.

h. All standard checks of the weighing apparatus at the plant will be made at the prescribed intervals.

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i. All mix produced for commercial customers and/or other projects must be discharged from bins other than those used for this project or directly from the pugmill into the haul vehicle; such mix shall not be loaded from the bin used for this project.

j. All surge bins shall be emptied each day unless written permission is obtained from the Engineer.

(b) Requirements for Batching Plants.

(1) Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand-raking or running over.

The weigh box or hopper shall be supported on fulcrums and knife edges constructed so that they will not be easily thrown out of alignment or adjustment.

All edges, ends, and sides of weighing hoppers shall be free from contact with any supporting rods of columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be hung so that the aggregate will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

(2) Aggregate Scales. Scales for any weigh box or hopper shall be springless dial or load cell with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required.

Dials shall be free of vibration and shall be located to always be plainly visible and readable to the operator at all times.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either using ten 50-pound test weights or by other methods approved by the Engineer. All test weights shall be certified annually by the Consumer Protection Section of the Vermont Agency of Agriculture, Food, and Markets.

(3) Bitumen Bucket. The bucket for weighing bitumen shall be of sufficient capacity to hold and weigh the amount required for a batch in a single weighing.

The filling system and bucket shall be designed, sized, and shaped so that bitumen will not overflow, splash, or spill outside the confines of the bucket during filling and weighing.

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The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be able to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 consecutive seconds.

(4) Bitumen Scales. Bituminous material shall be weighed on scales that conform to the Specifications for the weighing of aggregate. The value of the minimum graduation shall not exceed 2.0 pounds.

(5) Mixer Unit for Batch Method. The plant shall include an approved, twin pugmill type batch mixer, jacketed or insulated and capable of producing a uniform mixture within the applicable job-mix tolerance. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.

(6) Recording. The recording system of the batch plant shall print the weight of the bitumen, the weight of the aggregate, and the total combined weight of both in addition to printing the combined net weight of each load.

(c) Requirements for Drum-Mix and Continuous Mix Plants.

(1) Aggregate Cold Bin Feeders. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. Gravity type feeders will not be permitted. Indicators graduated to not more than 0.1 inch shall be provided on each orifice. Each aggregate feeder shall be interlocked so that production is interrupted if one or more cold bins become empty or the flow is obstructed.

(2) Mineral Filler System. When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall be able to feed the mineral filler at adjustable rates accurately and uniformly.

The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed so that no filler is lost as fugitive dust.

(3) Aggregate Weighing Equipment. All aggregates, including mineral filler, shall be weighed by a continuous weighing device, either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of the National Institute of Standards and Technology, as given in *NIST Handbook 44*, and shall be installed in accordance with the scale manufacturer's recommendations by a technician licensed by the Vermont Agency of Agriculture, Food, and Markets. Any other type of weighing device shall be approved by the Engineer prior to use.

(4) Bitumen Control Unit. The bitumen shall be proportioned by a meter. A flow switch designed to stop production if the bitumen flow is interrupted shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to a temperature of 60°F.

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(5) Proportioning Controls. All proportioning controls for aggregates, mineral filler, and bitumen shall be located at the panel which controls the mixer and temperature. The panel shall have a master control capable of increasing or decreasing the production rate without having to reset the individual controls.

a. Aggregate Feed Rate Control. The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow rate for each bin such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total weight of bituminous mixture per interval of time. When separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above for aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on weight or percentage of dry aggregates.

b. Aggregate Weight Indicator. The plant shall have an aggregate weight indicator which will display in the control room the mass of combined aggregates and mineral filler; it shall continuously accumulate the dry aggregate weight of material during the production period, generally one day. The indicator shall be resettable to zero and lockable.

c. Aggregate Moisture Compensator. The plant shall have a moisture compensation device capable of electronically changing the wet weight of aggregate to dry aggregate weight. The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.

d. Bitumen Control. The plant shall have a bitumen control capable of presetting the actual bitumen content directly as a percentage based on total weight of mixture. The maximum gradation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.

e. Bitumen Quantity Indicator. The plant shall have a bitumen quantity indicator in the control room indicating the accumulated quantity of bitumen during the production period, generally one day. The quantity indicated may be either weight or volume at 60°F. The indicator shall be resettable to zero and lockable.

(6) Recording of Proportions. The plant shall be equipped with an automatic digital recording device approved by the Engineer that simultaneously records the accumulated weight of dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month, and year, and time to the nearest minute for each print. The original recordings shall become the property of the Agency.

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(7) Calibration of Feed Rates. The feed rates of aggregates from the cold bins, mineral filler when used and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter, respectively. The feed rates shall be checked periodically or at the direction of the Engineer.

(8) Automatic Aggregate Sampling Device. The plant shall have an automatic aggregate sampling device which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for gradation testing.

The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

(9) Mixer Unit for Drum-Mix Plants. The plant shall have a drum mixer, approved by the Engineer, having an automatic burner control and capable of producing a uniform mixture within the job-mix tolerances. The mixture shall be discharged into a hot bituminous surge or storage bin meeting the requirements of this section.

(10) Mixer Unit for Continuous Mix Plants. The plant shall include an approved twin, pugmill type continuous mixer, and capable of producing a uniform mixture within the applicable job mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of mix.

406.06 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly heated to the specified temperature. A continuous supply of the bituminous material shall always be provided to the mixer at a uniform temperature.

406.07 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid depositing soot or unburned fuel on the aggregate.

For batch plants, immediately after heating, the aggregates shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

To meet gradation requirements mineral filler may be added. The way the mineral filler is introduced into the mix shall be approved by the Engineer.

406.08 MIXING. The mixture, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise approved by the Engineer.

The dried aggregates shall be combined in the mixer at the appropriate proportions required to meet the job-mix formula and thoroughly mixed prior to adding the bituminous material. Dry mix times shall be increased as approved by the Engineer in such cases that RAP material is introduced into the mixer.

The bituminous material shall be measured and introduced into the mixer in the amount consistent with the approved mix design's current job-mix formula.

After the required amounts of constituent material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. If complete and uniform coating of the particles is not achieved, the wet mixing time shall be adjusted as approved by the Engineer.

All plants shall have a means of eliminating oversized and foreign material from being incorporated into the mixer.

406.09 HAULING EQUIPMENT. To prevent the mixture from adhering to the beds, trucks used for hauling bituminous mixture shall have tight, clean, and smooth metal beds which have been thinly coated with a bond release agent. Petroleum-based products will not be permitted.

The trucks used for hauling bituminous mixture shall be compatible with the equipment used for placing the bituminous mixture. Trucks are not to be cleaned and/or emptied on surfaces to be paved.

Each truck shall have a cover of canvas or other suitable material of sufficient size to extend over all sides of the haul vehicle to properly protect the mix from the weather. When necessary, to ensure placement of material at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

406.10 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly capable of being heated if necessary and capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross-sectional shape.

Pavers shall be in good mechanical condition, equipped with all necessary attachments, and designed to operate electronically for controlling the grade of the finished surface. Additionally, pavers shall be equipped such that, upon extension of the screed by 24 inches or more, auger extensions shall be used as directed by the Engineer.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of bituminous material.

Bituminous concrete pavers shall be equipped with a sloped plate to produce a tapered or notched tapered edge at longitudinal joints. The sloped plate shall produce a tapered or notched tapered edge having a minimum face slope of 1:3 (V:H). The plate shall be able to accommodate compacted mat thicknesses from 1-1/4 inches to 4 inches. The bottom of the sloped plate shall be mounted 3/8 inch to 1/2 inch above the existing pavement.

As directed by the Engineer, bituminous pavers shall be equipped with a joint heater that has the capacity to supply at least 6,250 BTU/min of heat to the longitudinal edge of the previously placed mat and heat it to a surface temperature of 200°F, or higher if necessary, to achieve bonding of the newly placed mat with the

previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately ahead of the screed.

The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignites them with the forward movement of the paver. The joint heater shall heat the entire area of the previously placed wedge to the required temperature. Heating to the point of 200°F or higher shall immediately precede placement of the bituminous material.

406.11 ROLLERS. Rollers shall be in good mechanical condition, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The weight of the rollers shall be sufficient to compact the mixture to the required density without crushing the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls or tires.

Pneumatic-tired rollers shall be equipped with appropriate skirts and shall always be preheated prior to use in order to avoid picking. The Contractor shall remove all picked material from the surface.

Vibratory rollers shall have separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration prior to the roller stopping and/or reversing its direction of travel.

406.12 CONDITIONING OF EXISTING SURFACE. All surfaces shall be cleaned and sprayed with an emulsion meeting the requirements of emulsified asphalt, RS-1, CRS-1, RS-1h or CRS-1h before placing of any bituminous mixture, unless otherwise ordered by the Engineer. The emulsion shall be applied under pressure at a rate in accordance with Table 406.12A.

TABLE 406.12A – SURFACE TYPE AND EMULSION APPLICATION RATES

Surface Type	Application Rate (gal/SY)
New bituminous concrete	0.04 – 0.06
Existing bituminous concrete	0.06 – 0.08
Cold planed surface	0.08 – 0.10
Cold mix	0.06 – 0.08
Portland cement concrete	0.08 – 0.10

The application shall be made just prior to the placement of the bituminous concrete mixture and shall progress sufficiently ahead of the paving so that the surface to be paved will be broken such that the surface consists of residual asphalt only. Equipment used to apply the emulsion shall meet the requirements for distributors specified in Subsection 404.04.

Prior to paving any mainline or drive surfaces, the existing bituminous concrete pavement surface shall be prepared as shown on the Plans and as directed by the Engineer. Bituminous Concrete Pavement Surface Preparation shall consist of performing all necessary surface preparation, including pothole repairs, raveling repairs, and other repairs directed by the Engineer prior to placing the final surface treatment. Bituminous surface preparation material shall be a bituminous material or mixture as approved by the Engineer.

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Contact surfaces such as curbing, gutters, and manholes shall be coated with a thin, uniform coat of emulsified asphalt immediately before the bituminous concrete mixture is placed against them.

Grass growing adjacent to pavement or through cracks in the pavement which may hamper the placement of new bituminous concrete shall be removed by the Contractor as directed by the Engineer.

If there are deficiencies that require corrective action in the base course constructed under the Contract, a bituminous concrete mix approved by the Engineer shall be used to bring the base course to the designed grade and contour.

Where bituminous concrete pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions, or waves, such deficiencies shall be eliminated using extra bituminous material for spot leveling to bring the existing base to uniform section and grade before placing of the required courses of bituminous concrete.

406.13 PLACING AND FINISHING. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture.

At the time of placement, the bituminous mixture shall be within 10°F of the compaction temperature for the approved mix design.

The Contractor shall, during all phases of the paving operation, protect from damage all exposed surfaces which are not to be treated.

The bituminous mixture shall be placed and finished with the specified equipment, shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and elevation specified.

All paving operations shall be conducted such that, to the extent possible, all travel lanes are covered their full width in a single paver pass. Longitudinal construction joints within any travel lane will not be permitted. Screed extension to cover adjacent shoulders concurrent with any travel lane will be permitted considering the requirement for auger extensions.

Tandem paving operations shall have an independent rolling train for each paver sufficient to achieve compaction requirements.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, luted, and compacted by hand methods.

All material shall be produced early enough in the day such that the completion of spreading and compaction of the mixture will occur during daylight hours, unless night paving has been approved for the project.

No traffic will be permitted on placed material until the material has been thoroughly compacted and has cooled to 140°F unless otherwise authorized by the Engineer.

The use of water to cool the pavement will not be permitted.

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All work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, shall be completed prior to placing the wearing course.

When bituminous concrete pavement is to be placed on a bridge deck having a waterproofing membrane, a rubber-tired or rubber-tracked paver shall be used to place the intermediate course of pavement. Rollers shall operate in static mode when compacting bridge deck pavements.

On projects where traffic will be maintained, the Contractor may be required to schedule daily paving operations such that at the end of each work day all travel lanes of the roadway on which work is being performed will be paved to the same limits or as directed by the Engineer.

Suitable temporary aprons or fillets shall be constructed at side road intersections and driveways as directed by the Engineer within 24 hours of adjacent mainline paving. Permanent side road aprons shall be constructed within 5 working days of adjacent mainline paving. Reasonable access to and from the mainline mat shall be maintained at all times.

Mainline temporary transverse tapers shall have a minimum slope rate of 1 inch per 5 feet for speeds of 40 mph and lower and a minimum slope rate of 1 inch per 10 feet for speeds greater than 40 mph.

Permanent public and/or private drives and permitted drives (such as field drives for agriculture) shall be constructed within 5 working days of adjacent mainline paving. This work shall consist of the placement of one or more courses of bituminous concrete material by hand (non-mechanical) methods on a prepared foundation in conformance with the Plans or as directed by the Engineer.

For all drive construction operations, the existing surface and/or bed (subbase) upon which the bituminous concrete material is to be placed shall be compacted to the line, grade, and shape shown on the Plans or as directed by the Engineer. All vegetation and soft, yielding, or unsuitable material shall be excavated and replaced with properly compacted material meeting the requirements of Section 301 for Subbase of Crushed Gravel, Fine Graded. Crushed RAP generated from the project may be substituted for Subbase of Crushed Gravel, Fine Graded.

The existing edge of pavement shall be saw-cut or trimmed by mechanical means to provide a vertical edge for placing the hand-placed bituminous concrete material. Emulsified asphalt shall be applied uniformly and completely to all vertical and horizontal surfaces to be paved. All surfaces shall be free of moisture, dust, and debris prior to applying emulsified asphalt.

If cross slope allows, as determined by the Engineer, existing paved drives shall be cold planed the entire drive width to the depth of the wearing course, not to exceed 2 inches. Unless the drive is to be paved that day, all cold planed vertical edges shall have temporary fillets placed the same day as cold planing takes place.

Hand-placed bituminous concrete material shall be rolled with a minimum 1-ton mechanical roller with steel drums, or approved equal, until compacted to the satisfaction of the Engineer.

(a) QC Plan Information. The Field Section of the QC Plan shall contain the following minimum information as applicable, and will be subject to approval by the Engineer:

(1) Field project Manager and/or Superintendent – names and their duties.

(2) Field Process Control/Quality Control Technicians and/or Contractor Foreman – names and their duties.

(3) Pavers and Laydown Equipment – manufacturers and types.

(4) Material Transfer Vehicles (MTVs) – manufacturers and types in accordance with Section 410.

(5) Steel drum rollers – manufacturers and types, with the number of rollers, including total weight and weight per inch of drums and their respective location within the paving train.

(6) Pneumatic-tired rollers – manufactures and type, with the number of rollers, including the average or recommended ground pressure per tire and their respective location within the paving train.

(7) Mixing, loading, and transportation – the Contractor shall submit proposed plans of product delivery to the project site and will be subject to approval by the Engineer such that a balanced paving operation is achievable.

(8) Process Control Testing and Quality Control Testing – daily QC testing results shall be provided to the Engineer as requested and printed and bound copies of all project QC testing shall be provided on such dates that a biweekly estimate from the Agency is intended to be processed.

(9) Intended paving and construction sequence – a detailed, full project construction staging and sequence is required for the project; this detail shall be above and beyond, but include all traffic control plans as otherwise required by the Contract; this detail shall be inclusive and be in concert with any project schedule submitted.

(10) Paving limitations.

(11) Weather limitations.

(12) Any specific project issues with bridges, drives, intersections, structures, guardrails, or other items.

(b) Additional Information. The Contractor shall provide the following additional information as components of the QC Plan to have the QC Plan considered for acceptance by VTrans. All components provided shall be titled "Best Practices."

(1) Best Practices for minimizing segregation.

a. Loading trucks

b. Dumping trucks

c. Laydown operations

d. Troubleshooting

e Thermal segregation

(2) Best Practices for screed setup/operators.

(3) Best Practices for paver operators.

(4) Best Practices for breakdown roller operators.

(5) Best Practices for intermediate/finish roller operators.

(6) Best Practices for MTV operators.

(7) Best Practices for constructing and achieving longitudinal joint compaction.

(8) Best Practices for achieving ride quality.

(9) Other.

The Contractor shall also submit, as part of the QC Plan, all calculations which reveal hot mix plant daily capacity intended for the project, anticipated daily field laydown capacity, delivery vehicle availability and capacity, and delivery vehicle routes and timing. The Contractor shall calculate the resultant paver speed based on the delivery system and submit it to VTrans within the QC Plan indicating a balanced paving operation. Any calculations that may indicate repeated or frequent interruptions of paver laydown operations will not be approved. Any repeated or frequent interruptions of paver laydown operations that occur after the QC Plan has been approved will result in production suspension.

The Contractor shall submit any QC Plan a minimum of 5 working days prior to any project production. VTrans will review any QC Plan and provide any comments or approval within 5 working days of receiving the same. Outlines of that as specified above will be provided by the Engineer upon any request.

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406.14 COMPACTION. Prior to performing any construction operations, the Contractor shall submit to the Engineer for their approval the proposed rolling pattern and compaction equipment to be used. Leveling courses shall be compacted using a self-propelled pneumatic tired roller for intermediate rolling, unless otherwise permitted in writing by the Engineer. The Contractor shall take random investigative cores at locations as determined by the Engineer to verify the effectiveness of the proposed rolling pattern and equipment. Pending results of the investigative cores, necessary adjustments to the proposed rolling pattern and/or equipment shall be made by the Contractor to achieve densities to the satisfaction of the Engineer. In the absence of a Mat Density Pay Adjustment on any project, this provision will be the sole criterion governing compaction requirements.

The Contractor shall provide to the Engineer all compaction QC records in a printed and bound format at the conclusion of each day's paving operations.

If rolling causes undue displacement, cracking, tearing, or shoving, no further material will be produced for or placed on the project until a corrective action plan is proposed by the Contractor and accepted by the Engineer.

To prevent adhesion of the mixture to the rollers, the rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid and petroleum products will not be permitted.

For places not accessible to the rollers, the mixture shall be thoroughly compacted with hand tampers, smoothing irons, or mechanical tampers coated with a non-petroleum based bond release agent.

The Contractor assumes full responsibility for, and shall repair at the Contractor's expense, all damages which may occur to highway components and adjacent property if vibratory compaction equipment is used.

If the Agency elects to not take cores of any pavement course, the Density Pay Factor (PF_D) for that course will be considered equal to 0.000.

Leveling courses will not be analyzed for density.

(a) Short Projects. For projects less than or equal to 0.5 miles in length, bituminous concrete pavement will be analyzed for density according to the procedure specified below.

The density of the compacted pavement shall be at least 92.5%, but not more than 96.5%, of the corresponding daily average maximum specific gravity for each mix type (each mix design) of bituminous mix placed during each day. The Density Pay Factor (PF_D) will be determined in accordance with Table 406.14A and applied in accordance with Subsection 406.19(b).

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TABLE 406.14A – DENSITY PAY FACTORS FOR SHORT PROJECTS

Average Density	Density Pay Factor (PF_D)
90.5% – 90.9%	- 0.100
91.0% – 91.4%	- 0.075
91.5% – 91.9%	- 0.050
92.0% – 92.4%	- 0.025
92.5% – 93.4%	0.000
93.5% – 95.4%	0.010
95.5% – 96.5%	0.000
96.6% – 97.0%	- 0.025
97.1% – 97.4%	- 0.050
97.5% – 98.0%	- 0.075
98.1% – 98.5%	- 0.100

For material with an average density that is less than 90.5% or more than 98.5%, the Construction Engineer will determine whether the material will be removed and replaced by the Contractor at no expense to the Agency or if a greater penalty shall be imposed.

It shall be the responsibility of the Contractor to conduct all process control. Acceptance testing will be conducted by Agency personnel using cores extracted and provided by the Contractor.

Acceptance testing to verify the density of the compacted pavement will be done by averaging the densities of a minimum of four cores for each day's production for each type of bituminous mix placed.

The cores taken for acceptance testing will be the final cores taken for determination of densities.

(b) Long Projects. For projects greater than 0.5 miles in length, bituminous concrete pavement will be analyzed for density according to the procedures specified in this subsection.

(1) Quality-Level Analysis. Compacted bituminous concrete pavement specified to be sampled and tested using bituminous concrete pavement core samples for determining density will be analyzed by utilizing the statistical quality-level analysis Percent Within Limits (*PWL*) method.

(2) Quality Acceptance.

a. Sampling Bituminous Mixtures. Bituminous concrete mixtures will be sampled once per sublot using a stratified random sampling procedure in accordance with *ASTM D 3665* and tested and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the guidelines in Table 406.14B.

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TABLE 406.14B – ACCEPTANCE CRITERIA

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted in-place	Daily - 24 hour max.	*AASHTO T 166*, Method A and *AASHTO T 209*

b. Acceptance Test Properties. For the purpose of evaluating acceptance test properties, a lot shall consist of the total quantity of bituminous concrete mixture compacted in-place during any one day's production to a maximum of 24 hours. Sampling shall be performed at the rate of one sample per lane 0.5 mile, with the exception that there shall not be fewer than six samples taken per any one day's production. The quantity represented by each sample shall constitute a sublot.

If daily field laydown operations are unexpectedly halted by circumstances such as inclement weather or equipment breakdowns, the Engineer reserves the right to combine the truncated day's production with a subsequent day's production to constitute a single lot for density analysis.

c. Density Pay Factor (PF_D) Determination. Where the density PWL value, as defined in Subsection 406.03C(d), equals or exceeds the Rejectable Quality Limit (RQL) for density of 60%, the PF_D for each lot of bituminous concrete mixture, based on test results, will be determined by using the following applicable equations:

1. Superpave Bituminous Concrete Mixtures.

Where $80 \leq PWL \leq 100$,

$$PF_D = \frac{(0.10 \times PWL) + 92}{100} - 1.0$$

or, where $60 \leq PWL < 80$,

$$PF_D = \frac{(0.50 \times PWL) + 60}{100} - 1.0$$

2. Marshall Bituminous Concrete Mixtures.

Where $85 \leq PWL \leq 100$,

$$PF_D = \frac{(0.20 \times PWL) + 83}{100} - 1.0$$

or, where $60 \leq PWL < 85$,

$$PF_D = \frac{(0.40 \times PWL) + 66}{100} - 1.0$$

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The PF_D for each lot of bituminous concrete mixture used for low production activities not associated with any traveled way paving operation will be 0.00. Low production activities are defined as those not associated with traveled way paving operations and having a maximum daily production of 300 tons of bituminous concrete mixture.

d. Compacted Pavement Density. The density of the base course pavement after compaction shall not be less than 92.5% nor more than 97.0% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot. For this subsection, the base course will be defined as the first, single lift of hot mix asphalt pavement placed directly on the aggregate subbase or Full Depth Reclamation material. The density of all intermediate and surface courses of compacted pavement shall not be less than 92.5% nor more than 96.5% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot.

e. Process Control. It shall be the responsibility of the Contractor to conduct all process control. Acceptance testing will be conducted by Agency personnel using cores provided by the Contractor in accordance with the coring protocol below.

(3) Coring Protocol. Original core sampling locations will be restricted to travel lanes only and will not include those areas within 6 inches of a longitudinal joint nor within 50 feet of a transverse joint. That area encompassing a longitudinal tapered joint will not be selected as a sampling location. Independent shoulder and mat area core sampling locations may be selected by the Engineer to afford verification of Subsection 406.14(b)(4).

Original core sampling locations will be selected by the Engineer or designee in accordance with *ASTM D 3665* within 2 working days of the bituminous mixture being placed. The Contractor will be advised in writing of the selected sampling locations.

The Contractor may challenge whether any specific original sample location is representative of any specific lot by notifying the Engineer. This notification shall be made immediately upon the sublot locations being selected and conveyed to the Contractor, and being prior to extracting the cores, and shall be further documented in any Contractor job records citing just reasoning for recommending a reselection of original sample locations.

Upon receipt by the Engineer of a written challenge from the Contractor, the Engineer will evaluate it within one working day and notify the Contractor in writing of either acceptance or rejection of the challenge. Rejection of a challenge will result in the Engineer using the original core sampling locations for the determination of density data in any compaction pay factor calculations. Acceptance of a challenge will result in the Engineer selecting alternate core sampling locations for those challenged samples.

Alternate core sampling locations will be selected by the Engineer by generating new random numbers to determine both new longitudinal and transverse coordinates within the sublot in question. The alternate core sampling locations will not be subject to further challenge and will be used for the determination of density data in any compaction pay factor calculations. The Contractor will be notified in writing of the final core sampling locations.

Within one working day of the final selection of the core sampling locations, the Contractor shall extract cores in the presence of the Engineer or designee and shall deliver the samples to the Engineer, in a suitable container provided by the Contractor, on the same day the samples are taken. The Engineer will identify and record the core samples.

Any cores not delivered in a suitable container will be rejected and new cores taken at the Contractor's expense. The Contractor shall fill the core holes, at their expense, with hot bituminous concrete pavement at a temperature of at least 200°F on the same day that the cores are taken. Failure to comply with these provisions may result in payment being withheld for the representative lot of bituminous material.

Core samples 6-inches in diameter shall be taken to satisfy the provisions of this subsection. Agency personnel will process the core samples within 10 working days and will relay the test results to both the Engineer and the Contractor. Testing will be performed in accordance with *AASHTO T 166*, Method A, for bulk specific gravity (*B*) and *AASHTO T 209* for maximum specific gravity (*M*) from tests performed at the plant lab for that day. As necessary, the Contractor shall mark the cores for saw-cutting in the presence of the Engineer or designee for verification of cut locations.

The Degree of Compaction (*DC*) will be determined as follows:

$$DC = \frac{B}{M} \times 10$$

where:

DC = Degree of Compaction

B = Bulk specific gravity of bituminous sample

M = Maximum specific gravity from plant lab tests

To satisfy the requirements of Subsection 406.14(b)(4), physical core samples will be retained for a period of 2 working days from the time that *DC* test results are relayed to the Engineer and Contractor. In addition, any subsequently "retested" or "re-cored" samples, as defined in Subsection 406.14(b)(4), will be retained to the point of fully satisfying the requirements of Subsection 406.14(b)(4).

(4) Core Result Verification. Upon the test results required in Subsection 406.14(b)(3) being relayed to both parties (the Engineer and Contractor), any individual core sample result considered to be an outlier as determined in accordance with *ASTM E 178* will enter a core result verification process as defined herein. This process will consider only those core samples processed by the Agency as acceptance tested samples and does not preclude the provisions of Subsection 406.14 (b)(5).

The core result verification process consists of four levels as follows:

a. Level 1. The Agency will perform a statistical analysis on all lots of core sample compaction values to investigate any presence of statistical outlier(s) as determined in accordance with Table 1 of *ASTM E 178* at a 5% significance level. In cases where a statistical outlier is not detected, all core sample results as reported under Subsection 406.14(b)(3) will be used in any compaction pay factor calculations.

When an outlier is determined to exist, the core sample representing that outlying result will be retested to ensure procedural integrity, including support information accuracy, testing methodology, and mathematical accuracy. The core sample "retested" results will replace the original "outlier" core sample results for any future calculations within this Level. Should it be verified at this point that an outlier does in fact exist or the core sample retested results vary from those originally obtained, the options to either party will be either to compute any compaction pay factors using all core sample test results derived through Level 1 or to proceed to Level 2.

b. Level 2. Level 1 outlier core sample results will be replaced by "re-cored" sample results to be obtained under this Level. The re-coring location shall be at the same transverse offset as the original location and shall be offset longitudinally forward 18 inches from the original location. The re-cored sample will be tested as specified in Subsection 406.14(b)(3) and may reenter Level 1 analysis of this subsection up to and including the point of ensuring procedural integrity. The re-cored sample will not reenter Level 2 analysis.

Upon receiving re-cored sample test results of Level 2, the options to either party will be either to compute any compaction pay factors using those re-cored sample test results or to state reasons for belief that said re-cored sample test results are in error. Receipt of reasons shall be cause for this verification process to proceed to Level 3.

c. Level 3. A final attempt at field resolution of core sample test results will be addressed under this Level by introduction of a third-party testing facility. Selection of such a facility will be discussed and mutually agreed upon by both parties prior to beginning construction activities and will not be included in project QC or acceptance testing processes. Any findings of a third-party facility will become final and will not be subject to further review. Payment to a third party for services rendered will be borne by the party having provided the Level 2 reasons leading to Level 3.

The re-cored samples from Level 2 shall be provided to the third-party testing facility. The facility will process the re-cored samples and provide results to both the Agency and the Contractor. Upon receipt of the third-party re-cored sample test results, the options to either party will be either to compute any compaction pay factors using these results or to proceed to Level 4.

d. Level 4. At this level, the Agency and the Contractor will defer to the requirements specified in Subsection 105.02. Both parties shall submit to the Chief Engineer a written report describing the disparity, all subsequent actions taken to date, all documentation related to these actions, and a proposed course of action for settlement. The Chief Engineer will review the submittals and all relevant project records and act in accordance with Subsection 105.02.

If the Contractor does not concur with any final decision by the Chief Engineer, the Contractor may seek other remedies as specified under Subsection 105.02 and the Contract.

(5) Rejected Material. When the density *PWL* is less than the Rejectable Quality Limit (*RQL*) for density of 60%, and the lot has satisfied the requirements of Subsection 406.14(b)(4), the lot shall be termed "rejected material." For any lot of rejected material, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency, provided that any one of the following conditions is also met:

a. Lot Standard Deviation (s) is greater than 2.0, or

b. Lot Average Density ($\bar{x}$) is greater than 98.0%, or

c. Lot Average Density ($\bar{x}$) is less than 90.0%.

In addition, and at the discretion of the Contractor, any lot of rejected material that does not meet any of the above criteria may be removed and replaced at no additional cost to the Agency.

If none of the aforementioned criteria are met and removal and replacement is not implemented by the Contractor, any lot of rejected material will have any Density Pay Factors (PF_D) calculated as follows:

$$PF_D = \left(-0.05625\ \bar{x}^2 + 10.575\ \bar{x} - 496.125\right) - 1.0$$

where $\bar{x}$ is the lot average density.

In such cases that this subsection applies, any PF_D as computed above will be the solitary pay factor to the representative lot as per the provisions of Subsection 406.19 and Subsection 406.20. All other applicable pay factors of the representative lot will be set equal to 0.00.

406.15 JOINTS. Joints between old and new pavements, or between each successive day's work, shall have a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a transverse butt joint constructed.

Transverse butt joints shall be formed by cutting the pavement in a vertical plane, at a location approved by the Engineer, where the pavement has a true surface as determined using a straightedge at least 16 feet long. Otherwise, the transverse butt joint may be formed by trimming using mechanical means such that the full design depth of bituminous material is present at the trimmed joint. The transverse joint shall be thoroughly coated with emulsified asphalt just prior to depositing the new paving mixture.

When constructing transverse tapered joints, care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with emulsified asphalt just prior to the resumption of paving operations. As the paver places new mixture on the taper area, placement shall proceed such that an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake and properly rolled, with coarse material discarded.

Longitudinal joints that have become cold shall be coated with emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, such joints shall be cut back to a clean vertical edge prior to coating with the emulsion.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 6 inches from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 12 inches from the transverse joints constructed in lower courses.

Wherever possible, a 2 inch space should be maintained between all final pavement markings and parallel joints in bituminous concrete pavement. The Contractor shall conduct paving operations such that the paving joint between the travel lane and adjacent shoulder will be outside of all longitudinal pavement markings.

Projects that have a centerline length of more than 3 miles shall also be subject to the following provisions:

(a) General. For the purposes of longitudinal joint compaction acceptance, a lot shall consist of the total project length of joint constructed per pavement course, and the total project quantity of bituminous concrete mixture compacted in place per pavement course, including shoulders. Side roads or drives will not be considered part of the joint lot for this provision. Sampling on constructed joints shall consist of 6-inch minimum diameter cores taken at the rate of two cores per mile of joint per lot.

Sample locations will not include those areas within 50 feet of a transverse joint. Each individual core sample shall represent a project sublot. Once selected per that method in Subsection 406.15(b), sample locations will become final and not subject to revision, nor will any core sample be subject to the provisions specified in Subsection 406.14 (b)(4).

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(b) Sampling. Bituminous concrete mixtures will be sampled once per sublot on a stratified random sampling procedure in the longitudinal direction in accordance with *ASTM D 3665*. For a longitudinal butt joint, the transverse location of the sample shall be centered on the visible surface joint line. For a tapered joint, the transverse location of the sample shall be offset from the visible surface joint line approximately 50% of the taper width as directed by the Engineer.

Joint core samples shall be taken between any adjacent travel lanes and between any travel lane and shoulder provided the shoulder material was placed as a separate construction operation. All samples will be tested and evaluated by the Agency for each mix type (each mix design), excluding leveling/shim courses, for each project in accordance with Table 406.15A.

TABLE 406.15A – ACCEPTANCE CRITERIA

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted-in-place	Project (1)	*AASHTO T 166,* Method A and *AASHTO T 209*

For determining the degree of compaction, the maximum specific gravity (G_{mm}) used in the calculation shall be the average of the two G_{mm} values of the materials placed to construct the joint. The calculated compaction of any individual joint core sample shall not be less than 90.0% of the corresponding maximum specific gravity of the average of the two G_{mm} values for each mix type (each mix design) placed per lot.

(c) Longitudinal Joint Pay Factor (PF_J) Determination. In such case that an individual core sample (sublot) is above the minimum compaction as specified in Subsection 406.15(b), it shall be defined as above minimum.

Upon completion of any individual lot, the percentage of sublots equal to or above the acceptable minimum compaction shall be defined as the lot Percent Above Minimum (*PAM*) and shall be used as the basis for determining pay factors as follows:

$$For\ 85 \leq PAM \leq 100,\ \ PF_J = 0.03$$

$$For\ 75 \leq PAM < 85,\ \ PF_J = 0.00$$

$$For\ 0 \leq PAM < 75,\ \ PF_J = -0.03$$

406.16 SURFACE TOLERANCE. The surface will be tested by the Engineer using a straightedge at least 16 ft in length at selected locations parallel with the centerline. Any variations exceeding 1/8 inch between any two contact points shall be satisfactorily eliminated. A straightedge at least 10 feet in length may be used on a vertical curve. The straightedges shall be provided by the Contractor in accordance with Subsection 631.06.

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For projects that have a centerline length of one-half mile or greater, the surface roughness of the wearing course will be additionally measured by the Engineer or the Engineer's designee with an Agency-provided Road Surface Profiler (RSP) to determine a Surface Tolerance Pay Factor (PF_R). The Engineer will contact the Agency's Pavement Design Unit Project Manager to arrange for surface testing.

The surface will be tested by Agency personnel by traveling at highway speeds once in each direction on two-lane/two-way non-limited access State highways and other Routes as applicable. For those two-way limited or non-limited access highways containing truck or passing lanes, only the rightmost lane will be tested in any given direction. The reported International Roughness Index (*IRI*) value will be the average as calculated based upon travel in both directions.

Two-lane divided Interstate highways and other applicable limited access highways will have both passing and travel lanes tested at highway speeds, with the reported *IRI* value being the average as calculated based upon travel in both lanes. For those Interstate or other applicable limited access highways having both barrels of the highway constituting the project, the reported *IRI* value will be that average value as calculated based on travel in both lanes of both barrels.

Prior to the highway being surface tested, all Contract items shall be complete such that the project could be deemed substantially complete, unless otherwise directed by the Engineer, including but not limited to all guardrail, bridge joints, and permanent pavement markings installed, including all side road markings. There shall not be lane closures or equipment present that would impede highway travel. Additionally, and prior to the highway being surface tested, the highway surface shall be dry and free of snow, ice, and loose debris, and the ambient air temperature shall be a minimum of 40°F.

The roughness value used in the applicable formula below will be the average of the *IRI* values measured by the RSP in each lane. The roughness associated with any anomalous features beyond the control of the Contractor, such as mechanical bridge joints or utility structures, will be eliminated from the calculations of the final project average. The corresponding Surface Tolerance Pay Factor (PF_R) will be determined as follows and applied to the corresponding lot as defined below:

(a) Limited Access Highways:

$$PF_R = (-0.0029\,IRI + 1.1500) - 1.0$$

(b) All Other State Routes:

$$PF_R = (-0.0029\,IRI + 1.1786) - 1.0$$

For the evaluation of surface tolerance acceptance, a lot shall consist of the total project quantity of wearing surface of bituminous concrete pavement constructed and measured in place. Said measurement shall include all shoulders, side roads, drives, and any other miscellaneous mix, except for all limited-access highway on- and off-ramps.

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406.17 TRAFFIC CONTROL. Whenever traffic must be maintained during paving operations, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at such other locations as may be required by the Engineer. The uniformed traffic officers or flaggers shall conform to the requirements specified in Section 630.

Traffic shall be maintained in accordance with Subsection 104.04A and Subsection 104.04B.

406.18 ASPHALT PRICE ADJUSTMENT.

(a) General Requirements and Conditions. The purpose of the Asphalt Price Adjustment (*APA*) clause is to provide either additional compensation to the Contractor or a payment to the Agency, depending upon an increase or decrease in the average price of asphalt cement and emulsified asphalt during the construction of a project. No price adjustment will be applied beyond the Contract completion date, as adjusted by Change Order, or any applicable interim completion dates.

(b) Price Adjustment Procedures. Prior to advertising for bids, an Index Price (*IP*) for asphalt cement will be established by the Agency and will be the base from which the *APA* is computed. The Contract Index Price will be as stated elsewhere in the Contract for a ton of asphalt cement. The monthly Posted Prices (*PP*) will be those prices obtained from the Agency's website for the month that the construction activity was performed.

The *APA* will be debited or credited for asphalt cement when the Posted Price of asphalt cement increases or decreases over its respective Index Price.

The *APA* will be based upon the Quantity of Asphalt Cement (*QAC*) and Quantity of Emulsified Asphalt (*QEA*) incorporated in the work, determined as follows:

(1) QAC for Batch Plants. The *QAC* is determined using the cumulative virgin binder content for each applicable item as reported on the batch ticket.

(2) QAC for Drum-Mix and Continuous Mix Plants. The *QAC* is determined based upon the tons of mix placed, multiplied by the virgin binder content reported on the demand tickets, as verified by Agency personnel. In the event of multiple binder contents, the accepted quantity of mix at each binder content shall be determined, and the total *QAC* used shall be calculated accordingly. The accumulated asphalt cement total on the plant automation may be checked and verified by Agency personnel for each mix.

(3) QEA and ACEA for Emulsified Asphalt. The *QEA* is determined per the requirements of Subsection 404.11. The amount of Asphalt Price Adjustment will be based upon the actual asphalt content of the emulsified asphalt used, which is calculated by multiplying the *QEA* used by the asphalt content fraction for that emulsion type. The Asphalt Content of Emulsified Asphalt (*ACEA*) factor is determined from the type of emulsified asphalt used, as specified in Table 406.18A.

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TABLE 406.18A – ASPHALT CONTENT OF EMULSIFIED ASPHALTS

Emulsified Asphalt Type [1]	*ACEA* Factor
CSS-1h	0.57
MS-1	0.55
RS-1	0.55
RS-1h	0.55
CRS-1h	0.55
CRS-1p	0.63
CSS-1h Fog	0.28

[1] If an emulsified asphaltic liquid is used in the Contract work under any Contract item subject to the *APA* provisions and that liquid is not included in Table 406.18A, the *ACEA* factor for that liquid will be that as determined by averaging Contractor certified test results for the project.

(c) Calculation of APA. The *APA* to be paid shall be computed as follows:

$$APA = [QAC + (ACEA \times 0.05 \times QEA)] \times (PP - IP)$$

where:

APA = Asphalt Price Adjustment (lump units)

QAC = Quantity of Asphalt Cement (tons)

ACEA = Asphalt Content of Emulsified Asphalt factor (from Table 406.18A)

QEA = Quantity of Emulsified Asphalt (hundredweight)

PP = Posted Price of asphalt on the date of work (dollars/ton)

IP = Index Price of asphalt (dollars/ton)

406.19 METHOD OF MEASUREMENT. The quantity of Bituminous Concrete Pavement to be measured for payment will be the number of tons of mixture (each type) complete in-place in the accepted work.

The quantity of Bituminous Concrete Pavement Surface Preparation to be measured for payment will be the number of tons of material, complete in-place in the accepted work as determined from the weigh tickets.

The quantity of Hand-Placed Bituminous Concrete Material, Drives to be measured for payment will be the number of square yards complete in-place in the accepted work.

The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

(a) Air Voids Pay Adjustment. When applicable, and when the Air Voids Pay Factor (PF_{AV}), as calculated per Subsection 406.03C(e) or Subsection 406.03C(f), for a lot of Bituminous Concrete Pavement is non-zero, the measured quantity of Bituminous Concrete Pavement placed will be multiplied by such pay factor to determine an Air Voids Pay Adjustment (PA_{AV}) to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA_{AV} = PF_{AV} \times Q \times B$$

where:

PA_{AV} = Air Voids Pay Adjustment (lump units)

PF_{AV} = Air Voids Pay Factor

Q = Accepted tonnage placed (tons)

B = Contract bid price (dollars/ton)

When boxed samples are taken to determine mix properties for any project or portion thereof, the PF_{AV} shall be assumed to be equal to 0.00

Additionally, when the RQL for air voids of 50% is not attained for a lot, all other applicable pay factors for that lot shall not be greater than 0.00, but may be less than or equal to 0.00, except in the following situation:

(1) When the Density Pay Factor is calculated per Subsection 406.14(b)(5), the Air Voids Pay Factor shall be equal to 0.00 and the Density Pay Factor shall be the sole pay factor applied to the representative lot.

(b) Mat Density Pay Adjustment. When applicable, and when the Density Pay Factor (PF_D), as calculated per Subsection 406.14(a), Subsection 406.14(b)(2) or Subsection 406.14(b)(5), for a lot of Bituminous Concrete Pavement is non-zero, the measured quantity of Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Mat Density Pay Adjustment (PA_D) to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA_D = PF_D \times Q \times B$$

where:

PA_D = Mat Density Pay Adjustment (lump units)

PF_D = Density Pay Factor

Q = Accepted tonnage placed (tons)

B = Contract bid price (dollars/ton)

Additionally, when the *RQL* for density of 60% is not attained for a lot, and the Density Pay Factor is calculated per Subsection 406.14(b)(5), all other applicable pay factors for that lot shall be considered equal to 0.00.

(c) Longitudinal Joint Pay Adjustment. When applicable, and when the Longitudinal Joint Pay Factor (PF_J), as calculated per Subsection 406.15(c), for a lot of bituminous concrete pavement is non-zero, the measured quantity of bituminous concrete pavement placed will be multiplied by such pay factor to determine a Longitudinal Joint Pay Adjustment (PA_J) to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA_J = PF_J \times Q \times B$$

where:

PA_J = Longitudinal Joint Pay Adjustment (lump units)

PF_J = Longitudinal Joint Pay Factor

Q = Accepted tonnage placed (tons)

B = Contract bid price (dollars/ton)

(d) Surface Tolerance Pay Adjustment. When applicable, and when the Surface Tolerance Pay Factor (PF_R), as calculated per Subsection 406.16, for a lot of bituminous concrete pavement is non-zero, the measured quantity of wearing surface of bituminous concrete pavement placed will be multiplied by such pay factor to determine a Surface Tolerance Pay Adjustment (PA_R) to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA_R = PF_R \times Q \times B$$

where:

PA_R = Surface Tolerance Pay Adjustment (lump units)

PF_R = Surface Tolerance Pay Factor

Q = Accepted tonnage placed (tons)

B = Contract bid price (dollars/ton)

The Contract bid prices for the applicable Pay Items will be paid separately under the Contract. The asphalt price adjustment (APA), as calculated per Subsection 406.18, will be calculated and paid in the same biweekly estimate as the applicable Contract work.

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406.20 BASIS OF PAYMENT. The measured quantity of Bituminous Concrete Pavement will be paid for at the Contract unit price per ton. Payment shall be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The measured quantity of Hand-Placed Bituminous Concrete Material, Drives will be paid at the Contract unit price per square yard. Payment shall be full compensation for furnishing, mixing, hauling, placing, compacting, and finishing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

For drive construction, cold planing, emulsified asphalt, subbase material, cleaning existing paved surfaces, excavation, and filling joints, cracks and holes will not be paid for directly, but will be considered incidental to Hand-Placed Bituminous Concrete Material, Drives.

Payment for Pay Adjustments shall be debited or credited against the Contract prices (lump units) for the applicable Pay Adjustment items.

The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Bituminous Concrete Pavement.

The costs of obtaining, furnishing, transporting, and providing the straightedges required by Subsection 406.16 will be paid for under the appropriate Section 631 Pay Item included in the Contract.

The cost of taking cores for acceptance testing and filling the core holes will be incidental to the Contract item being cored. All other costs associated with obtaining samples for acceptance testing will be incidental to the cost of the Section 406 Pay Item. The cost of traffic control for taking cores for acceptance testing and filling the core holes will be paid under the appropriate Section 630 Contract item.

When not specified as items in the Contract, the costs of sweeping and cleaning existing paved surfaces and tacking of utility structures, curbing, gutters, and other contact surfaces will not be paid for directly but will be incidental to the appropriate Bituminous Concrete Pavement Pay Item.

Bituminous concrete mixtures approved by the Engineer for use in correcting deficiencies in the base course constructed as part of the Contract will not be paid for as Bituminous Concrete Pavement but will be incidental to the Contract item for the specified type of base course.

The accepted quantity of Bituminous Concrete Pavement Surface Preparation as approved by the Engineer will be paid for at the Contract unit price per ton. Payment shall be full compensation for furnishing, mixing, hauling, and placing the materials and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payments for Price Adjustment, Asphalt Cement shall be debited or credited against the Contract price (lump unit) for Price Adjustment, Asphalt Cement.

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Payment will be made under:

Pay Item	Pay Unit
406.25 Marshall Bituminous Concrete Pavement	Ton
406.27 Medium Duty Marshall Bituminous Concrete Pavement	Ton
406.28 Air Voids Pay Adjustment (N.A.B.I.)	Lump Unit
406.29 Mat Density Pay Adjustment (N.A.B.I.)	Lump Unit
406.30 Surface Tolerance Pay Adjustment (N.A.B.I.)	Lump Unit
406.31 Longitudinal Joint Compaction Pay Adjustment (N.A.B.I.)	Lump Unit
406.35 Superpave Bituminous Concrete Pavement	Ton
406.36 Superpave Bituminous Concrete Pavement, Type IVB	Ton
406.38 Hand-Placed Bituminous Concrete Material, Drives	Square Yard
406.45 Bituminous Concrete Pavement Surface Preparation	Ton
406.50 Price Adjustment, Asphalt Cement (N.A.B.I.)	Lump Unit

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SECTION 407 – BONDED WEARING COURSE

407.01 DESCRIPTION. This work shall consist of applying a surface treatment consisting of a polymer-modified emulsified asphalt coat followed immediately with a bonded wearing course and in conformance with the lines, grades, thicknesses, and typical cross-sections shown on the Plans or established by the Engineer.

407.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Performance Graded Asphalt Binder (Prepared from Petroleum) 702.02
Polymer-Modified Emulsified Asphalt ..... 702.04(c)
Aggregate for Ultra-Thin Bonded Wearing Course ..... 704.10(b)
Joint Sealer, Hot Poured ..... 707.04(a)

(a) Performance-Graded Asphalt Binder. Performance-graded asphalt binder shall be PG 70-28.

(b) Polymer-Modified Emulsified Asphalt. The emulsified asphalt shall be a polymer-modified type CRS-1P emulsion with the modifications specified in Table 407.02A.

If the residue from the residue by evaporation test fails to meet the requirements of Table 407.02A, the test shall be repeated using the distillation method specified in *AASHTO T 59*, with modifications to include distillation temperature and time in accordance with the manufacturer's recommendations.

TABLE 407.02A – REQUIREMENTS FOR POLYMER-MODIFIED EMULSIFIED ASPHALT

Residue from Residue by Evaporation Test	Test Method	Min.	Max.
Residue (%)	*AASHTO T 59*	63.0	--
Penetration (77°F, 100 g, 5s, dmm)	*AASHTO T 49*	60.0	150.0
Elastic recovery (%)	*AASHTO T 301*	65.0	--
Solubility in organic solvent (%)	*AASHTO T 44*	97.5	--

407.03 COMPOSITION OF MIXTURE. Formulate a Bonded Wearing Course Job Mix Formula (JMF) that satisfies the design limits specified in Table 407.03A. The JMF for each mixture shall establish a single percentage of aggregate passing each sieve and a single percentage of bituminous material to be added to the aggregate mixture. The gradation of the aggregate shall not vary more than the production tolerance from the mix design gradation (JMF) while also remaining within the Specification gradation band. The mixture shall not contain recycled asphalt materials.

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TABLE 407.03A – BONDED WEARING COURSE MIXTURE REQUIREMENTS

Sieve Designation	Type A		Type B		Type C	
	Design Limits (% Passing)	Production Tolerance (%)	Design Limits (% Passing)	Production Tolerance (%)	Design Limits (% Passing)	Production Tolerance (%)
3/4 inch (19.0 mm)	--	--	--	--	100	--
1/2 inch (12.5 mm)	--	--	100	--	85 – 100	± 4
3/8 inch (9.50 mm)	100	--	85 – 100	± 4	45 – 85	± 4
No. 4 (4.75 mm)	40 – 55	± 3	24 – 38	± 3	24 – 41	± 3
No. 8 (2.36 mm)	21 – 32	± 3	21 – 32	± 3	21 – 33	± 3
No. 16 (1.18 mm)	16 – 26	± 3	16 – 23	± 3	15 – 26	± 3
No. 30 (0.600 mm)	12 – 18	± 2	12 – 18	± 2	11 – 20	± 2
No. 50 (0.300 mm)	8 – 13	± 2	8 – 13	± 2	8 – 16	± 2
No. 100 (0.150 mm)	5 – 10	± 2	5 – 10	± 2	5 – 10	± 2
No. 200 (0.075 mm)	4 – 7	± 2	4 – 7	± 2	4 – 7	± 2
Asphalt Cement (%)	4.9 – 5.8		4.8 – 5.6		4.6 – 5.6	

The asphalt cement content shall be based on a minimum asphalt film thickness of 0.394 mils (10.0 microns). The minimum asphalt cement content shall be calculated according to the following formulas and the factors in Table 407.03B.

For English units: $W = 0.0052 \times A_s \times T \times G_b$

For metric units: $W = 0.001 \times A_s \times T \times G_b$

and, for consistent units: $P_{bmin} = \frac{W}{1+W} \times 100$

where:

W = Intermediate variable

A_s = Total aggregate surface area* (square feet per pound or square meters per kilogram of aggregate)

T = Minimum asphalt film thickness (mils or microns)

G_b = Specific gravity of asphalt cement

P_{bmin} = Minimum asphalt cement content (percent by mass)

* The total aggregate surface area is calculated by multiplying the percent passing each sieve (as a decimal, i.e. 30% = 0.30) in the JMF by the corresponding factor in Table 407.03B and summing the resultant values.

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TABLE 407.03B – AGGREGATE SURFACE AREA FACTORS

Sieve Designation	Surface Area Factors					
	Type A		Type B		Type C	
	SF/lb	SM/kg	SF/lb	SM/kg	SF/lb	SM/kg
3/4 inch (19.0 mm)	--	--	--	--	2.0	0.41
1/2 inch (12.5 mm)	--	--	2.0	0.41	0	0
3/8 inch (9.50 mm)	2.0	0.41	0	0	0	0
No. 4 (4.75 mm)	2.0	0.41	2.0	0.41	2.0	0.41
No. 8 (2.36 mm)	4.0	0.82	4.0	0.82	4.0	0.82
No. 16 (1.18 mm)	8.00	1.64	8.00	1.64	8.00	1.64
No. 30 (0.600 mm)	14.0	2.87	14.0	2.87	14.0	2.87
No. 50 (0.300 mm)	30.0	6.14	30.0	6.14	30.0	6.14
No. 100 (0.150 mm)	60.00	12.29	60.00	12.29	60.00	12.29
No. 200 (0.075 mm)	160.0	32.77	160.0	32.77	160.0	32.77

Drain-down from the loose mixture shall not exceed 0.10% when tested in accordance with the requirements specified in *AASHTO T 305*. The drain-down shall be tested at the design asphalt content plus 0.50%. The temperature shall be the mixing temperature plus 60°F. The temperature shall not exceed 360°F.

If granite or quartzite aggregates are used in the mixture, an anti-strip additive shall be added as specified in Subsection 704.15.

No work shall be started until the Contractor has submitted and the Materials Engineer has approved a mix design, including cold feed gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required.

The Materials Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement or finishing characteristics are determined by the Engineer to be unsatisfactory.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of 10 working days shall be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the JMF is valid until a change is made in aggregate source or PG asphalt binder grade. If a change is made in aggregate source or PG asphalt binder grade, a new mix design shall be submitted and a minimum 10 working days shall be allowed prior to resuming production. If a change is proposed to be made in the PG asphalt binder supplier, it shall be from an approved supplier and be in accordance with the most current VTrans mix design submittal policy.

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If there is a change in source for the polymer-modified emulsion, the emulsion shall be from an approved source, and the Engineer shall be notified at least 48 hours prior to resuming production.

407.04 QUALITY ACCEPTANCE.

(a) Bonded Wearing Course will be tested at the rate of once per 500 tons of material produced to ensure the requirements specified in Table 407.03A are being met. Polymer-modified emulsified asphalt will be tested at the rate of once per day of production and in accordance with the requirements specified in *AASHTO M 316* and Table 407.02A.

(b) Bonded Wearing Course will be tested for gradation and asphalt content based on printed ticket weights. The application rate of the polymer-modified emulsified asphalt will also be calculated to ensure target values are within tolerance. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program.

(c) If any analyzed sample is outside of the testing tolerances and/or other design criteria as defined herein, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. With the permission of the Engineer, the plant may continue production, pending results of these tests, but if the Engineer deems that it is in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

407.05 WEATHER AND SEASONAL LIMITATIONS. Bonded Wearing Course shall not be placed when the ambient air temperature and temperature at the paving site in the shade and away from artificial heat is below 50°F.

Bonded Wearing Course shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

Bonded Wearing Course shall not be applied before May 15th or after October 15th.

When it is in the public interest, the Construction Engineer may adjust the weather and seasonal limitations.

407.06 BITUMINOUS MIXING PLANT AND TESTING. The requirements of Subsection 406.05 shall apply except as modified by this subsection.

For Bonded Wearing Course, the following test equipment shall not be utilized for testing:

1 Superpave Gyratory Compactor

1 Automatic Marshall Compaction Hammer

2 Marshall compaction molds with base plates

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1 Marshall stability mold

1 Marshall flow meter

1 Motorized compression and testing machine

1 Water bath capable of maintaining a temperature of 140°F ± 2°F

407.07 FIELD QUALITY CONTROL PLAN. The Contractor shall prepare and submit a written Field Quality Control Plan (QC Plan) to include all surface treatments contracted for the project. The Contractor shall submit the QC Plan to the Engineer a minimum of 10 working days prior to any project production.

As a minimum, the QC Plan shall contain the following information:

(a) General Requirements. The QC Plan as specified within this subsection shall be separate from any other Quality Control (QC) Plan as required by VTrans within the Contract. Bituminous concrete material shall not be produced for any project that has not secured QC Plan approval as defined under this subsection.

The QC Plan shall contain the following minimum information as applicable, and will be subject to approval by the Engineer:

(1) QC Plan Administrator (Contractor Personnel/Project Manager) – names and their duties.

(2) Field Process Control/Quality Control Technicians (Contractor Foremen) – names and their duties.

(3) Pavers and Laydown Equipment – manufacturers and types.

(4) Emulsion application procedure and rate.

(5) Steel drum rollers – manufacturers and types, with the number of rollers, including total weight and weight per inch of drum, and their respective location within the paving train.

(6) Pneumatic-tired rollers – manufacturers and types, with the number of rollers, including the average or recommended ground pressure per tire and their respective location within the paving train.

(7) Mixing, loading, and transportation – the Contractor shall submit proposed plans of product delivery to the project site and will be subject to approval by the Engineer such that a balanced paving operation is achievable.

(8) Process Control Testing and Quality Control Testing – Daily QC testing results shall be submitted to the Engineer as requested and bound printed copies of all project QC testing shall be submitted on such dates that a biweekly estimate from the Agency is intended to be processed.

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(9) Paving limitations.

(10) Weather limitations.

(11) Project-specific issues with bridges, drives, intersections, structures, guardrails, or other items.

(b) Additional Information. The Contractor shall provide the following additional information as components of the QC Plan to be considered for acceptance by VTrans. All components provided shall be titled "Best Practices."

(1) Best Practices for minimizing segregation

a. Loading trucks

b. Dumping trucks

c. Laydown operations

d. Troubleshooting

e. Thermal segregation

(2) Best Practices for screed setup/operators

(3) Best Practices for paver operators

(4) Best Practices for breakdown roller operators

(5) Best Practices for intermediate/finish roller operators

(6) Best Practices for constructing and achieving joint construction

(7) Best Practices for achieving ride quality

(8) Daily application rate of polymer-modified emulsified asphalt to meet the requirements of Subsection 407.08(c)

407.08 CONSTRUCTION REQUIREMENTS.

(a) Equipment.

(1) Paving. Use a self-priming paver as approved by the Engineer. The self-priming paver shall be capable of spraying the polymer-modified emulsified asphalt, applying the hot mix asphalt overlay, and smoothing the surface of the mat in one pass at a rate of at least 35 feet per minute.

The self-priming paver shall be equipped with a receiving hopper, feed conveyor, emulsion storage tank, metered high-pressure emulsion spray bar, and a variable width, heated, ironing-type screed. The screed shall have the ability to be crowned at the center both positively and negatively and have vertically adjustable extensions to accommodate the desired pavement profile.

(2) Compaction. Use steel-wheeled double-drum rollers weighing at least 10 tons, equipped with functioning water systems and scrapers to prevent material from adhering to the roller drums.

(3) Hauling. Haul vehicles shall meet the approval of the Engineer prior to transporting the hot mix asphalt wearing course.

(b) Surface Preparation. Prior to paving, the existing bituminous concrete pavement surface shall be prepared as shown on the Plans and as directed by the Engineer and in accordance with the provisions of Subsection 406.12 and Subsection 417.05(c). Surface preparation shall consist of pothole repairs, raveling repairs, crack sealing, and other repairs directed by the Engineer prior to placing the final surface treatment.

Surface preparation material shall be a bituminous material or mixture as approved by the Engineer or as otherwise specified. Perform all surface preparation prior to applying the wearing course. Thoroughly clean the entire area to be overlaid. The surface of the area to be overlaid shall be free of dirt, oil, debris, other foreign materials, and standing water. A damp surface is acceptable if favorable weather conditions are expected during paving operations.

All utility structures within the area to be paved shall be covered with material approved by the Engineer and referenced for location and adjustment if necessary after paving.

(c) Application. The polymer-modified emulsified asphalt shall be applied at a temperature in accordance with Table 702.06A and uniformly applied across the entire width to be overlaid. The daily application rate shall be 0.225 ± 0.025 gallons per square yard for Type C, 0.190 ± 0.025 gallons per square yard for Type B, and 0.150 ± 0.025 gallons per square yard for Type A.

The spray rate shall be continuously monitored and daily application rates shall be checked for each day's production of Bonded Wearing Course (BWC). The daily application rate shall vary by no more than ± 0.025 gallons per square yard. If the actual daily application rate is less than the specified rate for that Type, the Contractor shall take corrective action as directed by the Engineer.

Daily application rates (R_{DA}) shall be calculated using the following formula:

$$R_{DA} = \frac{M_E - M_S}{A}$$

where:

R_{DA} = Daily application rate of polymer-modified emulsified asphalt (gallons/square yard)

M_E = Ending meter reading (gallons)

M_S = Starting meter reading (gallons)

A = Daily area measured for payment under BWC (square yards)

Field adjustments to the specified application rate of polymer-modified emulsified asphalt shall be determined based upon the existing surface condition of the pavement. Adjustments to the polymer-modified emulsified asphalt specified application rate shall be approved by the Engineer.

Equipment shall not come in contact with the polymer-modified emulsified asphalt before the BWC is applied. Immediately after applying the polymer-modified emulsified asphalt, apply the BWC across the full width of the emulsion within the temperature range of 293°F – 338°F.

A load ticket shall accompany each vehicle supplying BWC. Make one legible copy of the load ticket available to the Agency's Paving Inspector prior to placement of the mixture. Each load ticket shall identify the type of mix used as outlined in Table 407.03A and show all of the following information.

(1) Ticket number

(2) Mix design number

(3) Plant Identification

(4) Contract number

(5) Mix type (A, B, or C)

(6) Performance-graded binder type (PG Binder)

(7) Quantity of material in delivery vehicle, tons

(8) Date and time

A load ticket shall also be supplied for the polymer-modified emulsified asphalt such that the weight of actual project usage can be determined.

(d) Finishing. Finishing shall begin immediately after application of the BWC using a minimum of two static passes. Vibratory equipment shall not be used unless otherwise approved by the Engineer. The rollers will not be allowed to stop on the freshly placed BWC. Use an adequate number of rollers to complete finishing before the pavement temperature falls below 185°F.

Once finished, traffic will not be permitted on placed material until the material has cooled to 140°F unless otherwise authorized by the Engineer.

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407.09 METHOD OF MEASUREMENT. The quantity of Bonded Wearing Course to be measured for payment will be the number of square yards of pavement surface treated in the complete and accepted work.

407.10 BASIS OF PAYMENT. The accepted quantity of Bonded Wearing Course will be paid for at the Contract unit price per square yard. Payment shall be full compensation for furnishing all labor, materials, and equipment necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
407.15 Bonded Wearing Course	Square Yard
407.16 Polymer-Modified Emulsified Asphalt	CWT

SECTION 408 – THIS SECTION RESERVED

SECTION 409 – THIS SECTION RESERVED

SECTION 410 – MATERIAL TRANSFER VEHICLE (MTV)

410.01 DESCRIPTION. This work shall consist of furnishing and utilizing an approved Material Transfer Vehicle (MTV) in bituminous concrete paving operations.

410.02 CONSTRUCTION REQUIREMENTS. An approved MTV shall be used to transfer the bituminous material from the hauling equipment to the paver. The MTV shall operate independently from the paver and shall be a commercially manufactured unit specifically designed for the transfer of mix from the hauling equipment to the paver without depositing the mix on the roadway surface.

The MTV and/or separate hopper shall be designed such that the deposited mix is remixed prior to placement on the roadway. The minimum storage capacity of the MTV, not including any separate hopper, shall be 12 tons. The MTV shall be capable of "swinging" or "offsetting" the material transfer delivery system to side discharge into the paver. If the MTV and associated actions do not effectively eliminate mat segregation as determined by the Engineer, the Engineer may require a hopper insert with remixing capabilities or other measures. When the MTV traverses a bridge that is not a buried structure, it shall be as near to empty as possible and shall not exceed five miles per hour while on any structure. If the Contractor proposes moving the MTV over a bridge with more than a minimal amount of bituminous material in it, a proposal shall be submitted to the Structures Engineer for their review and approval prior to any mix being placed. Any submittal shall detail all wheel and axle loadings that will be placed on the bridge deck.

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410.03 METHOD OF MEASUREMENT. The quantities of Material Transfer Vehicle and Material Transfer Vehicle, Cold Mix to be measured for payment will be the number of tons of bituminous pavement transferred by the MTV to the paver in the completed and accepted work, as determined by the weigh slips.

410.04 BASIS OF PAYMENT. The accepted quantities of Material Transfer Vehicle and Material Transfer Vehicle, Cold Mix will be paid for at the Contract unit price per ton. Payment will be full compensation for the equipment as specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
410.10 Material Transfer Vehicle	Ton
410.11 Material Transfer Vehicle, Cold Mix	Ton

SECTION 415 – COLD MIXED RECYCLED BITUMINOUS PAVEMENT

415.01 DESCRIPTION. This work shall consist of cold planing and crushing and/or screening the existing bituminous pavement, adding additional asphalt emulsion, and mixing and repaving with the material to the depths, lines, and grades shown on the Plans

Recycling of the existing pavement shall be performed in a manner that does not disturb the underlying materials.

415.02 MATERIALS. The emulsified asphalt for Cold Mixed Recycled Bituminous Pavement shall meet the requirements of Section 404 and/or be as recommended by the Contractor as a result of Subsection 415.08 and as approved by the Engineer. The grade and initial application rate, based on emulsion rate-density curves [*AASHTO T 245 (Modified)*, 50 blows] developed from test section material, shall be recommended by the Contractor and accepted by the Engineer. The value for the emulsion rate shall be based on the optimum for achieving maximum density. The exact application rate may be varied by the Contractor as required by existing pavement conditions and approved by the Engineer.

The Cold Mixed Recycled Bituminous Pavement shall meet the gradation requirements in Table 415.02A for extracted aggregate taken from the pulverized material.

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TABLE 415.02A – EXTRACTED AGGREGATE GRADATION REQUIREMENTS

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1-1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	90 – 100
No. 4 (4.75 mm)	30 – 70
No. 200 (0.075 mm)	0 – 12

415.03 EQUIPMENT. The Contractor shall furnish a self-propelled machine capable of planing the existing bituminous pavement to the depth shown on the Plans in one pass. The machine shall be equipped with standard automatic depth controls and must maintain a constant cutting depth and width. The machine shall be capable of producing the proper size material required, or additional screening and/or crushing will be required. Oversized particles shall be reduced to the proper size by crushing.

Mixing equipment shall be provided which is capable of mixing the sized bituminous material and liquid binder into a homogeneous mixture. The mixing equipment shall be equipped with weighing and metering devices which assure that the correct amount of sized material and proper amount of emulsion are introduced into the Cold Mixed Recycled Bituminous mixture. The method of depositing the mixed material shall be such that segregation does not occur.

Placing of the Cold Mixed Recycled Bituminous Pavement shall be accomplished with a self-propelled bituminous paver. The Cold Mixed Recycled Bituminous material shall be spread without segregation to the lines and grades shown on the Plans or as directed by the Engineer. If a pick-up machine is used to feed a windrow of the bituminous material into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow down to the underlying materials.

The number, mass, and type of rollers shall be sufficient to obtain the required uniform density through the full depth while the mixture is in a workable condition. A rubber-tire roller shall perform the initial rolling after the emulsion initially "breaks," as indicated by the material's color changing from brown to black.

415.04 WEATHER AND SEASONAL LIMITATIONS. Recycling operations shall not be performed when either the ambient air temperature or the surface temperature of the pavement to be recycled is below 50°F. Recycling operations shall also not be performed when the weather is foggy or rainy, or when weather conditions or predicted weather conditions are such that proper mixing, spreading, and compacting of the recycled material cannot be accomplished.

When it is in the public interest for servicing traffic, the Construction Engineer may adjust the ambient air and/or pavement temperature requirements or extend the dates of the recycling season.

415.05 MOISTURE. The Contractor may add, under positive control, a small amount of water to the planed material to facilitate uniform mixing with the emulsion. The water may be added prior to the mixing phase of the operation. The water shall be added carefully so as not to cause any adverse effects.

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415.06 COMPACTION. Compaction shall be performed while the emulsion is in a workable state. The Cold Mixed Recycled Bituminous Pavement material shall be finished within a grade tolerance of ± 1/2 inch, provided that this deviation is not maintained for a distance longer than 50 feet, and provided that the required crown or superelevation is maintained.

The Cold Mixed Recycled Bituminous Pavement shall be compacted to a minimum of 95% of the target density approved by the Engineer in accordance with the requirements of Subsection 415.08.

415.07 CURING AND STABILITY. The Cold Mixed Recycled Bituminous Pavement may be opened to traffic as approved by the Engineer.

Hot mixed bituminous concrete pavements shall not be placed until the Cold Mixed Recycled Bituminous Pavement material has been allowed to cure and the free moisture content is reduced to a maximum of 1.5%.

The required density shall be achieved and maintained until a hot mixed bituminous concrete pavement has been placed. Any additional compactive effort or repair of imperfections in the Cold Mixed Recycled Bituminous material shall be performed as directed by the Engineer at no additional compensation to the Contractor.

415.08 CONTROL SECTION. The Contractor shall be responsible for performing all Process Control and Quality Control sampling and testing.

Process Control sampling and testing shall involve taking a set of four representative samples from the test section. The samples may be taken either before or after the cold recycling process. The four samples shall be combined to represent a uniform sample for determining maximum density. The material used, including that used for the Marshall series to determine the optimum emulsion rate, shall be in a processed pulverized state replicating the state which the material will be in immediately prior to the point when the emulsified asphalt is introduced during the recycling process.

The Contractor shall perform the Marshall Design series tests to determine the maximum density. A maximum density shall be obtained by performing a series of tests using the 50-blow Marshall Design method *AASHTO T 245 (Modified)*. The series of Marshall tests shall be prepared using a minimum of five different percentages of emulsion. The maximum density obtained from these tests shall be used as the recommended target density to be approved by the Engineer

The Contractor shall perform all tests necessary to verify that the target density is achieved and maintained prior to placement of a hot bituminous overlay. The necessity for additional testing will be determined by the Engineer. The Contractor shall provide the Engineer with the original copies of all Marshall Design series, Process Control, and Quality Control test results.

The Contractor shall construct a control section to assure the Engineer that the Contractor's equipment and procedure are suitable for the work specified and are capable in achieving the density specified. If the control section does not meet the requirements of this Specification, or the density achieved does not appear suitable, the Contractor shall modify their procedure and either construct another control section or reconstruct the original until acceptable results are obtained. The suitability of results will be determined by the Engineer.

The length of the control section shall be 500 to 1,000 feet. No further recycling shall be performed on the project until all aspects of the test section are approved by the Engineer.

415.09 METHOD OF MEASUREMENT. The quantity of Cold Mixed Recycled Bituminous Pavement to be measured for payment will be the number of square yards of existing pavement which has been recycled in an acceptable manner as determined by actual surface measurements of the lengths and widths of the recycled area as shown on the Plans or as directed by the Engineer. No additional compensation will be made for overlapping areas.

The quantity of Emulsified Asphalt, Cold Mix to be measured for payment will be the number of hundredweight (CWT) used in the complete and accepted work.

415.10 BASIS OF PAYMENT. The accepted quantity of Cold Mixed Recycled Bituminous Pavement will be paid for at the Contract unit price per square yard. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Emulsified Asphalt, Cold Mix will be paid for at the Contract unit price per hundredweight (CWT) for the specified material applied. Payment will be full compensation for furnishing, transporting, and placing the material and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
415.20 Cold Mixed Recycled Bituminous Pavement	Square Yard
415.25 Emulsified Asphalt, Cold Mix	CWT

SECTION 417 – BITUMINOUS CRACK SEALING

417.01 DESCRIPTION. This work shall consist of furnishing and placing crack-sealing material in the cracks of existing bituminous concrete pavement.

417.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Joint Sealer, Hot Poured ..... 707.04(a)

The Contractor shall provide the Engineer with a copy of the material manufacturer's recommendations pertaining to heating, application, and reheating prior to the beginning of operations or the changing of materials.

417.03 EQUIPMENT. Equipment shall meet the approval of the Engineer and shall always be maintained in working condition.

(a) Air Compressor. Air compressors shall be portable and capable of furnishing at least 3.7 cubic yards of air per minute with a minimum pressure of 90 psi at the nozzle. The compressor shall be equipped with traps that will maintain the compressed air free of any oil or water.

(b) Hand Tools. Hand tools shall consist of brooms, shovels, metal bars with chisel-shaped ends, squeegees, and any other tools which may be required to accomplish the work.

(c) Melting Kettle. The melting kettle shall be a double boiler, indirect-fired portable type. The space between the inner and outer shells shall be filled with a suitable heat transfer oil or substitute having a flash point of not less than 531°F. The kettle shall be equipped with a satisfactory means of agitating the joint sealer. This may be accomplished by continuous stirring with mechanically operated paddles and/or by a continuous circulating gear pump attached to the heating unit.

The melting kettle shall be equipped with a thermostatic control calibrated between 200°F and 550°F. The kettle shall be mounted on rubber tires and be equipped with a metal shield beneath the firebox to protect the pavement.

(d) Application Wand. The application wand shall apply a controlled flow of material via an insulated or heated hose. The nozzle shall distribute the material as called for on the Plans or this Specification. A pressure regulator shall be provided to regulate pressure at the nozzle. A bypass line into the holding tank is required for use when the nozzle is shut off.

(e) Router. Equipment for preparing cracks shall be a rotary-impact type cutter or a diamond-blade crack saw which will provide a reservoir of specified dimensions.

(f) Hot-Air Lance. Equipment for blowing clean and drying cracks and joints shall be a propane gas and compressed air burner (ATAFA unit or approved equivalent) operating at a temperature of 3,000°F and at a velocity of 3,000 feet per second.

417.04 TEMPERATURE LIMITATIONS. The ambient air temperature shall be in the range of 40°F to 104°F and the pavement temperature shall be in the range of 50°F to 140°F.

When it is in the public interest, the Construction Engineer may adjust the specified ambient air and/or pavement temperature requirements.

417.05 PREPARATION.

(a) General. Care must be taken in the preparation of all cracks to receive sealant material. All cracks must be clean, dry, and heated to ensure optimal bonding of the sealant material to the existing pavement.

(b) Bituminous Crack Sealing. All routed cracks shall be filled with sealant in the same work day as directed by the Engineer.

Cracks of 1/8 inch to 3/4 inch in width shall be shaped into a square cross-section of approximately 3/4 inch in width by 3/4 inch in depth using a router or crack saw. All cracks to be sealed shall be routed or saw-cut. All material removed from the cracks shall be immediately removed from the pavement. Cracks greater than 3/4 inch in width shall only be prepared and sealed at the direction of the Engineer.

Following crack routing or saw-cutting, the entire pavement area shall be cleaned using a power broom or blower device. Special care must be exercised in urban areas to ensure that the pavement area is cleaned after the crack sealing operation and to minimize the creation of dust in the cleaning process. Immediately prior to the application of the sealer material, all cracks shall be cleared of loose pavement, vegetation, sand, dust, and any other debris using the hot-air lance.

The full length of the cracks shall be heated with the hot-air lance to improve bonding of the sealant and pavement. Care shall be taken not to burn or char the pavement. Any charred pavement shall be cut out and removed and the crack prepared and resealed.

Areas of high density cracking indicating a structural failure should not be prepared for sealing as directed by the Engineer.

(c) Bituminous Crack Sealing, "Blow and Go" Method. Bituminous Crack Sealing, "Blow and Go" Method shall be performed in accordance with Subsection 417.05(b), with the exception that no routing or saw-cutting will be required prior to cleaning and sealing the crack.

417.06 PLACING OF SEALER. The joint sealer material shall be heated and applied at the temperature specified by the manufacturer and approved by the Engineer. Any material that has been heated above the manufacturer's Specification shall not be used. Material that is reheated or held at temperature for an extended period of time may be used as allowed by the manufacturer's Specification and approved by the Engineer.

The Contractor shall provide the Engineer with a suitable device for verifying the sealant temperature in the kettle and at the application site. The sealant application temperature shall not be lowered below the manufacturer's recommended temperature to address pooling problems at the end of the rout. This problem shall be addressed by using sealant material with appropriate flow characteristics to prevent pooling.

All routed cracks shall be fully filled with joint sealer material. A strike-off device may be used to facilitate placement of the material provided it has a maximum width of 1-1/2 inches. The joint sealer material should be struck off such that only a thin film band 1/16 inch or less is left on the pavement. Optimally, the pavement aggregate should be visible through the thin film band.

Any over application or spills are to be removed to the satisfaction of the Engineer. Any sealed areas with damaged or contaminated sealer or visible voids are to be removed, prepared, and resealed. Any filled areas that have sunk below the surface more than 1/16 inch shall be repaired by applying additional material.

The sealant material shall be applied while the cracks or joints are still hot from the hot-air lance preparation. Any loose material on the surface or in the crack, which may contaminate the joint sealer or impede bonding

of the sealant to the pavement, is to be removed by hand tools prior to crack sealing. No crack sealing material shall be applied in a crack that is wet or where frost, snow, or ice is present.

No vehicles or equipment should be allowed on the newly placed sealant material until it has cooled as specified by the manufacturer. If the pavement must be reopened to traffic prior to air cooling, the cooling process may be accelerated with water or other coolant as specified by the manufacturer and approved by the Engineer. As a last resort, sealant may be protected against tire pick-up by dusting with a fine sand, mineral dust, or similar material as approved by the Engineer.

Any procedure used to accelerate cooling time must be approved by the Engineer and follow the manufacturer's application Specifications. Costs for all material and labor for dusting or cooling shall not be paid for directly but shall be considered incidental to Bituminous Crack Sealing.

417.07 METHOD OF MEASUREMENT. The quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method to be measured for payment will be the number of pounds of joint sealer complete and in-place in the accepted work.

417.08 BASIS OF PAYMENT. The accepted quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method will be paid for at the Contract unit price per pound. Payment shall be full compensation for handling and placing the sealant material, including the cleaning and preparation of cracks, the removal and disposal of all bituminous grindings, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
417.10 Bituminous Crack Sealing	Pound
417.20 Bituminous Crack Sealing, "Blow and Go" Method	Pound

SECTION 418 – ASPHALTIC APPROACH MATERIAL

418.01 DESCRIPTION. This work shall consist of furnishing and installing asphaltic approach material at the transition between bituminous concrete pavement and Portland cement concrete, steel or other materials.

418.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Asphaltic Plug Joint Binder 707.17

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418.03 INSTALLATION. Asphaltic approach material shall be installed at the locations(s) and to the depth and configuration shown in the Plans and as directed by the Engineer.

418.04 METHOD OF MEASUREMENT. The quantity of Asphaltic Approach Material to be measured for payment will be the number of square feet used in the complete and accepted work.

418.05 BASIS OF PAYMENT. The accepted quantity of Asphaltic Approach Material will be paid for at the Contract unit price per square foot. Payment will be full compensation for detailing, furnishing, handling, transporting, and placing the material specified, including surface preparation, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Tack, prime, or seal coats of bituminous material required for the installation of asphaltic approach material will not be paid for separately, but will be considered incidental to the Contract unit price for Asphaltic Approach Material.

Removal of any existing asphaltic, bituminous or Portland cement concrete materials to allow for the installation of asphaltic approach material will not be paid for separately, but will be considered incidental to the Contract unit price for Asphaltic Approach Material.

Payment will be made under:

Pay Item	Pay Unit
418.10 Asphaltic Approach Material	Square Foot

SECTION 490 – THIS SECTION RESERVED

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DIVISION 500

STRUCTURES

SECTION 501 – PERFORMANCE BASED STRUCTURAL CONCRETE

501.01 DESCRIPTION. This work shall consist of designing, furnishing and placing high performance Portland cement concrete for structures and incidental construction.

The Portland cement concrete may consist of a homogeneous mixture of cement, fine aggregate, coarse aggregate, water, admixtures, and pozzolans, proportioned and mixed according to these specifications.

501.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Portland Cement.....701.02
Portland-Pozzolan Cement.....701.05
Portland Blast-Furnace Slag Cement.....701.07
Ternary Blended Cement.....701.08
Fine Aggregate for Concrete.....704.01
Coarse Aggregate for Concrete.....704.02
Lightweight Coarse Aggregate for Structural Concrete.....704.14
Preformed Joint Filler, Cork, and Asphalt-Treated Felt.....707.08
Polyvinyl Chloride (PVC) Waterstop.....707.10
Concrete Bonding Systems.....707.16
Stay-in-Place Corrugated Metal Forms for Superstructure Slabs.....715.05
Epoxy Bonding Compound.....719.02
Concrete Curing Materials.....725.01
Air-Entraining Admixtures.....725.02(b)
Retarding Admixtures.....725.02(c)
Water-Reducing Admixtures.....725.02(e)
Water-Reducing and Retarding Admixtures.....725.02(f)
Water-Reducing, High Range Admixtures.....725.02(g)
Water-Reducing, High Range, and Retarding Admixtures.....725.02(h)
Accelerating Admixtures.....725.02(i)
Water-Reducing and Accelerating Admixtures.....725.02(j)
Specific Performance Admixtures.....725.02(k)
Mineral Admixtures.....725.03
Silica Fume.....725.03(b)
Ground Granulated Blast-Furnace Slag (GGBFS).....725.03(c)
Polystyrene Insulation Board.....735.01

Blanket Insulation Material.....735.02
Pipe Insulation 740.08
Water.....745.01

The coarse aggregate for superstructure shall be conditioned so that the total moisture percentage shall be the absorption percentage plus, at a minimum, 0.25% free moisture for the aggregate.

Precast concrete stay-in-place forms (prestressed deck panels) shall conform to Section 510.

All hardened concrete surfaces to have plastic concrete placed against it will be saturated with water, and excess water shall be removed just prior to plastic concrete contacting it.

501.03 CLASSIFICATION AND PROPORTIONING. The following classes of concrete, shown in Table 501.03A, are included in these specifications and shall be used as shown on the Plans.

TABLE 501.03A – PERFORMANCE-BASED CONCRETE CLASSES AND PROPERTIES

Class of Concrete [1]	28-Day Compressive Strength (psi) [2]	Target W/CM Ratio [3]	VSI	Slump/Spread Target and Range (in.)	Max. Slump (in.)	Air Content Limits [4]	Free Shrinkage [5]	Max. 56-Day Surface Resistivity [6]
PCD	4,000	TBD	--	TBD ± 1.5 [7]	9	5.5% – 8.5%	0.032%	Low
PCS	3,500	TBD	--	TBD ± 2.5 [7]	9	5.5% – 8.5%	0.042%	Low
SCC	4,000	TBD	≤ 1	TBD [8]	--	6.5% – 8.5%	--	Low

[1] PCD = Performance Concrete, Deck

PCS = Performance Concrete, Substructure

SCC = Self Consolidating Concrete

[2] The listed 28-day compressive strength is the minimum strength required to meet the design intent.

[3] The target W/CM ratio is to be determined by the Contractor. During production the W/CM ratio shall be within + 0.05 of the target W/CM ratio. At no time may the W/CM ratio exceed 0.500, nor the total water content exceed 280 lbs/yd^3. For Class SCC, the maximum W/CM ratio shall be determined by the Contractor.

[4] See Subsection 501.03(b)(2).

[5] The Contractor shall determine the free shrinkage in accordance with Subsection 501.03(c)(3).

[6] The Contractor shall determine the surface resistivity in accordance with Subsection 501.03(c)(4).

[7] The Contractor shall determine a slump target that will allow enough workability to be placed and finished per Contract requirements. The slump shall be maintained within the specified range for the placement. The mix shall not exhibit segregation. If the mix does exhibit segregation or exceeds the maximum slump, the load shall be rejected and subsequent loads shall be tested by the Contractor until the mix meets the allowable limits.

[8] The Contractor shall determine the spread target and limits in accordance with Subsection 501.03(b)(1). The spread shall be maintained within the determined spread limits for the placement. The mix shall not exhibit segregation. If the mix does exhibit segregation or exceeds the upper spread limit, the load shall be rejected and subsequent loads shall be tested by the Contractor until the mix meets the allowable limits. The Engineer may perform a J-ring test at the time of placement if blocking is a concern.

If a nominal maximum aggregate size is not specified, the Contractor shall determine the nominal maximum aggregate size using guidance from *ACI 211.1* to do so. In no case will the maximum aggregate size exceed 1/5 of the narrowest dimension between sides of the forms, 1/3 the depth of slabs, nor 3/4 of the minimum clear spacing between individual reinforcing bars, bundles of bars, or pre-tensioning strands unless approved by the Engineer.

The Contractor may use industry methods to develop gradations not specified in Section 704 in order to create better optimized gradations to satisfy the required concrete performance characteristics. If the Contractor is using a combined gradation, they shall provide the method or methods of how they will monitor gradation, the limits of the gradation ranges, and the frequency of monitoring.

Lightweight fine aggregate may be used up to 30% by volume replacement for normal weight sand. The gradation of the lightweight fine aggregate shall conform to the requirements of *AASHTO M 195*. The lightweight fine aggregate shall be conditioned for enough time to fully saturate the material.

The stockpile shall be constructed so that it contains uniform moisture content throughout the pile. The stockpile will be allowed to drain 12 to 15 hours immediately prior to use, unless an alternate procedure is approved by the Structural Concrete Engineer. The Contractor shall state the method, duration and procedure used to confirm that the material is at or above its saturated surface dry (SSD) value, by weight, throughout the pile.

The mix may contain a shrinkage compensating admixture conforming to the requirements of *AASHTO M 194 M/M 194* or *ASTM C 494/C 494 M*.

The use of chlorides or admixtures containing chlorides is prohibited. All admixtures will be considered incidental to the work and included in the Contract unit price of the concrete.

The concrete shall have air content by volume as specified. The entrained air shall be obtained using an approved admixture.

The concrete materials may be proportioned using the absolute volumes method in accordance with the specified requirements. The volumetric proportioning method such as that outlined in *ACI 211.1*. or other approved volumetric proportioning methods, shall be employed in the mix design.

A minimum of 30 calendar days prior to placement of the trial pour (or prior to the pre-placement meeting, if the trial pour is waived by the Engineer), the Contractor shall submit for approval the mix design for the class of concrete specified. The mix designs shall be submitted to the Structural Concrete Engineer at the Agency's Materials Section Central Laboratory. No class of concrete shall be placed on a project, including the trial pour, until the mix design is approved.

(a) The mix design must contain the following information:

(1) Class of concrete.

(2) Type of mix, conventional or self-consolidating concrete (SCC).

(3) Specify if saturated surface dry or dry weights.

(4) Aggregates – Types, sources, specific gravities, and absorption values.

(5) Specified 28-day design compressive strength, psi.

(6) Cementitious content and the amount of each, pounds per cubic yard.

(7) Air content lower limit and upper limit, percent.

(8) Specified surface resistivity value.

(9) Slump range for conventional concrete, inches.

(10) Determined spread lower limit and upper limit for SCC.

(11) Water/cementitious materials (W/CM) ratio target value.

(12) Volumetric quantities of each material in the mix design.

(13) Design unit weight of the mix.

(14) Chemical Admixtures – Types, brand names, and dosages.

Concrete test mix or mixes shall be used to obtain the test results where applicable. All wet testing shall be done by personnel with current ACI Concrete Field Testing Technician Grade I certifications. All other tests shall be performed by an independent laboratory that is accredited in the particular test method, or as allowed by the Engineer.

(b) The following preliminary mix qualification tests shall be performed:

(1) The Contractor shall determine the lower and upper spread limit for SCC concrete. The J-Ring Test and the Spread Test will be conducted at both the lower and upper spread limits. The J-Ring Test will be conducted per the requirements of *ASTM C 1621/C 1621 M*, and the Spread Test will be conducted per the requirements of *ASTM C 1611/C 1611 M.*

The J-Ring test results shall be compared to the Spread Test results at both the upper and lower limits. The difference between the two tests at both the upper and lower limit shall not be greater than 2 inches. At both the upper and lower limits, the Visual Stability Index (VSI) shall not be greater than 1.

(2) The Contractor shall provide test results that establish the quality of the entrained air void structure and the freeze-thaw durability of the concrete. Sampling shall be performed in accordance with *AASHTO R 60* on a trial batch of concrete that is a minimum of 3 cubic yards, and which meets the following requirements:

a. For all concrete, the air content shall be no more than 1.5% above the lower limit established in Table 501.03A.

b. For conventional concrete, the slump shall not exceed 5 inches.

c. For SCC concrete, the spread shall not be more than 5 inches greater than the minimum spread determined as specified in Subsection 501.03(b)(1), nor shall the spread exceed the maximum spread determined as specified in Subsection 501.03(b)(1).

Conventional concrete shall be tested for slump (*AASHTO T 119 M/T 119*), air content (*AASHTO T 152*), concrete temperature (*ASTM C 1064/C 1064 M*), and characterization of the air-void system of freshly mixed concrete by the sequential pressure method (*AASHTO TP 118*). The Contractor shall make a minimum of 2 concrete cylinders per *AASHTO T 23*.

SCC concrete shall be tested for spread (*ASTM C 1611/C 1611 M*, Procedure B), air content (*AASHTO T 152*), concrete temperature (*ASTM C 1064/C 1064 M*), and characterization of the air-void system of freshly mixed concrete by the sequential pressure method (*AASHTO TP 118*). The Contractor shall make a minimum of 2 concrete cylinders per *AASHTO T 23*.

The cylinders shall be cured for a minimum of 5 calendar days prior to being tested according to the requirements of *ASTM C 457*. The wet test results shall be included with the *ASTM C 457* results.

The tests required in Subsection 501.03(b)(2) will be used by the Agency to evaluate the quality of the entrained air void structure of the concrete. These test results will be used for informational purposes only and will not be used to determine the acceptability of the mix design.

(c) The additional mix qualification test results specified below shall accompany the mix design. Testing should be done on the same test batch where applicable.

(1) The concrete used to determine the additional mix qualification properties shall meet the following requirements:

a. For all concrete, the air content shall be not be more than 1.5% above the lower limit.

b. For conventional concrete, the slump shall be between 5 inches and 9 inches, and the W/CM ratio shall be 0.05 above the target.

c. For SCC concrete, the spread shall be within 5 inches of the maximum spread limit, and the W/CM ratio shall be the maximum W/CM ratio, as determined by the Contractor.

(2) The compressive strength of the concrete shall be measured based on the requirements of *AASHTO T 22* for 7, 14, and 28-calendar day standard cured cylinders.

(3) The free shrinkage rate of the concrete shall be tested per the requirements of *AASHTO T 160*. The test specimen shall be a prism of 4 inch square cross section. Procedure 11.1.2 of *AASHTO T 160* shall be followed for storage and measurements, and all specified test age results shall be submitted. Specimen testing may be terminated after 28 calendar days of drying. Testing shall be performed by an independent laboratory accredited in the specific test method.

(4) The surface resistivity of the test mix shall be measured at 28 and 56 calendar days based on the requirements of *AASHTO T 358*. Results shall be categorized as Low, Very Low, or Negligible in accordance with *AASHTO T 358*, Table 1.

(d) The Alkali-Silica Reactivity (ASR) of each type of aggregate shall be measured separately based on the requirements of *AASHTO T 303*. If one or more of the aggregates exceeds 0.10% expansion, then the aggregate shall be tested again according to the requirements of *ASTM C 1567*.

The Contractor may elect to go directly to *ASTM C 1567* testing if they suspect that the aggregate may exceed the 0.10% expansion if tested by *AASHTO T 303*. Testing shall be performed by an independent laboratory accredited in the specific test method.

(e) After the mix design furnished by the Contractor has been reviewed and approved by the Structural Concrete Engineer, no new materials shall be incorporated. In no case shall concrete from more than one mix design be permitted to be used during the same pour without prior written approval of the Engineer.

Mix design approvals will be valid for a 12-month period. The approved mix design will be allowed a two consecutive year re-approval if no material proportioning or material sources have changed from the previous year's approved mix design and the mix design is submitted with updated aggregate properties and volumes adjusted accordingly. The aggregate properties shall be tested within 60 calendar days of the mix design submission. The properties to be tested include, but are not limited to, specific gravity, unit weight, and absorption. The mix design shall be accompanied by the previously completed and accepted test mix data and any applicable updated test information.

501.04 BATCHING. Measuring and batching of materials shall be done at an approved batch plant. Batch plants shall have an inspection completed prior to the first concrete placement on an Agency project if it has been longer than 12 calendar months from the last inspection. Request for inspection and required documentation must be received by the Materials Testing and Certification Section a minimum of 21 calendar days prior to the date of the requested inspection.

All deficiencies shall be corrected and verified a minimum of 5 calendar days prior to the first concrete placement for any Agency project. The batch plant shall meet the requirements of *AASHTO M 157*, except as modified in these specifications, and shall always be maintained in good repair. The batch plant shall

be subject to periodic inspections by authorized representatives of the Agency. The batch plant shall have approved methods of storing, measuring, and dispensing approved mineral admixtures.

All concrete batch plants offered for Agency approval shall be equipped for semi-automatic batching and proportioning of all cementitious material, aggregates, water, and for the automatic insertion of admixtures. The plants shall be equipped to automatically and accurately record, report, and print batch weight tickets in English units the quantity of all aggregates, cementitious material, and the water incorporated into each batch and shall identify and record the addition of the required admixtures. All materials added to the concrete batch after initial batching shall be added to the printed batch weight ticket prior to delivery.

Proper facilities shall be provided for the Engineer to inspect ingredients and processes used in the batching and delivery of the concrete. The Contractor shall, without charge, afford the Engineer all reasonable facilities for securing samples to determine whether the concrete is being furnished in accordance with these specifications. In the batch room area, the producer shall provide the Inspector with a 24 inch × 18 inch horizontal working surface, at a sufficient working height, with a seat and an adequate view of the batching controls, display, and power supply.

The Contractor shall give the Engineer 24-hour notice of intent to place concrete so that arrangements can be made for laboratory inspection and control. Failure to give notice which causes postponement of placing operations shall not be reason for determining extension of Contract time per the requirements of Subsection 108.11.

(a) Semiautomatic Batch Plants. When actuated by a starting mechanism, the semiautomatic batch controller shall start the weighing operation of the materials and stop the flow automatically when the designated weight has been reached. It shall be interlocked to ensure that the discharge mechanism cannot be opened until the weight is within the tolerance specified in Subsection 501.04(d).

Water and admixtures may be batched in a weigh batcher or by volume in a volumetric device. When actuated, volumetric controls shall start the measuring operation and stop the flow automatically when the designated volume has been reached.

(b) Testing Laboratory. The Contractor shall provide a weatherproof building or room at the plant site for the use of Agency personnel as a testing laboratory. The Contractor shall attain and maintain a qualified laboratory status in accordance with the current edition of the Agency's Qualified Laboratory Program. Failure to comply with this program may result in suspension or revocation of acceptance testing at the facility.

The testing laboratory shall have a minimum gross internal area of 150 square feet with a layout providing a minimum internal width of 7 feet, in which to house and use the equipment specified. Should the Contractor elect to provide additional equipment relevant to testing of Portland cement concrete and materials, the gross inside floor area of the laboratory shall be increased in proportion

to the area required to house and operate the additional equipment. If the additional equipment is to be operated on a bench, the length of bench sections shall also be proportionally increased.

Adequate ventilation, lighting, heating, and any necessary electrical or gas connections shall be provided. Proper sanitary toilet facilities with a lavatory shall be available for use by Agency personnel at the plant site. Dedicated private telephone and internet services shall be provided to the laboratory. The internet connection shall have a minimum download capacity of 3 Mbps (megabits per second) without utilizing compression algorithms and the bandwidth speed shall be verified using an online speed test.

The laboratory shall be equipped with the following items and equipment:

1 Standard office desk, with lockable drawers or a separate lockable two-drawer file cabinet and chair

1 VTrans Qualified Laboratory Binder with producer equipment calibration data

1 Set of bench sections at least 2 feet wide providing a minimum of 28 square feet of working area with under-counter shelving

1 Standard laboratory stool

1 Fully automatic electronic calculator with eight digit capacity

1 Standard laboratory sink and faucet provided with an adequate supply of water meeting the requirements of Subsection 745.01. The sink shall drain to the outside of the laboratory

1 Bench brush

1 Floor brush

1 Motorized 8-inch sieve shaker with an adjustable timer. The shaker's operation shall be conducted by means of lateral and vertical motion of the sieve accompanied by jarring action with the following 8-inch diameter sieves: 3/8 inch (9.50 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (0.600 mm), No. 50 (0.300 mm), No. 100 (0.150 mm), plus pan and cover.

1 Mechanical aggregate shaker with an adjustable timer, a 1 cubic foot capacity, together with the following screens: 1-3/4 inch (43.0 mm), 1-1/2 inch (37.5 mm), 1 inch (25. 0 mm), 3/4 inch (19.0 mm), 1/2 inch (12.5 mm), 3/8 inch (9.50 mm), 1/4 inch (6.30 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), and pan. The aggregate shaker may be placed in a separate enclosed area, or be shielded for dust and sound control. When the aggregate shaker is placed in a separate enclosed area, there shall be a minimum of 5 feet of clear space measured from the front frame of the aggregate shaker outward, as well as a bench section measuring approximately 36 inches high, 24 inches deep, and 50 inches long located adjacent to the aggregate shaker. The area shall be well lit and ventilated.

1 Square pointed shovel

5 Five gallon plastic buckets, with handles

1 Electronic balance with a minimum capacity of 50 pounds and accurate to 0.0002 pounds. If separate fine and coarse aggregate scales are to be used, the fine aggregate scale shall meet the requirements of *AASHTO M 231* Table 2, Class G2 with a minimum capacity of 1.75 pounds and readable to 0.0002 pounds. The coarse aggregate scale shall meet the requirements of *AASHTO M 231* Table 2, Class G5 with a minimum capacity of 50 pounds and readable to 0.002 pounds.

1 Set of standard masses (weights) to use for verifying the accuracy of the electronic balance

2 Double-burner hot plates with variable temperature controls

3 Metal pans with a nominal size of 9 inches × 9 inches × 2 inches

5 Metal pans with a nominal size of 9 inches × 13 inches × 2 inches

1 Sample splitter with a 2-1/2-inch chute

1 10-inch blunted trowel

1 4 foot × 4 foot minimum heavy canvas for quartering samples

1 Brass wire-bristle brush

1 Pair of heat-resistant gloves (500°F, short-contact)

2 1-1/2 inch soft bristle paint brushes

Acceptable substitutes for these items and equipment may be made with the approval of the Structural Concrete Engineer.

Batching operations shall not begin until the testing laboratory has been approved as being in compliance with these specifications and all equipment and equipment calibration requirements of the current VTrans Quality Assurance Program and Qualified Laboratory Program documents. Removal of any equipment, except with written request and written approval of the Structural Concrete Engineer, will revoke any prior approvals and/or qualifications and require the termination of batching operations.

The building or room designated as a testing laboratory shall be maintained in a clean condition by the producer and kept free of all articles not necessary for the testing of materials. Cleaning supplies shall be furnished by the Contractor.

(c) Bins and Scales. The batch plant shall include bins, weighing hoppers, and scales with adequate separate compartments for fine aggregate and for each required separate size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided so that when required, the material may be added slowly in minute quantities and shut off with precision.

Hoppers shall be constructed to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments shall be configured to prevent spilling under any working condition. All batch plant structures shall be properly leveled and maintained in that condition within the tolerance required by the design of the weighing mechanism.

The scales for determining the mass (weight) of aggregate, water and cementitious material shall be comprised of a suitable system of levers or load cells. The levers or load cells will determine the mass (weight) consistently within 0.5% under operating conditions, with loads indicated either by means of a beam with balance indicator, a full-reading dial, or a digital read-out or display.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either using 50 pound weights or by other methods approved by the Structural Concrete Engineer. Weights shall be certified annually by the Division of Weights and Measures of the Vermont Agency of Agriculture, Food, and Markets. All exposed fulcrums, clevises, and similar working parts of scales shall be kept clean.

When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. Poises shall be designed to be locked in any position to prevent unauthorized change of position. All measuring and weighing indicating devices shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

The scales shall be serviced and their accuracy verified annually by a hopper-scale service person licensed by the Division of Weights and Measures. For Vermont plants, an Inspector representing the Division of Weights and Measures shall witness all testing conducted by the service person and will attach a seal to each hopper scale, provided it meets the current specifications, tolerances, and regulations adopted by the Division of Weights and Measures. Standard test weights used to determine the accuracy of hopper scales shall be certified yearly by the Division of Weights and Measures in accordance with their established standards.

The ready-mixed concrete producer shall hire a licensed hopper scale service person for annual checking and service of scales. In addition, Vermont producers shall schedule an inspection with the Division of Weights and Measures between February 15th and April 30th of each year. After April 30th, Vermont plants without current seals affixed to the hopper scales will not be permitted to supply concrete to Agency projects, unless otherwise directed by the Engineer or until the seals are affixed.

Out-of-state concrete producers shall observe all annual hopper scale weighing and seal requirements of their respective states.

(d) Production Tolerances for Batching. For weighed ingredients, the accuracy of batching is determined by a comparison between the desired weight and the actual scale reading. For volumetric measurement of water and admixtures, accuracy is determined by checking the quantity either by weight on a scale or by volume in a calibrated container.

Admixture-dispensing systems shall, at a minimum, be annually calibrated by an admixture distributor representative. The admixture distributor representative shall check at least two volumes, with a check done at approximately 15% of the minimum and at 15% of the maximum manufacturer's recommended dosage range, or other targets as approved by the Structural Concrete Engineer.

Batching shall be conducted to accurately measure the desired quantities of materials within the tolerances specified in Table 501.04A.

TABLE 501.04A – CONCRETE PRODUCTION TOLERANCES FOR BATCHING

Material	Tolerance (%)
Cement	± 1
Water	± 1
Aggregates	± 2
Chemical admixtures	± 3
Mineral admixtures	+ 10, - 1

(e) Storage and Proportioning of Materials.

(1) Portland Cement. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting during operation. Facilities shall be provided for the sampling of cement at the batch plant, either from the storage silo or from the weighing hopper. The sampling device shall provide a sample that represents the true nature of the material being used. This device shall be a permanent installation located to allow for safe and easy access.

(2) Water. Water may be measured either by volume or by weight. When measurement is by meter, the water meter shall be so located that the measurements will not be affected by variable pressures and temperatures in the water supply line.

Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tanks.

All water metering methods shall be verified and calibrated on an annual basis or at any time there is a question of accuracy. All water added to the concrete at any point shall be through an approved metering method.

(3) Aggregates. Aggregate stockpiles shall be formed on hard, well-drained areas that prevent contamination from underlying material and accumulation of excessive moisture.

Aggregates from different sources or of different gradations shall not be stockpiled together. Only rubber-tired equipment shall be permitted to operate on aggregate stockpiles.

Stockpiles shall be constructed as follows:

a. If the stockpile is to be made using mechanical equipment (front end loader, clam bucket, rock ladder, radial stacker, or other approved equipment), the stockpile shall be made in such a manner that segregation is kept to a minimum.

b. If the stockpile is to be made by dumping from trucks in multiple layers, each layer shall be approximately 4 feet in depth. Each layer shall be completely in place before commencing the next layer. Care shall be taken that successive layers do not "cone" down over the previous layer.

c. No equipment shall be used to haul aggregate over the stockpiled material except to deposit the material for the layer being placed. It shall be the responsibility of the Contractor to ensure that the aggregate is kept free from deleterious material or degradation.

Stockpiles shall be maintained in such a manner that twice the anticipated aggregate requirement for any Agency project placements will be on hand and available for sampling and testing at least 48 hours before mixing operations for the placements are scheduled to begin. The Engineer may modify this requirement when special aggregates are required.

Aggregates shall be handled from stockpiles or other sources to the batch plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates, except lightweight coarse aggregate, produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. In case the aggregates have a high or non-uniform moisture content, a storage or stockpile period longer than 12 hours may be required by the Engineer.

Stockpiles being watered per the specifications or allowed through producer QC procedures shall be watered for a sufficient time to ensure consistent moisture throughout the stockpile. Aggregate stockpiles being watered shall be loaded in the bin within 1 hour of being batched.

The Contractor shall conduct moisture content tests within 1.5 hours of the anticipated concrete batching time. If there is a visual difference in aggregate moisture appearance, aggregate moisture content will be tested again and new moisture test results shall be obtained and used as soon as possible. Material that has been stored in a storage bin for more than 10 hours shall be retested for moisture content. A minimum of one cubic yard of aggregate will be removed from the bottom of the storage bin. A minimum of one cubic yard of aggregate will then be removed and a moisture content sample taken.

Plants that employ moisture probes shall have them calibrated and verified a minimum of 24 hours prior to batching or as directed by the Structural Concrete Engineer. The procedure for checking the meter will be to run aggregate over the probe and then collecting a portion of the aggregate on which to perform a moisture content test. If the difference between the meter and the tested moisture content is greater than 0.5%, then the meter must be calibrated.

d. Lightweight coarse aggregate stockpiles shall be presoaked for a minimum period of time to ensure that the aggregate is completely saturated surface dry or greater immediately prior to use as indicated by moisture testing. Soaking shall be accomplished by continuous sprinkling or other suitable means that will provide a uniform moisture content throughout the stockpile. The stockpile shall be allowed to drain for 12 to 15 hours immediately prior to use.

(4) Admixtures. The Contractor shall follow an approved procedure for adding the necessary amounts of admixtures to each batch. Admixtures shall be dispensed in such a manner that will ensure uniform distribution of the material throughout the batch within the required mixing period. Except as specified herein, all admixtures shall be added to the batch at the plant, unless otherwise authorized by the Structural Concrete Engineer.

Chemical admixture containers, metering equipment, and scales shall be calibrated annually by a qualified admixture distributor representative. Admixture calibration and verification shall be done at 15% of the high, at approximately the middle, and at 15% of the low recommended ranges for the admixture being dispensed by the system. The calibration and verification shall be done in the presence of an Agency representative when requested by the Agency.

All dispensers shall include visual inspection aids such as graduated transparent cylinders. A separate dispenser shall be provided for each liquid admixture. If the dispensing system does not provide visual inspection aids, then periodic verification tests shall be done at a

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frequency satisfactory to the Structural Concrete Engineer. Calibration and verification records shall be kept at the production facility for a minimum of one year. The producer shall do the calibration and verification of the metering systems when requested.

Storage and dispensing systems for liquid admixtures shall be equipped to allow thorough circulation and/or agitation of all liquid in the system. This shall be required prior to the first batching of concrete for Agency projects in any calendar year and periodically thereafter at intervals not to exceed 60 calendar days for the duration of the period the plant is supplying concrete for Agency projects.

If the plant has received a delivery of at least 25% of the volume of the storage container, this will be considered as a method of circulation or agitation. If the circulation method is used, the admixture shall be circulated until a complete exchange of admixture is achieved. If an agitation method is used, the method shall be subject to approval by the Structural Concrete Engineer. If an admixture does not need agitation, then the admixture manufacturer shall submit in writing stating this annually.

Storage and dispensing systems for liquid admixtures shall be maintained within the manufacturer's stated temperature and environmental conditions.

It shall be the responsibility of the Contractor to use the quantity of Agency-approved admixtures needed to obtain concrete meeting the requirements of the Contract. All admixtures will be approved by the Structural Concrete Engineer prior to incorporation into the mix.

a. Air-Entraining Admixture. Air-entraining admixture shall be used as required to obtain the specified air content.

b. Water-Reducing, Retarding, and Water-Reducing and Retarding Admixtures, Accelerators and Specialty Admixtures. Dosages shall be in the recommended range as stated by the Manufacturer, unless otherwise approved by the Manufacturer.

(5) Fly Ash or GGBFS. Fly Ash or Ground Granulated Blast-Furnace Slag (GGBFS) shall be stored at the batch plant in separate storage or holding bins or other approved holding containers and shall be protected from rain and moisture.

501.05 MIXING AND DELIVERY.

(a) General. Concrete may be mixed at the site of construction, at a central point, or wholly or in part in transit mixers. The production of concrete shall meet the requirements of *AASHTO M 157* with the following additional requirements:

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(1) All concrete shall reach its final position in the forms no more than 1.5 hours after the cement has been added to the water. When the ambient air temperature is 60°F or above, the elapsed time may be reduced as necessary as directed by the Engineer or in accordance with the requirements of Subsection 501.07(a).

If, in the opinion of the Engineer, the concrete visual characteristics appear to be noticeably different from the last acceptance test or previous concrete for that pour, the Engineer may direct the Contractor to perform QC tests to confirm the concrete conforms with the specifications.

(2) Authorization by field inspection personnel must be obtained prior to the addition of water or admixtures at the project site. If water is added in excess of the specified maximum W/CM ratio, the concrete shall not be used.

(3) Each load of concrete delivered at the job site shall be accompanied by a State of Vermont Batch Slip signed by the authorized Agency representative, if present, at the plant. If an Agency representative is not present at the time of batching, a batch weight ticket meeting the requirements of Subsection 501.04 shall accompany the delivery vehicle.

(4) The Contractor shall provide direct communication service from the site of the work to the batch plant that shall always be available to the Engineer during concrete operations. The cost of this service will be considered incidental to the work.

(5) When use of a Water-Reducing, High Range Admixture or Water-Reducing, High Range, and Retarding Admixture is specified for deck concrete, the Contractor shall submit, for the Engineer's approval, information about the admixture manufacturer, the admixture addition rate, and when the admixture is to be added to the mixture (i.e., at the plant, on project, or a combination thereof).

To obtain the required concrete characteristics, a representative from the concrete producer is required on the project to determine the final admixture dosage and water addition for each load of concrete. The dosage shall be applied by means of a dispenser, or by other means of accurately measuring volume as approved by the Engineer. The Contractor shall provide QC concrete testing personnel, with current ACI Concrete Field Testing Technician Grade I Certification, to confirm the concrete is within specifications for the required work.

(6) All concrete shall be discharged into the forms before 300 revolutions of the drum or blades, not including initial mixing revolutions. The total allowed number of revolutions may be increased as directed by the Engineer.

Mortar shall be mixed in an approved mixer at the site of placement or in transit mixers when approved by the Engineer. The Engineer will withdraw approval for use of transit mixers, if necessary, to ensure a quality product or if the rate of delivery cannot be coordinated with finishing requirements.

(b) Stationary Mixers. When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers that have a capacity of 10 cubic yards or less shall be not less than 90 seconds. For mixers that have a capacity of more than 10 cubic yards, the mixing time shall be determined by the concrete producer.

The time is valid provided that mixer efficiency tests prove the concrete is satisfactory for uniformity and strength. The plant shall be equipped with a timing device that will not permit the batch to be discharged before the predetermined mixing time has elapsed. Vehicles used in hauling shall comply with the requirements of Subsection 501.05(c).

(c) Transit Mixers. Transit mixers and agitators shall be subject to periodic inspections by an authorized representative of the Agency. Such equipment shall bear a currently dated inspection sticker supplied by the Agency indicating that the transit mixer or agitator conforms to the Agency's requirements.

Transit mixers shall be equipped with a water-measuring tank with a visible sight gauge for use when the water for the batch is supplied from the transit mixer tank. The gauge shall be clean and legibly graduated. Measuring tanks shall be provided with outside drain valves or other means to check their calibration. These should be easily opened for checking at any time.

No transit mixer or agitator shall be charged with the ingredients of the concrete unless an authorized Agency representative is present and authorizes it. This requirement may be waived by the Engineer if a batch weight slip accompanies the delivery vehicle to the site.

Electrically-actuated revolution counters shall be required on all transit mixers except on mixers charged at central mix plants and utilized as agitator trucks only.

If bagged mineral admixtures are being used, the transit mixer maximum load size shall be limited to 80% of the manufacturer's rated mixing capacity. Also, legal vehicle load restrictions shall not be exceeded. The mixer shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

If bagged mineral admixtures are being used, agitators, when loaded, shall also not exceed 80% of the manufacturer's rated mixing capacity or legal load restrictions and shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass, and of discharging the concrete with a satisfactory degree of uniformity.

The Engineer may require the Contractor to perform uniformity tests on a transit mixer or agitator. Two samples shall be taken. The first sample shall be taken after 15% of the load volume has been discharged, and the second prior to 85% of the load volume being discharged.

Slump and air content tests shall be performed on each sample. The maximum difference in air content between the two samples shall be 1%. For concretes with a specified slump of 4 inches or less, the maximum difference between the two samples shall be 1 inch. For concretes with a

specified slump greater than 4 inches, the maximum difference shall be 1-1/2 inches. If both conditions are not met, then the Contractor will be required to either modify the mixing procedure and/or batching sequence, or that transit mixer or agitator will not be allowed to deliver concrete to the project. The Contractor will be required to perform uniformity tests to confirm the changes have satisfactory results.

All mechanical details of the mixer or agitator such as water measuring and discharge apparatus, condition of the blades, speed of rotation of the drum, general mechanical condition of the unit and clearance of the drum shall be checked before a further attempt to use the unit will be permitted.

Mixers and agitators shall be kept free from accumulation of hardened concrete or mortar. The mixing blades shall be rebuilt or replaced when any part or section is worn 3/4 inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangements of blades shall be available to the Engineer at the plant at all times.

The mixing of concrete containing silica fume is very important and shall be mixed in accordance with the appropriate situation:

(1) When silica fume is added to the batch by bags or in bulk from a silo, each batch of concrete shall be mixed for not less than 125 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer.

(2) When silica fume is blended with cement or a combination of cement and mineral admixture at the cement plant prior to being delivered to the concrete plant, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer. If inconsistent test results are obtained, or the batch of concrete appears not to be completely mixed, the mixing revolutions shall be extended as necessary.

When a transit mixer or agitator is used for transporting concrete, mixing during transport shall be continuous and at two to six rotations per minute or as designated by the manufacturer of the equipment as agitating speed. Failure to do so is cause for rejection of the concrete.

Transit mixers and agitators assigned to a project shall not be used for other purposes until the desired work is completed at the site, and shall arrive at the project within the cycle that anticipated placement conditions dictate. The interval between loads shall be controlled in order that concrete in place shall not become partially hardened prior to placing succeeding batches. The plant capacity and transportation facilities shall be sufficient to ensure continuous delivery at the rate required.

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Before discharging transit mix from a transit mixer that has been operating at agitating speed, the drum or blades shall be rotated approximately one minute at mixing speed. The same procedure shall apply to agitators if admixtures, water, or other ingredients are added to the mix in the field.

If additional mixing water is required to maintain the specified slump and is added with the permission of the Engineer, a minimum of 20 revolutions of the transit mixer drum at mixing speed shall be required before discharge of any concrete. At no time shall the total water introduced into any mix exceed the maximum W/CM ratio specified in Table 501.03A.

Upon discharge of the concrete from the drum, a sufficient amount of water shall be charged into the drum to properly cleanse the drum. This water shall not be used as a part of the next succeeding batch but shall be discharged from the drum prior to the charging of the drum with the concrete ingredients. The drum shall be completely emptied before receiving materials for the succeeding batch. Re-tempering of concrete or mortar that has partially hardened, by remixing with or without additional materials, shall not be permitted.

501.06 FIELD TESTS. The Contractor shall provide assistance, equipment, materials, and curing for field sampling and testing as required by the Engineer. All costs shall be included in the Contract unit prices under Section 631. The Engineer shall perform all acceptance sampling and testing in accordance with the Agency's Quality Assurance Program. For bridge deck pours, and other pours as required by the Engineer, the Contractor shall perform all on-site Quality Control (QC) sampling and testing. The person performing the QC sampling and testing shall have, as a minimum, current ACI Concrete Field Testing Technician Grade I Certification.

(a) Trial Pour. When concrete will be used for a deck or overlay, or when deemed necessary by the Engineer, the Contractor shall construct a slab to be used for the trial pour. The purpose of the trial pour is to ensure that the mix can be placed and finished in accordance with these specifications. The slab shall be a minimum of 10 feet × 10 feet × 9 inches thick.

If the concrete is intended to be placed by pump, the trial pour concrete shall be placed by pump. The pump will be setup in the configuration that best represents the most difficult pumping condition. The wet concrete properties will be checked at the point of placement. The Contractor will demonstrate that they can provide an acceptable finish to the concrete for the element to be completed. The Contractor will need to bull float a minimum of 50% of the surface area of the slab and hand finish the curb areas in the same manner as anticipated during the production pour.

The Contractor may elect to construct the slab so that the same screed equipment and same finishing method can be used as anticipated for the production pour. In this case the Contractor will not be required to bull float a minimum percentage of surface area unless that will be included in their process for finishing the concrete deck surface during the deck pour. The test slab will become the property of the Contractor and removed from the project after completion of the trial pour.

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Concrete production activities shall be closely monitored to ensure that no deviations are made from the approved mix design. If test results indicate a failure to obtain the characteristics as specified in Table 501.03A, the Engineer may reject the material. The Contractor will be responsible for proposing solutions which could include changes to the mix design and will require testing be done with no extra payment. The modified mix design shall not be used until successful test results are obtained during a trial pour that is representative of the anticipated pour conditions.

For evaluation, new mix design submittals shall be considered as initial mix design submittals when the cementitious content target changes by more than 5% and/or the aggregate targets are changed by more than 10%. The volumetric proportioning will need to be adjusted on the mix design to achieve the target volume of 27 cubic feet. Any proposed adjustments will be based on the target values of the originally approved mix design.

Admixtures which do not affect concrete shrinkage or permeability may be adjusted from the approved mix design as necessary to provide a mix to meet the project requirements. The sources of these admixtures which do not affect concrete shrinkage or permeability can be changed with permission of the Engineer and Structural Concrete Engineer and may not require a new initial mix design submittal. A trial batch may be required as evidence that any change will result in wet test results, and possibly selected hardened concrete properties to confirm they are in compliance with job requirements.

(b) Sampling. Sampling for tests shall be taken in accordance with the requirements of *AASHTO R 60* or other procedures approved by the Agency. Sampling will be done at point of placement or as close to it as practical.

(1) Changes. Any time that there is a change in admixture dosage outside of the allowable tolerances, whether modified at the batch plant or at the site, additional QC sampling and testing shall be performed on the modified load prior to incorporating the concrete into the work.

(2) Beginning of Load Sampling. Beginning of Load Sampling is sampling for QC testing purposes that is taken before 15% of the load has been discharged. Beginning of Load Sampling shall be performed as required by the Engineer, or as needed to ensure that the Concrete meets the Contract requirements at the point of placement. The QC personnel shall monitor the placement operation and adjust the mix accordingly to ensure that the material being incorporated into the work meets Contract requirements.

(c) Slump Tests. Slump tests shall be made in accordance with *AASHTO T 119 M/T 119*.

(d) Spread Tests. Spread tests for SCC shall be made in accordance with the requirements of *ASTM C 1611/C 1611 M,* Procedure B. The concrete inside the cone shall not be tamped.

(e) Visual Stability Index (VSI) Tests. VSI tests for SCC shall be made in accordance with the requirements of *ASTM C 1611/C 1611 M,* Appendix X.1 and shall be performed on each completed spread test.

(f) Air Content Tests. Air content tests shall be made in accordance with the pressure method specified in *AASHTO T 152*, for acceptance or rejection.

For Class SCC, the specimens shall be fabricated in accordance with *ASTM C 1758/C 1758 M.*

(g) Compressive Strength Tests.

(1) General. The number of compressive strength tests performed should be in accordance with the guidance given in the current edition of the VTrans *Materials Sampling Manual*. The Engineer may order additional tests as deemed necessary.

Compressive test cylinders shall be made in accordance with the requirements of *AASHTO T 23*, and tested for compressive strength in accordance with the requirements of *AASHTO T 22*.

For Class SCC, the specimens shall be fabricated per *ASTM C 1758/C 1758 M.*

(2) Categories of Testing.

a. Acceptance Testing. Acceptance testing utilizes specimens to determine the compliance with requirements for the project. All test cylinders used for quality acceptance testing shall be stored in an approved curing box until they are shipped to the Agency's Materials Section Central Laboratory.

b. Job Control Testing. Job control testing utilizes specimens to determine whether adequate curing procedures are being followed and for early form removal or early loading of structure. All job control specimens shall be stored on the structure and shall receive the same curing and protection from the elements as the concrete that they represent up until 24 hours before anticipated testing of specimens.

c. Specimen Curing Requirements. Specimen curing requirements shall be as stated in the specifications or as directed by the Engineer. If not specifically stated, the curing shall be as specified in Table 501.06A.

TABLE 501.06A – CONCRETE SPECIMEN CURING REQUIREMENTS

Testing Category	Number of Specimens	Curing Location
Acceptance	2	Curing box
Job control – applicable curing period	2	On structure

(h) Concrete Temperature. Concrete temperature tests shall be made in accordance with the requirements of *ASTM C 1064/C 1064 M*.

501.07 WEATHER AND TEMPERATURE LIMITATIONS – PROTECTION OF CONCRETE. The temperature of the concrete just prior to placement in the forms shall not be less than 50°F nor more than 85°F. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits.

Placement and curing procedures shall be approved by the Engineer prior to actual placement.

(a) Hot Weather Concrete. Placement of concrete during hot weather may be limited by the Engineer based on an assessment of temperature, humidity, wind velocity, and sun radiation conditions. No concrete shall be placed when the ambient air temperature is, or is expected to be, above 90°F.

(b) Cold Weather Concrete.

(1) General. Cold weather concrete will be any concrete placed or cured when the ambient air temperature is expected to be below freezing at any point or below 40°F for a continuous 8-hour period. No concrete shall be placed when the ambient air temperature is lower than 10°F except by written permission of the Engineer. A cold weather concrete plan shall be submitted to the Engineer for their review and acceptance before any cold weather concrete is placed.

When placing cold weather concrete, the Contractor shall have adequate equipment for heating and protecting the materials and freshly-placed concrete meeting the approval of the Engineer. This equipment shall be on the job and ready to deploy prior to the commencement of concrete placing operations.

No concrete shall be placed in any superstructure or thin section under cold weather conditions.

(2) Heating of Materials. The heating equipment deployed for cold weather concrete placement shall be capable of heating the materials uniformly. Aggregates shall not be heated to a temperature exceeding 150°F. If water is heated to a temperature exceeding 140°F, the water shall be mixed with the aggregate before the cementitious material is added.

The materials shall be heated in such a manner, for such a period of time, and in such quantity, as to produce concrete having a uniform temperature within the specified temperature range at the time of placement. Materials containing frost or frozen lumps shall not be used.

Stockpiled aggregates may be heated using dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. When aggregates are heated in bins, steam-coil or water-coil heating, or other methods that will not be detrimental to the aggregates, may be used.

(3) Antifreeze Compounds. Salts, chemicals, or other foreign materials shall not be used in the mix to lower the freezing point of the concrete.

(4) Preparation of Forms. Before placing concrete; any ice, snow, or frost shall be completely removed from the forms.

Concrete shall not be placed on any surface or in any forms that are frozen, have surface temperatures below 32°F, or that contain frozen materials. The frozen surface or forms shall be completely thawed the day before the placement of the concrete and shall be kept continuously thawed until the concrete is poured. The temperature difference between forms or substrate and the plastic concrete shall not exceed 40°F.

(5) Housing. The Contractor shall furnish sufficient canvas with a supporting framework or other suitable type of housing to fully enclose and protect the structure when placing and curing cold weather concrete. The sidewalls and roofing of the protective housing shall be completely built before the placing of any concrete. The sidewalls for decks shall extend below and fully enclose the entire superstructure.

The protective housing shall be constructed independently of the forms and bracing and with adequate space to allow for form removal and the initial finishing of the concrete as required during the heating period. Joists shall be located to suitably support the housing roof with no sagging. The protective enclosure shall be heated to the proper temperature before placing any concrete.

When the temperature readings taken on or in the concrete indicate the temperature of the concrete may fall below 50°F, the Contractor shall, without exposing the concrete, immediately build the necessary enclosures around the area involved and supply heat to ensure curing conditions as specified in Subsection 501.17. The enclosure shall be removed when directed by the Engineer.

(6) Heating the Enclosure. The enclosure shall be heated in such a manner that the temperature of the concrete and the enclosed air shall be kept above 50°F, and not more than 20°F above the concrete temperature, for the designated curing period. During this time, the concrete shall be kept continuously wet to provide proper curing. After the curing period, the temperature shall be gradually lowered to that of the surrounding atmosphere, taking at least 48 hours for the transition but at no time exceeding a 1°F change per hour.

When dry heat is used, a means of maintaining atmospheric moisture shall be supplied. The Contractor shall also maintain adequate fire protection and shall provide personnel to keep the heating units in continuous operation. When concrete placement operations are in locations where water levels may fluctuate, the supports for heating equipment shall be built so that the heating equipment can be raised and steam lines shall be placed above the probable high water level.

When using direct-fired or indirect-fired heaters, the enclosure shall be well-ventilated to avoid accumulation of carbon dioxide and carbon monoxide.

When using a hydronic heating system with heat-transfer fluid that circulates through a series of hoses, the heat-transfer hoses shall be laid on top of the vapor barrier, usually plastic sheeting, then covered with approved insulating materials or by other approved methods for retaining heat.

(7) Temperature Records. The Contractor shall provide an automatic temperature recorder to continuously record concrete curing temperatures and ambient air temperatures for the entire curing period. Recording thermometers shall be capable of measuring and recording temperatures within the range of 0°F to 200°F with maximum graduations of 5°F.

Temperature sensors shall be carefully placed within the curing enclosure or in the concrete to ensure that temperatures are measured at typical locations. The recorder's accuracy shall be certified once every 12 months, with the certificate displayed with each recorder. The Engineer may make random checks of each recorder.

On each recorder chart, the Engineer shall indicate the location of the representative concrete, the placement date, and start and finish times of the temperature record. At the completion of the curing period, the recorder charts shall be submitted to the Engineer.

A thermometer shall be provided that is capable of displaying the current temperature with a maximum gradation of 1°F. The Inspector will use the thermometer to take periodic temperature measurements of the concrete and enclosure temperatures at varying locations.

When the Contractor places concrete at more than one location within the specified curing period or if the Engineer determines that monitoring of a single pour is necessary in multiple locations, additional monitoring and recording equipment shall be furnished to provide temperature records at each location.

501.09 FORMS. The Contractor shall be responsible for, and shall make good, any injury arising from inadequate forms. The Engineer shall inspect and accept all forms prior to concrete placement.

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Unless the Plans specifically allow for the use of stay-in-place forms, such forms shall not be used in the construction of any superstructure or bridge deck. Stay-in-place forms will only be allowed in the construction of substructure elements in locations where the Engineer agrees that removable formwork is impossible to employ.

(a) Falsework. In general, falsework that cannot be founded upon a solid footing shall be supported by falsework piling. The Engineer may require the Contractor to employ screw jacks or hardwood wedges to correct any deflections or settlement, however slight, occurring in the falsework.

(b) Construction. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations, including vibration. Forms shall be constructed and maintained to prevent the opening of joints due to shrinkage of the lumber. Sealers and caulking as approved by the Engineer shall be used where forms abut structural steel members, such as top flanges of beams and girders, etc.

To ensure their easy removal, forms shall be filleted and chamfered at all sharp corners, unless otherwise shown on the Plans or directed by the Engineer, and shall be given a bevel or draft in the case of all projections, such as girders and copings.

Falsework and forms for slabs, beams, and girders shall be constructed to provide the camber shown on the Plans or ordered by the Engineer.

Falsework and forms for Class SCC construction shall be designed with consideration given to concrete placement rates, mix temperature, additives, and placement procedures that effect hydrostatic pressure of the concrete. Forms shall be water-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including vibration, which should not be needed.

(c) Form Lumber. All face form lumber for exposed surfaces shall be concrete form exterior grade plywood, not less than five ply and with a minimum thickness of 3/4 inch. In computing stud spacing, plywood shall be considered 1 inch lumber, provided that the grain of three of the plies runs perpendicular to the studs.

Form lumber for unexposed surfaces may be dressed tongue-and-groove, dressed shiplap, or square-edge surfaced four sides of uniform width and thickness, with a minimum thickness, after finishing, of 3/4 inch.

All form lumber shall be sound and free from loose or rotten knots, knotholes, checks, splits, or wanes showing on the surface that will be in contact with the concrete. Used face form lumber, having defects or patches which may produce work inferior to that resulting from new material, shall not be used.

Other form materials may be used with the permission of the Engineer.

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(d) Form Ties. Metal ties or anchorages within the forms shall be constructed to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. Wire ties shall be used only in locations where they will not extend through surfaces exposed in the finished work and then only when authorized.

The cavities shall be filled with cement mortar in accordance with the requirements of Subsection 501.16.

(e) Surface Treatment. All forms shall be treated with commercial form oil prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the concrete. Any material that will adhere to or discolor the concrete shall not be used.

(f) Metal Forms. The specifications for wood forms regarding design, mortar-tightness, filleted and chamfered corners, beveled projections, bracing, alignment, removal, reuse, and oiling also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape throughout the concrete placement operations.

All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms that do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

(g) Removal of Forms.

(1) Deck Superstructure. The forms, or their supports, for any portion of a structure shall not be removed before the end of the 10-day cure period for the deck. Forms under beams or floor slabs may be removed upon approval of the Engineer after the concrete attains 85% of the minimum compressive strength as specified in Table 501.03A, but not prior to the end of the 10-day cure period.

(2) Substructure. The forms, or their supports, for any portion of a substructure shall not be removed without the approval of the Engineer. Forms under arches, pier caps, or other special design conditions may be removed upon approval of the Engineer after the concrete attains 85% of the minimum compressive strength as specified in Table 501.03A.

The removal of forms and supports may begin when the concrete is found to have the required strength. In no case shall the number of curing days be less than specified in Table 501.17A.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take up the stresses due to its own dead load.

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(h) Stay-in-Place Corrugated Metal Forms (SIPCMF) for Superstructure Deck Slabs.

(1) General. Use of SIPCMF for superstructure deck slab construction shall be subject to the following requirements:

a. Fascia overhangs shall be formed with removable forms that leave the resulting concrete with a flat-surfaced finish.

b. Bays that are constructed in stages such that a longitudinal joint is required shall be made with removable forms.

(2) Design Requirements. The following requirements shall govern the design of SIPCMF:

a. The design span shall be the clear span of the form plus 2 inches, measured parallel to the form flute (also referred to as the form valley).

b. The design load shall be the sum of the weight of forms, bar reinforcement, plastic concrete, and 55 pounds per square foot for construction loads.

c. The unit working stress shall not exceed 75% of the specified minimum yield strength of the material.

d. The dead load deflection shall not exceed 1/180 times the form span length or 1/2 inch, whichever is less.

e. Physical design properties shall be computed with the requirements of the latest edition of the *American Iron and Steel Institute Specifications for the Design of Cold-Formed Steel Structural Members*.

(3) Construction Requirements. The following construction requirements shall apply to the use of SIPCMF:

a. Construction Drawings. The Contractor shall submit construction drawings for SIPCMF in accordance with the requirements of Subsection 105.03. These drawings shall contain the following information as a minimum:

1. The name of the SIPCMF supplier.

2. A layout showing the compression and tension region of each beam/girder.

3. The method of SIPCMF attachment for the compression and tension regions.

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4. The geometric properties of each type of panel being used.

5. The number, location, and type of panels being used within each girder bay.

6. Panel laps, considering the direction of concrete pours.

7. The specifications for the material used to fill the flutes.

8. Any other material data, erection information, or miscellaneous notes that may be required.

b. Handling and Installation. Care and protection shall be given the metal form sheets, supports, and accessory items during handling, shipping, and storage. During loading, hoisting, and unloading operations, extra precaution and care shall be taken to prevent damage to ends, corners, and edges of form sheets, supports, and accessory items.

If the form units and accessories are to be stored prior to installation, they shall not be placed in contact with the ground and shall be adequately covered or protected to keep them dry.

Form supports shall be placed in direct contact with the flange of beam/girder/stringer or floor beam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. The welding of form supports to steel not considered weldable or to portions of flanges subject to tensile stresses shall not be permitted. Welds and welding shall be in accordance with the requirements of Subsection 506.10, with the exception that a 1/8-inch fillet weld will be permitted.

Form sheets shall not be permitted to rest directly on the flanges. They shall be securely fastened to form supports by self-tapping screws and shall have a minimum bearing length of 1 inch at each end. Transverse construction joints shall be located at the bottom of a valley. A 1/4 inch diameter weep hole shall be drilled at the lower end of each flute or valley.

Screed and pouring runway supports shall not be located directly on the form sheets, form supports, or reinforcing steel. No loose sheets or miscellaneous hardware shall be left on the structural slab at the end of the working day.

The corrugated metal sheets shall be fabricated for the placement sequence used, with the joints between sections of sheets overlapped or securely fastened to eliminate differential deflections. Any exposed form metal where galvanizing has been damaged shall be cleaned and repaired to the satisfaction of the Engineer.

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(4) Inspection Procedures. The following three-step inspection procedure will be used to check the soundness of the concrete deck against the SIPCMF.

a. Step 1. Not less than two days after completion of a concrete structural slab pour, but prior to the next slab pour, one panel of the SIPCMF shall be removed from the most recently completed pour of each span, at a location selected by the Engineer, to provide visual evidence that the concrete mix or the construction procedures are obtaining the desired results.

If the concrete mix or the construction procedures are varied significantly within a pour, such as a change in the extent of vibration or change in the workability of the mix, another section of forming shall be removed to verify that the new procedures are yielding desirable results.

b. Step 2. After the concrete has attained 85% of the specified design strength, the Engineer will spot-check the underside areas of the steel forms by sounding with a suitable weight hammer. If honeycomb or voided areas are detected, the SIPCMF at that location shall be removed for a visual inspection.

c. Step 3. A minimum of 2% of the total SIPCMF area shall be removed for visual inspection of the concrete surface. The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of the slab has been constructed and inspected, if the Contractor's methods of construction and results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slab.

If, after removing a section of form, the concrete is found to be defective, additional panels shall be removed as directed by the Engineer. All defective concrete shall be repaired to match the adjacent concrete in section and color to the satisfaction of the Engineer.

The Contractor shall provide all facilities required for the safe, suitable, and convenient means of access to the forms for the Engineer's inspection procedures.

The form sections shall be removed by a metal saw or air-carbon-arc gouging with minimum damage to the concrete. Cuts shall only be sufficiently deep to sever the form. Any other method of removal shall be submitted to the Structures Engineer for approval. Cuts parallel to the corrugations in the forms shall be located on the sloping surface midway between a crest and valley. Cuts parallel to the supporting beams/girders shall be made through the supporting angles taking care not to damage the structural steel beams/girders.

The Contractor will not be required to replace the forms which have been removed.

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501.10 PLACING CONCRETE.

(a) Workforce. The Contractor shall always have sufficient skilled personnel during the concreting operations to properly place, consolidate, and finish the concrete. If, in the opinion of the Engineer, the Contractor does not have sufficient skilled personnel to handle the concrete properly, the Engineer may postpone the start of the concreting operations until the Contractor has remedied this situation.

(b) Pre-Placement Meeting. For deck pours, or as required by the Engineer, a pre-placement meeting shall be scheduled by the Contractor to take place at least 7 calendar days before concrete placement, and prior to the Trial Pour, if required. Attendees at the pre-placement meeting shall include, but not be limited to, the Contractor's Project Superintendent, the Engineer, the Agency's Structural Concrete Engineer, and the concrete producer.

The Contractor shall provide a placement plan that addresses, but is not limited to, the following topics:

(1) Time of concrete placement and amount

(2) Batch plant testing

(3) Delivery of concrete

(4) Method of concrete placement on the deck

(5) Consolidation and finishing of concrete

(6) QC testing of the plastic concrete

(7) Protection of the concrete from evaporation

(8) Curing of the concrete

(9) How to avoid long delays for balance loads

(10) Screed, work bridge, and rail set-up

(11) Dry run schedule

(12) Contingency plans for long delays, break downs, weather events and other potential problems

(13) Crew size and responsibilities

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(14) Available equipment

(15) Project layout including locations for all pumps, cranes, testing, cleanouts, staging, etc.

(c) Placement Limitations. All concrete shall be placed in daylight, unless otherwise authorized in writing by the Engineer. Authorization to place concrete at any other time shall not be given unless an adequate lighting system is provided prior to beginning the concrete placement operations.

Concrete shall not be placed under adverse environmental conditions that the Engineer determines will interfere with acceptable placement and/or finishing operations.

Concrete shall not be placed until the depth and character of the foundation, the apparent adequacy of the forms and falsework, and the placing of the reinforcing steel have been approved by the Engineer. The interior of the forms shall be clean of all debris before concrete is placed.

The Contractor shall submit to the Engineer a schedule of batching, delivery, and placement prior to the beginning of the concreting operations. The Contractor shall comply with the requirements of Subsection 501.05.

Equipment and tools necessary for handling materials and performing all parts of the work shall meet the approval of the Engineer as to design, capacity, and mechanical condition and must be on the site before the work is started. Any equipment, in the judgment of the Engineer, that proves inadequate to obtain results prescribed shall be improved or new equipment substituted or added.

The Engineer may suspend the pour or reject the pour if the Contractor deviates from the accepted pour plan which will also include unacceptable delivery rates. The Contractor will not be allowed compensation due to the pour being suspended or rejected do to the Contractor deviating from the accepted pour plan or uncontrolled delivery rates.

For simple spans, concrete should be deposited by beginning at the lower end of the span and working toward the upper end. For continuous spans, where required by design considerations, the concrete placing sequence shall be as shown on the Plans.

Concrete shall not be deposited in the forms more than 4 feet from its final position.

The dropping of unconfined concrete more than 5 feet will not be permitted.

Concrete shall not be deposited in running water.

The rate of placing the concrete shall be so regulated that no excessive stresses are placed on the forms. Concrete in all decks shall be placed in one continuous operation, unless otherwise specified.

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Concrete shall be placed in continuous horizontal layers, the thickness of which shall not exceed 18 inches, unless otherwise directed by the Engineer. Each succeeding layer shall be placed before the underlying layer has taken initial set and shall be consolidated in a manner that will eliminate any line of separation between the layers. When it is necessary, due to any emergency, to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or straining the ends of projecting reinforcing bars.

(d) Placement of Overlays. For a period of at least 12 hours before the placement of overlay material, the prepared surface shall be flooded with water. After removal of all free water, the overlay material shall be deposited on the damp surface and manipulated to coat the horizontal and vertical surfaces to be covered. The rate of progress shall be controlled to prevent the drying of previously deposited materials.

(e) Use of Chutes. Chutes, troughs, and pipes used in placing concrete shall be arranged to avoid segregation of the materials and the displacement of the reinforcement and shall be approved by the Engineer. Aluminum chutes, troughs, or pipes will not be permitted.

All chutes, troughs, and pipes shall be kept clean and free of hardened concrete by thoroughly flushing with water after each run. Open troughs or chutes shall be either of metal or metal-lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping of unconfined concrete more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

(f) Use of Vibrators. Unless otherwise specified, the concrete shall be consolidated with mechanical vibrators, of an approved type and design, operating within the concrete. When required, vibrating may be supplemented by hand-spading with suitable tools to ensure proper and adequate consolidation.

Vibrators shall be manipulated to work the concrete thoroughly around the reinforcement and imbedded fixtures and into corners and angles of the forms to produce surfaces free of imperfections. Vibrators shall not be used to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish consolidation but shall not be prolonged to the point where segregation occurs.

Vibrators shall have non-metallic or rubber-coated heads. Vibrating machines shall at no time be left running unattended in the concrete.

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When it is necessary due to an emergency to discontinue the placing of a monolithic section, the use of vibrators shall cease. Vibrators shall not again be used until a sufficient depth of fresh concrete is placed to prevent any possibility of the effect of vibration on the concrete already in place and in no case shall this depth be less than 2 feet.

The number of vibrators used shall be ample to consolidate the incoming concrete immediately after it is deposited in the form. The Contractor shall have at least one spare vibrator in serviceable condition at the site of the structure in which more than 25 cubic yards of concrete are to be placed.

The vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute under load. The vibration shall be of sufficient intensity and duration to cause plasticity, settlement, and complete consolidation of the concrete without causing segregation. The vibrator shall visibly affect a mass of concrete of 2-inch slump over a radius of at least 18 inches.

(g) Blasting Operations. All blasting operations within 200 feet of any concrete work shall be completed prior to the placement of the concrete. Regardless of the above limitation on blasting operations, the Contractor shall be responsible for any damage resulting from blasting operations.

501.11 DEPOSITING CONCRETE UNDER WATER.

(a) General. Concrete shall not be deposited under water except as specified by the Contract or upon approval of the Engineer and shall be subject to the following specifications.

(b) Placement. When placing concrete underwater, the Contractor shall use a tremie or an alternate method of conveyance, approved by the Engineer, which minimizes the mixing of fresh concrete and water. A tremie shall have a hopper at the top that empties into a watertight tube at least 10 inches in diameter.

The discharge end of the tube on the tremie shall include a device to seal out water while the tube is first filled with concrete. An inflatable ball will not be permitted. The device shall keep its shape and float without danger of deflation.

The placement shall be continuous to the elevations shown on the Plans and the resulting concrete shall be monolithic and homogeneous.

Concrete shall not be deposited in water that has a temperature of 35°F or below. When the water temperature is between 35°F and 40°F, the mixing water, the aggregates, or both shall be heated as specified in Subsection 501.07(b).

A tremie shall be constructed of heavy-gauge steel pipe and consist of watertight joints between the tremie sections with a diameter of not less than 10 inches. The tremie hopper shall have a capacity of at least 1/2 cubic yard. When a batch is dumped into the hopper, the flow of the concrete shall be induced by slightly raising the discharge tube, always keeping it in the concrete.

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Tubes shall be kept continuously submerged in concrete during discharge. The depth that the tube is submerged in concrete and the height of the concrete in the tube shall be sufficient to prevent water from entering the tube. The Contractor shall continuously monitor the difference in elevation between the top of the concrete and the end of the discharge tube.

Horizontal movement of discharge tubes through the concrete will not be allowed.

For minor quantities, at the sole discretion of the Engineer, a direct pumping method may be approved. If a direct pumping method is to be implemented, the pipe discharging the concrete shall consist of heavy-gauge steel sections. The Contractor shall demonstrate the ability to pump the concrete without the pump line surging or otherwise moving in the water as concrete is being pumped.

Cylinders cured as field cure shall be cured at the same temperature as the water covering the concrete.

501.12 PUMPING. Where concrete is conveyed and placed by mechanically-applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The pump shall be capable of pumping concrete within the specified slump limits. The use of aluminum pipe as a conveyance for the concrete will not be permitted.

The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. The equipment shall be arranged so that no resulting vibrations may damage freshly placed concrete.

501.13 CONSTRUCTION JOINTS.

(a) Construction Joint Locations. Joints shall be formed at the location shown on the Plans. Any variation or new location of joints shall require written permission of the Engineer. Feather edges at construction joints will not be permitted. Joints shall be formed with inset formwork so that each layer of concrete will have a thickness of not less than 6 inches.

(b) Joining Fresh Concrete to Previously Set Concrete. When joining fresh concrete to concrete that has hardened, the surface of the set concrete shall be roughened in such a manner that will not leave loosened particles or damaged concrete at the surface and shall be thoroughly cleaned of all laitance, loose, and foreign material. Immediately prior to the placing of the new concrete, the surface shall be saturated with water.

When shown on the Plans or ordered by the Engineer, the surface shall be thoroughly coated with a very thin coating of mortar, neat cement grout, or approved bonding agent and all forms drawn tight against the face of the concrete. This coating shall not be allowed to dry out before being covered with fresh concrete.

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(c) Filled Construction Joints. Filled construction joints shall contain a pre-formed cork joint filler or other pre-formed joint filler that may be shown in the Contract. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joints, that portion of the joint to be filled shall be formed with a separate material (other than the pre-formed joint filler) that can easily be removed prior to placement of the above indicated filler.

(d) Water Stops. Approved water stops shall be placed at locations shown on the Plans. They shall form continuous watertight joints.

(e) Bond Breakers. Bond breakers shall be asphalt-treated felt or pipe insulation, as shown on the Plans.

501.14 EXPANSION JOINTS. All expansion joints shall be constructed according to details shown on the Plans.

(a) Filled Compression and Expansion Joints. Filled compression and expansion joints shall be made with a pre-formed self-expanding cork joint filler or other pre-formed joint filler that may be shown in the Contract. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joint, that portion of the joint to be filled shall be formed with a separate material (other than the expansion joint filler) that can easily be removed prior to placement of the above indicated filler.

(b) Special Types of Expansion Joints. Special types of expansion joints may be used when shown on the Plans or ordered by the Engineer.

501.16 CONCRETE FINISHING.

(a) Finishing Bridge Decks and Overlays.

(1) General. The Contractor shall follow the procedures and details for placing the deck in accordance with the pre-placement meeting. The procedure shall provide for adequate labor, equipment, and material supply to complete placement of concrete on the entire deck, or specified portion thereof.

If, during the placement, unforeseen circumstances delay the progression of the pour to a point where the concrete begins to lose plasticity, the Contractor shall be prepared to place a bulkhead, as directed by the Engineer.

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If at any time the screed machine does not advance in a 15-minute period due to delayed concrete delivery, mechanical breakdown or other problem, the Contractor shall immediately cover concrete that is under the screed machine past the leading edge of the concrete with wet burlap. Just before concrete placement is to begin, the burlap shall be removed, the screed machine will be moved back, fresh concrete will be added to the area that was directly under the screed to the leading edge, and the area will be vibrated again. The screed machine may then be advanced forward to continue the placement.

Approval of their methods and equipment does not relieve the Contractor of full responsibility for obtaining the required surface finish.

Prior to texturing, the finished concrete surface shall be examined by the Contractor. Surface irregularities greater than 1/8 inch in 10 feet in either the longitudinal or the transverse direction shall be corrected in a manner acceptable to the Engineer. When a bituminous concrete surface is to be placed on a bridge deck, the deviation shall not be greater than 1/4 inch. When a sheet membrane is being applied, sharp ridges shall not be allowed. Thin mortar or laitance, which may have accumulated ahead of the finishing machine screed, shall be removed from the work site. These materials shall not be used to fill depressions.

If the bridge deck concrete does not meet the above smoothness requirements, the Contractor shall remove high spots up to 1/2-inch high by means of grinding. Any other corrections shall be made only with the written approval of the Engineer. The use of bush hammers will not be allowed. No concrete shall be removed that will result in a concrete slab thickness less than that shown on the Plans.

Any deck that cannot be corrected by a method satisfactory to the Engineer shall be removed and replaced at the Contractor's expense.

Sidewalks shall receive their final finish with a fine bristled broom.

(2) Bridge Decks with No Asphalt Wearing Surface. After finishing, the surface shall be given a suitable texture with an artificial turf drag made of molded polyethylene or other material or method that will provide an acceptable finish. The selection of turf drag or other method should be capable of producing a surface texture with a horizontal peak-to-peak distance ranging from 0.02 inch to less than or equal to 0.25 inch and having a peak-to-peak amplitude of 0.005 inch to 0.8 inch. A turf drag material or other acceptable method that will minimize tearing and rolling of coarse aggregate from the surface shall be used.

The Contractor shall apply the finish texture in a transverse direction using hand methods. Other directions may be allowed with the approval of the Engineer. All texturing shall be performed from a work bridge immediately following the finishing operations and prior to curing operations. A second work bridge will be required for curing purposes unless a method using a single work bridge has been approved by the Engineer.

One pass of the turf drag over the finished area is desired. The drag shall leave a seamless strip between passes. The finish texture resulting from the drag shall stop within 15 inches of the curb face, rail anchor bolts, or edge of deck. Any buildup of concrete at the beginning or end of the pass shall be hand troweled to provide an even transition.

The drag should produce a transverse, skid-resistant micro-texture acceptable to the Engineer, but should not tear the surface. If the drag is not producing an acceptable micro-texture, the Contractor shall adjust the means and methods until an acceptable micro-texture is achieved.

The Contractor shall check the drag material before the deck pour and from time-to-time during finishing for tears, worn surface, or hardened concrete. The Contractor shall clean or replace the drag as often as necessary to maintain a well-defined micro-texture.

The turf drag or other acceptable methods should not be applied when the surface is so wet or plastic that the ridges formed flow back into the valleys when the drag has passed, nor should dragging be delayed until the concrete is so hard that sharp ridges cannot be formed by the drag. Fogging or similar methods shall be deployed to ensure that the surface does not dry prematurely.

If the 10-minute maximum, as specified in Subsection 501.17(c), for applying the wet cure cannot be met, then fogging of the area shall be performed in a manner that keeps the relative humidity above the evaporation rate of the concrete surface, but not so excessive that water begins to collect on the surface prior to texturing or other surface manipulating procedures.

(3) Finishing Machine Rail Supports. Finishing machine rail supports shall be of substantial construction and accurately set so that the finished deck surface will conform to the profile and transverse sections shown in the Plans. Finishing machine rail supports shall be placed and adjusted to properly provide for the deflection of forms, falsework, and structural supporting members which will occur during the placement of the concrete.

The finishing machine rail supports shall be spaced at a maximum of 2 feet on center and of sufficient design as to secure the rail to prevent it from falling off the support. The screed rails shall be configured to allow the screed machine and work bridges to be fully functional over the entire deck area.

Sufficient screed rails shall be provided so that all rails necessary for any one continuous pour may be preset and graded before the start of concreting operations. The removal of screed rails and exposed chairs shall be accomplished without walking in the fresh concrete and while the concrete is still plastic.

The Contractor shall furnish a work bridge or bridges of an approved type, capable of spanning the entire width of the deck without deflection to the concrete slab surface.

(4) Finishing. After the concrete has been placed, it shall be struck off by a finishing machine and the operation shall be repeated as necessary to produce a uniformly consolidated, dense, smooth surface. The final passage of the finishing machine shall result in a uniform surface at the required grade and slope over its entire area.

Finishing machines shall be kept in true adjustment. Machines shall not be used until the proper adjustments have been made and the adjustments have been checked and approved by the Engineer.

Sufficient time shall be provided prior to beginning concreting operations for the finishing machine to be operated over the full length of the bridge deck segment to be placed. This test run shall be made with the screed adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement shall be measured, and the controlling dimensions of slab reinforcement and forms shall be checked.

After the concrete is placed, it shall be struck off by one of the following methods:

a. A self-propelled concrete finishing machine may be deployed, supported on suitable rails, and equipped with adjustable strike-off and finishing roller screeds capable of producing the required finish surface for the full width of the bridge from face-to-face of curbs.

b. An approved mechanical vibrating screed may be deployed, capable of exerting a force of at least 12 pounds per linear foot, and generating at least 6,500 vibrations per minute when checked by a vibration reed-type tester. The vibrating screed shall provide a uniform finish throughout its entire length and shall be properly adjusted so as not to drive the aggregate more than 1/4 inch below the surface.

In areas that are inaccessible to finishing machines, an approved manual vibratory-equipped power screed with an approved grade-control method may be used with approval from the Engineer. Smoothness shall be checked as specified in Subsection 501.16(a)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area.

If manual vibratory-equipped power screeds are used, then initial vibration of the concrete for consolidation in those areas shall be of the minimal duration possible to avoid over-vibration and loss of air entraining of the surface concrete in these areas.

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Hand finishing shall be allowed only in areas inaccessible to finishing machines or manually driven vibratory-equipped power screeds. Hand screeds or bull floats shall be magnesium and at least 10 inches in width. Care shall be taken not to overwork the concrete surface during any finishing operation. Smoothness shall be checked as specified in Subsection 501.16(a)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area.

501.17 CURING CONCRETE.

(a) General. Water for use in curing concrete shall conform to the requirements of Subsection 745.01. The effective cure time shall be only the time that the concrete has been maintained in a wet condition with the concrete surface temperature above 50°F. If the concrete is not maintained in a wet condition and/or the concrete surface temperature drops below 50°F, it shall not be counted as effective cure time. The cure period will be extended 4 hours for every 1 hour the concrete is below 50°F, beginning when the concrete temperature is raised to or exceeds the minimum curing temperature.

Regardless of the curing medium specified, the entire surface of the newly placed concrete shall be kept damp. This shall be achieved by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The moisture shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate in a quantity sufficient to cause a flow or washing of the surface.

The atomized flow shall be applied continuously until the surfaces can be covered by the specified curing mediums. For bridge barriers, curbs, and sidewalks the curing method shall be applied within 15 minutes of the completion of the finishing process.

Concrete components shall be cured for the times specified in Table 501.17A.

TABLE 501.17A – CURING TIMES FOR CONCRETE COMPONENTS

Type of Construction	Curing Methods (Subsection)	Effective Cure Time (Days)
Substructure	501.17(b)(1), (2), (3), (5), (7), (8)	7
Superstructure	501.17(b)(2), (8)	10 [1]
Retaining walls	501.17(b)(1), (2), (5), (6), (8)	7
Headwalls	501.17(b)(1), (2), (5), (6), (8)	7
Sidewalks, curbs, and gutters	501.17(b)(2), (8)	7

[1] There shall be no activity on the superstructure during the cure period.

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(b) Curing Methods. All exposed surfaces of newly placed concrete shall be cured by one of the following specified methods:

(1) Water Curing. Curing with water shall be by continuously sprinkling or flooding of all exposed surfaces for the entire required curing period.

(2) Burlap Curing. The entire exposed surface of the concrete shall be covered with two layers of approved burlap that has been pre-soaked with water. The burlap shall then be covered with a lapped layer of white polyethylene sheeting. Once the concrete superstructure has hardened sufficiently, a stream of water, applied with a soaker hose or similar device, shall be run continuously under the polyethylene sheeting until the cure period is complete.

(3) Sand Cover. The entire exposed surface of the concrete shall be covered with at least 3 inches of approved sand that shall be kept wet for the entire curing period.

(4) White Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white polyethylene sheeting, maintained and fastened to provide a nearly airtight condition in contact with the surface where possible. If, in the opinion of the Engineer, this cover is not adequately provided or maintained to ensure the proper conditions for the concrete cure, then the white polyethylene sheeting cure shall be terminated and another method substituted.

(5) White Burlap-Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white burlap-polyethylene sheeting. The burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All joints shall be lapped a minimum of 18 inches. The burlap shall be kept damp throughout the curing period.

(6) Membrane-Forming Curing Compounds. White-pigmented or fugitive-dye membrane-forming curing compounds may be used for curing concrete in minor drainage structures. All other uses of curing compounds shall be approved in writing by the Engineer. Only membrane-forming curing compounds approved by the Agency's Materials Section may be used.

When membrane curing is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. The concrete inside the forms shall be sealed immediately after the forms are removed and necessary finishing has been done.

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The solution shall be applied in one or two separate applications. If the solution is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and ensure the direct application of the curing solution to the concrete surface to result in a uniform coverage of the surface area at the rate of 1 gallon of solution for each 150 square feet.

If rain falls on the newly-coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions equal in curing value to that specified above.

Should the surface be subject to continuous injury or the use of curing compound results in a streaked or blotchy appearance, the method shall be stopped and water curing applied.

(7) White Polyethylene Sheeting with Sand Cover. This method may be used only when approved by the Engineer and shall conform to the requirements of Subsection 501.17(b)(4). The airtight condition shall be obtained by the addition of a uniform sand cover with a minimum depth of 2 inches.

(8) Pre-Dampened Cotton Mats. The entire exposed surface of the concrete shall be covered with a blanket of cotton mats that has been pre-dampened with water. The mats shall be maintained in a damp condition until the curing period is complete.

If, in the opinion of the Engineer, the Contractor's curing procedure is not producing an adequate cure, the Engineer may direct a change in the cure method at no additional cost to the Agency.

(c) Bridge Decks. For bridge decks, the curing method shall promptly follow the screed machine, within a maximum lag time of 10 minutes and without interruption. If this lag time cannot be met, then fogging of the area shall be performed in a manner that keeps the relative humidity above the evaporation rate of the concrete surface, but not so excessive that water begins to collect on the surface prior to texturing or other surface manipulating procedures.

501.18 LOADING OF CONCRETE. After the concrete has been placed and the finishing operations concluded, it shall not be walked on or disturbed in any manner, including removal of forms, for a minimum period of 18 hours. If retarder is used as an admixture, this minimum period may be extended as directed by the Engineer.

(a) Substructure. No backfill material shall be placed against a newly completed structure unless the concrete cure is maintained in accordance with Table 501.17A, and until the field cured test cylinders have attained 85% of the compressive strength specified in Table 501.03A. However, the Contractor may erect forms for subsequent concrete placement on footings after 18 hours have elapsed from the time that the footing placement was completed, provided the concrete has sufficient strength to allow it to be worked on without damage, and proper cure is maintained.

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Static loads, such as forms, reinforcing steel, or other materials necessary for construction, may be placed on any concrete after it has been in place 72 hours, or a compressive strength of 1,800 pounds per square inch has been obtained, provided proper curing is maintained. Superimposed loads from subsequent concrete pours will not be allowed on any substructure unit or section in place until the field cured test cylinders have attained 85% of the compressive strength specified by Table 501.03A, and provided curing of the supporting section is maintained in accordance with Table 501.17A.

(b) Superstructure. Static loads, such as forms, granite curbing, cast-in-place concrete curb, and other materials necessary for deck construction, shall not be placed on deck concrete until the effective cure time specified in Table 501.17A is complete and the field-cured test cylinders for this concrete have attained 85% of the compressive strength specified in Table 501.03A.

The Contractor shall keep bridge floors free of all motor vehicles, transit mixers, and heavy construction equipment until the curing period is satisfactorily completed, the field-cured test cylinders for the bridge floor concrete have attained the compressive strength specified in Table 501.03A, and the field-cured test cylinders for the curb concrete or bridge rail concrete, as applicable, have attained 85% of the compressive strength specified in Table 501.03A.

(c) Vertical Joints. Concrete shall not be placed against a vertical construction joint until the previously placed concrete has been in place a minimum of 72 hours.

501.19 METHOD OF MEASUREMENT. The quantity of High Performance Concrete of the class specified to be measured for payment will be the number of cubic yards of the class of concrete specified in the complete and accepted work, as determined by the prismoidal method using dimensions shown on the Plans or as directed by the Engineer.

The quantity of concrete shall also include the volume of superstructure precast concrete stay-in-place forms, but exclude the volume of steel or other stay-in-place forms and form filling materials. No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel, expansion joint material, scuppers, weep holes, conduits, tops of piles, scoring, chamfers or corners, inset panels of 1-1/2 inches or less in depth, or any pipe less than 8 inches in diameter.

501.20 BASIS OF PAYMENT. The accepted quantity of High Performance Concrete of the class specified will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for performing the work specified, including designing the mix, performance of trial pours, and satisfactory finishing and curing. Payment will also be full compensation for furnishing all forms, materials, including joint filler and bond breaker, labor, tools, admixtures, and equipment, including automatic temperature recording units, trial batches, and incidentals necessary to complete the work.

The cost of heating materials and protecting the concrete against cold weather, and any additional cost for cement, will not be paid for separately but will be considered incidental to the Contract unit prices for the applicable Section 501 pay items.

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The cost of furnishing testing facilities and supplies at the batch plant and the setting of inserts, bench marks, and bridge plaques furnished by the Agency will not be paid for separately but will be considered incidental to the Contract unit prices for High Performance Concrete.

Costs for all materials, labor, and incidentals for steel or other stay-in-place forms and form filling materials will not be paid for separately, but will be considered incidental to the Contract unit prices for High Performance Concrete.

Payment will be made under:

Pay Item	Pay Unit
501.37 High Performance Concrete, Class PCD	Cubic Yard
501.38 High Performance Concrete, Class PCS	Cubic Yard
501.39 High Performance Concrete, Class SCC	Cubic Yard

SECTION 502 – SHORING SUPERSTRUCTURES

502.01 DESCRIPTION. This work shall consist of furnishing the necessary shoring, or vertically jacking of any structure or bearing to a position immediately above its present location, holding it in position during any construction process, lowering it to its supports, removing all shoring or falsework, and cleaning up the site.

502.02 CONSTRUCTION DRAWINGS. Construction drawings shall be submitted in accordance with the requirements of Section 105. The Contractor shall submit the drawings and associated calculations, procedures, and details a minimum of 28 days prior to the anticipated start of work.

502.03 CONSTRUCTION REQUIREMENTS. Associated details, procedures, and calculations for shoring and jacking shall conform to the latest version of the *AASHTO LRFD Bridge Design Specifications* and *AASHTO LRFD Bridge Construction Specifications*.

The Contractor shall be responsible for the strength, capacity, and performance of the construction methods employed.

When components and/or materials that are not otherwise specified for removal are removed from the structure during shoring operations and the components and/or materials are to be re-installed in the construction, the components and/or materials shall be carefully removed and salvaged by the Contractor.

Components and/or materials to be retained and re-installed shall be stored at the location specified in the Contract or as directed by the Engineer.

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The Contractor shall take every precaution necessary to prevent damage to remaining components and/or materials and those to be retained for re-installation. Damage to remaining structure components and/or materials and to those to be re-installed shall be repaired or replaced by the Contractor both to the satisfaction of the Engineer and at no additional cost to the Agency.

502.04 METHOD OF MEASUREMENT. The quantity of Shoring Superstructure to be measured for payment will be on a lump sum basis for each location in the complete and accepted work specified in the Contract or ordered by the Engineer.

Unless otherwise specified in the Contract, all work for removing, salvaging, stockpiling, and re-installing existing structure components and/or materials during the Contractor's shoring operations will not be measured for payment, but will be considered incidental to Shoring Superstructure.

The quantity of Shoring Superstructure Bearings to be measured for payment will be on a unit basis for each bearing shored in the complete and accepted work as specified by the Contract or ordered by the Engineer.

502.05 BASIS OF PAYMENT. The accepted quantity of Shoring Superstructure will be paid for each location specified at the Contract lump sum price. Payment will be full compensation for preparing and submitting construction drawings, details, procedures, and calculations as specified, performing the work specified including assuming all liability for the structure being shored and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the work.

The accepted quantity of Shoring Superstructure Bearings will be paid for at the Contract unit price for each. Payment will be full compensation for preparing and submitting construction drawings, details, procedures, and calculations as specified, performing the work specified including assuming all liability for the structure being shored and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the work.

When the structure or bearing has been jacked and blocked onto its temporary position, a payment of 75% of the Contract unit price will be allowed. The remaining 25% will be paid when all shoring or falsework has been removed and the site cleaned up.

Payment will be made under:

Pay Item	Pay Unit
502.10 Shoring Superstructure	Lump Sum
502.11 Shoring Superstructure Bearings	Each

SECTION 503 – THIS SECTION RESERVED

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SECTION 504 – FURNISHING EQUIPMENT FOR DRIVING PILING

504.01 DESCRIPTION. This work shall consist of furnishing the equipment required to drive piles.

504.02 EQUIPMENT.

(a) General. The Contractor shall obtain from the Engineer a copy of the "Pile and Driving Equipment Data Form." The Contractor shall complete this form in its entirety and shall submit copies to the Geotechnical Consultant employed by the Contractor when load tests are required, and to the Engineer so that a wave equation analysis may be performed.

At least 14 calendar days prior to the beginning of any pile driving, the Contractor shall furnish for the Engineer's acceptance, specifications and applicable information to verify the capacity and capability of the proposed pile driving hammer. No test piles or production piles shall be driven prior to this acceptance. During the pile driving operations, no changes to the accepted equipment will be permitted without the Engineer's permission.

(b) Hammers. The type of hammer or driver shall be adequate in size to develop sufficient energy to drive the type and length of pile specified to the maximum ultimate pile capacity or nominal axial pile resistance shown on the Plans.

Each hammer shall be equipped with an anvil or clamp suitable for transmitting the driving force to the pile. The valve mechanism and the other parts of the air or diesel hammer shall be maintained in first class condition to ensure that the length of stroke for a single-acting hammer and the design number of blows per minute for a double-acting hammer will be obtained.

The drive head shall be axially-aligned with the hammer and pile and shall be guided by leads and not be free-swinging. It shall fit around the pile head in such a manner as to prevent transfer of torsional forces during driving while maintaining proper alignment of the hammer and pile.

The pile driving equipment shall not induce a compressive stress greater than 90% of the yield stress of the pile material. In addition, the pile driving equipment shall be capable of driving the pile to the required ultimate capacity at a blow count of between 3 and 15 blows per inch as indicated by the Wave Equation Analysis Program (WEAP).

(c) Leads and Bracing. The Contractor shall locate and brace each pile so that upon driving, its final position and alignment will be as specified and as shown on the Plans. The selection of leads or form of bracing must be adequate to align and restrain the piling during placement. If the leads or bracing are not adequate to place the piling to within the specified tolerance, the Contractor shall modify the leads or system of bracing until it obtains results acceptable to the Engineer.

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(d) Hammer Cushion. All impact pile driving equipment except gravity hammers shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Hammer cushions shall be made of durable manufactured materials, such as Micarta, provided in accordance with the hammer manufacturer's guidelines. Wood, wire rope, or asbestos hammer cushions will not be permitted. A striker plate, as recommended by the hammer manufacturer, shall be placed on the hammer cushion to ensure uniform compression of the cushion material.

The hammer cushion shall be inspected in the presence of the Engineer prior to beginning pile driving at each substructure unit or after each 100 hours of pile driving, whichever is less. Hammer cushions shall be replaced when either damaged or worn to 75% of their original thickness.

(e) Saximeter. The Contractor shall provide a Saximeter or equivalent device to assist the Inspector in collecting data to monitor the blow count (for all hammer types), the stroke (for open-end diesel hammers only), or the kinetic energy (if the hammer is equipped with proximity switches for measuring impact velocity). The Saximeter shall be completely charged and in sound working order prior to Agency use and shall be available for the duration of the pile driving operation. Pile driving operations shall not be conducted without the use of a Saximeter.

The Saximeter shall perform the following functions:

(1) Detect hammer blows automatically using sound recognition circuits, or manually with a keypad.

(2) Automatically count blows and determine the blows per minute (BPM) for all impact hammers.

(3) Calculate the stroke for open-end diesel hammers.

(4) Store blow count, penetration, average stroke or BPM data in memory.

(5) Permit viewing of results on built-in screen.

(6) Permit data transfer to PCs or printers.

For hammers equipped with proximity switches, the Saximeter shall be deployed to acquire hammer impact velocity data by communicating with a transmitter mounted on the hammer and use this information to calculate the hammer's kinetic energy.

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The Saximeter shall operate on rechargeable batteries, with batteries and charger supplied by the Contractor.

(f) Other Equipment. Other equipment required and not specified in this section shall be suitable for the use intended and shall be approved by the Engineer.

504.03 GENERAL. The type and size of the equipment for driving piling shall be accepted by the Engineer prior to being moved onto the project. Unsatisfactory equipment shall be removed from the site and replaced with satisfactory equipment when directed by the Engineer.

504.04 METHOD OF MEASUREMENT. The quantity of Furnishing Equipment for Driving Piling to be measured for payment will be on a lump sum basis for furnishing the equipment to drive all piles required on the project.

504.05 BASIS OF PAYMENT. The accepted quantity of Furnishing Equipment for Driving Piling will be paid for at the Contract lump sum price. Payment will be full compensation for furnishing and mobilizing the required equipment to the project and demobilizing equipment from the project, including the erecting, dismantling, and all incidentals necessary to complete the work.

When the equipment for driving piles has been set up and driving operations have started, a payment of 50% of the Contract unit price will be paid. The remaining 50% will be paid when pile-driving operations are complete and the equipment has been removed from the site.

The cost of all labor and materials, including operation and maintenance of the equipment for driving piles when used in connection with the driving of piles, except for the costs specified in this subsection, will be considered as being included in the Contract unit prices for the types of piles being driven.

Payment will be made under:

Pay Item	Pay Unit
504.10 Furnishing Equipment for Driving Piling	Lump Sum

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SECTION 505 – PILING

505.01 DESCRIPTION. This work shall consist of furnishing and driving piles of the size and type specified, making field splices and performing pile load tests.

505.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Steel Piling 730.01
Steel Sheet Piling 730.02

Receipt of approved mill test reports and verification that they correspond to the heat or lot numbers marked on the piles is required before the piles are driven.

505.03 FURNISHING PILING.

(a) General. Piling shall be of the type and size shown on the Plans. The lengths shown for a structure are for estimating purposes only, unless otherwise specified.

(b) Steel Piling. Steel piling up to and including 20 feet in length shall be furnished in one un-welded piece. Steel piling over 20 feet in length shall be furnished with not more than the number of splices specified in Table 505.05A.

(c) Permanent Steel Sheet Piling. The length, type, and classification of permanent steel sheet piling shall be as shown on the Plans.

505.04 DRIVING PILING.

(a) General. Piling other than sheet piling shall not be driven until the excavation has been made to the elevation shown for the bottom of the footing. In embankment areas, the fill shall be completed to the bottom of the footing elevation prior to driving any piles. Any material forced up between the piles shall be removed at the Contractor's expense to the correct elevation before concrete for the foundation is placed.

Driving shall be done in a manner that will not damage or overstress the piles.

All piling shall be driven to the required maximum ultimate axial pile capacity or nominal axial pile resistance and to the penetration depth as shown on the Plans. Under no condition shall the required maximum ultimate axial pile capacity or nominal axial pile resistance be less than that shown on the Plans except upon written approval of the Engineer.

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When the Contractor proposes to use a vibratory or sonic method for driving piling, the Engineer reserves the right to require the Contractor to demonstrate that such methods are capable of driving the piles to the penetration and resistance shown on the Plans. Acceptance of this method shall be based on load tests on one or more piles driven by sonic or vibratory methods or verification of required maximum ultimate axial pile capacity or nominal axial pile resistance of one or more piles with an air, or diesel hammer. Verification of required maximum ultimate axial pile capacity or nominal axial pile resistance of sonic or vibratory driven piles shall be at the Contractor's expense.

Piling shall not be driven within 75 feet of any concrete footings or structures that have not cured for at least 72 hours or attained a compressive strength of 1,800 psi.

The placing of concrete and the driving of piles shall be scheduled so that fresh concrete and setting concrete will not be damaged by the pile driving.

Piles pushed up by driving adjacent piles or by any other cause shall be re-driven to the required maximum ultimate axial pile capacity or nominal axial pile resistance <u>and</u> to the required penetration depth as shown on the Plans.

Any pile damaged during installation, driven out of its proper location, or driven below the elevation shown on the Plans or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer:

(1) Withdrawing and replacing the damaged pile with a new and, if necessary, longer pile.

(2) Driving a second pile adjacent to the damaged pile.

(3) Splicing the damaged pile or extending the footing to properly enclose the pile. This will not be allowed for a substructure unit containing only a single row of piles.

(b) <u>Tolerances</u>. The piling after driving shall not vary more than 1/4 inch per foot from vertical or the specified batter. The Engineer may require that driving be stopped in order to check the pile for plumb. Pulling or pushing laterally on piles to correct out-of-plumb errors, or splicing a section that meets the tolerances for plumb in this section on an out-of-plumb section will not be permitted.

The tops of foundation piling after driving shall not vary from the position shown on the Plans by more than 6 inches and shall have a minimum of 6 inches of concrete encasement.

The rotation about the vertical axis of the pile shall not vary by more than 5° from that shown on the Plans.

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The Contractor shall demonstrate how the tolerances will be met to the satisfaction of the Engineer prior to driving. If the verticality, location, and/or rotation tolerances specified herein are exceeded, the extent of corrective measures will be evaluated by the Engineer. If, in the judgment of the Engineer, corrective measures are necessary, suitable measures shall be designed and constructed by the Contractor. The Contractor shall bear all costs, including delays, associated with the corrective action.

(c) Pile Load Tests. Pile load tests, when required, shall be performed prior to driving any production piles. When not driven as a permanent production pile, the test pile shall be driven near the substructure footing, at a location acceptable to the Engineer.

When pile load tests are required, the Contractor shall provide the services of a Geotechnical Consulting firm for dynamic testing of the test piles.

A dynamic load test pile may be used and paid for as a permanent production pile if it meets all of the following requirements:

(1) After testing is completed, the test pile meets all of the requirements for a permanent production pile (i.e. it is driven to the required maximum ultimate axial pile capacity or nominal axial pile resistance and to the required penetration depth as shown on the Plans).

(2) The test pile is driven at the correct location and with the correct batter and has not failed under test loading, is not damaged, and does not exceed maximum number of splices, etc.

(3) The use of the test pile as a permanent production pile is approved by the Engineer.

(d) Determination of the Maximum Ultimate Axial Pile Capacity or Nominal Axial Pile Resistance. These values shall be determined by dynamic loading tests, wave equation analysis, or a combination thereof, as follows:

(1) Dynamic Load Test. Dynamic monitoring of the test piles shall be conducted by the Contractor's Geotechnical Consultant and results will be used by the Engineer to verify that the required maximum ultimate axial pile capacity or nominal axial pile resistance has been met.

In addition to equipment and services to dynamically monitor the pile driving, the Contractor's Geotechnical Consultant shall perform wave equation analyses (WEAP) as necessary to determine the suitability of the pile driving equipment proposed by the Contractor and to determine the preliminary driving criteria for testing. The Geotechnical Consultant shall submit copies of the wave equation analysis a minimum of 14 calendar days prior to the beginning of any pile driving. Also, the Geotechnical Consultant shall perform a laboratory case pile wave analysis (CAPWAP) for each test pile to verify the field results.

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The Geotechnical Consultant shall provide a preliminary and final written report including all data collected and the results of both the WEAP and CAPWAP for each test pile in accordance with the requirements of *ASTM D 4945*. The preliminary report shall be presented to the Engineer, when required, and the final report shall be submitted following completion of all load tests.

The effective capacity of battered piles shall be reduced by multiplying by the factors specified in Table 505.04A.

TABLE 505.04A – EFFECTIVE CAPACITY FACTORS FOR BATTERED PILES

Batter	Factor
1 to 12	0.99
2 to 12	0.97
3 to 12	0.95
4 to 12	0.92

As a guide, a pile may be considered driven to refusal when the driving resistance is 15 blows per 1 inch or 10 blows per 1/2 inch, but only when the hammer stroke is equal to or above the required stroke as specified in the wave equation analysis. This refusal value may be adjusted by the Engineer according to the results of the dynamic pile monitoring.

The Contractor's driving operations shall be monitored with a pile driving analyzer supplied and operated by the Contractor's Geotechnical Consultant during the installation and re-striking of the test piles. Dynamic pile load tests shall be performed on the test pile prior to driving production piles at any substructure. Production pile driving procedures may be adjusted based on the results from the pile driving analyzer.

Dynamic monitoring shall be performed in accordance with the requirements of *ASTM D 4945* with equipment capable of determining the maximum force, velocity, and transmitted energy as well as the ultimate static bearing capacity computed by the case method for each pile tested. Gauges shall be attached to the pile approximately 3 feet below the pile head and connected with a cable to recording instruments on the ground, away from the pile. The gauge system shall include two accelerometers, two strain transducers, and a junction box. Dynamic monitoring shall be performed with the assistance of the Contractor, as specified in this subsection.

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The Contractor may be required by the Engineer to modify the test pile driving operation based on the results from the pile driving analyzer.

The Geotechnical Consultant shall furnish the pile driving analyzer and supplemental equipment specified in these specifications. All test piles shall be monitored using the pile driving analyzer. The Contractor shall make the test piles available for drilling and tapping holes prior to driving. The Geotechnical Consultant shall furnish equipment, materials, and labor necessary for drilling and tapping holes in the test piles for attaching the monitoring instruments.

The Contractor shall provide the following support, items, and equipment:

a. Access. The Contractor shall provide the Geotechnical Consultant's personnel safe and reasonable means of access to the pile head for attaching transducers. A platform having a minimum size of 4 feet × 4 feet shall be equipped so that it may be raised to the top of the pile while the pile is located in the leads.

b. Power Source. The Contractor shall furnish an electric power source for the pile driving analyzer. If a field generator is used as the power source, it shall be equipped with functioning meters for monitoring voltage and frequency levels. Single-phase electricity, 10 A, 115 V AC with a line frequency of 60 Hz shall be provided.

   Dynamic measurements shall be taken by the Geotechnical Consultant during full length driving of all test piles and during all re-striking of the test piles. The stresses in the piles shall be monitored to ensure that the driving stresses do not exceed 90% of the yield stress of the pile. The Contractor shall reduce the energy transmitted to the pile by using cushions or reducing the energy of the hammer to maintain the above criteria.

The Contractor shall assist in preparing the piles to be monitored with the necessary gauge attachments on opposite sides of the pile. The gauges shall be attached by drilling and threading appropriately sized holes. The estimated time for performing the above tasks is approximately 30 minutes per section of pile driven. The Geotechnical Consultant shall do the drilling and tapping of holes in each section to be driven. The Contractor shall assist in moving and giving access to the piles. All drilling and tapping of holes shall be done on the ground.

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After the gauge attachments are prepared and all gauges and cables are removed from the pile segment, the Contractor shall lift and spot the pile according to normal procedures. The pile shall be made available for the installation of gauges after placing the pile in the leads. The Contractor shall then send one person up to the pile head to assist the Geotechnical Consultant in attachment of the gauges. The time required to ascend, complete the attachments, and then descend is estimated to be approximately one hour.

Pile driving during monitoring is typical of conventional driving. The cable from the gauges hangs freely down along the pile and to the monitoring equipment. The Geotechnical Consultant may temporarily stop the pile driving during the monitoring to review the data or change gauges or other equipment. The Contractor shall assist and cooperate with the Geotechnical Consultant as required during dynamic monitoring. Delays to pile driving due to dynamic monitoring after pile driving has begun should not exceed more than one hour per pile.

When the level of the gauges approaches the ground, the driving shall be halted to remove the gauges from the pile. The time required for removal of gauges is estimated to be about 30 minutes. If additional driving is required, the Contractor shall complete the pile splice and shall repeat the process of attaching gauges at the top of the next segment. The gauges shall be attached prior to continuation of driving.

Re-striking of all test piles is required. The minimum time between the end of initial driving and re-striking shall be 24 hours. Prior to re-striking the test piles, the dynamic testing gauges shall be reattached to the pile and the pile hammer shall be warmed up by striking at least 20 blows on another pile. Re-striking shall consist of either 2 inches of penetration or 30 hammer blows, whichever occurs first.

(2) Wave Equation Analysis. When load tests are not specified, the Engineer will verify the required maximum ultimate axial pile capacity or nominal axial pile resistance based on the Agency's wave equation analysis.

(e) Steel Sheet Piling. Permanent sheet piling shall be left in place as part of the finished structure.

(f) Steel Piling. Unless otherwise specified, the driving point of all piling, including test piling, shall be reinforced. Point reinforcement may be either a commercially fabricated weldment or a casting designed to protect the end of the pile during driving or for seating the pile on ledge. Point reinforcement details shall conform to the Contract requirements and shall be approved by the Engineer.

Requirements for commercially fabricated weldments are:

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(1) Point reinforcement cut sheets and welding procedures shall be submitted for approval in accordance with the requirements in Subsection 105.03.

(2) Weldments shall be fabricated so that the direction of rolling of weldment plates is in the same direction as the axis of the pile.

Pile flanges shall be welded to the outside faces of a pile point with a continuous bevel groove weld. The depth of the groove weld shall be at least 50% of the pile flange thickness but in no case less than 5/16 inch.

The minimum thickness of the cutting edge of the point shall be 1 inch or 150% of the flange thickness of the pile, whichever is greater.

When the Contract requires the piles to be driven to point bearing on ledge, the ledge bearing surface of the point shall have at least five cutting wedges, a minimum of one centered along the strong axis of the web and one on each corner of the flanges.

505.05 SPLICES.

(a) Splices for Steel Piling. Splices shall be made in accordance with details shown on the Plans at the locations approved by the Engineer. The maximum allowable number of splices are shown in Table 505.05A.

TABLE 505.05A – ALLOWABLE NUMBER OF SPLICES FOR STEEL PILING

Length of Steel Piling (feet)	Maximum Number of Splices Allowed
> 20 – 60	1
> 60 – 120	3
> 120 – 180	5

All piles to be spliced shall be cut square and even, and the flanges shall be beveled in accordance with approved welding procedures. Webs shall be cut so that full bearing is obtained between the two surfaces. The splice shall be made in such a manner that the spliced pile shall be straight and true.

Welds shall be continuous and develop the full strength of the parts being welded.

When a substructure unit contains only a single row of piles, only one pile splice shall be allowed in the top 20 feet of that substructure unit, measured from the bottom of the pile cap.

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(b) Splices for Steel Sheet Piling. Splices for steel sheet piling will not be permitted unless authorized in writing by the Engineer.

505.06 WELDING. Welding shall conform to the requirements of Subsection 506.10.

505.07 CUTTING OF PILING. Piling shall be cut to the elevations shown on the Plans or as ordered by the Engineer. Cut-offs shall remain the property of the Contractor.

505.08 METHOD OF MEASUREMENT. The quantities to be measured for payment will be measured as follows:

(a) Piling.

(1) Steel Piling. Steel Piling will be the total number of linear feet for each pile driven, accepted, and left in place, measured to the nearest linear foot.

If a test pile is driven within foundation limits and subsequently accepted as permanent foundation piling, measurement for payment as Steel Piling will be made for the test pile.

If a test pile is driven outside of foundation limits, no measurement for payment as Steel Piling will be made for the test pile

(2) Steel Sheet Piling. Steel sheet piling will be the total number of square feet of Permanent Steel Sheet Piling driven, accepted, and left in place after cut-off.

(b) Pile Loading Tests. Pile Loading Tests will be measured in units of one for each load tested pile. Any necessary retests shall be at the Contractor's expense.

505.09 BASIS OF PAYMENT. The accepted quantities of piling will be paid for at the Contract unit prices as follows:

(a) Steel Piling. Steel piling of the size specified will be paid for at the Contract unit price per linear foot.

(b) Steel Sheet Piling. Steel sheet piling of the type specified will be paid for at the Contract unit price per square foot.

Payment for the above specified items will be full compensation for furnishing, transporting, storing, handling, and placing the material specified, including metal collars, metal shoes, reinforcing material for ends of steel piling, reinforcing steel, splices, wales, and braces for steel sheet piling, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

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The accepted quantity of Dynamic Pile Loading Test will be paid for at the Contract unit price for each. Payment will also be full compensation for providing, cooperating with, and assisting the Geotechnical Consultant in the performance of dynamic testing, for providing dynamic testing equipment, and for re-striking the test pile. Payment will be full compensation for cutting off the test pile at the elevation directed by the Engineer, for preparing and submitting geotechnical reports, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for furnishing and driving test piling driven outside of foundation limits will be included in the unit price bid for Dynamic Pile Loading Test.

Payment will be made under:

Pay Item		Pay Unit
505.10	Steel Piling, HP 10 × 42	Linear Foot
505.12	Steel Piling, HP 10 × 57	Linear Foot
505.15	Steel Piling, HP 12 × 53	Linear Foot
505.155	Steel Piling, HP 12 × 63	Linear Foot
505.16	Steel Piling, HP 12 × 74	Linear Foot
505.165	Steel Piling, HP 12 × 84	Linear Foot
505.17	Steel Piling, HP 14 × 73	Linear Foot
505.18	Steel Piling, HP 14 × 89	Linear Foot
505.19	Steel Piling, HP 14 × 102	Linear Foot
505.20	Steel Piling, HP 14 × 117	Linear Foot
505.35	Permanent Steel Sheet Piling	Square Foot
505.45	Dynamic Pile Loading Test	Each

SECTION 506 – STRUCTURAL STEEL

506.01 DESCRIPTION. This work shall consist of furnishing, erecting, and when specified, coating fabricated metal structures and structural components.

506.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV	707.03
Structural Steel Coating Systems	708.03
Grease Rustproofing Compound	708.04
Carbon Steel Bolts, Nuts and Washers	714.04
High-Strength Bolts, Nuts, and Washers	714.05
Heat-Treated Steel Structural Bolts	714.06
Anchor Bolts, Bearing Devices	714.08
Welded Stud Shear Connectors	714.10

Steel Tubing 714.11
Direct Tension Indicators 714.12
Tension Control Assemblies 714.13
Galvanizing 726.08
Metalizing 726.09

Structural Steel shall meet the requirements of Subsection 714.01 through Subsection 714.03.

Unless otherwise specified in the Contract, all steel shall be high-strength low-alloy structural steel conforming to the requirements of *AASHTO M 270 M/M 270,* Grade 345W (Grade 50W).

All materials shall conform to the prescribed AASHTO or ASTM specifications, and no substitutions will be allowed.

506.03 GENERAL FABRICATION REQUIREMENTS. Material furnished under this section that is permanently incorporated into a Federal-Aid Project shall be entirely manufactured and coated in the United States.

Except as modified below, fabrication shall be performed in accordance with the latest editions of the applicable AASHTO design code, *ANSI/AASHTO/AWS D1.5* hereinafter designated as *AWS D1.5*, and interim specifications in effect on the date of the Executed Contract. Unless otherwise indicated in the Contract, the applicable AASHTO design code shall be the latest edition of the *AASHTO LRFD Bridge Design Specifications*.

Prior to performing any work under this section, the fabricator must have received approval for all fabrication drawings, welding procedures and any special Contract requirements and have notified the Agency's Structural Steel Fabrication Engineer in writing at least 10 working days in advance of fabrication. The Contractor shall bear full responsibility and costs for all materials ordered, raw materials stockpiled, or for work performed prior to approval of the fabrication drawings or written authorization from the Structures Engineer.

Excepted as noted in this subsection, all work shall be performed by the fabricator indicated on the approved fabrication drawings, unless otherwise authorized in writing by the Structural Steel Fabrication Engineer. For coatings, if the fabricator intends to use a Subcontractor, it shall be clearly outlined on the fabrication drawings to be submitted for review. At a minimum, the provided information shall include the Subcontractor's name and address; the name, phone number and e-mail address of the quality control (QC) contact; and an acknowledgement of the VTrans quality assurance (QA) inspection requirements which apply to the Subcontractor.

If the fabricator wishes to request the use of a Subcontractor for material processing (e.g. cutting, drilling, bending, rolling, punching, machining, etc.), they shall submit a set of the previously approved shop drawings to the Agency for review, with the requested changes and required information clearly marked and indicated (e.g. by making all additional notes red). At a minimum, the submittal shall include the Subcontractor's name and address; the name, phone number and e-mail address of the quality control (QC) contact; an acknowledgement of the VTrans quality assurance (QA) inspection requirements which apply to the Subcontractor; and clear information on the extent and limits of work to be performed by the Subcontractor

Requests will be evaluated on a case by case basis and may be rejected by the Agency for any reason. Use of a Subcontractor does not relieve the fabricator of any responsibilities or quality control requirements specified by the Contract.

Structural steel furnished under this section shall be fabricated in a plant having an AISC Certified Bridge Fabricator – Advanced (ABR), or Intermediate (IBR) Certification, and in a plant approved by the Agency prior to Contract Execution. Structural steel components (such as bridge rail, bridge joints, and overhead sign structures) which are fabricated under this section may be fabricated in a plant that does not have an ABR or IBR Certification, provided that the fabrication plant has either an AISC Certified Bridge Fabricator – Simple (SBR) Certification, or an AISC Bridge Component QMS Certification, and is approved by the Agency prior to Contract Execution.

Minor steel components, including, but not limited to, downspouts, scuppers, and pedestrian hand railings may be fabricated in a plant that does not have an ABR or IBR Certification, provided that the fabrication plant is approved in writing by the Structures Engineer prior to Contract Execution. All plants without certification shall have an organization, operation and equipment capable of producing a product equal to a certified plant.

Structural steel that is to be painted or metalized under this section shall be coated in a plant having an AISC Sophisticated Paint Endorsement – Enclosed, or SSPC-QP 3 – Enclosed Shop certification and which has been approved by the Agency prior to Contract Execution.

When certified fabrication or coating plants are required, the plant shall maintain certified status throughout the duration of the work under the Contract.

VTrans reserves the right for the Structures Engineer to give written notification to any fabricator (regardless of certification level or status) restricting the types of items that they are approved to fabricate, up to and including restricting all structural steel fabrication for the Agency. Causes for such restrictions shall include concerns of quality, production, accountability, or any other cause that is deemed justifiable by the Agency.

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The fabricator shall demonstrate full capability for fabricating materials meeting the requirements of the Contract. Failure to meet Contract requirements will result in rejection of the material being fabricated and the termination of the ability to fabricate material for the State.

All steel fabrication plants must satisfy the following minimum requirements:

(a) Reference Materials. The plant shall have a library containing the latest editions of the following publications:

(1) *AWS A5.1, A5.5, A5.17, A5.18, A5.20, A5.23, A5.28, A5.29, C2.18, C2.23, D1.1, D1.2, D1.3, D1.4,* and *D1.5*

(2) *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Parts I and II*

(3) *AISC Quality Criteria and Inspection Standards, A Guide to the Shop Painting of Structural Steel, Manual of Steel Construction,* and *Structural Steel Detailing*

(4) Vermont Agency of Transportation *Standard Specifications for Construction*

(5) *AASHTO LRFD Bridge Design Specifi*cations

(6) *AASHTO LRFD Bridge Construction Specifications*

(7) *AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges*

(8) *AREMA* Specifications, when applicable

(9) *American Society for Nondestructive Testing (ASNT) SNT-TC-1A*

(10) *SSPC Steel Structures Painting Manual, Volume 1* and *Volume 2*

(11) *AASHTO/NSBA G1.1*

In addition to the above, access to the latest editions of any applicable ASTM standards is required.

(b) Files. The fabricator shall maintain an organized file containing the following records:

(1) Records of material purchased

(2) Inventory of material in stock

(3) Certification records of all material and welding supplies

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(c) Personnel. Fabrication personnel shall meet the following minimum requirements:

(1) Inspectors. Quality control inspectors shall be onsite full time during any hot work (e.g. burning, heating, welding, etc.), as well during as any operations that may affect the quality of the coating system.

a. Fabrication Inspectors. The fabricator's representative responsible for fabrication inspection, testing and quality matters shall be qualified and certified in accordance with the provisions of *AWS QC 1*.

b. Coating Inspectors. The fabricator's coatings quality control manager shall possess a minimum classification as a NACE Coating Inspector Level 2 – Certified. The coatings quality control inspector shall possess a minimum classification as a NACE Coating Inspector Level 1 – Certified.

(2) Welders. Welders shall be certified for each process and position of prequalified joints in the approved welding procedures, including tacking, in accordance with the requirements of *AWS D1.5* for all structural bridge items and *ANSI/AWS D1.1*, hereinafter designated as *AWS D1.1*, for items not covered in *AWS D1.5.*

(d) Material Fabrication Facilities.

(1) All fabrication shall be performed in an enclosed permanent structure, unless otherwise approved by the Structures Engineer.

a. To meet minimum requirements, a plant shall have the following facilities:

b. Dry storage for manual electrodes and fluxes

c. Ovens with proper temperature ranges for drying electrodes and fluxes

d. Calibrated tools, gauges, tapes, and instruments

e. Suitable preheating equipment and means for measuring preheat temperatures

f. DC and AC manual shielded metal arc welding equipment capable of at least 500 A output

g. Mechanically-guided burning equipment

h. Machine shop facilities sufficient to perform the work specified

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i. Facilities and equipment for applying shop paint to perform the work specified

j. Blast cleaning equipment suitable for preparing a surface meeting the requirements of Subsection 506.14

k. Suitable storage for materials and finished products

(2) A plant engaged in fabrication of plate girders, rolled beams, and other main member components requiring continuous welds over 2 feet in length shall also have the following equipment:

a. Automatic arc equipment

b. Semiautomatic arc equipment

c. Stud-welding equipment capable of installing a 7/8-inch diameter stud, when applicable

d. Equipment suitable for heat curving or heat cambering

e. Hydraulic jacking equipment suitable for aligning and positioning structural components

(3) Adequate office facilities and equipment for the Agency's Quality Assurance Inspector shall be separate from the Quality Control facilities and shall include the following items:

a. A standard office desk with drawers, locks, and keys

b. Adjustable office chair

c. Telephone

d. Plan rack and file cabinet with lock and keys

e. The following tools shall be available for the Inspector's use:

1. Weld gauges

2. Micrometer

3. Dry and wet film paint gauge

4. 10-foot steel measuring tape

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5. 100-foot steel measuring tape

6. 6-foot straightedge

7. Temperature and marking crayons

8. Ambient air thermometer

9. 2-foot level

10. 2-foot carpenter's square

The Structural Steel Fabrication Engineer reserves the right to reject inadequate office facilities and require suitable alternatives.

(e) Testing Equipment. When code requirements necessitate nondestructive testing for quality control or quality assurance, the fabricator shall have available the necessary nondestructive testing equipment for material or weld inspection (such as magnetic particle, radiograph, ultrasonic, or dye penetrant) or employ an outside inspection firm to fulfill the necessary nondestructive test requirements of the code. Nondestructive tests shall be performed in accordance with the applicable code in effect on the date of the Contract Execution.

506.04 DRAWINGS AND PROCEDURES.

(a) General. As soon as practical after Contract Execution, the fabricator shall prepare fabrication drawings in accordance with the requirements of Section 105. Drawings, details, and welding procedures must be submitted as a complete package for each structure.

The Agency will review fabrication drawings, details, and procedures for their compliance with the Contract. The Agency shall refer to the requirements of *AASHTO/NSBA G1.1*, Section 4, and use them as the basis for the review of structural steel fabrication drawings.

The Agency assumes no responsibility for dimensions and other information calculated by the fabricator. The fabricator is responsible for the fit of all components. If errors occur that cause problems during erection, the Contractor is responsible for making acceptable corrections.

The Agency is responsible for all principal dimensions and material properties contained in the Contract. The fabricator and Contractor are responsible for bringing to the Agency's attention any errors or discrepancies they discover.

The fabricator is responsible for dimensioning members and ordering material to compensate for weld shrinkage, distortion, elastic deformation, sweep, slope, machining, waste from cutting, and other incidentals that are affected by the fabrication process.

(b) Details. Details not shown on the Plans that are necessary for completing the fabrication drawings shall be developed by the fabricator.

The fabrication drawings shall provide a material list on each sheet for tabulating the number of pieces, piece marks, description, dimensions, type of material, and weight of each piece. When the Contract item pay unit is on a per pound basis, the weight of each piece shall be extended and summarized for each sheet as specified in Subsection 506.24. Weight extensions (extended weights) shall be submitted to the Agency upon completion of fabrication.

All welds shown on the fabrication drawings shall identify, by symbol, the applicable procedures and appropriate nondestructive testing requirements. A separate symbol must be used to identify each approved welding procedure.

(c) Welding Procedures. Detailed welding procedures shall be prepared in accordance with the provisions of the applicable AWS/ANSI/AASHTO code revisions and submitted in accordance with the following:

(1) All procedures shall be prequalified. Procedure qualification test records shall be submitted along with each procedure. Heat input values during welding shall be shown for each procedure.

(2) Welding procedure Specifications shall be presented in a format similar to *Form O-2* of *AWS D1.5,* Annex O (See Annex M for *AWS D1.1*). Procedure qualification test records shall be presented in a format similar to *Form O-3* and *Form O-4* of *AWS D1.5,* Appendix O (See Annex M for *AWS D1.1*).

(3) Details of welded joints not prequalified under *AWS D1.5,* Section 2.7 shall be qualified.

(d) Revisions. Adjacent to or incorporated with the title box of each sheet shall be a revision record box including provision for the date of revision, symbol of revision number, revision made by, and description of each revision. As changes or revisions are made to previously approved sheets, the appropriate information shall be recorded, a revision number symbol placed adjacent to the appropriate detail, and the sheet resubmitted for approval. It is the fabricator's responsibility to transfer all "as noted" corrections to the originals.

Revisions of welding procedures shall also be resubmitted, as they occur.

506.05 QUALITY ACCEPTANCE. Quality Acceptance is inspection of fabrication by the Agency or the Agency's representative (Quality Assurance Inspector, QAI), to verify compliance with these specifications. Refer to the VTrans *Quality Assurance Manual for Metal Fabrication*, which may be found on the Agency's Structures website, for more information.

(a) Scope of Work. Inspection will include the examination of materials, processes, quality of work, reports, and test results; the performance of tests specified; the evaluation of reports and tests; the approval, disapproval, or rejection of materials, processes, quality of work, reports, and test results; or other work specified or directed by the Engineer.

(b) Control of Work. The Quality Assurance Inspector (QAI) is a representative of the Engineer and will perform all the duties assigned and delegated to the Engineer in Section 105 as they pertain to the Contract except for measuring quantities of materials and payment thereof. The Inspector will witness, interpret, and accept or reject all testing.

This sentence deleted. Inspection of the work will conform to the requirements of the applicable AWS/ANSI/AASHTO codes and specifications referenced in the Contract.

(c) Tools and Equipment. QAI's are expected to furnish their own personal safety equipment. They may make use of any tools the fabricator is required to make available; however, the fabricator is responsible for verifying that the equipment is properly calibrated and in working order.

506.06 QUALITY CONTROL.

(a) General. Quality Control is the inspection, testing, and management of quality matters necessary for producing a product that conforms to the requirements of the Contract. The fabricator is responsible for Quality Control.

The fabricator is responsible for performing all nondestructive tests required by the Contract and any nondestructive tests necessary to determine the extent of metallurgical defects discovered in the base metal.

(b) Qualifications of Inspectors. Inspectors shall meet the requirements of Subsection 506.03(c).

(c) Nondestructive Testing. The fabricator shall notify the Agency sufficiently in advance of any scheduled nondestructive testing so that all tests can be witnessed by an Agency Quality Assurance Inspector. Nondestructive tests shall be performed in accordance with the requirements of *AWS D1.5*.

Personnel performing and interpreting nondestructive tests (radiographic, magnetic particle, ultrasonic and dye penetrant) shall be NDT certified for Level II qualification in accordance with the American Society for Nondestructive Testing, *Recommended Practice Number SNT-TC-1A*.

(d) Ultrasonic Testing. Ultrasonic testing will not be permitted as a substitute for radiographic testing; however, ultrasonic testing may be used by the fabricator to determine the extent of discontinuities, laminations, and inclusions discovered in any weld or base metal.

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506.07 MATERIAL IDENTIFICATION.

(a) Material Traceability. The origin of each piece of material to be incorporated in a product shall be clearly identified at all times during the fabrication of the product. If fabrication operations could obliterate the identity, the fabricator may use a low-stress die stamp placed in an area not exposed on the finished structure. The die stamp character size shall be a minimum of 1/8 inch and a maximum of 1/4 inch. Nonmetallic materials shall be identified to the satisfaction of the Engineer.

When requested, the Contractor shall furnish an affidavit certifying that throughout the fabrication operation identification of the steel has been maintained in accordance with this specification.

When a steel stamp identification is used at a tension joint transition, the impression shall be placed on the thicker of the members.

506.08 BASE METAL REQUIREMENTS. When backing bars, extension bars, and runoff plates are part of a welding process, the material used shall be of the same chemistry as the base metal.

Discontinuities, laminations, inclusions, or other anomalies discovered in the base metal during the manufacturing process shall be individually evaluated. The Agency may require nondestructive testing to determine the extent of the defect. Repair procedures or replacement will be approved on an individual case basis.

Rolled beams shall be ordered from the mill without camber, unless pre-approved in writing by the Structures Engineer.

Primary stress-carrying material shall be ordered and prepared so that the direction of rolling is parallel to the stress in the member, in accordance with the requirements of *AASHTO LRFD Bridge Construction Specifications,* Article 11.4.3.1.

Members identified as "fracture critical" shall be subject to additional base metal requirements as specified in Subsection 506.11.

Members or components of members designated in the Contract as requiring Charpy V-Notch (CVN) testing, or members subject to tensile or compressive stress as specified in Subsection 714.01 shall be identified as a main member and shall therefore be subject to the requirements of main members.

506.09 PREPARATION OF BASE METAL. Material flame cuts by any thermal cutting process shall be made with an approved mechanically-guided torch.

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The fabricator shall use preheating, post-heating, or control of the cutting process to ensure that flame-cut edges of main members of structural steel are not flame-hardened. Flame-cut edges that will not be included in a permanent weld shall have a Rockwell Hardness Value not greater than C30.

Pieces that are to be bent during fabrication shall be done so in accordance with the requirements of *AWS D1.5* and the applicable design code as defined in Subsection 506.03.

Cold bending of main members will not be permitted without written approval of the Agency. This approval may limit the radius of curvature and require nondestructive testing to verify that no internal distress or separation has occurred. Expenses incurred in performing any such nondestructive test examination shall be the responsibility of the fabricator.

506.10 WELDING.

(a) General. All design details, quality of work, procedures, and inspection of welding shall conform to the requirements of the *AWS D1.5 Bridge Welding Code*. For welding items other than those covered in *AWS D1.5*, one of the following publications shall be adhered to:

ANSI/AWS D1.1 Structural Welding Code - Steel
ANSI/AWS D1.2 Structural Welding Code - Aluminum
ANSI/AWS D1.3 Structural Welding Code - Sheet Steel
ANSI/AWS D1.4 Structural Welding Code - Reinforcing Steel

Welding will not be permitted without approved welding procedures and fabrication drawings meeting the requirements of Subsection 506.04.

Welding and inspection of shear connectors shall conform to the requirements of Section 508.

Stitch welds are not permitted; however, the skip-and-fill technique may be used when applicable to prevent distortion.

Prior to performing any corrective weld repairs to base metal, the fabricator shall do the following:

(1) Submit the proposed repair procedure to the Agency's Structural Steel Fabrication Engineer in writing. Corrective procedures for radiographed butt welds may be included in the welding procedure.

(2) Receive written authorization from the Agency to proceed. Repair procedures detailed in an approved welding procedure may be authorized by the Agency's Quality Assurance Inspector.

The fabricator will be permitted a maximum of two repairs on any given welded joint. Should nondestructive test inspection indicate weld rejection after two repairs, the Agency may reject the entire weld and require its removal.

(b) Welding Processes. Shielded Metal Arc Welding (SMAW) conforming to the requirements of *AWS D1.5,* Section 1 shall be deemed prequalified. Submerged Arc Welding (SAW), Flux Core Arc Welding (FCAW), and Gas Metal Arc Welding (GMAW) shall be subject to qualification testing as described in *AWS D1.5,* Section 5 prior to approval. Other processes may be approved, on a project-by-project basis, provided procedure qualification results meet the specified acceptance criteria.

Submerged Arc Welding (SAW) shall be used for all principal welds, as follows:

(1) The fully automatic process shall be used for attaching cover plates, flange to web welds, and attaching connection or stiffener plates to girder webs.

(2) The semiautomatic process may be used when joint length, position, or physical location restricts the use of the automatic process.

The manual Shielded Metal Arc Welding process shall be limited to attaching connection plates to rolled beams, welding bearing assemblies, repairs, tack welding, joints under 24 inches in length, minor attachments, and other applications where the use of an automatic process is impractical.

When prior authorization has been granted, the Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW) processes will be limited to indoor shop welding of bridge rail, expansion joints, cross frames, bearing devices, scuppers, sign fixtures, light fixtures, and low-stressed members or components. Gas Metal Arc Welding-Short Circuit Arc (GMAW-S) will not be permitted.

Any gas shielded process subject to wind velocities in excess of 5 miles per hour shall be protected using draft barriers.

(c) Shop Welding. The fabricator shall maintain a file of the qualifications of all welders, welding operators, and tackers qualified in accordance with the requirements of *AWS D1.5,* Section 5. Requalification may be required in accordance with the requirements of *AWS D1.5,* Section 6. The requirements of *AWS D1.1* shall be adhered to for welding of items not covered in *AWS D1.5*.

Groove welds shall be started and terminated with extension bars or runoff plates.

Fillet welds shall be performed in the flat or horizontal position unless restricted by member size or physical position.

(d) Field Welding. Welding performed in the field shall be done by welders or welding operators who are on the VTrans prequalified welder list. This list may be found on the Agency's Structures Section website.

The Agency's requirements for field welding are contained in the VTrans *Field Welding Manual* and shall be adhered to. This manual may be obtained from the Agency's Structures Section website.

Welding performed in the field is subject to all of the requirements of Subsection 506.10. The SMAW process is the only process approved for field welding.

The axis of any weld used to attach miscellaneous construction fixtures to main members as defined in Subsection 714.01 shall be in the same direction as the primary stress in the member and shall be approved in writing by the Engineer.

Welding of miscellaneous construction fixtures such as form supports, screed supports, and reinforcing steel chairs to any portion of the bridge structure will not be permitted without approved drawings and welding procedures. Any increase in material thickness made necessary by reduced allowable stresses resulting from such welding shall be at the Contractor's expense. Approval for any welding requiring an increase in material thickness must be obtained before the affected structural steel is fabricated.

Shear connectors shall be installed in accordance with the requirements of Section 508.

(e) Process and Procedure Qualification.

(1) General. Welding processes and procedures requiring qualification shall be qualified in accordance with the requirements of *AWS D1.5*.

Welding and testing of samples shall be witnessed by the Agency, or the Agency's Quality Assurance Inspector, or an authorized representative of a testing agency that is AWS certified in accordance with the provisions of *AWS QC 1*.

This paragraph deleted.

This paragraph deleted.

(2) Acceptance Requirements. The basis for acceptance shall conform to the requirements of *AWS D1.5*. The requirements of *AWS D1.1* shall be adhered to for items not covered in *AWS D1.5*.

506.11 FRACTURE CRITICAL MEMBERS. The Agency will identify in the Contract the members or member components that are categorized as "fracture critical."

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Material for members or member components identified as "fracture critical" shall be furnished and fabricated in conformance with the requirements of *AWS D1.5* for fracture critical components.

Welding performed on fracture critical members or components, and testing, shall be witnessed by an Agency representative. Qualification acceptance for any welding procedure shall be based on the results of mechanical tests and chemical analysis of deposited weld metal. Procedure requirements and basis of acceptance shall meet the requirements in *AWS D1.5* for fracture critical components

506.12 ASSEMBLY.

(a) Camber. Beams and girders shall be fabricated to the camber indicated on the approved fabrication drawings.

(b) Curved Girders. Welded curved girders with radii less than 750 feet shall be fabricated by cutting the flange plates to the required curvature. Each plate shall be flame cut simultaneously on both edges to reduce unbalanced shrinkage stresses. The flange plate lengths between shop splices shall not be less than 20 feet. Web plates shall be aligned to the center of the flange plates.

If the final curvature is not as specified after the flanges have been welded to the web, the girder shall be corrected by application of heat in accordance with an approved procedure.

(c) Heat Curving and Cambering. The final horizontal curvature and vertical camber shall be measured only after the member has cooled. The member shall be supported in a manner that will ensure accurate measurements for sweep and camber. The web shall be in a vertical position for measuring curvature and in a horizontal position for measuring camber.

Heating shall be performed in such a manner that the temperature of the steel does not exceed 1,150°F. Artificial cooling will not be permitted until a member has cooled to 600°F. Under no conditions will water be permitted for cooling. Air may be used subject to the approval of the Quality Assurance Inspector. Any member heated to a temperature of more than 1,200°F shall be rejected.

(d) Finish. All sharp corners, and edges that are marred, cut, or roughened in handling shall be rounded to a minimum 1/16-inch radius by grinding.

(e) Connections and Bolting. The materials and fabrication procedures shall comply with the provisions of Subsection 506.19.

(f) Bearing Connections. Field bearing connections shall not be permitted. Connections in bearing may require different tolerances of fit. Terms used to define the fit of connections are as follows:

(1) Tight Fit. Fifty percent of the projected bearing area shall be in contact within 0.02 inch with a permissible variation of 1/16 inch for the remaining 50% of projected area.

(2) Grind to Bear. Seventy-five percent of the projected area shall be in contact within 0.01 inch with a permissible variation of 1/32 inch for the remaining projected area.

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(3) Mill to Bear. One hundred percent of the projected bearing area shall be in full contact.

(g) Intermediate Stiffeners. The ends of intermediate stiffeners shall fit closely to the flanges with a maximum allowable gap of 1/16 inch.

(h) Straightening Material. Straightening or repair of any member or component will be subject to written approval by the Agency. Procedures will be required describing in detail the distortion to be corrected and all procedures for heating, cooling, verifying final dimensions, and nondestructive tests.

506.13 TOLERANCES. Rolled steel plates, shapes, and bars shall be supplied to the permissible tolerances specified in *ASTM A 6/A 6 M*. The camber and sweep of fabricated rolled members shall be subject to the same dimensional tolerances specified for welded members in *AWS D1.5*.

The metal bearing surface of any masonry bearing plate shall be flat, with a maximum permissible variation of 0.04 inch from a plane determined by any three of its corners.

The fabricator is responsible for straightening to specification tolerances any weldments that may have been distorted through stress relieving during the galvanizing process.

506.14 SURFACE PREPARATION. All materials shall be blast-cleaned to the specified grade as defined by the *SSPC Painting Manual* and supplemented by reference to *SSPC-VIS 1*. Further preparation shall conform to the following:

(a) Surfaces to Remain Uncoated. Surfaces shall be blast-cleaned at least equivalent to Preparation Grade *SSPC-SP 10.* This work may be performed either before or after fabrication. The final surface appearance after fabrication shall be clean and free from any contaminants or blemishes so as to allow the metal to weather uniformly.

(b) Surfaces to be Coated. Prior to application of any coating, all material to be coated shall be cleaned and prepared in accordance with the appropriate Contract specifications.

506.16 MARKING, STORING, AND SHIPPING.

(a) Marking. Each member shall be identified with an erection mark corresponding with the member identification mark on the approved fabrication drawings.

Identification marks may be painted on members that will receive field coats of paint.

Identification marks on unpainted steel shall be impressed into the member with a low-stress stamp in a non-stressed or low-stressed area of the member. The fabricator shall identify to the Contractor the procedure used for marking material.

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(b) Storing. Material at the fabricator's plant shall be stored above ground on platforms, skids, or other suitable supports. It shall be kept clean, properly drained, and protected from unwanted corrosion. Free circulation of air shall be provided around all surfaces.

Girders and beams shall be stored in the upright position, supported at their ends or points of bearing. Long members (e.g., columns and chords) shall be supported at sufficient points to prevent damage from deflection.

Special care shall be taken for unpainted steel to ensure that it can weather uniformly.

In addition to the requirements specified above, material or raw material stockpile storage shall be subject to any other storage criteria deemed necessary by the Engineer in accordance with the requirements of Subsection 106.09.

(c) Shipping. Beams and girders shall be transported in the upright position. If the member's size or shape prohibits shipment in the upright position, the fabricator shall submit a proposed method and details of shipment to the Agency for approval.

The fabricator shall not ship any material, either to the project or to another manufacturer, without the Agency's approval. The Agency's Quality Assurance Inspector will place a seal of approval on all material that has been accepted and will approve the loading, positioning, and anchorage of all material being shipped.

506.17 FIELD HANDLING AND STORING. The Contractor is responsible for providing equipment that is adequate for safely lifting and placing, without damage, all material furnished. Permanent distortion caused by handling or storage will be cause for rejection.

The edges of nicks or bumps caused by handling shall be carefully ground to a 1/16-inch radius.

The storage requirements in Subsection 506.16 shall be applicable for all materials stored in the field.

506.18 ERECTION.

(a) Methods and Equipment. Cranes, lifting devices, and other equipment for all structural steel erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the structural steel. However, the Contractor shall lift and erect curved girders so that the web of the girder is maintained vertical within a 10° vertical tolerance.

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The Contractor shall submit construction drawings in accordance with the requirements of Section 105 for the methods and sequence of structural steel erection, the temporary bracing, and the equipment to be used for the erection. The Agency shall use the requirements specified in *AASHTO/NSBA S10.1,* Appendices E and F, as the basis for review of erection plans.

The erection plan shall include the necessary computations to indicate the magnitude of stress in the segments during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed. The erection plan shall contain provisions for all stages of construction, including temporary stoppages.

The Contractor shall include additional information in the erection plan for curved girders as indicated in *AASHTO LRFD Bridge Construction Specifications,* Section 11.8.2.

The structural steel may be used for support of equipment prior to placement of the deck only with the written permission of the Engineer. The proposed use of structural steel for support of equipment shall be detailed in the erection plan.

Submittal of the erection plan is for documentation purposes only, and shall in no way be construed as approval of the proposed method of erection. Unless otherwise directed by the Engineer, the Contractor shall follow the erection plan as submitted

(b) Assembly.

(1) Parts shall be accurately assembled as shown on the Plans, fabrication drawings, or erection drawings, following match marks when provided. Material shall be carefully handled so that no members or pieces will be bent, broken, or damaged. Hammering that will injure or deform members will not be permitted. Bearing surfaces and contact surfaces shall be clean.

(2) Drift pins shall be used to align and center the connections of main and secondary members. Only light drifting will be permitted. Any member subjected to drifting that results in distortion of the member or elongation of the holes will be rejected. Cylindrical erection pins, the same size as the hole, shall be used at least in the extreme corners of all main member connections.

Main members shall be match marked by the Fabricator and should fit together easily.

Main members shall not be reamed larger than the hole size indicated on the approved fabrication drawings without written authorization from the Project Manager. Secondary members may be subjected to limited field reaming with the written approval of the Engineer. Assembled parts that have been approved for field drilling or reaming shall be disassembled to remove any burrs, shavings, oils, or lubricants.

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Pins used for hinged connections and bearings shall be inserted with care and aligned so the members take full and even bearing. Nuts shall be adequately tightened and locked in position either by upsetting the threads or tack welding the nut to the bolt.

(3) Errors in shop fabrication that prevent proper assembly shall be reported immediately to the Engineer. The Engineer shall approve any corrective action prior to it occurring.

506.19 BOLTING AND CONNECTIONS.

(a) General. Connections shall be made with high-strength bolts conforming to the requirements of Subsection 714.05 unless otherwise specified. Bolts and nuts shall be furnished by the same supplier. Bolts, nuts, and washers shall be packaged and shipped so they are kept dry. When not in transit, bolts, nuts, and washers shall be stored indoors under dry, ventilated conditions.

All bolts and nuts shall be adequately and uniformly lubricated. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation in accordance with applicable specifications.

Bolt holes are specified as 1/16 inch larger in diameter than the bolt. Bolt holes shall be fabricated to the requirements of the *AASHTO LRFD Bridge Construction Specifications*, Section 11.4.8, except that holes shall not be punched full-size unless otherwise permitted in the Contract or approved by the Structural Steel Fabrication Engineer.

(b) Bolted Parts. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or other interposed compressible material. All joint contact surfaces and areas adjacent to bolt holes shall be free of scale, burrs, dirt, and other foreign material that may prevent solid seating of the parts.

Prior to assembly, contact surfaces of galvanized stress-carrying members shall be lightly brushed or blasted to a dull gray appearance.

Unless otherwise specified in the Contract, faying surfaces of bolted connections shall have a Class B slip coefficient value of not less than 0.50 as specified by AASHTO.

Splices and field connections of main members shall have all holes filled with high-strength bolts or cylindrical drift pins, with bolts snug-tightened before external support systems are removed. Cylindrical drift pins shall be used in the extreme corners of all main member connections to ensure alignment and shall remain until all bolts in the connection have been fully tightened.

(c) Installation. Bolted connections shall be assembled with a hardened washer under the turned element. Hardened steel washers shall be used under both the head and the nut when bolts are used for the following connections:

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(1) Oversized holes (fabricated as per Contract)

(2) Replacing existing bolts or rivets

(3) Oversized and irregular hole conditions caused from field drilling or reaming

(4) Connections between new and existing steel members

Where an outer face of the bolted parts has a slope of more than 1:20 (V:H) with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

Bolts installed with the stem oriented vertically shall have the heads up. Bolts installed with the stem oriented horizontally shall have the head towards the weather unless clearance restrictions dictate otherwise.

Normally the nut will be the turned element; however, if the position of bolt entering or wrench operation clearances prohibit this procedure the bolt may be the turned element.

Tightening of a bolt group shall progress systematically from the most rigid part of the joint to its free edges.

Previously tightened bolts shall be re-tightened until all bolts in the connection are tightened to the minimum required tension.

Recalibration of the tightening wrench may be required any time there appears to be a significant change in the bolt tightening conditions.

All bolts in a connection shall first be brought to a "snug tight" condition. "Snug tight" is defined as initial tension sufficient to bring all the plies of the connection into firm contact while the drift pins remain in the connection. Snugging shall progress systematically, beginning at the most rigid part of the connection and progressing to the free edges until the connection is fully compacted.

All high-strength bolts shall be tightened to the specified tension as soon after installation as feasibly possible. Under no circumstances shall bolts be left untightened for more than five days after installation unless specific requirements to do so are indicated in the Contract or directed by the Engineer. Bolts left in place beyond five days without specific requirements in the Contract or as directed by the Engineer shall be removed and replaced with new bolts at the Contractor's expense.

Bolts shall be tightened to develop a tension not less than 5% more than the minimum bolt tension specified in Table 506.19A. Unless otherwise indicated on the Plans, *ASTM F 3125/F 3125 M* Grade A 325 hex head bolts shall be used.

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(d) Bolt Tensioning Methods. Bolts shall be tensioned by the Contractor in the presence of the Engineer using one of the following methods:

(1) Tension Control Assembly Method. A tension control assembly consists of a tension control bolt with a spline end and a suitable nut and washer. This method shall be employed when installing button-headed or dome-headed high-strength bolts. This method shall only be used when required by the Contract.

All bolts shall be tightened by the application of torque to the nut and counter-torque to the spline end of the bolt using an approved spline drive installation tool. A random sample of not less than three tension control assemblies of each diameter, length, grade, and type to be used in the work shall be checked a minimum of once each working day in a device capable of indicating bolt tension.

The test shall be performed to verify that the spline twist-off develops a tension at least 5% greater than the minimum bolt tension specified in Table 506.19A. Additional verification of the tension control assemblies shall be performed as directed by the Engineer. Separate checks will be required for each diameter fastener with hardened washers placed under the nut and/or bolt head as they will be used in the structure. Variations in the number or location of washers will require separate checks.

(2) Direct Tension Indicator Method. Direct tension indicators (DTIs) are compressible washers capable of indicating that a specified minimum bolt tension has been attained. DTIs installed with high strength bolts to indicate bolt tension shall be subjected to field verification testing prior to installation and the installation requirements specified in this subsection.

DTIs installed with high-strength bolts to indicate bolt tension shall be placed under the head of the bolt with the protrusions facing the head of the bolt, and the nut shall be turned, with a hardened washer underneath it, to tension the fastener. If for reasons of wrench operations clearance it is necessary to place the DTI under the turned element, the DTI shall be oriented so that the protrusions face outward from the work, and a hardened washer shall be placed between the DTI and the turned element. Placement of the DTI under the turned element will only be allowed when approved by the Engineer.

The bolt, DTI, hardened washer, and nut assembly used in the verification testing device and installed in the work shall be such that at least three and preferably not more than five threads are in the grip. The grip is defined as the distance between the bearing face of the nut and the bolt head.

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The Contractor shall supply 5-mil tapered feeler gauges, a calibrated bolt tension-measuring device and equipment necessary to perform field verification testing and inspection of tensioned bolts. The feeler gauges, fasteners, and impact and manual wrenches shall be the same as that to be used in the work.

The Contractor shall obtain the services of a qualified technical advisor employed by the DTI manufacturer to make at least one site visit to assist the Contractor and to assure the proper installation and use of DTIs. This requirement may be waived by the Engineer if the Contractor can demonstrate to the Agency's satisfaction successful use of DTIs on previous projects for the Agency.

Verification testing shall be performed in a calibrated bolt tension measuring device, such as a Skidmore-Welhelm Calibrator, with a special flat insert (supplied by the Contractor) replacing the normal bolt head-holding insert. The special insert allows the DTI to be located on the flat front face of the tension measuring device for ease of observation and improved access for measuring the DTI gap during testing.

The purpose of verification testing is to validate the DTI assembly's ability to indicate installation tension above the minimum. The verification tension specified in Table 506.19B is 5% higher than the minimum required installation tension in Table 506.19A. The increase provides confidence that the installation tension can be achieved for the lot. Three verification tests are required to be performed on random samples of each combination of fastener rotational-capacity lot, DTI lot and DTI position (under the nut or bolt head) used on the project. All three tests must pass for the DTI and assembly combination to be approved. Testing shall be performed at the project site by the Contractor and witnessed by the Engineer.

When testing for the normal DTI position, the nut shall be turned from the rear of the tension measuring device, with the bolt head against the DTI restrained from turning with another wrench. When testing with the DTI under the turned element, the turned element shall be placed on the flat front face of the tension measuring device and the unturned element will be in the rear held by another wrench.

a. Verification Test. The verification test shall be conducted as follows:

1. Tension the fastener to the Verification Tension load specified in Table 506.19B for the grade and size of fastener. If an impact wrench is used, tension to a load two-thirds below the required load and use a manual wrench to attain the required tension.

2. Determine and record the number of entries of a 5-mil feeler gauge in the spaces between the protrusions. When using galvanized or epoxy coated DTIs under the turned element, there shall be at least one entry of the feeler gauge.

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3. The DTI lot will be rejected if the number of entries is less than the value in Column 4 of Table 506.19B. If coated DTIs are used under the turned element, the DTI lot will be rejected if there are no entries.

If the bolts are too short to be tested in the tension measuring device, the Verification Test for the DTI shall be conducted on a longer bolt. Three verification tests are required as specified above.

Bolts and DTIs used in verification tests shall be marked and shall not be reused in the work.

(b) Installation. Installation of fasteners utilizing DTIs shall be conducted in two steps as follows:

1. Step 1. All of the bolts in a connection shall be installed to a snug-tight condition. Snugging shall progress systematically beginning at the most rigid part of the connection and progressing to the free edges until the connection is fully compacted. At the snug-tight condition all of the DTIs shall be inspected with the feeler gauge to verify that they meet the number listed in Column 4 of Table 506.19B.

   If the number of entries is less than the values specified in Table 506.19B, the fastener must be removed and another DTI installed, followed by re-snugging of the fastener. This is required because a fastener's tension may have relaxed during the snugging of adjacent fasteners. A compressed DTI does not rebound if the fastener tension is reduced. If a DTI which has fewer entries were left in place, it would give a false indication of bolt tension.

2. Step 2. The bolts in the connection shall then be further tensioned to the point that the number of entries for a 5-mil feeler gauge meets the number listed in Column 5 of Table 506.19B. Tightening shall progress systematically beginning at the most rigid part of the connection and progressing to the free edges. Drift pins shall be removed during this process. Several cycles may be required.

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TABLE 506.19A – BOLT TENSION VALUES FOR ASTM F 3125/F 3125 M, GRADE A 325 BOLTS

Nominal Bolt Diameter (in.)	Min. Bolt Tension (lbs) [1]
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1-1/8	56,450
1-1/4	71,700
1-3/8	85,450
1-1/2	104,000

[1] Equal to 70% of the specified maximum tensile strength of bolts.

TABLE 506.19B – NO. OF DTI ENTRIES FOR ASTM F 3125/F 3125 M, GRADE A 325 BOLTS

Nominal Bolt Diameter (in.)	Number of Spaces Between DTI Protrusions	Verification Tension (kips) [1]	Verification - Required Number DTI of Entries [2, 3]	Installation - Required Number DTI of Entries [2, 4]
1/2	4	13	2 – 4	0 – 1
5/8	4	20	2 – 4	0 – 1
3/4	5	29	3 – 5	0 – 2
7/8	5	41	3 – 5	0 – 2
1	6	54	3 – 6	0 – 2
1-1/8	6	59	3 – 6	0 – 2
1-1/4	7	75	4 – 7	0 – 4
1-3/8	7	89	4 – 7	0 – 4
1-1/2	8	108	5 – 8	0 – 4

[1] Verification tension is 1.05 times the minimum tension in Table 506.19A.

[2] An entry occurs when a 5-mil tapered feeler gauge fits into the space between DTI protrusions and touches the bolt shank.

[3] For coated DTIs under the turned element, at least one entry is required.

[4] For coated DTIs under the turned element, 0 – 1 entries are required

(e) Acceptance of Bolt Tensioning. The installation and tightening of bolted connections shall be observed to determine if the tightening procedure is working properly and the correct tension has been achieved

The Contractor shall provide a tension measuring device, such as a Skidmore-Wilhelm Calibrator, that has been calibrated within the last year and is accompanied by a certificate verifying its date of calibration.

Before the installation of fasteners in the work, the Engineer shall check the marking, surface condition, and storage of bolts, nuts, and washers and the faying (contact) surfaces of joints for compliance with the Contract requirements.

Bolt tension for fasteners with DTIs shall be verified using 5-mil tapered feeler gauges provided and operated by the Contractor.

All bolts installed using DTIs shall be inspected after snug tightening and again after full tensioning, with 100% of the bolts inspected visually and 10% of the bolts in any connection (but not less than two) inspected by feeler gauge. If the installation of inspected bolts is accepted, then the connection shall be accepted as properly tensioned.

If any bolt in a connection does not pass inspection, then all (100%) of the bolts in that connection shall be inspected with the feeler gauge. Any bolt which does not pass inspection as described herein shall be further tensioned if required.

Bolts installed using tension control assemblies shall be visually inspected for consistent "twist-off" and thread stick-out.

Undamaged fasteners may only be reinstalled with the approval of the Engineer, and with the following exceptions: galvanized bolts, *ASTM F 3125/F 3125 M* Grade A 490 bolts, tension control assemblies, and direct tension indicators shall not be reused.

An additional required inspection step is to check the bolt thread stick-out on the nut side after installation to the final specified gap to look for inconsistency of pattern. Any stick-outs greater than the other bolts shall be investigated and discarded (e.g., if necking down of the bolt has occurred or the wrong length bolt was used). The end of the properly installed bolt shall be at least flush with the nut.

The Engineer shall be provided with safe access in accordance with the requirements of Section 105 to conduct all inspection deemed necessary during and after the installation of the bolts. If the Engineer determines that the access provided is unsafe, work will be ordered to halt until such time the access is made safe. Any delays incurred by the unsafe access will not be cause for a monetary, material, or delay Claim.

506.21 STRAIGHTENING BENT MATERIAL. Damaged, bent, or misaligned structural steel may only be straightened or corrected by procedures approved by the Agency. The method of repair proposed by the Contractor shall be submitted as construction drawings for approval in accordance with the requirements of Section 105. No corrective work shall be performed without Agency approval. Heating limitations and procedures shall conform to the requirements of Subsection 506.12.

Members or parts to be heat straightened must be free of stress from external forces other than those necessary and used in conjunction with the application of heat. Following straightening, the surface of the metal shall be free of any evidence of distortion or fracture. Required nondestructive tests shall be performed by NDT Level II or III personnel at the Contractor's expense.

506.22 FIELD CLEANING. When assembly of the fabricated structural components is complete, any rust, scale, dirt, grease, or other foreign material shall be removed from the metal components.

If the components are new steel which are metalized or galvanized or which are to remain unpainted, the cost of such necessary cleaning will not be paid for directly, but will be considered incidental to the Section 506 items in the Contract.

506.23 STEEL SURFACES AND COATINGS.

(a) Uncoated Steel. Care must be taken to keep chemicals and oils from contacting the exposed surfaces of unpainted steel during storage, erection, and construction of the deck.

(1) Staining of Masonry. The Contractor shall protect all concrete and masonry from staining due to oxide formation on the steel

(2) Cleaning of Steel. After all concrete has been placed, the outside surface of the fascia beams and bottom surface of their lower flanges shall be cleaned of all foreign material to a uniform appearance. The Engineer may require the exposed surfaces to be blast cleaned to Preparation Grade *SSPC-SP 10*. The use of acids for cleaning is prohibited.

(b) Galvanized Steel. All steel surfaces to be galvanized per Plans shall be coated in accordance with Subsection 726.08. Certifications as described in *ASTM A 123*, Section 10 for the completed products shall be furnished to the QA Inspector (or the Structural Steel Fabrication Engineer, if there is no QA Inspector assigned to the project) prior to shipment from the galvanizer's plant. Certifications shall include a report of all test results.

(c) Metalized Steel. All steel surfaces to be metalized per Plans shall be metalized and seal coated in accordance with Subsection 726.09.

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(d) Painted Steel. When the Plans specify shop painted structural steel, the work shall be performed in accordance with the requirements of this subsection.

(1) Materials. The fabricator shall provide a three coat paint system meeting the requirements of Subsection 708.03.

Shop applied systems may have isolated areas where the coatings were damaged during shipping or erection and will have areas around faying surfaces that may need field applied primer, intermediate, and top coatings. Thus, any coating system that is used in the shop shall be acceptable for the field conditions that are expected to be encountered.

(2) Submittals. The fabricator shall submit a complete package, in accordance with Subsection 105.03 for construction drawings, which includes the following information. The submittals shall be made sufficiently in advance of coating work to allow for review, resubmittals, and approval.

a. Surface Preparation/Painting Plan. The surface preparation/painting plan shall include the specified methods of surface preparation and type(s) of equipment to be utilized for removal of rust, mill scale, or foreign matter. The plan shall identify the solvents proposed for solvent cleaning, together with the solvent Safety Data Sheets (SDS). If any detergents, additives, or inhibitors are incorporated into the water used for any coating work operations, the plan shall include the names of the materials and their SDS.

The plan shall also include the methods of coating application, including any required stripe coats, and all equipment to be utilized.

The plan shall also identify all applicable QC/QA Hold Points. Specific inspection items throughout these specifications are designated as Hold Points. These Hold Points are for the QA Inspector to perform inspections. QA inspections will be performed only after a proper QC inspection by the fabricator. Permission to proceed beyond a Hold Point without a QA inspection will be granted solely at the discretion of the Structural Steel Fabrication Engineer, and only on a case-by-case basis. If re-work is necessary, as determined by a QA inspection, it shall be accomplished and a new Hold Point for the re-work shall be observed as defined above.

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b. Abrasives. The fabricator shall submit the type of abrasives to be used for abrasive blast cleaning and their SDS. For expendable abrasives, the Contractor shall provide certification from the abrasive supplier that the abrasive meets the requirements of *SSPC-AB 1*. For steel grit abrasives, the certification shall indicate that the abrasive meets the requirements of *SSPC-AB 3*.

c. Coating System Information. The fabricator shall submit the latest version of the product manufacturer's application and thinning instructions, SDS, and product data sheets for each and every coating, thinner, sealer, and grease rustproofing compound. Specific attention shall be drawn to storage temperatures and the temperatures of the material, surface, and ambient air at the time of application. Recommended minimum ambient weather conditions during curing shall also be included A letter or written instructions from the coating manufacturer shall be provided indicating the length of time that each coat must be protected from cold or inclement weather (e.g. exposure to rain) during the drying/curing period.

When the Agency accepts the submittals, the fabricator will receive written notification. The fabricator shall not construe Agency acceptance of the submittals to imply approval of any particular method or sequence for conducting the work, or for addressing health and safety concerns. Acceptance of the submittals does not relieve the fabricator from the responsibility to conduct the work according to the requirements of Federal, State, or local regulations, this specification, or to adequately protect the health and safety of all workers involved in the project and any members of the public who may be affected by the project. The fabricator remains solely responsible for the adequacy and completeness of the programs and work practices, and adherence to them.

(3) Quality Control (QC) Inspections. The fabricator shall perform first line, in progress QC inspections. The personnel performing any QC tests shall be trained in coatings inspection and the use of the testing instruments. Documentation of training shall be provided upon request. Painters shall perform wet film thickness measurements, with the Quality Control Inspector conducting random spot checks of the wet film. Reports for all quality control testing and observations shall be completed and provided to the QA Inspector on a daily basis.

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a. Fabricator QC inspections shall include, but are not limited to, the following:

1. Ambient conditions.

2. Compressed air cleanliness.

3. Surface preparation and surface profile (solvent cleaning, abrasive blast cleaning, etc.).

4. Coating application (materials verification, mixing, thinning, induction/sweat-in time, and wet/dry film thickness).

5. Recoat times and cleanliness between coats.

6. Coating continuity and coverage (freedom from runs, sags, overspray, dry spray, pinholes, shadow-through, skips, misses, etc.).

7. Records of fabricator QC inspections shall document any applicable product batch numbers.

b. The following equipment shall be provided by the fabricator as necessary to perform QC inspections:

1. Psychrometer or comparable equipment for the measurement of dew point and relative humidity, together with all necessary tables or psychrometric charts.

2. Surface temperature Digital Spot Thermometer.

3 *SSPC-VIS 1* and *SSPC-VIS 3*, as applicable.

4. Commercially available putty knife of a minimum thickness of 40 mils and a width between 1 and 3 inches.

5. Replica tape and spring micrometer.

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6. Wet film thickness gauge.

7. Blotter paper for compressed air cleanliness checks.

8. Type 2 electronic dry film thickness gauge per *SSPC-PA 2.*

9. Calibration standards for dry film thickness gauge.

10. Light meter for measuring light intensity during surface preparation, painting, and inspection activities.

11. Printed copies of all applicable ASTM and SSPC Standards used for the work.

12. *SSPC Manual of Good Painting Practice, Volume 1*.

The instruments shall be calibrated within 12 months of the date of project usage or according to the equipment manufacturer's recommendations and the fabricator's QC Program if they require a shorter duration.

(4) Quality Assurance (QA) Observations. The QA Inspector will conduct QA observations of any or all phases of the work. The presence or activity of QA Inspector observations in no way relieves the fabricator of the responsibility to provide all necessary daily QC inspections and to comply with all requirements of this specification.

The Structural Steel Fabrication Engineer has the right to reject any work that was performed without adequate provision for QA observations.

(5) Inspection Access and Lighting. The fabricator shall provide artificial lighting in areas where natural light is inadequate, to allow proper cleaning, inspection, and painting. Illumination for inspection shall be at least 30 foot-candles.

(6) Surface Preparation and Painting Equipment. All cleaning and painting equipment shall include gauges capable of accurately measuring fluid and air pressures and shall have valves capable of regulating the flow of air, water, or paint as recommended by the equipment manufacturer. The equipment shall be maintained in proper working order.

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Hand tools, power tools, abrasive blast cleaning equipment, brushes, rollers, and spray equipment shall be of suitable size and capacity to perform the work required. All power tools shall be equipped with vacuums and High Efficiency Particulate Air (HEPA) filtration. Appropriate filters, traps, and dryers shall be provided for the compressed air used for abrasive blast cleaning and conventional spray application. Paint pots shall be equipped with air operated continuous agitation devices unless prohibited by the coating manufacturer. The air discharge from power tools and air motors shall be directed away from steel surfaces; if this is not possible a filtering device shall be appropriately placed.

(7) Ambient Conditions. Surfaces to be painted after cleaning shall remain free of moisture and other contaminants. The fabricator shall control operations to ensure that dust, dirt, or moisture does not come in contact with surfaces cleaned or painted that day. The following ambient conditions shall be met:

a. The surface and ambient temperatures shall be at least 5°F above the dew point during final surface preparation operations.

b. The surface and ambient temperatures shall be a minimum of 40°F, at least 5°F above dew point, and the maximum relative humidity shall be less than or equal to 85% during the application and cure/dry time of each coat of the paint system. If the manufacturer's published literature is more restrictive it shall be followed for specific temperature, dew point, and humidity conditions during the application cure/dry of each coat. The cure/dry time shall be measured as the time following application when the ambient conditions are within the ranges above.

The fabricator shall monitor and document temperature, dew point, and relative humidity at the beginning of each work day and every 4 hours during surface preparation and coating application, in the specific areas where the work is being performed. The frequency of monitoring shall increase if weather conditions are changing. If the weather conditions are forecast to be borderline relative to the limits established by the manufacturer, monitoring shall continue at a minimum of 4 hour intervals throughout the curing/drying period. The Structural Steel Fabrication Engineer has the right to reject any work that was performed under unfavorable weather conditions. Rejected work shall be removed, re-cleaned, and repainted at the fabricator's expense.

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(8) Compressed Air Cleanliness. Prior to using compressed air for abrasive blast cleaning, blowing down the surfaces, and painting with conventional spray, the fabricator shall verify that the compressed air is free of moisture and oil contamination in accordance with the requirements of *ASTM D 4285*. The tests shall be conducted at least one time each shift for each compressor system in operation. If air contamination is evident, the fabricator shall change filters, clean traps, add moisture separators or filters, or make other adjustments as necessary to achieve clean, dry air. The fabricator shall also examine the work performed since the last acceptable test for evidence of defects or contamination caused by the compressed air. Affected work shall be repaired at the fabricator's expense.

(9) Surface Preparation and Profile (Hold Point).

a. Surface Preparation. All steel surfaces to be painted shall be prepared by dry abrasive blast cleaning to meet the requirements of *SSPC-SP 10*.

b. Abrasives. Abrasive blast cleaning shall be performed using either expendable abrasives (other than silica sand), or recyclable steel grit abrasives. Expendable abrasives shall be used one time and disposed of. The fabricator shall verify that recycled abrasives are free of oil contamination by conducting oil content tests in accordance with *SSPC-AB 2* on a daily basis.

c. Surface Profile. The abrasives used for blast cleaning shall have a gradation such that the abrasive will produce a uniform surface profile of 1.5 to 3.5 mils. If the profile requirements of the coating manufacturer are more restrictive, the fabricator shall advise the Structural Steel Fabrication Engineer and comply with the more restrictive requirements. For recycled abrasives, an appropriate operating mix shall be maintained in order to control the profile within these limits.

The surface profile produced by the fabricator's surface preparation procedures shall be determined by replica tape and spring micrometer at the beginning of the work, and each day that the surface preparation is performed. Areas having unacceptable measurements shall be further tested to determine the limits of the deficient area. The replica tape shall be attached to the daily report.

When unacceptable profiles are produced, work shall be suspended. The fabricator shall make the necessary adjustments to ensure that the correct surface profile is achieved on all surfaces. The fabricator shall not resume work until the new profile is verified by the QA observations and he/she confirms that the profile is acceptable.

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d. Surface Condition Prior To Painting. Prepared surfaces shall meet the specified degrees of cleaning immediately prior to painting, and shall be painted before rusting appears on the surface. If rust appears or bare steel remains unpainted for more than 8 hours, the affected area shall be prepared again at the expense of the fabricator.

All surface preparation cleaning residue on steel surfaces shall be removed prior to painting.

The quality of surface preparation and cleaning of surface dust and debris must be accepted by the QA Inspector prior to painting. The Structural Steel Fabrication Engineer has the right to reject any work that was performed without adequate provision for QA observations to accept the degree of cleaning. Rejected coating work shall be removed and replaced at the fabricator's expense.

(10) General Paint Requirements. Paint storage, mixing, and application shall be accomplished according to these specifications and as specified in the paint manufacturer's written instructions and product data sheets for the paint system used. In the event of a conflict between these specifications and the coating manufacturer's instructions and data sheets, the fabricator shall advise the Structural Steel Fabrication Engineer and comply with the most restrictive requirements.

a. Paint Storage and Mixing. All paint shall be stored according to the manufacturer's published instructions, including handling, minimum and maximum temperatures, and warming as required prior to mixing. All coatings shall be supplied in sealed containers bearing the manufacturer's name, product designation, batch number, and mixing/thinning instructions. Leaking containers shall not be used. The paint shall be stored in a secure fireproof location.

Mixing shall be performed according to the manufacturer's instructions. Thinning shall be performed using thinner provided by the manufacturer, and only to the extent allowed by the manufacturer's written instructions. In no case shall thinning be permitted that would cause the coating to exceed the local Volatile Organic Compound (VOC) emission restrictions. For multiple component paints, only complete kits shall be mixed and used. Partial mixing is not allowed.

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The ingredients in the containers of paint shall be thoroughly mixed by mechanical power mixers according to the manufacturer's instructions, in the original containers before use or mixing with other containers of paint. The paint shall be mixed in a manner that will break up all lumps, completely disperse pigment, and result in a uniform composition. Paint shall be carefully examined after mixing for uniformity and to verify that no unmixed pigment remains on the bottom of the container.

Excessive skinning or partial hardening due to improper or prolonged storage will be cause for rejection of the paint, even though it may have been previously inspected and accepted. Manufacturer recommended induction/sweat-in times and temperature of mixed coatings shall be observed.

Multiple component coatings shall be discarded after the expiration of the pot life. Single component paint shall not remain in spray pots, paint buckets, etc. overnight and shall be stored in a covered container and remixed before use.

b. Paint Application. Unless prohibited by the coating manufacturer's written instructions, paint may be applied by spray methods, rollers, or brushes. If applied with conventional or airless spray methods, paint shall be applied in a uniform layer with overlapping at the edges of the spray pattern.

The painters shall monitor the wet film thickness of each coat during application. The wet film thickness shall be calculated based on the specified dry film thickness using the solids by volume of the material and the amount of thinner added.

When brushes or rollers are used to apply the coating, additional applications may be required to achieve the specified thickness per layer.

c. Re-coating and Film Continuity (Hold Point for Each Coat). Paint shall be considered dry for re-coating according to the re-coat time/temperature/humidity criteria provided in the manufacturer's instructions, and when an additional coat can be applied without the development of film irregularities such as lifting, wrinkling, or loss of adhesion of the under coat.

d. Stripe Coats. Unless indicated otherwise in the Contract, the Contractor shall apply an additional stripe coat to edges, crevices, welds, and similar surface irregularities for the prime coat and intermediate coat. The stripe coat shall be applied by brush or roller, as per manufacturer's recommendations, such that the coating is thoroughly worked into or on the irregular surfaces, and shall extend onto the surrounding steel a minimum of 1 inch in all directions. The purpose of the stripe coat is to build additional thickness and to assure complete coverage of these areas.

The stripe coat shall not be applied as part of the application of the full coat. The stripe coat shall be applied and dried separately according to the manufacturer's recommended drying times. Also, the color of the stripe coat shall contrast with the colors used for the full coats immediately preceding and succeeding the stripe coat.

e. Coating Sequence. For locations painted under this specification, coatings shall be applied as follows:

1. Prime Coat. The full prime coat shall be applied first to protect the steel. Once the full prime coat has dried, the prime stripe coat shall be applied.

2. Intermediate Coat. After the prime stripe coat has dried, an intermediate stripe coat shall be applied and allowed to dry, followed by the full intermediate coat.

3. Top Coat. After the full intermediate coat has dried, the full top coat shall be applied.

(11) Coating Thickness. The dry film thicknesses of the full coats shall be as follows, as measured in accordance with *SSPC-PA 2*. If the manufacturer's upper or lower thickness limit is more restrictive, it shall be followed instead.

1. The prime coat of organic zinc-rich primer shall be between 3.5 and 5.0 mils dry film thickness.

2. The intermediate coat of epoxy or urethane shall be between 3.0 and 6.0 mils dry film thickness.

3. The finish coat of aliphatic urethane shall be between 2.5 and 4.0 mils dry film thickness. Finish coat color shall be according to Contract.

(12) Amine Blush. Amine blush is a residue that can form on newly applied epoxy coating films under certain conditions. Amine blush often appears as a yellowish milky and/or a blotchy residue on the coating surface and is a deterrent to the adhesion of subsequently applied coating layers. If amine blush is detected, the Contractor shall provide the Engineer with written procedures from the coating manufacturer for complete removal prior to the application of additional coating layers.

Painting shall be done in a neat and workmanlike manner. Each coat of paint shall be applied as a continuous film of uniform thickness free of defects including, but not limited to, runs, sags, overspray, dry spray, pinholes, voids, skips, misses, and shadow-through. Defects such as runs and sags shall be brushed out immediately during application.

(13) Repair of Damage to New Coating System. The Contractor shall repair all damage to the newly installed coating system, at no cost to the Agency. If the damage extends to the substrate, the damaged areas shall be prepared to meet *SSPC-SP 3*.

The surrounding coating at each repair location shall be feathered for a minimum distance of 1-1/2 inches to achieve a smooth transition between the prepared areas and the existing coating.

If the bare steel is exposed, all coats shall be applied to the prepared area. If only the intermediate and finish coats are damaged, the intermediate and finish coats shall be applied. If only the finish coat is damaged, the finish coat shall be applied.

All Hold Points and specifications are applicable to the repair of damaged areas and areas concealed by containment.

(e) Grease Coating. When the Plans specify that any steel surfaces are to be grease coated, all work shall be performed in accordance with Subsection 708.04.

Grease rustproofing compound shall be uniformly applied in a single coat by brush or spray at an approximate rate of 20 ft^2/gal to the steel as specified. This shall occur after all concrete form work has been removed, and after the final coat of paint, including repairs, has fully cured. A fully cured condition has occurred when a thumbnail driven into the coating surface does not leave an impression and when a thumb firmly pushed against the surface and twisted does not disturb the coating.

Surfaces adjacent to areas being grease coated shall be protected against over-spray. Non-metallic and stainless steel surfaces shall not be coated.

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506.24 METHOD OF MEASUREMENT.

(a) Bids on a Pound Basis. The quantity of Structural Steel, or other material being paid under this item, to be measured for payment will be the number of pounds used in the complete and accepted work. The weight of the material to be measured for payment under this item will be computed based on the approved fabrication drawings, as follows:

(1) Weight determined by the volume of material will be computed based on the densities specified in Table 506.24A.

TABLE 506.24A – MATERIAL DENSITIES

Material	Density (lbs/ft^3)
Aluminum, Alloy	173
Bronze, Cast	536
Copper, Alloy	536
Copper, Sheet	558
Iron, Cast	445
Iron, Wrought	487
Lead, Sheet	707
Steel – Rolled, Cast, Copper Bearing, Silicon, Nickel, or Stainless	490

For any material not listed in Table 506.24A, the material will be paid for by actual weight as measured on a certified scale.

(2) The weight of rolled structural shapes will be computed based on their nominal weight per foot as shown on the Plans or, if not shown on the Plans, by the weights shown in the current edition of the *AISC Manual*.

The weight of rolled shapes will be based on the overall net length shown on the approved fabrication drawings, with no allowance for milling, finishing, or overrun, and with no deduction for cuts, clips, copes, or open holes.

(3) The weight of plates will be based on the net finished dimensions shown on the approved fabrication drawings, with no allowance for milling, finishing, tolerance, or overrun, and with no deductions for copes, clips, and open holes. The weights of beveled plates or curved surface plates will be based on the finished maximum thickness shown on the approved fabrication drawings.

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For gusset plates, scupper components, slotted plates, and similar minor fixtures the net finished dimensions will be the minimum rectangular dimensions from which the parts are cut, except when it is practical to cut the parts in multiples from pieces of larger dimensions, in which case the weight will be based on the dimensions of the larger pieces, making necessary allowance for the material lost in cutting.

The net finished dimensions of flange plates will be the nominal width and the finished length measured along the centerline of the flange without deduction for width transitions, bevels, or chamfers.

The net finished dimensions of the webs of all girders and of the webs of rigid frame legs will be the actual area of the web as detailed on the approved fabrication drawings.

(4) The weight of fabricated metal items such as U-bolts, welding studs, and lugs will be based on net dimensions of the finished product as shown on the approved fabrication drawings.

(5) All welding shall be considered as incidental work to the fabrication, and no measurement will be made for the weight of weld metal used.

(6) Measurement for castings will be by weight measured on scales.

(7) When it is specified that any part of the material is to be measured by actual weight, finished work shall be weighed in the presence of the Engineer. In such case, the scales shall have been certified for accuracy within a one-year period.

(8) The weight of permanent shop and field bolts, nuts, direct tension indicators, and washers incorporated into the structure and temporary erection bolts, nuts, and washers shall be incidental to the Structural Steel item and no measurement will be made for weight of the bolts, nuts, direct tension indicators, and washers.

(b) Bids on Lump Sum Basis. The quantity of Structural Steel, or other material being paid under this item, to be measured for payment will be the number of units for each structure complete and accepted as specified in the Contract.

506.25 BASIS OF PAYMENT. The accepted quantity of Structural Steel will be paid for at the Contract unit price per pound for the items specified in the Contract. Payment will be full compensation for furnishing, detailing, handling, transporting, and placing the materials specified, including nondestructive testing of welds; for preparing the surface of new steel to be painted, galvanized, metalized, or to remain unpainted; for necessary field cleaning; and for painting, metalizing, sealing, galvanizing, or grease coating of surfaces, unless otherwise paid for. Payment will also be full compensation for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

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Payment for Structural Steel on a lump sum basis will be full compensation for performing all work specified and for furnishing all labor, materials, tools, equipment, erection plans, and incidentals necessary to complete the work.

The Engineer may authorize progress payments in the following manner:

(a) A maximum of 15% of the estimated quantity may be paid when the fabrication drawings are approved for fabrication.

(b) A maximum of 75% of the estimated quantity may be paid when the steel has been entirely completed and accepted per the approved fabrication drawings, stored in a location and manor accepted by the Structural Steel Fabrication Engineer, and all applicable material certifications have been approved.

(c) A maximum of 90% of the estimated quantity may be paid when the steel has been erected, falsework removed, and painting of connections, and "touch-up" completed where required.

(d) After completion and acceptance of all work under this section, including extended weights being received and checked, 100% of the quantity will be paid.

All nondestructive testing and required quality control activities will be considered incidental to fabrication, and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
506.50 Structural Steel, Rolled Beam	Pound
506.55 Structural Steel, Plate Girder	Pound
506.56 Structural Steel, Curved Plate Girder	Pound
506.57 Structural Steel, Truss	Pound
506.60 Structural Steel	Pound
506.75 Structural Steel	Lump Sum

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SECTION 507 – REINFORCING STEEL

507.01 DESCRIPTION. This work shall consist of furnishing and placing bar reinforcement of the level specified, dowels, wire, welded wire reinforcement (WWR), and mechanical bar connectors.

Levels and associated types of reinforcing steel are specified as follows:

(a) Level I (Limited Corrosion Resistance). Level I reinforcing includes plain, low-alloy, and epoxy-coated reinforcing steel.

(b) Level II (Improved Corrosion Resistance). Level II reinforcing includes stainless-clad, dual-coated, and continuously-galvanized reinforcing steel.

(c) Level III (Exceptional Corrosion Resistance). Level III reinforcing includes solid stainless reinforcing steel.

The location, level, and when specified, type of reinforcing shall be as indicated in the Plans. Reinforcing supplied shall meet the requirements of the level specified or any higher level. Only one type of reinforcing steel shall be used for each level for the Contract work, unless permitted in writing by the Engineer.

507.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV 707.03
Bar Reinforcement 713.01
Mechanical Splices for Bar Reinforcement 713.02
Cold Drawn Steel Wire 713.04
Welded Wire Reinforcement 713.05

Spiral reinforcement for columns may be bar reinforcement or cold-drawn steel wire.

507.03 FABRICATION AND SHIPMENT. Bar reinforcement shall be deformed bar cold-bent to the shapes required. Bar reinforcement shall be fabricated, bundled, tagged, marked, and shipped in accordance with the Concrete Reinforcing Steel Institute (CRSI) *Manual of Standard Practice*. The fabricator shall maintain records that will provide traceability of identifying heat numbers for all material being fabricated for Agency projects or Contract orders referencing materials covered under this section.

507.04 PROTECTION OF MATERIAL. Reinforcing steel shall always be protected from damage by storing on blocking, racks, or platforms. When multiple levels of reinforcing steel are used on a project, they shall be stored separately, including during transport in order that there is no direct contact between the bars. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substances.

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All systems for handling and storing coated reinforcement shall have padded contact areas. Epoxy-coated and dual-coated reinforcement stored on a project or between phases of work shall be covered with canvas or other suitable material that will effectively protect it against damage from ultraviolet light.

All damaged areas of reinforcement coating shall be repaired with materials and procedures recommended by the coating manufacturer. The materials and procedures must be approved by the Engineer prior to the repairs.

Coatings shall be repaired prior to installation of the reinforcement. Repair prior to installation does not relieve the Contractor from repairing areas damaged during placement.

All repairs shall be inspected and accepted by the Engineer prior to placing concrete. All bars with total damage, including previously repaired areas, greater than 2% of the bar surface area shall be rejected.

When cutting coated reinforcement, a cutting torch shall not be used. The use of a power hacksaw is acceptable. All cut ends shall be repaired per the coating manufacturer's recommendations and to the satisfaction of the Engineer.

Ends of Level II reinforcing steel where the mild steel is exposed shall be repaired in the following manner:

(a) Cut ends of dual-coated reinforcing steel shall be coated with a two-part epoxy patching material as specified by the coating manufacturer. The materials and procedures shall be approved by the Engineer prior to the repairs being performed.

(b) Cut ends of stainless-clad reinforcing steel shall be epoxied and capped in accordance with the manufacturer's recommendations with either stainless steel caps or plastic caps. Caps shall be sealed to prevent the intrusion of moisture.

(c) Cut ends of continuously-galvanized reinforcing steel shall be coated with a zinc-rich paint. The paint used in the repair shall be organic-rich and contain at least 92% zinc by weight in the dry film. The paint shall be applied per the manufacturer's recommendations to a thickness equivalent to the surrounding galvanizing.

507.05 PLACING AND FASTENING REINFORCING STEEL. Steel reinforcement shall be placed in the position shown on the Plans and held securely in place during the placing of concrete. Unless otherwise noted on the Plans, placement tolerances for reinforcing steel shall be 1/4 inch for cover and clearance and 1 inch for spacing of bars. Stirrups and spirals shall pass around main tension members and be securely attached to those members.

Reinforcing steel shall be spaced as specified from the face of the forms. Horizontal layers shall be spaced vertically by means of approved supports. Support material within 1-1/2 inches of a finished concrete surface shall be stainless steel, epoxy, plastic coated galvanized steel, or plastic.

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Bar reinforcement shall not be further bent or straightened from the curvature produced at initial fabrication except when approved by the Engineer. If heating is approved for field bends, the temperature should not exceed that which produces a dull red color in the bar.

Bars spaced 12 inches apart or further shall be tied at every intersection. Bars spaced less than 12 inches apart shall be tied at every other intersection. If reinforcement shows signs of distress during construction, the Engineer may direct additional tying.

Welding procedures shall be submitted for approval for any type of reinforcement welding. Welding of reinforcement steel will not be permitted without written permission of the Engineer. Welding shall conform to the requirements of Subsection 506.10. Special care shall be taken so that no undercut will occur and reduce the effective area of the reinforcing bars.

Tie wires and supports used for installation of reinforcement shall be composed of the same material as any steel being contacted or shall be plastic. When forms are to be removed in their entirety, uncoated steel chairs equipped with snug-fitting, high-density, polyethylene tips which provide a 1/4-inch clearance between the metal and any exposed surface may be used.

Horizontal mats of reinforcing steel shall have lines of support not exceeding a 4-foot spacing in either direction. Additional individual chairs may be required near the fascia.

Reinforcement placed in any member shall be inspected and approved before any concrete is placed. Mechanical bar connectors shall be installed per the manufacturer's instructions.

507.06 PLACING DOWELS. Dowels shall be placed in existing concrete or ledge at locations shown on the Plans. Where Type IV mortar is to be used, holes shall be drilled to the depth shown on the Plans and shall be at least 1 inch greater in diameter than the dowel. Where approved adhesives are used, the manufacturer's recommendations shall be followed for hole sizing. Dowels shall be grouted with Type IV mortar or other approved material.

507.07 SPLICES. All reinforcement shall be furnished in the lengths shown on the Plans. No splicing of any type, except where shown on the Plans, will be permitted without the written approval of the Engineer. Welded butt splices or mechanical splices shall be used only when specified in the Contract or with written approval of the Engineer.

507.08 LAPPING. Sheets of WWR shall overlap not less than the wire spacing and be securely fastened at the ends and edges. The edge lap shall be not less than the wire or bar spacing.

507.09 METHOD OF MEASUREMENT. The quantity of Reinforcing Steel of the type and size specified to be measured for payment will be the total number of pounds of reinforcing bars, dowels, wire, and WWR used in the complete and accepted work except as otherwise provided, computed on the following basis:

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(a) The mass of bars, wire, and dowels will be measured as either:

(1) The product of the length as shown on the approved shop bar lists and the standard weight per foot of length as adopted by the CRSI.

(2) If approved by the Engineer, the weight on a certified bill of lading from the reinforcement supplier. The bill of lading must be broken down and sub-totaled based on individual bar marks and types of reinforcement.

(b) The weight of WWR will be measured as either:

(1) The computed weight in accordance with the details shown on the Plans based on the standard weight accepted by the trade for the unit of material specified.

(2) If approved by the Engineer, the weight on a certified bill of lading from the reinforcement supplier. The bill of lading must be broken down and sub-totaled based on individual bar marks and types of reinforcement.

(c) Measurement for payment will not be made for any clips, wire, or other material that may be used by the Contractor for keeping the reinforcing bars in their correct position.

(d) Measurement for payment will be adjusted for any material accepted with an overall dimensional length less than or greater than the 1 inch CRSI tolerance.

(e) When the substitution of bars of greater diameter than specified is permitted by written authorization of the Engineer, payment will be made for only the weight of steel that would have been required if the specified diameter had been used. In case short bars are used when full length bars are shown on the Plans, the weight to be measured will be only the equivalent of the weight of full length bars as if they had been used, with no allowance for laps.

The quantity of Drilling and Grouting Dowels to be measured for payment will be for the length of hole in linear feet to be drilled as shown on the Plans. If not shown on the Plans, the depth of drilled holes shall be 2 feet. The dowel will be measured as Reinforcing Steel of the type specified.

The quantity of mechanical bar connectors will be the number of mechanical connectors installed in the complete and accepted work.

507.10 BASIS OF PAYMENT. The accepted quantities of Reinforcing Steel of the type specified will be paid for at the Contract unit price per pound. Payment will be full compensation for furnishing, handling, welding, and placing the material specified and for furnishing all labor, fastening devices, tools, equipment, and incidentals necessary to complete the work.

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The accepted quantity of Drilling and Grouting Dowels will be paid for at the Contract unit price per linear foot. Payment will be full compensation for drilling the dowel hole, grouting the dowel in the hole, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When the Contract does not contain a quantity for Drilling and Grouting Dowels, this work will not be paid for directly but will be considered as incidental to all other Contract items.

The accepted quantity of Mechanical Bar Connectors will be paid for at the Contract unit price for each.

Payment will be full compensation for furnishing, handling, placing, and joining the materials; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
507.11 Reinforcing Steel, Level I	Pound
507.12 Reinforcing Steel, Level II	Pound
507.13 Reinforcing Steel, Level III	Pound
507.16 Drilling and Grouting Dowels	Linear Foot
507.19 Mechanical Bar Connector	Each

SECTION 508 – SHEAR CONNECTORS

508.01 DESCRIPTION. This work shall consist of furnishing and welding shear connectors.

508.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Welded Stud Shear Connectors 714.10

508.03 WEATHER LIMITATIONS. Application of stud shear connectors or other welding on shear connectors shall not be done when the base metal temperature is below 0°F or when the surface is wet or exposed to falling rain or snow.

508.04 PLACING, INSPECTING, AND TESTING.

(a) General. The Contractor shall install the shear connectors as detailed in the Contract and the approved structural steel fabrication drawings. Shear connectors shall be placed, inspected, and tested in accordance with the latest edition of *AWS D 1.5*.

When the base metal temperature of a member to which automatically welded shear connectors are to be attached is less than 35°F, the following requirements shall apply:

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(1) Base Metal in Compression Only. The Contractor has the option of obtaining an approved welding procedure for application of the studs or preheating the base metal to a minimum temperature of 50°F.

(2) Base Metal in Tension or Stress Reversal Zones. The base metal shall be preheated to a minimum temperature of 70°F.

The base metal of all portions of a member in tension to which shear connectors are to be welded shall be preheated to a temperature of 70°F for thicknesses up to 1-1/2 inches, preheated to 150°F for thicknesses of 1-1/2 to 2-1/2 inches, and preheated to 225°F for thicknesses more than 2-1/2 inches. Preheating applies to either shop or field-applied shear connectors.

If, during the progress of the work, inspection and testing indicate that the shear connectors being furnished are not satisfactory, the Contractor shall make changes in the welding procedure, welding equipment, and type of shear connector as necessary to provide satisfactory results. Such changes shall be made at the Contractor's expense.

(b) Studs. Installation and acceptance of stud shear connectors shall be in accordance with the requirements of *AWS D1.5*.

After being allowed to cool, the first two studs welded on each beam or girder shall be bent 45° by striking the stud with a hammer. If failure occurs in the weld zone of either stud, the procedure shall be corrected, and two additional studs shall be successfully welded and tested before any more studs are welded to the beam or girder. The Contractor shall promptly inform the Engineer of any changes in the welding procedure.

After the studs have been welded to the beams, the Engineer will make a visual inspection, and each stud will be given a light blow with a hammer. Any stud that does not emit a ringing sound when given a light blow with a hammer, that has been repaired by welding, or that has less than normal reduction in height due to welding shall be struck with a hammer and bent 15° from the correct axis of installation.

In the case of a repaired weld, the stud shall be bent 15° in the direction that will place the repaired portion of the weld in the greatest tension. Studs that crack either in the weld or in the shank shall be replaced.

All tested shear connectors that show no sign of failure shall be left in the bent position.

The Engineer may select additional studs to be subjected to the bend test specified above.

508.05 METHOD OF MEASUREMENT. The quantity of Shear Connectors to be measured for payment will be on a lump sum basis for all the shear connectors installed in the complete and accepted work at each structure specified.

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508.06 BASIS OF PAYMENT. The accepted quantity of Shear Connectors will be paid for at the Contract lump sum price for each structure specified. Payment will be full compensation for detailing, furnishing, transporting, handling, preheating, and welding of the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
508.15 Shear Connectors	Lump Sum

SECTION 509 – LONGITUDINAL DECK GROOVING

509.01 DESCRIPTION. This work shall consist of saw cutting longitudinal grooves into the surface of a concrete deck at the locations indicated in the Plans.

509.02 MATERIALS AND EQUIPMENT. Materials shall meet the requirements of the following subsections:

Water.....745.01

Saw cutting shall be completed by multi-bladed wet saw cutting equipment using circular saw blades. The Engineer may allow the use of single blade, circular saw equipment, where it is determined such equipment is necessary to complete the work as required.

The equipment the Contractor proposes to use will be subject to the approval of the Engineer prior to use.

509.03 CONSTRUCTION DETAILS. The Contractor is hereby notified that concrete curing requirements may have a significant effect upon the specific time at which saw-cut grooving may be performed. The Contractor shall be familiar with the limits imposed by these factors and conduct operations accordingly.

Saw-cutting shall be done only after the specified curing period has elapsed, unless otherwise allowed by the Structural Concrete Engineer. Longitudinal grooves parallel to the centerline of roadway shall be cut in a single pass. The grooves shall be spaced at 3/4 inch (± 1/16 inch).

All grooves shall be cut leaving a rectangular cross-section that is 3/32 inch (+ 1/32 inch, - 0.0 inch) wide and 1/4 inch (± 1/16 inch) deep.

During the grooving operations, the Engineer will verify, at random, that the minimum groove depth is being achieved. Should the Engineer determine that minimum groove depth is not being achieved, the Contractor shall stop grooving operations and make all adjustments necessary to achieve the minimum depth. The Contractor shall go back and correct any previous grooves to bring them into conformance with the specification.

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Prior to beginning grooving operations, the Contractor shall supply the Engineer with two accurate, easily readable gauges with which to verify groove depth. The gauges shall come with applicable manufacturer's instructions.

Unless otherwise indicated in the Contract, grooves shall be terminated as specified in Table 509.03A.

TABLE 509.03A – GROOVE TERMINATION DISTANCE REQUIREMENTS

Location	Closest Allowable Distance (in.)	Farthest Allowable Distance (in.)
Drainage structure	4	15
Face of curb or barrier	4	15
Joint system [1]	4	15

[1] Dimension measured perpendicular to the centerline of the joint system.

The Contractor shall use a self-contained system to continuously collect any slurry or debris created by the grooving operation such that it does not accumulate on the surface.

509.04 METHOD OF MEASUREMENT. The quantity of Longitudinal Deck Grooving to be measured for payment will be the number square yards of deck satisfactorily grooved in the complete and accepted work, measured transversely between curb or barrier and longitudinally between the ends of the deck, computed to the nearest whole square yard. No deduction will be made for areas left un-grooved near concrete railing, joints, or other objects embedded in the deck.

509.05 BASIS OF PAYMENT. The accepted quantity of Longitudinal Deck Grooving will be paid for at the Contract unit price per square yard. Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
509.10 Longitudinal Deck Grooving	Square Yard

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SECTION 510 – PRESTRESSED CONCRETE

510.01 DESCRIPTION. This work shall consist of manufacturing, transporting, and erecting precast prestressed concrete members.

510.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Portland Cement.....701.02
High Early-Strength Portland Cement.....701.04
Portland-Pozzolan Cement.....701.05
Portland Blast-Furnace Slag Cement.....701.07
Ternary Blended Cement.....701.08
Fine Aggregate for Concrete.....704.01
Coarse Aggregate for Concrete.....704.02
Mortar, Type IV.....707.03
Preformed Joint Filler, Cork, and Asphalt-Treated Felt.....707.08
Polyvinyl Chloride (PVC) Waterstop.....707.10
Bar Reinforcement.....713.01
Prestressing Strand.....713.06
Carbon Steel Bolts, Nuts, and Washers.....714.04
High-Strength Bolts, Nuts, and Washers.....714.05
Concrete Curing Materials.....725.01
Air-Entraining Admixtures.....725.02(b)
Retarding Admixtures.....725.02(c)
Water-Reducing Admixtures.....725.02(e)
Water-Reducing and Retarding Admixtures.....725.02(f)
Water-Reducing, High Range Admixtures.....725.02(g)
Water-Reducing, High Range, and Retarding Admixtures.....725.02(h)
Accelerating Admixtures.....725.02(i)
Water-Reducing and Accelerating Admixtures.....725.02(j)
Specific Performance Admixtures.....725.02(k)
Mineral Admixtures.....725.03
Polystyrene Insulation Board.....735.01
Blanket Insulation Material.....735.02
Pipe Insulation.....740.08
Water.....745.01
Overhead and Vertical Concrete Repair Material.....780.02

Structural Steel shall meet the requirements of Subsection 714.01 through Subsection 714.03.

Bearing Pads for Structures shall meet the requirements of Section 731.

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510.03 GENERAL FABRICATION REQUIREMENTS.

(a) General. The manufacture of the prestressed units shall be in accordance with the latest editions of *PCI MNL-116* and *PCI MNL 135-00,* except as modified in this section.

(b) Qualification. The prestressed members shall be manufactured in a plant that has been certified by the Prestressed Concrete Institute (PCI) under its Plant Certification Program for prestressed concrete. The plant must be certified at a minimum to the level of product being produced. If there is an architectural finish for the product, the plant shall be certified at a minimum to the level of product being produced plus the architectural certification at that level.

Prestressed concrete shall be manufactured in a plant that maintains a quality control laboratory that meets the requirements of the Agency's Qualified Laboratory Program. As a minimum, the laboratory shall be equipped with a compression testing machine, curing room or chamber, apparatuses for measuring slump/flow and air entrainment, and a complete set of Aggregate sieves. The compression testing machine shall be calibrated yearly by an independent laboratory using equipment that is certified by the National Institute of Standards and Technology. The testing machine shall be power-operated and capable of applying the load continuously rather than intermittently, and without shock.

(c) Quality Control. The fabricator shall demonstrate a level of quality control testing that satisfies the Agency as to its ability and commitment to produce concrete to the requirements of this section. A satisfactory program of quality control shall include gradation and moisture determinations of the aggregates, as well as slump, air content, and strength determinations of the concrete.

These tests shall be performed at regular and suitable intervals as specified in the *Materials Sampling Manual* and actively used to maintain the quality of the concrete within the specified requirements. The fabricator shall have a plant specific Quality Control Plan approved by the Agency prior to the beginning of any fabrication activities.

510.04 SUBMITTALS. As soon as practical after award of the Contract, all required information shall be prepared and submitted.

Fabrication drawings, also referred to in the precast industry as production drawings or shop drawings, for the prestressed concrete shall be submitted in accordance with the requirements of Section 105, with an additional copy to the Structural Concrete Engineer. Fabrication drawings shall include such detail needed to fully describe the intended as-built condition of the prestressed elements including any connections between prestressed elements and/or existing structures and materials.

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In addition to the requirements in Section 105, the following shall be included:

(a) Concrete Mix Design. The concrete mix design submittal shall include, but not be limited to, the following items:

(1) Batch weights specifying dry or saturated surface dry.

(2) Material names and sources.

(3) Aggregate properties and testing dates. Aggregates shall be tested on an annual basis, at a minimum, to verify that they meet the requirements of *AASHTO T 84* and *AASHTO T 85* for absorption and specific gravity and *AASHTO T 19 M/T 19* for unit weight.

(4) Chemical and physical properties of cementitious materials.

(5) Admixture names and sources.

(6) Lab data that shall include, but not be limited to, the following items:

a. The maximum W/CM ratio that will be allowed during production, including water contributed to hydration by all admixtures, when the cumulative total exceeds 1 gallon per cubic yard. All mix qualification test results shall be generated with concrete from batches that are produced at this maximum W/CM ratio.

b. The slump/spread minimums and maximums, as determined from trial batches.

The concrete shall be classified and tested as Self-Consolidating Concrete (SCC) if the minimum spread is at least 18 inches. When the concrete is tested as a SCC mix, the difference between the J-Ring test, *ASTM C 1621/C 1621 M* and the spread test, and *ASTM C 1611/C 1611 M*, shall be 2 inches or less for the minimum and maximum spread.

Concrete that fails to meet the 18 inches minimum spread threshold will be classified and tested as conventional concrete. The Visual Stability Index (VSI) determination will be included for the minimum and maximum values and shall not be greater than 1. The concrete shall not demonstrate segregation at the minimum or maximum slump/spread.

c. Air Content results obtained in accordance with the requirements of *AASHTO T 152*.

d. Temperature results obtained in accordance with the requirements of *ASTM C 1064 M/C 1064*.

e. Cylinder compression stress results obtained in accordance with the requirements of *AASHTO T 22* for early breaks and design strength, and 28-day standard cure results obtained in accordance with the requirements of *AASHTO T 23*. The type of cure shall be listed for each age of break.

f. Chloride ion penetration test results obtained in accordance with the requirements of *AASHTO T 358.*

The information shall include the individual results from testing three standard 4 inch x 8 inch cylinder specimens, but no specimen shall exceed the limits specified herein. Testing shall be performed by an independent AMRL qualified laboratory.

The chloride ion penetrability result must be "Low" as defined in the requirements of *AASHTO T 358*, tested at or before 56 calendar days from the date specimens were cast. Test results shall also be provided for sample ages of 3, 5, 7, and 28 calendar days.

Test results that are suspected to have been adversely affected due to the presence of polymeric admixtures in the proposed mix may be retested with the polymeric admixture omitted.

g. The Alkali-Silica Reactivity (ASR) of each type of aggregate shall be measured separately based on the requirements of *AASHTO T 303*. If one or more of the aggregates exceeds 0.10% expansion, then the aggregate shall be tested again according to the requirements of *ASTM C 1567*.

The Contractor may elect to go directly to *ASTM C 1567* testing if they suspect that the aggregate may exceed the 0.10% expansion if tested by *AASHTO T 303.* Testing shall be performed by an independent AMRL qualified laboratory accredited in the specific test method.

h. Length change test results obtained in accordance with the requirements of *AASHTO T 160*. Testing shall be performed by an independent AMRL qualified laboratory accredited in conducting testing that meets the requirements of *AASHTO T 160*. The maximum free shrinkage test result shall not exceed 0.06%. The cross-section of the prism shall be 4 inches × 4 inches. *AASHTO T 160* Procedure 11.1.2 shall be followed for storage and measurements.

(7) Mix design approvals will be valid for a 12-month period. The approved mix design will be allowed re-approval if the following conditions are satisfied:

a. A determination has been made that no material proportioning or material sources have changed from the initial approved mix design.

b. The mix design for re-approval is submitted with updated aggregate properties and volumes adjusted accordingly. The properties to be tested are, but not limited to, specific gravity, unit weight, and absorption. Approval of the mix design will expire 14 months from the date the updated aggregate testing was performed.

c. The re-approved mix design shall be accompanied by the test mix data that was completed and accepted for the initial mix design approval, as well as any applicable updated test information.

New mix designs and mix designs that were initially approved approval more than 36 months ago shall have new testing completed to be submitted for approval.

The proposed concrete mix design, including performance history and all requests for variance from the material requirements of these specifications, shall be submitted for approval. The Structural Concrete Engineer may require a minimum of 8 weeks for testing, review, and approval of new mix designs.

(b) Dimensions and Tolerances. The dimensions and tolerances of the sections to be fabricated shall be submitted. Fabricators shall calculate the camber estimate at the time of release and at the estimated time of delivery. The camber control plan shall be as detailed in Subsection 510.08(h).

(c) Locations. The locations of reinforcing steel and pre-stress strands shall be submitted.

(d) Prestressing Methods. The methods of pre-stressing, including certified calibration charts for all jack and gauge combinations shall be submitted.

(e) Tensioning Calculations. Tensioning calculations for pre-stress strands that include gauge pressure, elongations, and movement of anchorage abutments. A professional engineer registered in the State of Vermont shall review and stamp the calculations.

(f) Strand De-tensioning. The method and sequence of strand de-tensioning.

(g) Surface Finish. The type of surface finish and how the finish will be obtained.

(h) Curing Method. The curing method, detailing the sequence and duration in accordance with the requirements of Subsection 510.09.

(i) Minimum Strength Requirement. The minimum required concrete strength for the transfer of pre-stress forces.

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(j) Lifting. The design of the lifting attachments, including the minimum required concrete strength to allow lifting, based on calculations stamped by a professional engineer registered in the State of Vermont.

(k) Logistics. Transportation, handling, and storage details.

(l) Installation. The installation and grouting procedures.

(m) Quality Control. A full description of all Quality Control procedures.

All design details shall be in accordance with the most recent edition of the *VTrans Structures Design Manual* available on the Agency's website and the *AASHTO LRFD Bridge Design Specifications.* A professional engineer registered in the State of Vermont shall stamp any design calculations included in the submittal materials.

510.05 CONCRETE.

(a) Batch Plants. Batch plant equipment, materials, and batching procedures shall conform to the provisions of Section 501 identified in Table 510.05A.

TABLE 510.05A – BATCH PLANT OPERATION SUBSECTIONS AND TOPICS

Subsection	Topic
501.04	Batching [1]
501.04(b)	Testing Laboratory
501.04(c)	Bins and Scales
501.04(d)	Production Tolerances for Batching
501.04(e)	Storage and Proportioning of Materials
501.05	Mixing and Delivery [2]

[1] Paragraphs 1 and 3 only.

[2] For plants not located in Vermont, the Agency has the option of waiving the requirements of Subsection 501.05(a)(4) and Subsection 501.05(c), Paragraphs 1 and 3 only.

(b) Acceptance Testing. For Acceptance testing, refer to the Agency's *Materials Sampling Manual* for sampling, curing, and testing requirements.

Specimens shall be tested either at the Agency's Materials Section Central Laboratory, or at the fabricator's plant laboratory. An Agency representative shall witness all tests.

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Concrete for prestressed members shall conform to the following:

(1) The compressive strength test results obtained at or before 28 days shall not be less than the design compressive strength shown on the Plans. When a 28-day test result is below the specified design strength, all concrete represented by that test shall be unacceptable for the requirements of this section. The Engineer reserves the right to reject all members that were manufactured from this concrete.

(2) The maximum total water batched shall not exceed 280 pounds per cubic yard, including water contributed to hydration by all admixtures when the cumulative total exceeds 1 gallon per cubic yard. If total cementitious material content exceeds 900 pounds per cubic yard, then water batched shall not exceed 300 pounds per cubic yard. The maximum W/CM ratio in production shall not exceed maximum W/CM ratio specified in Subsection 510.04(a)(6)a.

(3) The percentage of air entrainment shall be 7% with a tolerance of ± 2% as tested in accordance with the requirements of *AASHTO T 152*.

(4) The temperature of the concrete at the time of placement shall be between 50°F and 85°F as tested in accordance with the requirements of *AASHTO T 309*.

(5) The concrete shall not demonstrate segregation at any time. If the mix fails to remain within the minimum and maximum slump or spread ranges submitted in the mix design, the load may be rejected. The VSI shall be less than or equal to 1.

(6) The Agency may request that the producer fabricate three concrete test cylinders that will be cured along with the piece they represent through the complete curing period. These cylinders shall be kept with the piece they represent until collected by the Agency as specified by the requirements of *AASHTO T 277* and *AASHTO T 358*.

(c) Cementitious Materials. Only the cementitious combinations and sources from the approved mix design shall be used in the prestressed units required for any one structure, unless otherwise authorized by the Structural Concrete Engineer. Any admixture containing calcium chloride shall not be used.

510.06 INSPECTION. Materials furnished and the work performed under the requirements of Section 510 shall be inspected by the Agency. The Inspector shall have the authority to reject any material or work that does not meet the requirements of these specifications. Any work performed that has not been inspected may be rejected, unless waived in writing by the Engineer.

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The Inspector shall be provided with a minimum office space of 100 square feet with the least dimension of 6 feet. A desk surface with minimum of two drawers and a dedicated private telephone service shall be provided in the office space. A dedicated internet connection, which provides Agency personnel a minimum download speed of 3 Mbps, without utilizing compression algorithms, shall be provided in the office space. Any variances shall be approved by the Structural Concrete Engineer. This office space shall be located on the premises as close to the production area as practicable.

The Engineer reserves the right to reject inadequate office facilities and require suitable alternatives.

510.07 PRESTRESSING. Prestressing shall be accomplished by the pre-tensioning method.

The fabricator shall provide all equipment necessary for the prestressing operations. Prestressing shall be done with approved jacking equipment. Hydraulic jacks shall be equipped with pressure gauges or other indicating devices. The combination of jack and pressure gauge, or other tensioning system, shall be accompanied by a certified calibration chart showing the relationship between the gauge reading and the force in the ram for both ascending and descending movements of the ram. The calibration date of each combination jack and gauge or indicating device shall be within the 12-month period immediately prior to the start of work.

If other types of jacks are used, calibrated proving rings or other devices shall be furnished so that the jacking force may be accurately determined.

Suitable precautions shall be taken by the fabricator to prevent accidents due to breaking of the prestressing steel or slippage of the grips during Prestressing operations.

The tensioning operation shall proceed until the calculated gauge reading has been reached. The elongation of each strand shall then be measured. If the measured elongation differs from the theoretical by more than 5%, the tensioning operation shall be stopped, and the cause of the discrepancy determined prior to continuing.

Immediately after tensioning, the final position of each strand shall be marked to check any strand slippage prior to placing concrete. If slippage is suspected or if the time between tensioning and placing concrete exceeds 48 hours, then 10% of the total number of strands including the strands that are suspected to have slipped shall be re-tensioned and the elongation measured. The specific strands to be re-pulled will be selected by the Agency Inspector, but no fewer than two strands shall be re-pulled.

If additional elongation is gained, the amount gained shall be subtracted from the theoretical elongation. If the result of the theoretical elongation minus the gain in elongation is less than the minimum allowable elongation per the requirements of *PCI MNL-116* for any of the strands tested, the final force shall be applied to all strands.

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For abutment anchorage set-ups where the strands are anchored to abutments that are independent from the form, thermal adjustments shall be made if the ambient temperature at the time of tensioning differs by more than 25°F from the concrete temperature prior to placement and if the net force differential is greater than 2.5%.

Consideration shall be given to partial bed length usage and adjustments made when the net effect on the length of the bed used exceeds the allowable. The thermal coefficient of steel shall be taken as 6.5×10^{-6}/°F.

510.08 FABRICATION.

(a) Pre-Production Meeting. A pre-production meeting shall be requested by the producer with a minimum notice of two weeks prior to beginning concrete placement, unless the Engineer deems, in writing, that a pre-production meeting is unnecessary. The meeting shall be held a minimum of 5 calendar days prior to beginning concrete placement unless otherwise approved by the Structural Concrete Engineer.

The pre-production meeting shall be attended by, and include but not be limited to, the Crew Supervisor, Plant Manager, Inspector or Inspector's Supervisor, a representative from the Materials Section Structural Concrete Unit, and the Project Manager and/or Designer. Additionally, the fabricator shall have available at the pre-production meeting the approved fabrication drawings and a complete anticipated production schedule for all components included in the fabrication drawings.

(b) Forming Members. Side forms shall be supported without the use of ties or spreaders within the body of the member. Any defects or damage due to formwork, stripping, or handling may be cause for rejection.

Forms for interior voids or holes in the members shall be constructed of a material that will adequately resist breakage or deformation during concrete placement and that will not materially increase the mass (weight) of the members. Interior void forms shall be accurately positioned as shown on the Plans and secured to prevent displacement during concrete placement. All voids shall be adequately vented to prevent damage to the members during curing. Each void shall contain a suitably located drain hole.

Holes or cutouts for anchoring devices, diaphragm connections, openings for connection rods, recesses for grout holes for railing bolts, and any other related details shown on the Plans shall be provided for in the members. Where diaphragm dowels do not pass through the member, the dowels may be attached by use of an approved anchorage embedded in the concrete member.

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(c) Placing Transverse Conduits and Tendons. Each tendon to be post-tensioned shall be encased in an approved conduit. Unless otherwise shown on the Plans, the ratio of cross-sectional area of the tendon to be encased to the interior cross-sectional area of the conduit shall not exceed 0.4, except when a steel bar is used as a tendon. The inside diameter of the conduit shall be at least 3/8 inch greater than the diameter of the bar. Conduit that has been crushed or has opened seams shall not be used.

The conduit shall be rigidly constructed, completely sealed, accurately placed, and securely fastened to maintain the desired profile during concreting. No conduit shall be located more than 1/4 inch from the position shown on the Plans. Bundling of conduits will not be permitted.

(d) Placing Pre-Stress Strands. Pre-stress strands shall be accurately placed in position to achieve the center of gravity of the steel as shown on the approved shop drawings. Pre-stress strands shall be protected against corrosion and be free of nicks, kinks, dirt, rust, oil, grease, and other deleterious substances.

(e) Bar Reinforcement and Welded Wire Reinforcement. Bar reinforcement and welded wire reinforcement shall be furnished and installed in conformance with the requirements of Subsection 507.03, Subsection 507.04, Subsection 507.05, Subsection 507.07, and Subsection 507.08. The chairs or spacers used to support or locate the reinforcement that bears on the faces of the forms shall be made of, or be coated with, a non-corrosive material so that no discoloration will show on the faces of the prestressed concrete units.

(f) Pre-Tensioning. The pre-stress strands shall be stressed by jacking in accordance with the requirements of Subsection 510.07, and in the presence of an Agency representative. The jacking force exerted and the elongation produced shall be recorded. Several units may be cast and stressed at one time in a continuous line. Sufficient space shall be maintained between the ends of the units to permit access for cutting strands after the concrete has attained the required strength.

(g) Placing Concrete. Concrete shall not be deposited in the forms until the Agency representative has reviewed and approved the placement of the reinforcement, conduits, anchorages, and Prestressing strands.

The concrete shall be vibrated internally, externally, or a combination thereof to the required consolidation. The vibrating shall be done with care and in such a manner that the concrete is uniformly consolidated, any displacement of or damage to reinforcement, conduit, voids, and Prestressing strand is avoided, and acceptable finish surfaces are produced.

When a vibrator is used with rebar with special coatings or made of non-metallic material or material that could be susceptible to damage, the vibrator head shall be non-metallic or rubber-coated.

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SCC concrete should not be vibrated. If there is a need to vibrate SCC concrete, it shall only be vibrated for the minimum time necessary so as to avoid segregation.

(h) De-Tensioning. No stress shall be transferred to the concrete until 80% of the design compressive strength (f'_c) has been attained, or as stated on the approved fabrication drawings. The compressive strength shall be determined by cylinders tested in accordance with the Agency's *Materials Sampling Manual*. The Prestressing strands shall be released in the de-tensioning pattern detailed on the shop drawings.

If de-tensioning is accomplished by single strand release, each strand shall be cut by gradually heating the strand at both ends of the member simultaneously. A minimum length of 5 inches of strand shall be heated to prevent any shock or snap when the strand is finally severed. Each strand shall be cut at all spaces between members cast continuously, before starting de-tensioning on the following strand in sequence.

Strands shall be cut flush and epoxy-painted unless otherwise specified on the Plans. If the strands are required to be recessed, a block-out shall be built into the bulkhead that will allow the strands to be cut without damaging the concrete. The recess shall be thoroughly cleaned and patched with Mortar, Type IV. The mortar shall be wet cured for three days or as specified by the manufacturer.

(i) Dimensional Tolerances. All dimensional tolerances shall be in accordance with the latest editions of *PCI MNL-116* and *PCI MNL 135-00* unless otherwise noted in the Contract or as approved by the Engineer.

The camber and differential camber between beams measured at pre-shipping inspection shall be within PCI tolerances and shall be measured with dunnage placed under bearing areas of the beam and at no less than 72 hours after the removal of any means of camber correction. Tolerances shall be compared to the calculated camber estimates at the time of the pre-shipping inspection.

The camber control plan shall detail how the fabricator will achieve the calculated camber estimate submitted in the fabrication drawings as required in Subsection 510.04(b). The fabricator must achieve a beam camber at time of delivery that is within PCI tolerances of the calculated camber estimate. In addition, it is the responsibility of the Contractor to confirm at the time of fabrication drawing review that the calculated camber estimate is compatible with the grades and elevations of the rest of the structure.

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(j) Dimensional Tolerances for Prestress Deck Panels. Prestress deck panels shall have dimensional tolerances as specified in Table 510.08A.

TABLE 510.08A – PRESTRESS DECK PANEL TOLERANCES

Element	Tolerance
Vertical position of strand group (measured from bottom of panel)	+ 0 inches, - 1/8 inch
Dunnage	± 6 inches
Warping (distance from nearest adjacent corner)	1/16 inch per foot
Finish of strands (minimum extension beyond ends of panel)	4 inches

(k) Defects. Units that contain defects caused by manufacture or handling may be repaired at the manufacturing site.

Minor defects are defined as the intermittent presence of holes, honey-combing, chips, or spalls, which measure 6 inches or less in the longest dimension, and that do not penetrate deeper than 1 inch into the concrete. Minor defects may be repaired using an approved standard repair procedure as detailed in Subsection 510.08(k)(3).

Surface voids or "bug holes" that are less than 5/8 inch in diameter and less than 1/4 inch deep need not be repaired. Minor defects that recur with any identifiable regularity or pattern may be required to be addressed through a non-conformance report (NCR), at the discretion of the Structural Concrete Engineer.

Any defect that has the potential to affect structural capacity or integrity shall be categorized as a major defect. It is at the sole discretion of the Structural Concrete Engineer to determine into which category any defect is categorized.

(1) Cracking. Cracks less than 0.01 inch in width shall be sealed by a method approved by the Structural Concrete Engineer. Cracks equal to or greater than 0.01 inch may be cause for rejection based on their width, length, location, and frequency. At the Structural Concrete Engineer's discretion, cracked members shall be repaired or replaced at the Contractor's expense. De-tensioning procedures causing web-splitting or other member cracking shall be revised before de-tensioning the next bed. Cracks with a width of 0.05 inch and greater found in any member will be cause for rejection.

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(2) Repairs. Repairs shall be made using an overhead and vertical concrete repair material from the Agency's *Approved Products List*. Any unsound concrete shall be carefully chipped out and the perimeter saw-cut to a minimum depth of 1/4 inch or deeper if recommended by the repair material manufacturer. The prepared surface profile shall be as specified by the repair material manufacturer. If not, the prepared surface profile shall conform to, at a minimum, the *International Concrete Repair Institute's Surface Preparation Chip CSP 6 (Medium Scarification)*. The repair material shall be cured as specified by the manufacturer.

(3) Standardized Repair Procedures (SRP). Standardized Repair Procedures shall be a comprehensive documented process for repairing minor defects at the fabricator's facility. At a minimum, the SRP must detail the scope of defects for which that procedure is intended to be used, a detailed narrative including every step of the repair procedure, and the product documentation for the specific repair materials that will be used.

The SRP must include example pictures of defects for which the procedure could be used, detailed example pictures covering every step of the repair procedure, and example pictures of a successfully completed repair job.

Approval to use an SRP for any given defect is at the sole discretion of the Structural Concrete Engineer, and all SRPs must be approved by them prior to their use. SRPs must be submitted to the Structural Concrete Engineer at least two weeks in advance of the repair work. The Agency's consent to use a SRP for the repair of a defect does not constitute acceptance of that repair.

(4) Non-Conformance Report (NCR). Any defects existing in the pieces, other than those defined as minor above, shall be documented with a non-conformance report. NCRs must be submitted within 2 working days of the discovery of the defect. At a minimum, the NCR must detail what the defect is, including detailed pictures of the piece and defect, and what caused it.

The NCR shall further document the proposed repair, the procedure for carrying out the proposed repair, and a plan of action to prevent additional similar defects from occurring. Any approved repairs must be documented and photographed during the repair work and after completion of the repair.

(l) Deck Panel Rejection Criteria. Deck panels that exhibit any of the following conditions shall be rejected.

(1) Any crack that has a transverse or diagonal orientation relative to the strand pattern and crosses more than one strand.

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(2) Any crack that is parallel to a strand and is longer than 33% of the panel length.

(3) Cracks that are shorter than 33% of the panel length and occur at more than 12% of the total number of strands in the panel.

(4) Voids or honeycombed areas with exposed strands.

(5) Any other reason that the Structural Concrete Engineer determines could have an adverse impact on the structural integrity of the deck panel.

(m) Finishing Riding Surfaces with No Asphalt Wearing Surface. All exposed riding surfaces not covered with an asphalt wearing surface shall be given a finish as specified on the approved shop drawings, or if not specified, in accordance with the requirements of Subsection 501.16.

(n) Welding. All welding shall conform to the requirements of Subsection 506.10.

(o) Cold Weather Concrete. Cold weather concrete will be any concrete placed or cured when the ambient air temperature is expected to be below freezing at any point in time or below 40°F for an 8-hour continuous period. The requirements of Subsection 501.07(b) shall apply in addition to the requirements of Subsection 510.09.

(p) Marking. The date of manufacture, the production lot number, and the piece mark shall be clearly marked on each individual piece of prestressed concrete. The mark shall be in a location that will not be visible in the finished product.

510.09 CURING.

(a) General. All curing methods for prestressed concrete shall be subject to the Structural Concrete Engineer's approval. The fabricator shall submit complete details of the proposed methods for approval with the fabrication drawings.

The "curing period" for prestressed concrete is defined as wet curing for a minimum of 72 hours, to begin immediately following the completion of placing and finishing of the concrete. The following requirements shall apply:

(1) The method of curing shall prevent the loss of moisture throughout the cure period. Except where modified herein, prestressed concrete structure components shall be cured by water curing, by wetted burlap covered with white polyethylene sheeting, or by burlap-white polyethylene sheeting (burlene) as specified in Subsection 501.17.

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(2) When a curing enclosure is used, free water must be evident and the relative humidity within the enclosure shall exceed 90% throughout the duration of the curing period. A curing enclosure is considered any means of moisture-retention that allows air to contact the surface of the piece.

(3) The concrete's strength shall be determined by test specimens cured with the product they represent, or by specimens match-cured in an approved match-curing system.

(4) Wet curing shall continue until 80% of the 28-day design strength is achieved, but shall be no less than 72 hours in duration.

(5) Curing by the approved method shall continue uninterrupted until the start of de-tensioning operations. De-tensioning shall be accomplished while the product is still warm. Wet curing shall be resumed upon removal of the product from the forms.

(b) Curing Temperatures.

(1) The controlling temperatures for concrete curing shall be those actually achieved within the concrete elements, and not the ambient temperatures of the curing area unless specifically stated as such.

(2) The internal temperature of the prestressed concrete shall be to raised at least 68°F within the first 12 hours of the curing period, and shall be maintained at or above 68°F for the remainder of the entire curing period.

(3) The internal temperature of curing concrete shall be monitored using "sacrificial" thermocouples placed as near as practicable to the center of mass of the finished piece. In addition, the temperature within the curing enclosure shall be monitored using strategically placed temperature sensors so that the reported temperatures accurately represent the curing conditions.

The requirement for temperature monitoring may be waived by the Structural Concrete Engineer if the concrete is not subject to accelerated curing and ambient temperatures are expected to be well in excess of 40°F throughout the duration of production.

(c) Accelerated Curing. Accelerated curing procedures may be employed in lieu of the standard 72-hour curing procedure described in Subsection 510.09(a), in accordance with the requirements of *PCI MNL-116,* Section 4.19*,* and the following:

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(1) The initial "time of set" is defined in *AASHTO T 197 M/T 197* and *ASTM C 403/C 403 M* as the time it takes for fresh concrete to attain a compressive strength of 500 psi.

Testing to determine the time of set shall be done when the concrete temperature is within ± 5°F of the anticipated concrete placement temperature.

Alternately, time of set may be found by taking a minimum of three different concrete temperatures at intervals of approximately 10°F, entering that data on a graph, and then drawing a best-fit smooth curve line through the three data points. This graph will be used to determine the time of set for the anticipated concrete placement temperature, rounded up to the nearest half hour.

(2) Immediately upon completing placement of the concrete for each prestressed concrete structure component, an enclosure that is suitable for containing live low-pressure steam or heat shall be placed over the forms. The fabricator shall make these enclosures available for inspection prior to casting.

(3) When low-pressure steam heating methods are used for accelerated curing, precautions shall be taken to prevent the live steam from being directed on the concrete or forms in such a way as to cause damage from localized high temperatures.

(4) When radiant heat is used for accelerated curing, all exposed concrete surfaces shall be covered with plastic sheeting. Radiant heat may be applied by means of a circulation pipes containing steam, hot oil, or hot water, or by electric heating elements.

(5) While waiting for the initial set to take place, the temperature within the concrete may be increased at a maximum rate of 10°F per hour. However, the temperature within the concrete shall not be more than 40°F higher than the initial concrete placement temperature or more than 104°F, whichever is less.

Following the initial set, the internal concrete temperature shall be increased at a rate of not more than 40°F per hour until the desired curing temperature is reached. The maximum internal concrete temperature shall not exceed 160°F. The maximum differential between the curing enclosure temperature and internal concrete temperature shall not exceed 40°F. The selected curing enclosure temperature range shall be as approved on the fabrication drawings.

The accelerated curing cycle shall be considered complete when the method of supplying heat is stopped and/or the concrete temperature drops below 120°F. Two concrete cylinders shall be tested immediately upon completion of the accelerated cure cycle.

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The maximum cooling rate from the sustained accelerated curing temperature shall be 50°F per hour. Cooling at this rate shall continue until the concrete temperature is 40°F or less above the ambient temperature outside the curing enclosure.

(6) Prestressed concrete that has not attained 80% of its 28-day design strength shall be additionally wet-cured until this strength threshold is met. If the precast concrete has attained 80% of its 28-day strength during the accelerated curing cycle, no further curing will be required.

(d) Conditioning. Following the completion of the chosen curing method, precast elements that are to be exposed to Cold Weather conditions as defined in Subsection 540.07(i) must be allowed to cool and dry in an environment of at least 40°F for 24 hours to prior to exposure to Cold Weather conditions. For pieces cast outdoors in Cold Weather ambient conditions, all requirements of Subsection 501.17(b) shall apply.

(e) Temperature Recording. The fabricator shall install one automatic temperature recorder for every 100 feet of production length. The Structural Concrete Engineer may require that additional temperature recorders be installed if it is determined that the one per 100 feet of production length spacing does not allow for adequate monitoring of the curing conditions.

Temperatures recorded on the data logs shall be used to determine whether the prestressed concrete structure components have been cured in accordance with the specifications and the approved fabrication drawings.

The recorder shall record, at intervals not to exceed 15 minutes, the temperature of the air surrounding the piece as well as the internal concrete temperature. Temperature recording shall continue until completion of the chosen curing method.

Each recorder's data log shall indicate the casting bed, the date of casting, the start and finish times of record, and the mark number of the prestressed concrete structure component being cured. At the completion of the temperature recording period, the data logs shall be given to the Agency representative.

Recorder accuracy shall be certified at least once every 12 months, and the certificate displayed with the recorder. Calibration and certification shall be performed by either the manufacturer, the supplier, or an independent laboratory. Random temperature checks of each recorder may be made by an Agency representative.

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510.10 HANDLING, STORAGE, AND SHIPPING. Handling and installation of prestressed members shall be performed with members in an upright position and with points of dunnage support and direction of lifting reactions as specified in the approved lifting calculations.

Prestressed concrete shall be handled, stored, and shipped in such a manner as to minimize chipping, cracks, fractures, discoloration, and excessive bending stresses. Units damaged by handling, storage, or shipping shall be replaced at the Contractor's expense.

Prior to shipment of any members, all NCRs shall be resolved and all required testing shall demonstrate that the design requirements have been met. All applicable material certifications will be approved in accordance with Subsection 700.01.

510.11 INSTALLATION.

(a) Prestressed Concrete Members.

(1) Methods, Equipment and Erection. Cranes, lifting devices, and other equipment for all prestressed concrete member erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the prestressed concrete member.

Construction drawings for prestressed concrete member erection shall be submitted in accordance with the requirements of Section 105. The erection plan shall include the methods and sequence of prestressed concrete member erection, temporary bracing requirements, the equipment to be used for the erection, and the necessary computations to demonstrate that all of the erection equipment has adequate capacity for the work to be performed.

The erection plan shall also include provisions for all stages of construction, including temporary stoppages. When the fabricator-designed lifting hooks will be used by the Contractor, computations indicating the magnitude of stress in the segments during erection are not required, unless otherwise ordered by the Engineer.

The prestressed concrete members may be used for support of equipment prior to placement of the deck only with written permission of the Engineer. The proposed use of the prestressed members for support of equipment shall be detailed in the erection plan.

Submittal of the erection plan is for documentation purposes only and shall in no way be construed as approval of the proposed method of erection. The Contractor shall follow the erection plan as submitted.

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(2) Initial Post-tensioning. The Contractor shall insert post-tensioning strands in the conduits and tension them to 3.0 kips.

(3) Grout. Grout shall be placed in accordance with the requirements of Subsection 510.12.

(4) Fairing Surfaces. This work shall consist of placing grout between prestressed members as required for fairing out any unevenness between adjacent units. Mortar, Type IV shall be used, and grout placement shall occur at the same time mortar is placed to fill shear keys between members and in accordance with the requirements of Subsection 510.12.

The mortar shall be placed to eliminate unevenness, forming a smooth surface from the higher beam edges to the lower surface. The finished surface shall be feathered smoothly and be free of depressions or sharp edges.

(5) Final Post-tensioning. Strands shall be post-tensioned in accordance with the requirements of Subsection 510.13.

(b) Prestressed Deck Panels.

(1) Prestressed deck panels shall be installed as shown on the Plans. The temporary supports shall be attached to the top of the flange of the girder with an adhesive, approved by the Engineer, in accordance with the manufacturer's recommendations.

The temporary supports shall be cut in the field to the required height after the blocking depth has been determined. The bottom of the panels shall be a minimum of 1 inch above the top of the top flange of the girder.

(2) Prestressed deck panels shall not be used to support heavy loads, such as additional deck panels, until the top slab is cast and cured. Construction loads on individual panels shall be uniformly applied and shall not exceed an average loading of 40 pounds per square foot.

(3) After the prestressed deck panels have been placed on temporary supports, the area under the ends of the panels and over the girder flanges up to the bottom of the panels shall be completely filled with the material specified on the Plans.

Temporary supports and grout dams for prestressed deck panels shall consist of continuous strips of high density, extruded Polystyrene insulation board with a minimum compressive strength of 60 psi.

If leveling screws are used, polyethylene foam weighing 1.7 pounds per cubic foot shall be employed as a grout dam. Prior to placement of the cast-in-place deck, the concrete shall be wet cured until a minimum of 85% of f'_c is attained by the average strength of two field-cured concrete cylinders. The leveling screws shall be completely removed and the holes filled with grout prior to the placement of deck concrete.

(4) Prior to placing the deck concrete, any laitance or other contaminates that would interfere with full bond to the panels shall be removed by an approved method.

510.12 GROUT.

(a) Surface Preparation. The fabricator must ensure that surfaces to be grouted are clean, oil-free, and roughened in accordance with the Plans. The surface to be grouted shall be thoroughly wetted, yet free of all standing water. Shear keys shall be saturated surface dry prior to grouting.

(b) Grout Mixes. Grout shall be used to fill shear keys, transverse tie anchor recesses, and dowel holes, level screw voids, and for fairing joints as detailed in the Contract or as ordered by the Engineer.

Grout shall be Mortar, Type IV meeting the requirements of Subsection 707.03. Additional Aggregates shall not be added to the material during field mixing.

The Contractor shall submit a proposed grouting procedure, including a premix name brand, to the Engineer for their review and approval.

The Contractor, with the written permission of the Engineer, has the option to use ready-mixed mortar for the grouting process. However, the time from batching to completion of placement must not exceed 90 minutes. Ready-mixed mortar shall be used in small quantities as needed and shall not be re-tempered or used after it has begun to set.

Ready-mixed grout mix design shall be submitted to the Structural Concrete Engineer for approval. The mix design shall include test results that meet the requirements of Subsection 707.03(a)(1) and Subsection 707.03(a)(3). Tests on the mix design shall be performed by an AMRL-accredited lab in those test procedures.

Materials used for grouting must be sampled and tested in accordance with the VTrans *Materials Sampling Manual*. The cubes produced for testing conformance with strength requirements shall be field-cured with the field-placed grout. A minimum of six additional test cubes shall be produced to facilitate early breaks to determine when post-tensioning may proceed.

(c) Placing Grout. The grout shall be mixed using a mechanical mixer according to the manufacturer's recommendations and shall be readily pourable so that it completely fills the shape of the shear keys or holes, depending on the product being installed. The placement of the grout for each shear key shall be continuous. The grouting of each shear key shall be completed in its entirety within a single working day.

(d) Curing Grout. In the absence of manufacturer curing recommendations, all exposed grout shall be cured for not less than three days by the wetted burlap method in accordance with the requirements of Section 501. Curing shall commence immediately following completion of grouting of individual shear keys.

510.13 POST-TENSIONING. Post-tensioning strands shall not be bonded to the concrete and shall be protected against corrosion as specified in the Contract.

Post-tensioning of strands shall not commence until a minimum compressive strength of 1,500 psi has been attained in the grout, as tested per the requirements of Subsection 510.12(b). If the design strength is met prior to completion of the required curing, the grout cure must be maintained during the post-tensioning operation.

Strands shall be stressed in the following sequence: Before grouting, the strands shall be pulled with a maximum force of 3.0 kips. After the grout has attained the required strength, the strands shall be pulled to the final design tension. Stressing shall begin by pulling the inner-most strands first, then proceeding symmetrically towards the members ends. The inner strands shall be rechecked to ensure the strands still have the design tension.

In the case where the Plans call for top and bottom strands, the sequence shall be followed using an initial pull of 15.0 kips, top and bottom, followed by a sequence using the final design tension.

No loading of elements shall be allowed until post-tensioning is completed.

510.14 METHOD OF MEASUREMENT. The quantities of Prestressed Concrete Box Beams, Prestressed Concrete Voided Slabs, Prestressed Concrete Girders, Prestressed Concrete Solid Slabs and Prestressed Concrete NEXT D Beams to be measured for payment will be the number of linear feet of the types and sizes of prestressed concrete members used in the complete and accepted work.

The quantity of Grouting Shear Keys to be measured for payment will be the number of linear feet of grouted shear keys in the complete and accepted work.

Prestressed deck panels and concrete support beds for the panels will not be separately measured for payment, but will be considered within the volume measurement limits for payment of superstructure concrete.

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510.15 BASIS OF PAYMENT. The accepted quantities of Prestressed Concrete Box Beams, Prestressed Concrete Voided Slabs, Prestressed Concrete Girders, Prestressed Concrete Solid Slabs and Prestressed Concrete NEXT D Beams will be paid for at the Contract unit price per linear foot for the types and sizes of prestressed concrete members specified. Payment will be full compensation for detailing, fabricating, repairing, sandblasting, quality control testing, transporting, handling, and installing the materials specified, including the concrete, reinforcement, Prestressing steel, transverse ties, enclosures for Prestressing steel, anchorages, mortar, and anchor rods. Payment will be full compensation for any other material contained within or attached to the members, for furnishing and implementing the erection plans, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The Engineer may authorize progress payments in the following manner:

(a) A maximum of 25% of the Contract bid amount may be paid when the fabrication drawings have been approved by VTrans.

(b) In accordance with the requirements of Subsection 106.09, stockpile payment may be authorized when the prestressed elements have met the requirements of Subsection 540.09 for shipping.

(c) After completion and acceptance of all work under this section, 100% of the quantity will be paid.

The accepted quantity of Grouting Shear Keys will be paid for at the Contract unit price per linear foot. Payment will be full compensation for providing all materials and performing the work specified herein, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any other grouting work, such as fairing out unevenness between adjacent units and filling leveling screw holes, transverse anchor recesses, and dowel holes, is considered incidental to the work for prestressed concrete members.

Payment will be made under:

Pay Item	Pay Unit
510.21 Prestressed Concrete Box Beams	Linear Foot
510.22 Prestressed Concrete Voided Slabs	Linear Foot
510.23 Prestressed Concrete Girders	Linear Foot
510.24 Grouting Shear Keys	Linear Foot
510.25 Prestressed Concrete Solid Slabs	Linear Foot
510.26 Prestressed Concrete NEXT D Beams	Linear Foot

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SECTION 511 – THIS SECTION RESERVED

SECTION 512 – THIS SECTION RESERVED

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SECTION 514 – WATER REPELLENT, SILANE

514.01 DESCRIPTION. This work shall consist of furnishing and applying a penetrating-type protective sealer on concrete surfaces.

514.02 MATERIALS. The material shall be a one-component substance consisting of a penetrating-type sealer which does not alter the color or texture of the Portland cement concrete.

Acceptable penetrating-type sealers shall be those appearing on the Agency's *Approved Products List*.

514.03 PACKAGING, DELIVERY, AND STORAGE. The material shall be delivered to the project in the original, unopened manufacturer's containers and stored in accordance with the manufacturer's recommendations.

514.04 PREPARATION OF SURFACES. All surfaces on which the protective sealer is to be applied shall be clean and thoroughly dry to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations. Dirt, grease, curing compounds, asphalt, or other foreign materials shall be removed from the concrete surface before application of the sealer.

514.05 APPLICATION. The material shall be applied to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations.

In the absence of specific recommendations from the manufacturer, the protective sealer shall not be applied to new concrete surfaces that are less than 14 calendar days old. The concrete surfaces shall be free from precipitation for 48 hours prior to application of the sealer. Application of the sealer shall be completed within 40 calendar days of original concrete placement.

514.06 PROTECTION. After application of the sealer, the concrete surfaces shall be protected to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations.

514.07 METHOD OF MEASUREMENT. The quantity of Water Repellent, Silane to be measured for payment will be the number of gallons of solution applied in the complete and accepted work, measured to the nearest gallon.

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514.08 BASIS OF PAYMENT. The accepted quantity of Water Repellent, Silane will be paid for at the Contract unit price per gallon. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
514.10 Water Repellent, Silane	Gallon

SECTION 515 – THIS SECTION RESERVED

SECTION 516 – EXPANSION DEVICES

516.01 DESCRIPTION. This work shall consist of furnishing and installing, or partially removing and modifying expansion devices.

516.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Joint Sealer, Preformed Neoprene 707.06
Preformed Fabric Material 707.07
Joint Sealer, Butyl Rubber Tape 707.12
Asphaltic Plug Joints for Bridges 707.15
Structural Steel 714.02
High-Strength Low-Alloy Structural Steel 714.03
Carbon Steel Bolts, Nuts, and Washers 714.04
High-Strength Bolts, Nuts, and Washers 714.05
Welded Stud Shear Connectors 714.10
Epoxy Bonding Compound 719.02
Galvanizing 726.08
Metalizing 726.09

516.03 FABRICATION DRAWINGS. The fabricator of the expansion devices furnished under this section shall submit detailed fabrication drawings in accordance with the requirements of Section 105 and Section 506.

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516.04 FABRICATION. Material furnished under this section shall conform to all applicable provisions of Section 506.

Assemblies shall be fabricated to the designed roadway cross-section within 1/8 inch tolerance of the theoretical dimensions at any point.

Unless otherwise specified, all expansion devices shall be galvanized or metalized.

Extruded cellular and strip-type sealers shall be furnished in one continuous piece without splices.

When it is specified that a neoprene seal be bonded to a steel surface that is not galvanized, the contact surface area shall be blast-cleaned and properly primed with adhesive. Contact surfaces of neoprene seals that will be bonded with an adhesive shall be cleaned and primed in accordance with the seal manufacturer's instructions.

Expansion devices shall be fabricated, assembled, and certified by one supplier. Each device shall be completely shop-assembled and shipped as a complete unit except that curbs or other assemblies designed to be attached and adjusted by field bolting may be removed for transport. Angles or other suitable sections shall be furnished to secure opposite halves of a unit during shipment. Temporary shipping attachments shall be attached by bolting; welding will not be permitted.

516.05 INSTALLATION. Expansion devices shall be installed in conformance with the Plans and all applicable provisions of Section 506.

Final gap adjustments of an expansion joint assembly shall be made during installation in accordance with the movement chart shown on the Plans, fabrication drawings, or as directed by the Engineer.

Joint assemblies shall be properly positioned within 1/8 inch of theoretical crown and straightness and attached to the structure by anchorages furnished with the assembly or as specified in the Contract. Prior to the placement of the concrete, all steel surfaces that will be embedded in concrete shall be coated with epoxy bonding compound. Application of the epoxy bonding compound shall be done in accordance with the manufacturer's recommendations.

516.06 PARTIAL REMOVAL AND MODIFICATION. The Contractor shall partially remove and modify the existing bridge joint at the locations indicated in the Plans and as directed by the Engineer.

Steel for new joint plates shall meet the requirements of Subsection 714.02. The Contractor shall remove and dispose of existing joint plates, drain troughs, and associated hardware.

The Contractor shall grind existing steel plates and/or shoulder concrete to the configuration shown on the Plans. The final surface shall be to the satisfaction of the Engineer.

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516.07 METHOD OF MEASUREMENT. The quantity of Bridge Expansion Joint of the type specified to be measured for payment will be the number of linear feet used in the complete and accepted work, measured along its centerline.

The quantity of Partial Removal and Modification of Bridge Joint to be measured for payment will be the number of linear feet of bridge joint removed and modified in the complete and accepted work, measured along its centerline.

516.08 BASIS OF PAYMENT. The accepted quantity of Bridge Expansion Joint of the type specified will be paid for at the Contract unit price per linear foot. Payment will be full compensation for detailing, furnishing, handling, transporting, and placing the material specified, including nondestructive testing of welds, surface preparation, protective coating, and epoxy bonding compound, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Partial Removal and Modification of Bridge Joint will be paid for at the Contract unit price per linear foot. Payment will be full compensation for partially removing and modifying the existing joint as specified and as detailed in the Plans, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
516.10 Bridge Expansion Joint, Asphaltic Plug	Linear Foot
516.11 Bridge Expansion Joint, Vermont	Linear Foot
516.12 Bridge Expansion Joint, Finger Plate	Linear Foot
516.20 Partial Removal and Modification of Bridge Joint	Linear Foot

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SECTION 519 – SHEET MEMBRANE WATERPROOFING

519.01 DESCRIPTION. This work shall consist of the application of a membrane to bridge decks to serve as a waterproof barrier between the concrete deck and the bituminous concrete surface pavement. This membrane shall consist of either a torch applied membrane or a spray applied membrane as required by the Contract.

Torch applied membranes shall incorporate the use of a prime coat over the horizontal deck surface and an acceptable polyurethane liquid membrane on the lower portion of the curb face and adjacent deck area.

Spray applied membranes shall incorporate a primer, the waterproofing membrane, tack coat, and any required aggregate.

519.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Waterproofing Membrane System, Type I .....726.11(a)
Waterproofing Membrane System, Type II .....726.11(b)

Spray applied membranes shall be a Waterproofing Membrane System, Type I, and torch applied membranes shall be a Waterproofing Membrane System, Type II.

519.03 SUBMITTALS. The following information shall be provided by the Contractor to the Engineer prior to application of the membrane system:

(a) Safety Data Sheets (SDS) and Material Detail Sheets prepared by the membrane manufacturer, provided a minimum of 7 calendar days prior to the scheduled commencement of work.

(b) Written certification from the manufacturer regarding the Applicator's qualifications and references for a minimum of three membrane projects completed by the Applicator within the last 5 years, provided a minimum of 7 calendar days prior to the application of any system component. The certification shall apply only to the named individuals performing the application.

519.04 WEATHER LIMITATIONS. Waterproofing shall not be done in rainy weather or when the temperature is below 40°F without the authorization of the Engineer.

519.05 SURFACE PREPARATION. The surface of the deck shall have a smooth, fine-textured finish. All honeycombed areas and surface cavities shall be cleaned and filled with Agency and manufacturer approved patching materials. The entire deck shall be abrasive blast-cleaned to achieve an anchor profile that is clean and free of laitance, oil, and foreign materials. Prior to blasting, the surface shall be dry and free of sharp protrusions. In addition to these requirements, the deck surface shall meet any additional requirements of the Manufacturer's recommendations.

519.06 CONSTRUCTION DETAILS.

(a) General. All work performed shall be in accordance with the manufacturer's recommendations. The entire system shall be applied by an individual (Applicator) certified by the manufacturer.

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The manufacturer shall have a competent technical representative with necessary equipment to perform the quality control testing at the job site during all phases of preparation and installation. The technical representative will be responsible for performing and reporting all quality control testing required during membrane application. The technical representative will present all quality-control testing equipment to the Engineer to verify calibration dates and demonstrate their competency to perform quality control testing.

Quality Control testing includes, but is not limited to measuring and verifying Substrate Moisture Content and Temperature, Primer Adhesion, Membrane Thickness, Membrane Pin Holes, and Membrane Adhesion.

(b) Material Storage. All components of the membrane system shall be stored in accordance with the Material Detail Sheets.

(c) Surface Condition. Prior to application of primer, the concrete deck shall be cured such that the moisture content reaches 6% or less. Except on minor areas of the deck as approved by the Engineer, torching or other forms of rapidly evaporating free moisture from the surface will not be allowed to achieve initial surface conditions. Cracks should be blown out to ensure excess water is not present. The Contractor shall supply a portable electronic surface moisture meter capable of measuring the moisture content percentage of concrete surfaces.

Immediately prior to application of the primer, the deck shall be cleaned using brooms and compressed air that is free of oil. The concrete surfaces shall be inspected and approved by the Engineer and the Applicator prior to priming.

(d) Application of Primer. The air temperature for primer application shall be at least 40˚F and rising. The primer shall consist of one coat covering the entire deck with an overall coverage rate of 200 square feet per gallon or as specified by the manufacturer. The primer shall be applied by brush, roller, or sprayer.

The primer shall cure tack-free in accordance with the manufacturer's recommendations before application of the waterproofing membrane.

(e) Membrane Application. The waterproofing membrane shall be applied by equipment approved by the Engineer. The equipment shall be capable of applying the membrane in a uniform manner onto the prepared substrate in accordance with the manufacturer's recommendations to assure bond with the primed surface and elimination of air bubbles. In small areas, the membrane shall be hand-welded by torch around drains, joints, and along the curb as directed by the Engineer. The Applicator shall be responsible for the protection of adjacent areas.

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Sheet membrane shall be installed in a shingled pattern so that water is permitted to drain to the low areas of the deck without accumulating against seams. Laps shall be staggered at the beginning and ends of rolls, shall overlap the previous roll and shall be sealed in accordance with the manufacturer's recommendations. Prior to suspension of work for any reason, all exposed edges shall be heated, troweled, and sealed in accordance with the manufacturer's recommendations.

The Contractor shall repair and/or correct any deficiencies in the membrane system and substrate noted during quality-control testing as recommended by the manufacturer's representative to the satisfaction of the Engineer at no additional cost to the State.

If the membrane is damaged and/or de-bonding from the deck surface occurs after application and quality control testing is complete the membrane shall be patched or repaired in accordance with the manufacturer's recommendations at no additional cost to the State.

519.07 PROTECTION OF MEMBRANE. Care shall be exercised to prevent damage to the completed membrane, especially during paving operations. All damaged areas shall be cleaned and patched to the satisfaction of the Engineer. A rubber-tired or rubber-tracked paver shall be used to place the bottom course of bituminous mix.

The temperature of the bituminous concrete pavement to be placed on the membrane shall be as recommended by the membrane manufacturer and approved by the Engineer.

(a) Membrane Waterproofing, Spray Applied. An aggregate wearing surface shall be adhered to the top membrane coat. Unless otherwise specified, the aggregate shall be broadcast at the rate of 0.25 to 0.50 pounds per square foot to achieve adequate uniform coverage.

Where bituminous concrete pavement will be applied to the membrane surface, a tack coat compatible with the membrane system shall be used between the membrane and the bituminous concrete pavement. The surface preparation and tack coat shall be applied per the manufacturer's recommendations.

(b) Sheet Membrane Waterproofing, Torch Applied. No traffic shall be permitted on an exposed membrane surface.

The specified bituminous overlay shall be placed on the membrane within three days after application.

The Contractor shall maintain a small supply of Portland cement on the project during the time of paving. The cement dust shall be sparingly cast over the membrane surface to reduce tackiness and thereby prevent the paver or truck tires from sticking to the membrane and damaging it.

The paver operator shall be directed not to ride the curb lines while paving such areas since the screed shoe may damage the polyurethane sealant on the vertical curb face.

519.08 PROTECTION OF EXPOSED SURFACES. The Contractor shall exercise care in the application of the waterproofing materials to prevent surfaces not receiving treatment from being spattered or marred. Particular reference is made to the face of curbs, copings, finished surfaces, substructure exposed surface, and outside faces of the bridge. Any material that spatters on these surfaces shall be removed and the surfaces cleaned to the satisfaction of the Engineer.

519.09 METHOD OF MEASUREMENT. The quantity of Membrane Waterproofing, Spray Applied or Sheet Membrane Waterproofing, Torch Applied to be measured for payment will be the number of square yards of the specified type used in the complete and accepted work. Measurement will be based on the horizontal distance between the face of the curbs and the horizontal length of membrane installed. Any material specified to be lapped up the face of the curb will not be included in the measured quantity.

519.10 BASIS OF PAYMENT. The accepted quantity of Membrane Waterproofing, Spray Applied or Sheet Membrane Waterproofing, Torch Applied will be paid for at the Contract unit price per square yard. Payment will be full compensation for furnishing, transporting, handling, and placing the waterproofing system specified, including primer, tack coat, aggregate, mastic, polyurethane membrane sealant, and surface preparation, and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
519.10 Membrane Waterproofing, Spray Applied	Square Yard
519.20 Sheet Membrane Waterproofing, Torch Applied	Square Yard

SECTION 520 – THIS SECTION RESERVED

SECTION 522 – LUMBER AND TIMBER

522.01 DESCRIPTION. This work shall consist of detailing, furnishing, fabricating, transporting, framing, and placing or erecting lumber, structural timber, or structural glued laminated timber; installing hardware; and applying preservative treatment.

522.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Joint Sealer, Hot Poured	707.04(a)
Coatings for Wood	708.05
Structural Lumber and Timber	709.01
Miscellaneous Hardware, Shapes, and Fabricated Materials	709.01(h)
Nonstructural Lumber	709.02
Structural Glued Laminated Timber	709.03

Timber Preservative 726.01
Waterproofing Pitch 726.05
Galvanizing 726.08

Unless otherwise specified, all metal parts and hardware shall be galvanized.

522.03 GENERAL FABRICATION REQUIREMENTS. Glued laminated timber furnished under this section shall be fabricated by an AITC or APA-EWS licensed laminator and shall comply with *ANSI/AITC A190.1*. In addition to being a licensed laminator, the fabricator must have been in continuous operation for at least five years, and must demonstrate the capability to fabricate the end products specified.

Unless otherwise specified, all material shall be fabricated prior to preservative treatment.

Dimensions and bolt hole locations of prefabricated material shall be within a tolerance of 1/16 inch of the details specified.

522.04 DRAWINGS. Unless otherwise specified, as soon as practical after award of the Contract, the Contractor shall prepare and submit fabrication drawings for glued laminated timber in accordance with Section 105.

The Contractor shall prepare and submit construction drawings for structural timber erection in accordance with Section 105.

The erection plan shall include methods and sequence of structural timber erection, temporary bracing requirements, the equipment to be used for the erection, the necessary computations to indicate the magnitude of stress in the segments during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages. The Contractor shall follow the erection plan as submitted.

522.05 STORAGE. Timber, lumber, and glued laminated materials stored on the site shall be kept in orderly piles, open stacked, and on supports that provide at least 12 inches of ground clearance. For outside storage, the ground area in the vicinity of the material shall be cleared of grass, weeds, and rubbish. Free circulation of air shall be provided between the tiers and courses for untreated timber. Treated timber shall be stacked together, with no separation between the tiers and courses. Free circulation of air shall be provided between the pile and the ground for both treated and untreated timber.

Both shall have free circulation of air from the ground.

Timber, lumber, and glued laminated timber (treated or untreated) shall be stored under cover. The covering shall adequately protect these materials from direct and blowing rain or snow while providing for full circulation of air and adequate drainage.

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All timber, lumber and glued laminated timber (treated or untreated) shall meet the requirements of Subsection 709.01(b) before being incorporated into the work.

All glued laminated timber shall meet the moisture requirements of Subsection 709.03(b) at the time laminations are glued.

Fabricated material shall be stored in a manner that will prevent dimensional changes in the members prior to assembly.

522.06 HANDLING. Materials shall be carefully handled to avoid damaging the edges or surface and to keep them clean.

Materials shall be picked up or moved with slings or other devices that will not damage or mar the surface. Peavies, cant hooks, timber dogs, or other pointed tools will not be permitted.

Cranes, lifting devices, and other equipment for all structural timber erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the structural timber members.

522.07 FRAMING. Timber, lumber, and glued laminated timber shall be accurately cut and framed to a close fit in such a manner that the joints will have full and even bearing over the entire contact surface. Mortises shall be true to size for their full depth, and tenons shall fit snugly. Except as indicated in the Contract, shimming will not be permitted in making joints, and open joints will not be accepted. Nails and spikes shall be driven with the heads set flush with the surface of the wood. Except as directed by the Engineer, structure framing and boarding shall be constructed square, plumb, and straight.

When permitted by the Engineer, forms or temporary braces may be attached to treated material. Upon removal, any holes, cuts, or abrasions shall be treated in accordance with Subsection 522.13.

522.08 CONNECTIONS.

(a) Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for metal round drift-bolts or dowels shall be bored with a bit 1/16 inch less in diameter than the drift-bolt or dowel to be used. The diameter of holes for metal square drift-bolts or dowels shall be equal to the least dimension of the drift-bolt or dowel.

Except as required for timber connectors in Subsection 522.08(d), holes for machine bolts shall be bored with a bit the same diameter as the bolt.

Holes for round wood dowels or trunnels shall be bored with a bit the same diameter as the dowel.

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Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod.

Lead holes for lag screws, wood screws and spikes shall conform to requirements specified within the latest edition of the *AITC Timber Construction Manual*.

(b) Countersinking. Countersinking shall be done wherever smooth faces are required. All recesses in treated lumber and timber formed for countersinking shall be painted with copper naphthenate solution. Recesses likely to collect injurious materials shall be filled with a hot-poured joint sealer or other material, as directed by the Engineer.

(c) Bolts and Washers. A washer of the size and type specified shall be used under all bolt heads and nuts that would otherwise come in contact with wood.

All nuts shall be effectively locked after they have been finally tightened.

(d) Timber Connectors. In addition to wood dowels, bolts, and rods, timber (wood member) connectors may be the split ring, shear plate, or spike grid type. The split ring and shear plate types shall be installed in precut grooves of dimensions as recommended by the manufacturer. The spike grid type shall be forced into the contact surfaces of the wood members joined by means of pressure equipment. All connectors of this type at any given joint shall be embedded simultaneously and uniformly.

Bolt holes shall be perpendicular to the face of the material and 1/16 inch larger in diameter than the bolt.

(e) Framed Bents. Framed bents shall be constructed in accordance with *AASHTO LRFD Bridge Construction Specifications* and interim specifications in effect on the date of the Contract.

522.09 TRUSSES. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and, in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

522.10 TRUSS HOUSING. The finished appearance of the housing is considered of primary importance. Special care shall be taken to secure a high quality of work and finish on this portion of the structure.

Unless otherwise directed by the Engineer, housing and railings shall be constructed after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

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522.11 DECKING.

(a) Plank Flooring. Plank material shall be of dimension lumber of the grade specified.

Unless otherwise specified, all material shall be surfaced four sides (S4S).

Single layer plank floors shall consist of a single thickness of dimension lumber planks supported by stringers or floor beams. The planks shall be laid heart side down, with 1/4 inch openings between them. Each plank shall be securely fastened to each supporting member. The planks shall be carefully graded as to thickness and so laid that no two adjacent planks vary in thickness by more than 1/16 inch. Unless otherwise specified, the lengths of transverse planks on stringers shall be full width of the designed cross-section.

Two-ply plank floors shall consist of two layers of dimension lumber planks supported on stringers or floor beams. Each plank of the top course shall be securely fastened to the lower course. At the ends of the bridge, if required, the decking shall be beveled to match the approach surfaces. For stringer supports, the top course of planks may be laid either diagonal or parallel to the centerline of roadway. Joints in the top layer shall be staggered at least 3 feet and care shall be taken to securely fasten the ends of each plank. For floor beam supports, unless otherwise specified, the lengths of transverse top course planks shall be full width of the designed cross-section.

(b) Nail Laminated Decking. Nail laminated deck material shall be furnished and installed in accordance with the Contract or as ordered by the Engineer. Deck material shall be of the grade specified. Unless otherwise specified, in transverse applications the lengths of laminations shall be the full width of the designed cross-section.

Spike placement in laminated decks shall follow the requirements of the *AASHTO LRFD Bridge Design Specifications,* Section 9. Spikes shall be placed in pilot holes that are bored through pairs of laminations at each end and at intervals of not more than 12.0 inches. The spikes shall be driven alternately near the top and bottom edges of the laminations and shall be of sufficient length to fully penetrate four laminations. Laminations shall not be butt spliced within their unsupported length. Drive spike spacing at ship-lap joints shall be as shown on the Plans.

When timber nailing strips are used, every other plank shall be toe-nailed to every other nailing strip. The size of the spikes shall be as shown on the Plans or as directed by the Engineer.

When shown on the Plans or authorized by the Engineer, the laminated decking may be attached to steel supports by the use of approved metal clips. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on all supports.

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(c) Glued Laminated Decking. Glued laminated decking material shall be furnished and installed in accordance with the Contract, approved fabrication drawings, or as directed by the Engineer.

522.12 SAWN LUMBER STRINGERS. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the compression portions of the stringers.

Outside stringers may have butt joints over intermediate supports with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least 1/2 inch for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are two panels in length, the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified, cross-bridging shall be placed at the center of each span.

522.13 PRESERVATIVE TREATMENT.

(a) Pressure Treatment. Timber, lumber, and glued laminated timber shall be pressure treated with the type of preservative specified in the Contract. When a specific type or option is not specified, Type II preservative shall be used. Prior to handling or erecting pressure treated timber, lumber, or glued laminated timber the Contractor shall read and provide a copy of any Safety Data Sheets (or Consumer Information Sheets) required for the material to the Engineer. The Contractor shall also provide the Engineer with a plan detailing clean-up, storage, and disposal procedures for pressure treated sawdust and cutoffs.

All preservative treatment shall adhere to the recommendations of the Western Wood Preservers Institute (WWPI) and the American Wood Protection Association (AWPA).

(1) Treatment of Cuts, Abrasions and Holes. Cuts, abrasions, and holes bored after treatment shall be treated with two coats of copper naphthenate solution. Cuts and abrasions shall be carefully trimmed prior to treatment. Holes left unfilled shall be filled with wooden plugs treated with copper naphthenate solution.

(2) Temporary Attachments. Holes remaining after the removal of nails and spikes used to attach temporary forms or bracing to treated material shall be filled by driving galvanized nails or spikes flush with the surface or plugging the holes with wooden plugs treated with copper naphthenate solution.

(b) Untreated Timber, Lumber and Glued Laminated Timber. For untreated timber, lumber, and glued laminated timber, all cuts, notches, bore holes, contact surfaces and other areas specified by the Contract shall be treated with two coats of copper naphthenate solution.

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(c) Field Treatment. When field applications of preservative are specified, the materials shall be furnished, prepared, and applied in accordance with *AWPA Standard M4*.

522.14 PAINTING. The surface of any material to be painted or stained shall be dry and free of dirt, dust, oil, or other foreign materials. Unless otherwise specified, all surfaces shall be coated with a prime coat and one finish coat.

522.15 METHOD OF MEASUREMENT. The quantity of Structural Lumber and Timber and of Nonstructural Lumber to be measured for payment will be the number of thousand feet board measure (MFBM) incorporated into the complete and accepted work, as computed from the nominal cross-section sizes and the actual in-place lengths of members. Final accepted in-place length of any member will be determined as the maximum length of a member as projected along one edge-line, measured to the next whole 1-foot increment. Further measurement shall not be made for cutoffs or actual stock lengths. For bridges requiring completely new materials for longitudinal nail-laminated decking, longitudinal plank decking, runners or roof boards, member length will be measured as the overall superstructure length of the in-place decking, runners or roof boards, measured to the next whole 1-foot increment.

For round timbers, the number of board feet will be computed by the Vermont Log Rule, as follows:

$$BF = \frac{D \times R \times L}{12}$$

where:

BF = Number of board feet in round timber

D = Diameter, measured under the bark at the small end (inches)

R = One half the diameter (inches)

L = Length (feet)

The quantity of Structural Glued Laminated Timber to be measured for payment will be on a lump sum basis for each structure or each structural unit in the complete and accepted work.

522.16 BASIS OF PAYMENT. The accepted quantities of Structural Lumber and Timber and of Nonstructural Lumber will be paid for at the Contract unit prices per thousand feet board measure (MFBM). Payment for each quantity will be full compensation for detailing, fabricating, furnishing, transporting, handling, placing or erecting, and painting or treating the material specified, including all hardware and timber connectors; for providing all falsework, forms, bracing, sheeting, or other timber used for erection purposes; for furnishing and implementing the erection plan, when required; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

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The accepted quantity of Structural Glued Laminated Timber will be paid for at the Contract lump sum price. Partial payments will be made as follows:

(a) The first payment of 50% of the lump sum price will be made upon the original delivery of the timbers to the project, provided the materials are acceptable and certified.

(b) The remaining 50% will be paid when the installation is complete and the work accepted.

Payments for the quantity of Structural Glued Laminated Timber will be full compensation for detailing, fabricating, furnishing, transporting, handling, placing or erecting, and painting or treating the material specified, including all hardware and timber connectors; for providing all falsework, forms, bracing, sheeting, or other timber used for erection purposes; for furnishing and implementing the erection plan, when required; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
522.20 Structural Lumber and Timber, Untreated	MFBM
522.25 Structural Lumber and Timber, Treated	MFBM
522.30 Nonstructural Lumber, Untreated	MFBM
522.35 Nonstructural Lumber, Treated	MFBM
522.40 Structural Glued Laminated Timber	Lump Sum

SECTION 523 – THIS SECTION RESERVED

SECTION 524 – JOINT SEALER

524.01 DESCRIPTON. This work shall consist of furnishing and placing a joint sealer of the type specified at the locations shown on the Plans.

524.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Joint Sealer, Hot Poured	707.04(a)
Joint Sealer, Cold Poured	707.04(b)
Backer Rod	707.04(c)
Joint Sealer, Polyurethane	707.05
Bond Breaker	707.05(c)
Asphaltic Plug Joints for Bridges	707.15

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Joints sawn in bituminous concrete pavement shall be filled and sealed with hot poured or cold poured joint sealer or asphaltic plug joint binder, appropriate backer rod, and an approved bond breaker.

524.03 TEMPERATURE LIMITATIONS. The joint sealer shall be applied per the manufacturer's recommendations, however, the ambient air and pavement temperatures must be greater than 40°F at the time of application.

524.04 SAWED JOINTS. Roadway or bridge deck joints shall be formed by means of concrete floor sawing equipment capable of dry-cutting the designed joint in a single pass.

The joint shall be cut and sealed in one continuous operation. The sawed joint shall not be exposed to traffic until after the sealer has been placed, cured, and is not subject to "picking."

When placing new bituminous concrete pavement, each lift of pavement shall be scored with a single blade cut to a depth of 75% of the lift thickness, at the location of the center of the proposed joint. This work shall be completed prior to exposing the location to traffic or, where traffic is not maintained, the same working day that the lift of pavement is placed.

The sawed joint in the newly-placed wearing course shall be cut and sealed within 24 hours of paving. If the joint location will not be exposed to traffic, the Engineer may allow the Contractor an additional 48 hours to cut and seal the joint.

The width of the sawed joint shall be as shown on the Plans or may be adjusted by the Engineer for seasonal temperature variations. The depth of the sealant shall be approximately 50% of the width of the sawn joint when hot or cold poured materials are specified in the Contract.

The equipment for sawing the single blade cut shall be on the project and approved by the Engineer prior to beginning paving operations.

524.05 PREPARATION OF JOINTS. Surfaces to which the joint sealer is to adhere shall be free of all foreign material, including curing compound, oil, dirt, sawing film, laitance, and rust. All surfaces shall be thoroughly dry before placing joint sealers.

(a) For Poured or Preformed Joint Sealers. Prior to placing poured or pre-formed joint sealers, the vertical faces of the sawed joint and the horizontal pavement surfaces within 1 inch of the joint edge shall be thoroughly blast-cleaned to improve joint sealant adhesion. The resulting dust, blasting debris, etc. shall be removed with a blast of high-pressure air or industrial vacuum equipment.

Regardless of the cleaning method used, the Contractor shall take all necessary precautions to avoid contaminating the other project construction work with the removed dust and debris.

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(b) For Polyurethane Joint Sealer. Prior to placing polyurethane joint sealer, the concrete surface shall be blast-cleaned to remove surface mortar and expose underlying aggregate. Blast-cleaning equipment shall be operated such that no oil is introduced into the air line. Surfaces formerly sealed with other sealers shall be bush-hammered or sawed to clean the material and then blast-cleaned.

Steel surfaces shall be blast cleaned to the bare metal. Primer shall be applied immediately after the blast-cleaning is completed. Epoxy mortar surfaces shall be cleaned by use of suitable solvents or by blast-cleaning as required.

524.06 PLACEMENT.

(a) Joint Sealer, Hot Poured. The material shall be heated in a double-walled, oil-jacketed kettle equipped with positive temperature controls that allow the sealer to be heated to, and maintained within, a range of 390°F to 410°F or such other temperature range as recommended by the sealant manufacturer. The kettle shall arrive on the project empty.

Heating of the sealant to the placement temperature and maintaining the sealer at placement temperature shall not exceed six hours. The Contractor shall empty the kettle before heating more material. New material shall not be added to a partially-filled kettle and cooled material shall not be reheated.

Prior to pouring the sealant into the joint, a heat-resistant backer rod shall be placed in the bottom of the joint. The rod shall be 1/8 inch greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with hot poured sealants.

The hot sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U- or V-shaped squeegee to provide a thin layer of sealant spread over the blast-cleaned horizontal pavement surfaces adjacent to the joint.

(b) Joint Sealer, Cold Poured. The two-component material shall be mixed in the container in which it is furnished using 100% of both components. Mixing shall be accomplished with a variable-speed drill and mixing paddle operated at speeds not greater than 400 rpm for a period of not less than five minutes. Mixing by hand will not be permitted.

The mixed sealant may be transferred to a smaller clean container for ease of pouring. All mixed sealants must be placed within the 30 to 45 minute pot life of the material.

Prior to pouring the sealant into the joint, a backer rod shall be placed in the bottom of the joint. The rod shall be 1/8 inch greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with poured sealants.

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The sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U- or V-shaped squeegee to provide a thin layer of sealant spread over the blast-cleaned horizontal pavement surfaces adjacent to the joint.

(c) Joint Sealer, Polyurethane. Polyurethane joint sealer shall be placed as shown on the Plans in accordance with the manufacturer's recommendations. Joint sealer shall not be installed until concrete has been in place for 28 days.

A foam spacer, approved by the Engineer, shall be installed in such a manner as to control the depth of the sealer and give support during its cure time. The foam spacer shall fit tightly against the sides of the opening beneath the sealer.

Polyurethane-coated tape, or other strip material approved by the Engineer, shall be applied to those surfaces where bond is not desired.

Primer materials shall be applied strictly as specified by the joint sealer manufacturer on the surfaces to which the joint sealer is intended to adhere. Primed surfaces that may have been contaminated by dirt or other foreign material shall be cleaned and primed again prior to the application of the joint sealer.

The finished surface of the joint sealer shall present a smooth, even appearance. Only minimum tooling of horizontal joints will be allowed. Overlaying or shimming material shall not be applied over material that has cured.

When it is necessary to place a portion of a joint, the edge of the cured material shall be primed as specified by the manufacturer prior to placing additional sealer.

Any joint sealer that is not completely bonded to the intended surface after being in place for 72 hours shall be removed, the joint prepared again, and the application repeated as specified.

(d) Asphaltic Plug Joint Binder. Asphaltic plug joint binder shall only be used in the saw-cut joint as indicated in the Plans.

The material shall be heated in a double-walled, oil-jacketed kettle equipped with positive temperature controls that allow the sealant to be heated to the temperature range recommended by the sealant manufacturer. The kettle shall arrive on the project empty.

Heating of the sealant to the placement temperature and maintaining the material at placement temperature shall not exceed the time interval recommended by the manufacturer. The Contractor shall empty the kettle before heating more material. New material shall not be added to a partially-filled kettle and cooled material shall not be reheated.

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Prior to pouring the sealant into the joint, a heat-resistant backer rod shall be placed in the bottom of the joint. The rod shall be 1/8 inch greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with hot poured sealants.

The hot sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U or V-shaped squeegee to provide a thin layer of sealant spread over the blast-cleaned horizontal pavement surfaces adjacent to the joint.

524.07 JOINT PROTECTION. The completed joint shall be protected against damage from traffic during the curing time.

Polyurethane joint sealer shall be covered with an impervious material to prevent contact with the linseed oil-mineral spirits mixtures, paints, or other materials containing mineral spirits and similar solvents.

524.08 METHOD OF MEASUREMENT. The quantity of Joint Sealer of the kind specified to be measured for payment will be the number of linear feet or gallons used in the complete and accepted work.

524.09 BASIS OF PAYMENT. The accepted quantity of Joint Sealer of the kind specified will be paid for at the Contract unit price. Payment will be full compensation for furnishing, handling, placing, and installing the specified materials, including any required backer rod or bond breaker. Payment will also be full compensation for preparing the joint, including saw-cutting where required, cleaning the joint prior to installing the sealer and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
524.10 Joint Sealer, Hot Poured	Gallon
524.11 Joint Sealer, Hot Poured	Linear Foot
524.12 Joint Sealer, Cold Poured	Gallon
524.13 Joint Sealer, Cold Poured	Linear Foot
524.20 Joint Sealer, Polyurethane	Gallon
524.21 Joint Sealer, Polyurethane	Linear Foot

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SECTION 525 – BRIDGE RAILINGS

525.01 DESCRIPTION. This work shall consist of furnishing and erecting bridge railing and performing repairs to existing bridge railing.

525.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV 707.03
Grease Rustproofing Compound.....708.04
Structural Steel.....714.02
Anchor Bolts, Bridge Railing 714.07
Galvanizing 726.08
Metalizing 726.09
Preformed Fabric Bearing Pads 731.01
Bearing Pads 731.02
Metal Hand Railing.....732.01
Galvanized Box Beam Bridge Railing.....732.03
Steel Beam Bridge Railing.....732.04

Concrete shall meet the requirements of Section 501, Class PCD or Class SCC. If Class PCD is used, a shrinkage-compensating admixture shall be added during the initial concrete mixing phase or as recommended by the chemical manufacturer's product representative.

Reinforcing steel shall meet the requirements of Section 507.

525.03 FABRICATION DRAWINGS. The fabricator of steel components furnished under this section shall submit detailed fabrication drawings in accordance with the requirements of Section 105 and Section 506.

The Contractor shall submit a bending schedule for concrete bridge railing reinforcement in accordance with the requirements of Section 105 and Section 507.

These requirements do not apply to work performed under Subsection 525.06(d).

525.04 FABRICATION.

(a) Steel Components. Material furnished under this section shall conform to the applicable provisions of Section 506. Railing shall be fabricated in a plant approved by the Structures Engineer.

Unless otherwise specified, all ferrous metal railing components shall be galvanized.

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(b) Concrete Forms. Forms shall conform to the railing design shown in the Plans and forming requirements of Section 501. Forms shall be constructed to allow for checking and correcting the railing alignment and grade after the concrete has been placed and prior to initial set. The forms shall be reinforced in such a manner that finishing of the railing tops will not disturb the final adjusted alignment.

525.05 CONSTRUCTION TOLERANCES. Tolerances for railing components shall meet the requirements of the latest edition of the *AASHTO LRFD Bridge Construction Specifications*.

525.06. INSTALLATION.

(a) General. Railings shall be installed in conformance with the applicable provisions of Section 501, Section 506, Section 507, and these specifications. Alignment, grade, and clearances at joints shall be adjusted to the satisfaction of the Engineer.

Posts shall be adjusted and aligned to the satisfaction of the Engineer prior to placing any mortar.

Unless otherwise specified, removed railing shall become the property of the Contractor and shall be removed from the project.

Sleeves for hand railing shall be secured and accurately aligned prior to placement of any concrete.

Galvanized surfaces that have been scratched or have received minor abrasions shall be repaired in accordance with Subsection 726.08 or as directed by the Engineer.

Concrete railing shall receive an aesthetic finish in accordance with Subsection 501.16. Cracks in concrete railing shall be repaired by a method approved by the Engineer. Cracks in concrete greater than 0.01 inch may be cause for rejection.

(b) Painting. Railing required to be painted shall be coated in accordance with the appropriate painting items in the Contract. Wherever bridge railing panels are nested or overlapped full length, the surfaces on both panels that will be in contact with each other shall be coated with a grease rustproof compound.

(c) Delineation. Delineation devices shall be of the design shown on the Plans and shall be securely fastened to the bridge railing posts as shown on the Plans or as directed by the Engineer.

(d) Bridge Railing Repair. Bridge railing repair of the Type specified shall be performed at the locations indicated in the Plans and as directed by the Engineer.

(1) Bridge Railing Repair, Type I. Type I bridge railing repair shall consist of installing new heavy duty steel beam panels and offset blocks on existing fascia-mounted or curb-mounted posts spaced at 6.25 feet or less.

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(2) Bridge Railing Repair, Type II. Type II bridge railing repair shall consist of installing new nested heavy duty steel beam panels and offset blocks on existing fascia-mounted or curb-mounted posts spaced greater than 6.25 feet.

(3) Bridge Railing Repair, Type III. Type III bridge railing repair shall consist of installing new heavy duty steel beam panels and offset blocks on new fascia-mounted or curb-mounted posts utilizing existing anchor bolts.

525.07 METHOD OF MEASUREMENT. The quantity of Removal of Existing Bridge Railing or Reset Existing Bridge Railing to be measured for payment will be the number of linear feet of existing railing dismantled and disposed of, or repaired and reset, between the limits specified or as ordered by the Engineer.

The quantity of Bridge Railing of the type specified to be measured for payment will be the number of linear feet of the type of rail used in the complete and accepted work. Measurement will be made along the face of the rail from end to end or between the pay limits specified. No deductions or additions will be made for joints.

The quantity of Bridge Railing Repair of the type specified to be measured for payment will be the number of feet of railing repaired in the complete and accepted work, measured within the limits shown on the Plans or as directed by the Engineer. No additional measurement will be made for nested beam panels.

525.08 BASIS OF PAYMENT. The quantity of Removal of Existing Bridge Railing or Reset Existing Bridge Railing will be paid for at the Contract unit price bid per linear foot. Payment will be full compensation for dismantling and disposing of, or for repairing and resetting, existing railing and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Bridge Railing of the type specified will be paid for at the Contract unit price per linear foot. Payment will be full compensation for detailing, furnishing, handling, placing, delineating, galvanizing, applying grease rustproof compound, and painting the railing components; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Bridge Railing Repair of the type specified will be paid for at the Contract unit price per linear foot. Payment will be full compensation for detailing, treating, furnishing, handling, and placing railing components, and for bolts and hardware necessary for installing railing components. Payment will also be full compensation for all work necessary for verifying and adjusting post height and/or bolt spacing of existing posts, for furnishing all forms, joint filler, admixtures, trial batches, and connection plates for approach railing terminal connectors, for satisfactory completion of any necessary repairs, surface finishing, and curing and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

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Removal and disposal of existing railing components required for performing Bridge Railing Repair of the type specified will be paid for under Removal of Existing Bridge Railing.

Payment will be made under:

Pay Item		Pay Unit
525.10	Removal of Existing Bridge Railing	Linear Foot
525.11	Reset Existing Bridge Railing	Linear Foot
525.33	Bridge Railing, Galvanized 2 Rail Box Beam	Linear Foot
525.335	Bridge Railing, Galvanized 3 Rail Box Beam	Linear Foot
525.34	Bridge Railing, Galvanized 4 Rail Box Beam	Linear Foot
525.41	Bridge Railing, Galvanized HD Steel Beam/Fascia Mounted	Linear Foot
525.44	Bridge Railing, Galvanized HDSB/Fascia Mounted/Steel Tubing	Linear Foot
525.45	Bridge Railing, Galvanized Steel Tubing/Concrete Combination	Linear Foot
525.50	Bridge Railing Repair, Type I	Linear Foot
525.55	Bridge Railing Repair, Type II	Linear Foot
525.60	Bridge Railing Repair, Type III	Linear Foot
525.70	Bridge Railing, Concrete F-Shape	Linear Foot

SECTION 526 – THIS SECTION RESERVED

SECTION 527 – MAINTENANCE OF STRUCTURES AND APPROACHES

527.01 DESCRIPTION. This work shall consist of the maintenance of existing structures and approaches within the project limits.

527.02 ROAD MAINTENANCE. The Contractor shall maintain all highway sections within the confines of the work under the Contract to the satisfaction of the Engineer. When traffic is to be maintained over the present highway, the full width of the roadway shall be maintained.

The maintenance shall be done by means of an approved road grader or other approved equipment of a type that will be efficient in keeping the roadway in a reasonably smooth and passable condition for traffic and shall be subject to the approval of the Engineer. The material for and the necessary filling of holes and similar depressions that develop in the roadway shall be included in the Contract price for this item.

If, in the opinion of the Engineer, the Contractor fails to maintain a reasonably smooth roadway surface, and fails to fix the same after written notification, the Engineer will make the necessary provisions to maintain the roadway surface, and the cost shall be deducted from any money due or to become due under the Contract.

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527.03 BRIDGE MAINTENANCE. When traffic is maintained over an existing structure, the Contractor shall keep all parts of the structure safe for the legal or posted load of the structure including satisfactory maintenance of the substructure, superstructure, and the bridge surface. The Contractor shall strengthen, patch, shore, or renew any part or parts of this substructure or superstructure when necessary for the safety of the traveling public.

If the existing structure over which traffic is being maintained becomes unsafe for public travel, and if, on Written Order by the Engineer, the Contractor fails to make satisfactory repairs, the Engineer will make the necessary provisions to repair the structure, and the cost will be deducted from any monies due under the Contract.

527.04 METHOD OF MEASUREMENT. The quantity of Maintenance of Structures and Approaches to be measured for payment will be on a lump sum basis.

527.05 BASIS OF PAYMENT. The accepted quantity of Maintenance of Structures and Approaches will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to properly maintain substructures, superstructures, and roadway approaches.

Payment for this work will be made periodically as follows:

(a) 50% of the Contract lump sum price will be paid after all required repairs to the bridges or approaches have been made to the satisfaction of the Engineer and traffic is being maintained over the existing bridges and approaches.

(b) The remaining 50% of the Contract lump sum price will be paid when traffic is permanently moved to the new/rehabilitated bridges and approaches.

When the Contract specifically provides for Item 607.10, Roadway Patrol Maintenance, then Maintenance of Structures and Approaches shall only cover maintenance of the existing structures.

Payment will be made under:

Pay Item	Pay Unit
527.10 Maintenance of Structures and Approaches	Lump Sum

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SECTION 528 – TEMPORARY BRIDGE

528.01 DESCRIPTION. This work shall consist of the design, construction, maintenance, and removal of a temporary bridge, its substructures, and approaches.

528.02 MATERIALS. The Contractor may use any material or combination of materials that will conform to the requirements of this subsection and meet the approval of the Engineer. The Engineer reserves the right to reject materials and details that are structurally unsafe for the use proposed.

Unless specifically permitted in the Contract or upon written authorization of the Construction Engineer, the use of pipes will not be allowed for temporary bridges.

Unless otherwise authorized on the approved drawings, all main load carrying members shall be continuous between supports. Splices will only be approved for the following conditions:

(a) Fully-Bolted Connections. Fully-bolted connections, with high-strength bolts, shall be designed for their location in accordance with the *AASHTO LRFD Bridge Design Specifications*.

(b) Fully-Welded Connections. Fully-welded connections shall be designed, welded, inspected, and tested in accordance with the requirements of *AASHTO LRFD Bridge Design Specifications* and AWS requirements. Any welded connection performed in the absence of and without the approval of the Agency's Welding Inspector will not be approved.

Any welding done for work under this section must be detailed on the working drawings and performed in conformance with Section 506.

528.03 DRAWINGS. Working drawings shall be prepared by the Contractor for the proposed work under this item in accordance with the requirements of Section 105. Drawings for bridge approaches shall include plans, profiles, typical sections, and specific cross-sections for the temporary roadway and channel, when applicable, with complete details and identification of materials to be used. Geometrics of the temporary bridge and its approaches shall be adequate for the volume of traffic served and individual conditions encountered.

Plan, elevation, and section views of the structure shall include size and spacing of all members or components for the following:

(a) Abutments

(b) Piers

(c) Main supporting members or stringers

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(d) Floor system

(e) Diaphragms and lateral bracing

(f) Railing (bridge and approach)

(g) Curbs

(h) Bearings

(i) Other applicable information

528.04 DESIGN AND CONSTRUCTION DETAILS. The design and structural details of the temporary bridge, its substructures and approaches shall be signed, stamped, and dated by a professional engineer, either Structural or Civil.

In designing and constructing a temporary bridge, the Contractor shall provide for the waterway and clearances shown on the Plans. When temporary bridge requirements are not shown on the Plans, the opening area shall be at least equal to 40% of the waterway provided for the 100-year event (Q 100) for the new structure, with a clear height equal to a ten-year event (Q 10) headwater; this waterway to be adequate for safely conveying a mean annual flood (Q 2.33) at a headwater no greater than what would be created by the existing structure during a ten-year event.

Fill placed in or adjacent to the stream shall be clean granular or rock material meeting the requirements of Subsection 703.04 or Subsection 703.05 and protected with sufficient stone to prevent erosion to a Q 10 headwater elevation (based on the new structure). Any fill placed in the stream to protect the temporary bridge and approaches shall be removed to the satisfaction of the Engineer upon completion of the project. The sizing of any temporary bridges to be left in place between January 1st and May 1st, or for any period greater than seven months shall be approved by the Engineer. Questions regarding hydraulic information not furnished shall be addressed to the Engineer.

(a) Roadway. Approach embankments shall be constructed of acceptable fill material, compacted to adequately support design loading requirements. A minimum of 15 inches of approved gravel or other acceptable surfacing material shall be provided for the full width of the typical section.

When the Plans designate paved approaches, the approaches shall be paved with a minimum 2 inch wearing course of Type III or Type IV bituminous concrete pavement and the approaches and bridge shall have temporary pavement markings applied as per Section 646. Bituminous concrete pavement shall conform to the requirements of Section 406, except the mix design submittal and plant inspection requirements set forth in Section 406 will not be required.

The Engineer may also waive weather limitations. The temporary pavement shall extend for the full length of the approaches and the full clearance width described below.

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Turnouts with adequate space for two-way traffic shall be provided at each end of a one-way structure or coordinated with traffic signalization, if used.

(b) Bridge.

(1) Loading. Unless otherwise specified, all temporary bridge structures shall be designed for an HS-20 or HL-93 live load, and for all other applicable forces, in accordance with the *AASHTO Standard Specifications for Highway Bridges* or the *AASHTO LRFD Bridge Design Specifications*. Sidewalks and pedestrian structures shall be designed for a minimum live load of 60 pounds per square foot.

(2) Clearances. A one-way temporary bridge shall have a minimum clear width between faces of railing of 14 feet, 6 inches. A two-way temporary bridge shall have a minimum clear width between faces of railing of 24 feet.

Sidewalks and pedestrian bridges shall have a minimum clear width of 4 feet between faces of railing or edge of curb and face of railing. A minimum vertical clearance of 14 feet shall be provided for vehicular traffic and 8 feet for pedestrian traffic.

(3) Erection. As part of the working drawings submittal, the Contractor shall, dependent upon the type of structure being erected, include the information required under Section 506 or Section 510 pertaining to erection or installation. Submittal of the computations indicating the magnitude of the stresses in the segments is not required.

(c) Railing. Approach railing and temporary barrier rail shall conform to Subsection 621.07.

Details for either rail system or combination thereof shall conform to applicable AASHTO requirements. Rail sections shall be continuous from the approaches across the structure. Approach railing shall be provided for a minimum of 25 feet off the ends of any structure and shall be provided for all approach fill slopes steeper than 1:3 (V:H).

The free end of any steel beam rail shall be protected with a W-beam end section RE-6 (rounded) as defined in the *AASHTO Guide to Standardized Highway Barrier Hardware*, flared to a 4-foot offset. The free end of any concrete barrier rail shall be flared horizontally to a 4-foot offset for a minimum panel length 10 feet and project a maximum of 6 inches above the adjacent roadway surface.

The top of the steel beam railing shall be 30 inches (± 1 inch) above the adjacent surface and the concrete barrier railing shall be 31 inches (± 1 inch) above the adjacent surface.

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Vehicular bridge rail posts and anchorage shall be designed to withstand a horizontal loading of 600 pounds per foot applied 1 foot, 9 inches above the deck surface. Pedestrian railings and posts shall provide protection for a height of 42 inches above the walkway surface and be designed to withstand a horizontal loading of 50 pounds per foot applied 42 inches above the walkway surface.

When a pedestrian walkway is specified or used in conjunction with vehicular traffic, a 12 inch × 12 inch curb separation shall be provided. Curbs shall be anchored to withstand a horizontal loading of 250 pounds per foot. The outside pedestrian railing shall be a combination of vehicular and pedestrian railing. The pedestrian railing shall be constructed to limit clearance between horizontal rail components to 6 inches.

When temporary barrier rail is specified or used as a movable rail system (e.g., adjusting traffic flow patterns), the concrete median barrier specified herein shall be used. An adequate connection shall be provided when concrete median barrier is used in combination with standard steel beam rail.

(d) Walkways and Approaches. Temporary bridges with walkways, temporary pedestrian bridges, walkways, and approaches to walkways shall be designed and constructed to provide width, grade, surface, etc. in conformance with the requirements set forth in the current *ADA* standards for sidewalks.

528.05 MAINTENANCE AND LIABILITY. The Contractor shall maintain each temporary bridge and its approaches in conformance with Contract requirements and to the satisfaction of the Engineer. The Contractor shall assume all liability for the installation, maintenance, and removal of the temporary bridge and its approaches. Unless otherwise specified, all rights-of-way on private property required for the performance of this work shall be provided by the Contractor.

Costs for replacing the loss of any part of the temporary bridge or its approaches shall be included in the unit price for the temporary bridge item except as provided in Subsection 107.18.

528.06 METHOD OF MEASUREMENT. The quantity of One-Way Temporary Bridge, Two-Way Temporary Bridge, or Temporary Pedestrian Bridge measured for payment will be on a lump sum basis for each type specified, in the complete and accepted work.

528.07 BASIS OF PAYMENT. The accepted quantity of One-Way Temporary Bridge, Two-Way Temporary Bridge, or Temporary Pedestrian Bridge will be paid for at the Contract lump sum price for each type specified. Payment will be full compensation for designing, detailing, constructing, maintaining, and removing the bridge and its approaches, including placing and removing pavement and pavement markings when paved approaches are required.

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When working drawings have been submitted and approved in accordance with the requirements of Section 105, a payment of 10% of the lump sum price will be allowed. When a temporary bridge, its substructures, and approaches have been fully constructed and accepted by the Engineer, a further payment of 65% of the lump sum price will be allowed. When the temporary bridge and its approaches have been removed, a further payment of 15% of the lump sum price will be allowed. The remaining 10% of the lump sum price will be paid when the site is cleaned up and vegetation has been established to the satisfaction of the Engineer.

Unless otherwise specified as a separate Contract item, the costs of all approach and bridge railing associated with the temporary bridge will be considered to be included in the Contract lump sum price for Temporary Bridge.

Payment will be made under:

Pay Item	Pay Unit
528.10 One-Way Temporary Bridge	Lump Sum
528.11 Two-Way Temporary Bridge	Lump Sum
528.12 Temporary Pedestrian Bridge	Lump Sum

SECTION 529 – REMOVAL OF STRUCTURES AND BRIDGE PAVEMENT

529.01 DESCRIPTION. This work shall consist of the removal, wholly or in part, and the satisfactory disposal of all structures, including accessories and appurtenances, bridge pavements, and the backfilling of holes when required.

529.02 GENERAL. Unless otherwise specified, all materials resulting from the Removal of Structures and Removal of Bridge Pavements shall become the property of the Contractor, who shall properly dispose of them.

529.03 REMOVAL OF BRIDGE PAVEMENTS. The removal of pavement on bridges shall include the removal of bituminous concrete material. If removal is by cold planing, work shall be done in accordance with the requirements of Section 210. Removal methods shall be subject to the approval of the Engineer and shall be such as to prevent any damage to the remaining surface.

Sealants or membranes shall remain in place as shown on the Plans or directed by the Engineer. Any necessary deck repair will be paid for as shown on the Plans, except damage caused by Contractor's negligence shall be repaired at the Contractor's expense.

529.04 REMOVAL OF STRUCTURES. The Contractor shall dismantle the structure and shall remove the dismantled members or materials. Removal of structures spanning bodies of water will be conducted so as to avoid dropping materials into the water. The entire site of the old structure shall be restored to a condition satisfactory to the Engineer.

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The existing concrete or masonry shall be removed by drilling, chipping, or other methods approved by the Engineer. All cut surfaces, unless otherwise specified, shall be on a reasonably vertical or horizontal plane with sharp straight corners. Existing reinforcing steel to be retained shall be carefully preserved and cleaned for use in the new construction. Existing reinforcing steel damaged beyond reuse as determined by the Engineer shall be replaced by splicing a bar of equal diameter to the damaged bar in a manner approved by the Engineer at no additional compensation to the Contractor. Holes for expansion bolts or dowels shall be drilled in the retained concrete at the locations shown on the Plans.

When the material from the structure is to be retained by the Agency or others, or is to be reused in the construction, it shall be carefully dismantled by the Contractor and all adhering concrete removed. Materials to be retained or reused shall be stored at the location specified in the Contract or as directed by the Engineer. When the existing superstructure steel is to be retained for future use, the Contractor shall take every precaution necessary to prevent damage to the existing steel. Damage to the existing steel caused by the Contractor's operations shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost to the Agency.

Where portions of existing structures are to be removed, the portions indicated shall be removed to the lines shown on the Plans, or as directed by the Engineer, in such a manner as to leave the remainder of the structure undamaged and in proper condition for the intended use. Any damages to the portions remaining in service shall be satisfactorily repaired by the Contractor at no additional cost to the Agency. Explosives will not be permitted for partial removal of any structure.

Removed parts of the existing structure that are to be reused in the new construction shall be safeguarded, cleaned, or otherwise prepared as shown on the Plans or in the Contract and incorporated into the work as shown on the Plans or as directed by the Engineer.

529.05 METHOD OF MEASUREMENT. The quantity of Removal of Bridge Pavement to be measured for payment will be the number of square yards of bridge deck from which bituminous pavements have been removed as shown on the Plans or ordered by the Engineer.

The quantity of Removal of Structure to be measured for payment will be as follows:

(a) Removal of Structure will be on a unit basis for each removal at the locations shown on the Plans.

(b) Partial Removal of Structure will be on a unit basis for removal of the materials between the limits shown on the Plans.

(c) Removal of Concrete or Masonry will be the number of cubic yards or square yards of concrete or masonry measured in place and removed between the limits shown on the Plans or as ordered by the Engineer.

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529.06 BASIS OF PAYMENT. The accepted quantity of Removal of Bridge Pavement will be paid for at the Contract unit price per square yard. The accepted quantity of Removal of Structure and of Partial Removal of Structure will be paid for at the Contract unit price per each. The accepted quantity of Removal of Concrete or Masonry will be paid for at the Contract unit price per cubic yard or square yard.

Payment will be full compensation for the removal and disposal of the specified items; for removal, salvage, and stockpiling of components and materials specified in the Contract; for excavating, backfilling, regrading, and performing site restoration incidental to the removal of specified items; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Removal of Bridge Pavement, when not included as a separate pay item, will not be paid for directly, but will be considered incidental to either Removal of Structure or Partial Removal of Structure as specified in the Plans.

Payment will be made under:

Pay Item	Pay Unit
529.10 Removal of Bridge Pavement	Square Yard
529.15 Removal of Structure	Each
529.20 Partial Removal of Structure	Each
529.25 Removal of Concrete or Masonry	Cubic Yard
529.26 Removal of Concrete or Masonry	Square Yard

SECTION 530 – THIS SECTION RESERVED

SECTION 531 – BRIDGE BEARING DEVICES

531.01 DESCRIPTION. This work shall consist of furnishing and installing bridge bearing devices.

531.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV	707.03
Structural Steel	714.02
High-Strength Low-Alloy Structural Steel	714.03
High-Strength Bolts, Nuts, and Washers	714.05
Anchor Bolts, Bearing Devices	714.08
Galvanizing	726.08
Metalizing	726.09
Bearing Pads	731.02
Elastomeric Material	731.03

Stainless Steel 731.05
Brass Rings 731.07
PTFE Material.....731.08

Unless otherwise specified, all materials shall conform to the *AASHTO LRFD Bridge Design Specifications*, Section 14, *VTrans Structures Design Manual,* Section 14 (available on the Agency's website), *AASHTO LRFD Bridge Construction Specifications*, Section 18 and all AASHTO or ASTM specifications referenced in this section. Substitutions will not be allowed unless approved on the fabrication drawings.

531.03 FABRICATION DRAWINGS. The fabricator of bearings furnished under this section shall submit detailed fabrication drawings, bonding procedures, welding procedure specifications, and welder qualification test records in accordance with Section 105. Fabrication drawings shall identify the number of layers of vulcanized sheets and corresponding sheet thicknesses to be used for fabricating the bearing pad and shall include detailed procedures for bonding these sheets together.

531.04 FABRICATION.

(a) General. Material furnished under this section shall conform to all applicable provisions of Subsection 506.03 through Subsection 506.16. Bearings shall be fabricated in a plant having as a minimum an AISC Certified Bridge Fabricator – Advanced (ABR) Certification or in a plant approved by the Agency prior to the award of the Contract. Plants that are not certified must satisfy the requirements of Subsection 506.03.

During any welding, surfaces in contact with the elastomer shall be restricted to 200°F, and surfaces in contact with PTFE shall be restricted to 300°F. Temperatures shall be determined by temperature indicating wax pencils or other suitable means.

All corners and edges of steel plates shall be ground to a 1/16 inch radius.

Bearing devices shall be fabricated, assembled, and certified by one supplier. Anchor bolt assemblies may be fabricated and supplied by an alternate supplier.

Alternate configurations for bearings from that shown in the Plans may be submitted for approval. Any alternate submitted shall be designed and stamped in accordance with Subsection 105.03. All designs shall meet the design loads and criteria specified in the Plans.

The fabricator may propose minor alterations to the design of each device from that shown on the Plans to conform to the particular method of fabrication used at that fabricator's plant. The general design intent of the Plans shall be followed with modifications approved on the fabrication drawings, including minor changes to the overall height of the bearing.

If proposed bearing height varies from that shown in the Contract, the Contractor shall propose a method for accommodating the difference in height, which shall be shown in the submittal.

(b) Surface Protection. All bearings, except interior surfaces of pot bearings, shall be galvanized in accordance with Subsection 726.08 or metalized in accordance with Subsection 726.09.

(c) Tolerances. After fabrication and application of surface protection, bearing devices or components shall be within the following tolerances:

(1) Plain elastomeric pads and steel reinforced elastomeric pads shall be within the tolerances specified in of *AASHTO M 251,* Table 2.

(2) High-load multi-rotational bearings, external load plates, and guides shall be within the tolerances specified in the *AASHTO LRFD Bridge Construction Specifications,* Section 18.

(d) Sliding Surfaces.

(1) Stainless Steel. Stainless steel used as a mating surface with PTFE shall conform to the following parameters:

a. The thickness of the stainless steel sheet shall be at least 14 gauge when the maximum dimension of the surface is less than or equal to 12 inches, and at least 11 gauge when the maximum dimension is larger than 12 inches.

b. For bonded applications, stainless steel sheets may be affixed to backup plates with a combination of high-temperature resistant epoxy and mechanical attachment by spot welding or other approved procedures. The fabricator must demonstrate that any proposed alternate procedure for attachment will maintain adhesion between the backup material and stainless steel under loading, movement, and weather conditions anticipated to be encountered during life of the bearing.

c. For welded applications, stainless steel sheets shall be circumferentially seal welded to backup plates. Procedure qualification will be required for any welding process and welding procedures shall be submitted for approval in accordance with Subsection 506.04 and Subsection 506.10.

d. Prior to adhesion or attachment of the stainless steel to a backup plate, the contact surface of the backup plate shall meet the sliding surface tolerance specified herein and shall be blast cleaned to an appearance equivalent to *SSPC-SP 10*. The contact surface of stainless steel sheets to be bonded with epoxy shall be mechanically abraded or etched prior to application of adhesive.

(e) High Load Multi-Rotational (Pot or Disc). In addition to the requirements of the *AASHTO LRFD Bridge Design Specifications,* Section 14 and the *AASHTO LRFD Bridge Construction Specifications*, Section 18, the following shall apply to the design and fabrication of pot bearings:

(1) General. Bearings shall be designed for the vertical and horizontal forces shown on the Plans.

Exposed PTFE material on a guide bar or other component shall be pigmented to prevent penetration of ultraviolet light.

The shape characteristics, clearances, and sealing mechanism of the piston and cylinder must be designed to prevent extrusion of the elastomer under load and rotational movement.

Either PTFE sheets or other approved material shall be provided to lubricate compressive surfaces of the elastomer.

The internal floating portion of the bearing must be sealed to prevent the intrusion of foreign material.

The steel housing shall be manufactured by welding or machining from a single piece of plate. The shear restriction mechanism shall be connected to the bearing plate by mechanically fastening, welding, or other means approved by the Engineer.

High load multi-rotational bearings shall be tested in accordance with the requirements of *AASHTO LRFD Bridge Design Specifications* and the *AASHTO LRFD Bridge Construction Specifications*, Section 18, and modified as follows:

a. For each structure or pair of structures on a project, one of every ten fixed bearings and one of every ten expansion bearings shall be selected at random from the production lot. Sample or specially-made test bearings will not be permitted.

b. Load measuring instruments used in conjunction with the testing equipment should be calibrated yearly and be accompanied by a certificate indicating their date of calibration.

c. The measured static coefficient of friction shall be less than 4%.

d. The measured dynamic coefficient of friction shall be less than 4%.

e. The basis for acceptance shall be the following:

1. The coefficients of friction are less than 4%.

2. Acceptable material certifications.

3. Assembled bearings meet requirements and tolerances specified in the Contract.

4. Inspection of tested bearings shows no visual defects, such as extruded or deformed elastomer, polyether urethane, or PTFE, damaged seals or limiting rings, evidence of metal-to-metal contact between the pot wall and the top plate, or cracked steel.

f. Test results and material certifications shall be sent to the Agency's Materials Section with a copy of the test results sent to the Structures Engineer.

g. Acceptable test results are a prerequisite for certification acceptance. Expenses for performing any testing shall be incidental to the work.

531.05 INSTALLATION.

(a) General. Bearings shall be set level and parallel with full and uniform bearing. Pedestals detailed to be on a slope shall be set at the elevation and position specified.

The concrete under the bearing device shall be level.

Anchor bolts shall be positioned to the alignment and dimensions specified or approved in the fabrication drawings. When preset or cast-in anchorages are not specified, the Contractor shall drill holes and set the anchor bolts in a Type IV mortar. Additional aggregates shall not be added to the material during field mixing.

Prior to ordering materials and starting the work, the Contractor shall submit a drilling and mortaring proposal to the Engineer for approval, including a premixed mortar material brand name.

The drilled holes to be mortared shall be thoroughly cleaned, wetted, and free of standing water.

The mortar shall be mixed in a mechanical mixer in accordance the manufacturer's recommendations and shall be readily pourable so that when poured it completely fills the remaining hole cavities. The placement of mortar for each bearing shall be continuous and complete at all hole locations.

All exposed mortar shall be cured for a period of not less than three days by the wetted burlap method in accordance with Section 501. Curing shall commence as soon as practical after mortar placement. The Contractor shall not apply any forces to the anchor bolts during the curing period.

If allowed in the Contract or ordered by the Engineer, a pre-approved adhesive may be used to set the anchor bolts into the concrete. If an adhesive is used, the manufacturer's installation requirements for the adhesive shall be followed during installation. The Engineer shall be provided a copy of the Safety Data Sheet (SDS) and a copy of the manufacturer's installation requirements.

Unless otherwise specified on the Plans, anchor bolts shall have a minimum embedment of 18 inches into the concrete and shall conform to Subsection 714.08.

Anchor bolts to be double nutted shall use the following procedure: install lower nut in contact with top of sole plate, and then back off 1/2 turn; install upper nut snug tight to prevent lower nuts from loosening.

Whenever a bridge seat is off by 1/4 inch or more from its designed or adjusted elevation, corrective measures shall be required.

If shims are required, they shall be a single thickness plate that meets the requirements of *AASHTO M 270 M/M 270,* Grade 250 (Grade 36) or Grade 345 (Grade 50), steel, galvanized in accordance with the requirements of Subsection 726.08 or metalized in accordance with the requirements of Subsection 726.09. Details of shims shall be furnished and approved in accordance with the requirements of Subsection 105.03. The cost of any necessary corrective measures, including any costs due to a delay, shall be borne by the Contractor.

(b) Elastomeric Pad with External Load Plate and High-Load Multi-Rotational Bearings. During any welding, surfaces in contact with the elastomer shall be restricted to 200°F, and surfaces in contact with PTFE shall be restricted to 300°F. Temperatures shall be determined by temperature indicating wax pencils or other suitable means. No welding current shall be permitted to pass between the pot and piston components.

The welds for the sole plate connection should only be along the longitudinal girder axis. Transverse joints should be sealed with an acceptable caulking material.

Metal bearing plates shall be placed on a 1/8 inch thick bearing pad conforming to the requirements of Subsection 731.02. The bearing pad shall be the same size as the bearing plate with holes to accommodate the anchor bolts.

PTFE and stainless steel sliding surfaces shall be protected from splatter during welding, grouting, or painting operations if applicable.

High-load multi-rotational bearings shall not be disassembled once they have left the manufacturer, since the process could result in damage to the components or malfunction of the device. Pot bearings that have been disassembled shall not be accepted unless recertified by the manufacturer.

531.06 METHOD OF MEASUREMENT. The quantity of Bearing Device Assembly of the type specified to be measured for payment will be the number of units used in the complete and accepted work. All bearing device components and anchor bolt assemblies will be included as part of the measured unit. Anchor bolt assemblies include bolts, threaded rods, nuts, washers, and beveled plates required for attachment of bearing devices to the superstructure and substructure.

The quantity of Remove and Replace Existing Anchor Bolt to be measured for payment will be the number of each anchor bolt removed and replaced in the complete and accepted work.

531.07 BASIS OF PAYMENT. The accepted quantity of Bearing Device Assembly of the type specified will be paid for at the Contract unit price for each. Payment will be full compensation for detailing, furnishing, handling, transporting, and placing the material specified, including surface preparation, protective coating, testing, anchor bolt assemblies, drilling for anchor bolts, mortar, proprietary anchoring systems, bearing device components, and welding, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for alternate bearing designs and submittals will be considered incidental to the appropriate Section 531 pay item in the Contract.

Payment for Remove and Replace Existing Anchor Bolt will be paid for at the Contract unit price for each. Payment will be full compensation for removing the existing anchor bolt, removing and replacing the existing bearing assembly, welding, drilling for new anchor bolt, mortar, proprietary anchoring systems, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
531.15 Bearing Device Assembly, High Load Multi-Rotational	Each
531.16 Bearing Device Assembly, Plain Elastomeric Pad	Each
531.17 Bearing Device Assembly, Steel Reinforced Elastomeric Pad	Each
531.18 Bearing Device Assembly, Elastomeric Pad w/External Load Plates	Each
531.19 Remove and Replace Existing Anchor Bolt	Each

SECTION 534 – THIS SECTION RESERVED

SECTION 535 – THIS SECTION RESERVED

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SECTION 540 – PRECAST CONCRETE

540.01 DESCRIPTION. This work shall consist of manufacturing, transporting, and erecting precast concrete structure components. This specification also addresses the manufacture of precast concrete mechanically stabilized earth (MSE) wall panels. Hereafter, the phrase "precast concrete" will be used to include both precast concrete structure components and MSE wall panels.

540.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Portland Cement.....701.02
High Early-Strength Portland Cement.....701.04
Portland-Pozzolan Cement.....701.05
Portland Blast-Furnace Slag Cement.....701.07
Ternary Blended Cement.....701.08
Fine Aggregate for Concrete.....704.01
Coarse Aggregate for Concrete.....704.02
Mortar, Type IV.....707.03
Preformed Joint Filler, Cork, and Asphalt-Treated Felt.....707.08
Polyvinyl Chloride (PVC) Waterstop.....707.10
Bar Reinforcement.....713.01
Mechanical Splices for Bar Reinforcement.....713.02
Welded Wire Reinforcement.....713.05
Prestressing Strand.....713.06
Carbon Steel Bolts, Nuts and Washers.....714.04
High-Strength Bolts, Nuts, and Washers.....714.05
Concrete Curing Materials.....725.01
Air-Entraining Admixtures.....725.02(b)
Retarding Admixtures.....725.02(c)
Water-Reducing Admixtures.....725.02(e)
Water-Reducing and Retarding Admixtures.....725.02(f)
Water-Reducing, High Range Admixtures.....725.02(g)
Water-Reducing, High Range, and Retarding Admixtures.....725.02(h)
Accelerating Admixtures.....725.02(i)
Water-Reducing and Accelerating Admixtures.....725.02(j)
Specific Performance Admixtures.....725.02(k)
Mineral Admixtures.....725.03
Waterproofing Membrane System, Type III.....726.11(c)
Polystyrene Insulation Board.....735.01
Blanket Insulation Material.....735.02
Pipe Insulation.....740.08
Water.....745.01
Overhead and Vertical Concrete Repair Material.....780.02

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Structural Steel shall meet the requirements of Subsection 714.01 through Subsection 714.03.

Bearing Pads for Structures shall meet the requirements of Section 731.

540.03 GENERAL FABRICATION REQUIREMENTS.

(a) General. The manufacture of the precast units shall be in accordance with the latest editions of *PCI MNL-116* and *PCI MNL 135-00*, except as modified in this section, or with the *National Precast Concrete Association (NPCA) Quality Control Manual for Precast Plants.*

(b) Qualification. Precast concrete shall be manufactured in a plant that has been certified by either the Prestressed Concrete Institute (PCI) under its Plant Certification Program for precast concrete or by the National Precast Concrete Association (NPCA) Plant Certification Program.

Precast concrete shall be manufactured in a plant that maintains a quality control laboratory that meets the requirements of the Agency's Qualified Laboratory Program. As a minimum, the laboratory shall be equipped with a compression testing machine, curing room or chamber, apparatuses for measuring slump/flow and air entrainment, and a complete set of aggregate sieves.

The compression testing machine shall be calibrated yearly by an independent laboratory using equipment that is certified by the National Institute of Standards and Technology (NIST). The testing machine shall be power operated and capable of applying the load continuously rather than intermittently, and without shock.

(c) Quality Control. The fabricator shall demonstrate a level of quality control testing that satisfies the Agency as to its ability and commitment to produce precast concrete to the requirements of this section. A satisfactory program of quality control shall include gradation and moisture determinations of the aggregates, as well as slump, air content, and strength determinations of the concrete.

These tests shall be performed at regular and suitable intervals as specified in the *Materials Sampling Manual* and actively used to maintain the quality of the concrete within the specified requirements. The fabricator shall have a plant specific Quality Control Plan approved by the Agency prior to the beginning of any fabrication activities.

540.04 SUBMITTALS. As soon as practical after award of the Contract, all required information shall be prepared and submitted.

A complete copy of the structural design calculations for the precast concrete shall be submitted as construction drawings in accordance with the requirements of Section 105. The design calculations shall substantiate that the proposed precast concrete satisfies the design parameters of the Contract.

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The design calculations shall include a load rating for superstructures for the seven standard axle configurations shown in the load rating block in the Plans and any general or construction notes required for the fabrication and construction of the precast concrete. The applicable design code will be the latest edition of the *AASHTO LRFD Bridge Design Specifications* unless indicated otherwise in the Contract.

Fabrication drawings (also referred to in the precast industry as production drawings or shop drawings) for the precast concrete shall be submitted in accordance with the requirements of Section 105, with an additional copy to the Structural Concrete Engineer. Fabrication drawings shall include such detail needed to fully describe the intended as-built condition of the precast elements including any connections between precast elements and/or existing structures and materials.

In addition to the requirements for fabrication drawings in Section 105, the following shall be included:

(a) Concrete Mix Design. The concrete mix design shall include, but not be limited to, the following components:

(1) Batch weights specifying dry or saturated surface dry.

(2) Material names and sources

(3) Aggregate properties and date tested. Aggregates shall be tested on an annual basis, at a minimum for absorption and specific gravity per the requirements of *AASHTO T 84* and *AASHTO T 85* and unit weight per the requirements of *AASHTO T 19/T 19 M*.

(4) Chemical and physical properties of cementitious material.

(5) Admixture names and sources.

(6) Lab data that shall include, but not be limited to, the following items:

a. The maximum water/cementitious materials (W/CM) ratio that will be allowed during production, including water contributed to hydration by all admixtures when the cumulative total exceeds 1 gallon per cubic yard. All mix qualification test results shall be generated with concrete from batches that are produced at this maximum W/CM ratio.

b. Slump/spread minimum and maximum, determined from trial batches. The concrete shall be classified and tested as Self-Consolidating Concrete (SCC) if the minimum spread is at least 18 inches. When the concrete is tested as a SCC mix, the difference between the J-Ring test, the requirements of *ASTM C 1621/C 1621 M,* and the spread test, the requirements of *ASTM C 1611/C 1611 M*, shall be two inches or less for the minimum and maximum spread.

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Concrete that fails to meet the 18 inches minimum spread threshold will be classified and tested as conventional concrete. The Visual Stability Index (VSI) determination will be included for the minimum and maximum values and shall not be greater than 1. The concrete shall not demonstrate segregation at the minimum or maximum slump/spread.

c. Air Content as tested in accordance with the requirements of *AASTHO T 152*.

d. Temperature as tested in accordance with *ASTM C 1064/C 1064 M.*

e. Cylinder compression results obtained in accordance with the requirements of *AASHTO T 22* for early breaks, design strength, and the 28-day standard cure as defined in *AASHTO T 23*. The type of cure shall be listed for each age of break.

f. Chloride ion penetration test data that meets the requirements of *AASHTO T 358,* with information that includes the individual results from testing three standard 4-inch × 8-inch cylinder specimens. No specimen shall exceed the limits specified herein. Testing shall be performed by an independent AMRL qualified laboratory.

The chloride ion penetrability result must be "Low" as defined in *AASHTO T 358*, tested at or before 56 days from the date specimen were cast. Test results shall also be provided for sample ages of 3 days, 5 days, 7 days, and 28 days.

Test results that are suspected to have been adversely affected due to the presence of polymeric admixtures in the proposed mix may be retested with the polymeric admixture omitted.

g. The Alkali-Silica Reactivity (ASR) of each type of aggregate shall be measured separately based on the requirements of *AASHTO T 303*. If one or more of the aggregates exceeds 0.10% expansion, then the aggregate shall be tested again according to the requirements of *ASTM C 1567*.

The Contractor may elect to go directly to *ASTM C 1567* testing if they suspect that the aggregate may exceed the 0.10% expansion if tested by *AASHTO T 303*. Testing shall be performed by an independent AMRL qualified laboratory accredited in the specific test method.

h. Length change test data that meets the requirements of *AASHTO T 160* shall be performed by an independent AMRL qualified laboratory accredited in testing in accordance with the requirements of *AASHTO T 160*. The maximum free shrinkage test result shall not exceed 0.06%. The cross-section of the prism shall be 4 inches × 4 inches. Follow Procedure 11.1.2 for storage and measurements.

(7) Mix design approvals will be valid for a 12-month period. The approved mix design will be allowed re-approval if the following conditions are satisfied:

a. No material proportioning or material sources have changed from the initial approved mix design.

b. The mix design for re-approval is submitted with updated aggregate properties and volumes adjusted accordingly. The properties to be tested shall include, but not be limited to, specific gravity, unit weight, and absorption.

Approval of the mix design will expire 14 months from the date the updated aggregate testing was performed.

c. The mix design shall be accompanied by the previously completed and accepted test mix data and any applicable updated test information.

New mix designs and mix designs that were approved more than 36 months ago shall have new testing completed to be submitted for approval.

The proposed concrete mix design, including performance history and all requests for variance from the material requirements of these specifications, shall be submitted for approval. The Structural Concrete Engineer may require a minimum of 8 weeks for testing, review, and approval of new mix designs.

(b) Dimensions and Tolerances. The dimensions and tolerances of the sections to be fabricated.

(c) Steel Locations. The location of reinforcing steel, welded wire fabric, mechanical bar connectors, and inserts.

(d) Surface Finish. The type of surface finish and how the finish will be obtained.

(e) Curing Method. The curing method, detailing the sequence and duration in accordance with the requirements of Subsection 540.08.

(f) Minimum Required Strength. The minimum required concrete strength for form removal.

(g) Lifting Attachments. The design of the lifting attachments, including the minimum required concrete strength to allow lifting, with calculations stamped by a professional engineer registered in the State of Vermont.

(h) Logistics. A description of the transportation, handling, and storage details.

(i) Installation and Grouting. A description of the installation and grouting procedures.

(j) Quality Control. A description of the Quality Control procedures.

All design details shall be in accordance with the most recent edition of the *VTrans Structures Design Manual* available on the Agency's website and the *AASHTO LRFD Bridge Design Specifications*. A professional engineer registered in the State of Vermont shall stamp any design calculations included in the submittals.

540.05 CONCRETE.

(a) Batch Plants. Batch plant equipment, materials, and batching procedures shall conform to the provisions of Section 501 listed in Table 540.05A.

TABLE 540.05A – BATCH PLANT OPERATION SUBSECTIONS AND TOPICS

Subsection	Subject
501.04	Batching [1]
501.04(b)	Testing Laboratory
501.04(c)	Bins and Scales
501.04(d)	Production Tolerances for Testing
501.04(e)	Storage and Proportioning of Materials
501.05	Mixing and Delivery [2]

[1] Paragraphs 1 and 3 only.

[2] For plants not located in the State, the Agency has the option of waiving the requirements of Subsection 501.05(a)(4) and Subsection 501.05(c), paragraphs 1 and 3 only.

(b) Acceptance Testing. For acceptance testing, refer to the Agency's *Materials Sampling Manual* for sampling, curing, and testing requirements. Specimens shall be tested either at the Agency's Materials Section Central Laboratory, or at the fabricator's plant laboratory. An Agency representative shall witness all tests.

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Concrete for precast concrete shall conform to the following requirements:

(1) Compressive strength test results obtained at or before 28 days shall not be less than the design compressive strength shown on the Plans. When a 28-day test result is below the specified design strength, all concrete represented by that test shall be unacceptable for the requirements of this section. The Engineer reserves the right to reject all members that were manufactured from this concrete.

(2) The maximum total water batched shall not exceed 280 pounds per cubic yard, including water contributed to cement hydration by all admixtures when the cumulative total exceeds 1 gallon per cubic yard. If total cementitious material content exceeds 900 pounds per cubic yard, then water batched shall not exceed 300 pounds per cubic yard. The maximum W/CM ratio in production shall not exceed the maximum W/CM ratio determined in Subsection 540.04(a)(6)a.

(3) The air entrainment value shall be 7% with a tolerance of ± 2%, as tested in accordance with the requirements of *AASHTO T 152*.

(4) The temperature of the concrete at the time of placement shall be between 50°F and 85°F, as tested in accordance with the requirements of *AASHTO T 309*.

(5) The concrete shall not demonstrate segregation at any time. If the mix fails to remain within the minimum/maximum slump or spread submitted in the mix design, the load may be rejected. The Visual Stability Index (VSI) shall be less than or equal to 1.

(6) The Agency may request that the producer fabricate three concrete test cylinders that will be cured with the piece they represent through the complete curing period. These cylinders shall meet the testing requirements of *AASHTO T 277* and *AASHTO T 358,* and shall be kept with the piece they represent until collected by the Agency.

Any admixture containing calcium chloride shall not be used. Only the cementitious combinations and sources from the approved mix design shall be used in the precast units required for any one structure, unless otherwise authorized by the Structural Concrete Engineer.

540.06 INSPECTION. Materials furnished and the work performed under Section 540 shall be inspected by the Agency. The Inspector shall have the authority to reject any material or work that does not meet the requirements of these specifications. Any work performed that has not been inspected may be rejected, unless waived in writing by the Engineer.

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The Inspector shall be provided with a minimum office space of 100 square feet with the least dimension of 6 feet. There shall be provided a desk surface and with minimum of two drawers. A dedicated private telephone service shall be provided in the office space. A dedicated internet connection, which provides Agency personnel a minimum speed of 3 Mbps download, without utilizing compression algorithms, shall be provided in the office space. Any variances shall be approved by the Structural Concrete Engineer. This office space shall be located on the premises as close to the production area as practicable.

The Engineer reserves the right to reject inadequate office facilities and require suitable alternatives.

540.07 FABRICATION.

(a) Pre-Production Meeting. Unless the Engineer deems, in writing, that a pre-production meeting is unnecessary, a pre-production meeting shall be requested by the producer with a minimum notice of two weeks prior to beginning concrete placement. The meeting shall be held a minimum of 5 calendar days prior to beginning concrete placement unless otherwise approved by the Structural Concrete Engineer.

The pre-production meeting shall be attended by, and including but not limited to, the crew supervisor, plant manager, inspector or inspector's supervisor, a representative from the Agency Materials Section Structural Concrete unit, and the Project Manager and/or Designer. Additionally, the fabricator shall have available at the pre-production meeting the approved fabrication drawings and a complete anticipated production schedule for all components included in the fabrication drawings.

(b) Forming Members. Any defects or damage due to form work, stripping, or handling may be cause for rejection. Holes or cutouts for anchoring devices, diaphragm connections, openings for connection rods, recesses for grout holes for railing bolts, and any other related details shown on the Plans shall be provided for in the members.

(c) Post-Tensioning Strands and Conduits. Each post-tensioning strand to be post-tensioned shall be encased in an approved conduit. Unless otherwise shown on the Plans, the ratio of cross-sectional area of the post tensioning strand to be encased to the interior cross-sectional area of the conduit shall not exceed 0.4, except when a steel bar is used as a tendon, the inside diameter of the conduit shall be at least 3/8 inch greater than the diameter of the bar. Conduit that has been crushed or has opened seams shall not be used.

The conduit shall be rigidly constructed, completely sealed, accurately placed, and securely fastened to maintain the desired profile during concreting. No conduit shall be located more than 1/4 inch from the position shown on the Plans. Bundling of conduits will not be permitted.

(d) Bar Reinforcement and Welded Wire Reinforcement. Bar reinforcement and welded wire reinforcement shall be furnished and installed in conformance with the requirements of Subsection 507.03, Subsection 507.04, Subsection 507.05, Subsection 507.07, and Subsection 507.08. The chairs or spacers used to support or locate the reinforcement that bears on the faces of the forms shall be made of, or be coated with, a non-corrosive material so that no discoloration will show on the faces of the precast concrete units.

(e) Placing Concrete. Concrete shall not be deposited in the forms until the Agency representative has approved placement of the reinforcement, conduits, and anchorages. The concrete shall be vibrated internally, externally, or a combination thereof to the required consolidation. When a vibrator is used with rebar with special coatings or made of non-metallic material or a material that could be susceptible to damage, the vibrator head shall be non-metallic or rubber-coated.

SCC concrete should not be vibrated. If there is a need to vibrate SCC concrete, it shall only be vibrated for the minimum time necessary so as to avoid segregation. The vibrating shall be done with care and in such a manner to ensure that the following conditions are met:

(1) The concrete is uniformly consolidated.

(2) Displacement of or damage to reinforcement, inserts, conduits, and anchorages is avoided.

(3) Acceptable finish surfaces are produced.

(f) Dimensional Tolerances. All dimensional tolerances shall be in accordance with the latest editions of *PCI MNL – 116* and *PCI MNL 135-00*, or with the *National Precast Concrete Association (NPCA) Quality Control Manual for Precast Concrete,* unless otherwise noted in the Contract or as approved by the Engineer.

(g) Defects. Units that contain defects caused by manufacture or handling may be repaired at the manufacturing site.

Minor defects are defined as the intermittent presence of holes, honeycombing, chips, or spalls, which are 6 inches or less in the longest dimension, and that do not penetrate deeper than 1 inch into the concrete. Minor defects may be repaired using an approved standard repair procedure as detailed in Subsection 540.07(g)(3). Surface voids or "bug holes" that are less than 5/8 inch in diameter and less than 1/4 inch deep need not be repaired. Minor defects that recur with any identifiable regularity or pattern may be required to be addressed through a non-conformance report, at the discretion of the Structural Concrete Engineer.

Major defects are anything beyond the scope of minor as described above. It is at the sole discretion of the Structural Concrete Engineer to determine into which category any defect is categorized.

(1) Cracking. Cracks less than 0.01 inch in width shall be sealed by a method approved by the Structural Concrete Engineer. Cracks equal to or greater than 0.01 inch in width may be cause for rejection based on their width, length, location, and frequency.

At the Structural Concrete Engineer's discretion, cracked members shall be repaired or replaced at the Contractor's expense. Members with crack widths of 0.05 inch and greater will be rejected.

(2) Repairs. Repairs shall be made using an overhead and vertical concrete repair material from the Agency's *Approved Products List*. Any unsound concrete shall be carefully chipped out and the perimeter saw cut to a minimum depth of 1/4 inch or deeper if recommended by the repair material manufacturer. The prepared surface profile shall be as specified by the repair material manufacturer or if not specified it shall be, at a minimum, to *International Concrete Repair Institute Surface Preparation Chip CSP 6.* The repair material shall be cured as specified by the manufacturer.

(3) Standard Repair Procedures (SRP). Standardized Repair Procedures will document a prescribed procedure for repairing Minor defects at the fabricators facility. At a minimum the SRP must detail the scope of defects for which that procedure is intended to be used, detailed narrative including every step of the repair procedure, and the product documentation for the specific repair materials that will be used. The SRP must include example pictures of defects for which the procedure could be used, detailed example pictures of every step of the repair procedure, and pictures of an example completed repair.

All SRPs must be approved by the Structural Concrete Engineer prior to their use. Allow two weeks for approval of the SRP. Approval to use an SRP for any given defect is at the sole discretion of the Structural Concrete Engineer. The Agency's consent to use a SRP for the repair of a defect does not constitute acceptance of that repair.

(4) Non-Conformance Report (NCR). Any defects existing in the pieces, other than those defined as minor above, shall be documented with a non-conformance report. At a minimum, the NCR must detail what the defect is, including adequate pictures of the piece and defect, what caused it, the proposed repair, the procedure for carrying out the proposed repair, and a plan of action to prevent additional similar defects from occurring. Any approved repairs must be documented and photographed during the repair work and after completion of the repair.

NCRs must be submitted within 2 working days of the discovery of the defect.

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(h) Welding. All welding shall conform to the requirements of Subsection 506.10.

(i) Cold Weather Conditions. Cold weather concrete will be any concrete placed or cured in ambient conditions when the ambient air temperature is expected to be below freezing at any point in time or below 40°F for an 8-hour continuous period. The requirements of Subsection 501.07(b) shall apply in addition to the requirements of Subsection 540.08.

(j) Marking. The date of manufacture, the production lot number and the piece mark shall be clearly marked on each individual piece of precast concrete. The mark shall be in a location that will not be visible in the finished product.

(k) Form Removal. Unless otherwise specified, form removal shall be permitted only after the strength required and approved in Subsection 540.04(f) is achieved as specified in the Agency's *Materials Sampling Manual*.

(l) MSE Wall Panel Tolerances and Acceptance Criteria. MSE wall panels shall have a minimum structural thickness of 5 inches and a minimum cover for steel reinforcement of 1-1/2 inches. The concrete surface for the front face shall have a form liner finish as required on the approved fabrication drawings. The concrete surface on the rear face shall be an unformed flat finish. The concrete panels shall be constructed using colored concrete as specified in the Plans.

A full-size test panel shall be produced and approved by the Agency prior to production of the MSE wall panels. The panel shall be available for review a minimum of 5 working days prior to the start of production. The approved test panel shall be used as a benchmark for the correct color and form liner finish.

All MSE wall panels shall be manufactured within the following tolerances with respect to the dimensions shown on the approved fabrication drawings:

(1) Attachment Device Locations and Alignment. The lateral position of reinforcing element attachment devices shall be within 1 inch. The embedment measured from the back face of the panel shall be 4 inches (+1/4 inch, -1/2 inch).

(2) Panel Dimensions. All panel dimensions shall be within ± 1/4 inch. All hardware embedded in the panel except for attachment devices shall be within ± 1/4 inch.

(3) Panel Squareness. The panel's squareness, as determined by the difference between the two diagonals, shall not exceed 1/2 inch.

(4) Panel Surface Finish. Surface defects on smooth-formed surfaces, measured on a length of 5 feet, shall not exceed 1/4 inch. Surface defects on textured-finished surfaces, measured on a length of 5 feet, shall not exceed 5/16 inch.

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MSE wall panels shall be accepted for use in wall construction provided the concrete strength meets or exceeds the design compressive strength, the soil reinforcement connection devices and the panel dimensions are within tolerances, and any chipping, cracks, honeycombing, or other defects are repaired to the satisfaction of the Structural Concrete Engineer using methods submitted and approved under Subsection 540.07(g).

The MSE wall panels shall be subject to inspection by the Engineer at the time of unloading and once placed in their final position. MSE wall panels that do not meet the requirements of this subsection may be subject to rejection.

540.08 CURING.

(a) General. All curing methods for precast concrete shall be subject to the Structural Concrete Engineer's approval. The fabricator shall submit with the fabrication drawings complete details of the proposed methods for approval.

The curing period for precast concrete is defined as a minimum 72 hours wet curing to begin immediately following completion of placing and finishing of the concrete. The following requirements shall apply:

(1) The method of curing shall prevent the loss of moisture throughout the curing period. Except where modified herein, precast concrete structure components shall be cured by either water curing, wetted burlap covered with white polyethylene sheeting, or white burlap-polyethylene sheeting (burlene) as specified in Subsection 501.17.

(2) When a curing enclosure is used, free water must be evident and the relative humidity within the enclosure shall exceed 90% throughout the duration of the curing period. A curing enclosure is considered any means of moisture retention that allows air to contact the surface of the piece.

(3) The strength of the product shall be determined by test specimens cured with the product they represent, or by specimens match-cured in an approved match-curing system. Wet curing shall be continued until 80% of the 28-day design strength is achieved, but shall be no less than 72 hours in duration.

(4) MSE wall panels shall have an approved curing compound applied to the back face of the panel immediately following finishing.

(b) Curing Temperatures.

(1) The controlling temperatures shall be those actually achieved within the concrete elements, not ambient temperatures of the curing area unless specifically stated as such.

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(2) The precast concrete shall be raised to an internal temperature of not less than 68°F within the first 12 hours of the curing period, and shall be maintained at or above 68°F for the remainder of the curing period.

(3) The internal temperature of curing concrete shall be monitored using sacrificial thermocouples placed as near as practicable to the center of mass of the finished piece. In addition, the temperature within the curing enclosure shall be monitored using temperature sensors placed carefully within the curing enclosure in such a way that temperatures being measured accurately represent the curing conditions.

The requirement for temperature monitoring may be waived by the Structural Concrete Engineer if the concrete is not subject to accelerated curing and ambient temperatures are expected to be well above 40°F throughout the duration of production.

(c) Accelerated Curing.

(1) Accelerated curing procedures may be employed in lieu of the standard 72-hour curing procedure described in Subsection 540.08(a), in accordance with the requirements of *PCI MNL 116,* Section 4.19 and the following conditions:

a. The "initial time of set" is defined in *AASHTO T 197 M/T 197* and *ASTM C 403/C 403 M* as the time it takes fresh concrete to reach a compressive strength of 500 psi.

Testing to determine the time of set shall be done when the temperature is within ± 5°F of the anticipated concrete placement temperature.

Alternately, time of set may be found by taking a minimum of three different concrete temperatures at intervals of approximately 10°F, entering that data on a graph, and then drawing a best-fit smooth curve line through the three data points. This graph will be used to determine the time of set for the anticipated concrete placement temperature, rounded up to the nearest half hour.

(2) Immediately upon completing placement of the concrete for each precast concrete structure component, an enclosure that is suitable for containing live low-pressure steam or heat shall be placed over the forms. The fabricator shall make these enclosures available for inspection prior to casting.

(3) When low-pressure steam heating methods are used for accelerated curing, precautions shall be taken to prevent the live steam from being directed on the concrete or forms in such a way as to cause damage from localized high temperatures.

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(4) When radiant heat is used for accelerated curing, all exposed concrete surfaces shall be covered with plastic sheeting. Radiant heat may be applied by means of a circulation pipes containing steam, hot oil, or hot water, or by electric heating elements.

(5) While waiting for the initial set to take place, the temperature within the concrete may be increased at a maximum rate of 10°F per hour. However, the temperature within the concrete shall not be more than 40°F higher than the initial concrete placement temperature or more than 104°F, whichever is less.

Following initial set, the internal concrete temperature shall increase at a rate not exceeding 40°F per hour until the desired curing temperature is reached. The maximum internal concrete temperature shall not exceed 160°F. The maximum differential between the curing enclosure temperature and internal concrete temperature shall not exceed 40°F. The selected curing enclosure temperature range shall be as approved on the fabrication drawings.

The accelerated curing cycle shall be considered complete when the method of supplying heat is stopped and/or the concrete temperature drops below 120°F. Two cylinders shall be tested immediately upon completion of the accelerated cure cycle.

The maximum cooling rate from the sustained accelerated curing temperature shall be 50°F per hour. Cooling at this rate shall continue until the concrete temperature is 40°F or less above the ambient temperature outside the curing enclosure.

(6) Precast concrete that has not attained 80% of the 28-day design strength shall be additionally wet cured until this strength threshold is met. If the precast concrete has attained 80% of the 28-day strength during the accelerated curing cycle, no further curing will be required.

(d) Conditioning. Following the completion of the chosen curing method, precast elements that will then be exposed to cold weather conditions as defined in Subsection 540.07(i) must be allowed 24 hours to cool and dry in an environment of at least 40°F prior to exposure to cold weather conditions.

For pieces cast outdoors in cold weather ambient conditions, all requirements of Subsection 501.17(b) shall apply.

(e) Temperature Recording. The fabricator shall install a minimum of one automatic temperature recorder per contiguous form group and common heat source, per day. The Structural Concrete Engineer may require that additional temperature recorders be installed if it is determined that one per day of production does not adequately monitor the curing conditions.

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The recorder shall record, at intervals not to exceed 15 minutes, the temperature of the air surrounding the piece as well as the internal concrete temperature. Temperature recording shall continue until completion of the chosen curing method.

Each recorder's data log shall indicate the casting bed, date of casting, time of start and finish of record, and the mark number of the precast concrete structure component being cured. At the completion of the temperature recording, the data logs shall be given to the Agency representative. Temperatures recorded on the data logs shall be used to determine whether the precast concrete structure components have been cured in accordance with the specifications and the approved fabrication drawings.

Recorder accuracy shall be certified at least once every 12 months, and the certificate displayed with the recorder. Calibration and certification shall be performed by either the manufacturer, the supplier, or an independent laboratory. Random temperature checks of each recorder may be made by an Agency representative.

540.09 HANDLING, STORAGE, AND SHIPPING. All precast concrete shall be handled, stored, and shipped in such a manner as to minimize chipping, cracks, fractures, discoloration, and excessive bending stresses. Units damaged by handling, storage, or shipping shall be replaced at the Contractor's expense.

MSE wall panels shall be stored and shipped in stacks, front face down. Firm blocking of sufficient thickness to prevent the reinforcement attachments from contacting the adjacent panels shall be used. Lifting inserts shall be installed on the top edge of the MSE wall panels to permit lifting at the project site. Reinforcement connection inserts (tie strips) shall not be used for lifting or handling the panel at the project site.

Prior to shipment of any members, all NCRs shall be resolved. All applicable material certifications will be approved in accordance with Subsection 700.01. In addition, all required testing shall demonstrate the design requirements have been met.

540.10 INSTALLATION.

(a) Methods, Equipment and Erection. Cranes, lifting devices, and other equipment for precast concrete structure erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the precast concrete structure components.

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Construction drawings for precast concrete structure component erection shall be submitted in accordance with the requirements of Section 105. The erection plan shall include the necessary computations to indicate the magnitude of stress in the units during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages. When the fabricator-designed lifting hooks will be used by the Contractor, computations indicating the magnitude of stress in the segments during erection are not required, unless otherwise ordered by the Engineer.

Submittal of the erection plan is for the Agency's documentation only and shall in no way be construed as approval of the proposed method of erection. The Contractor shall follow the erection plan as submitted.

(b) MSE Walls. When included in the Contract, the installation of MSE wall panels shall be as specified in the MSE wall specification.

(c) Sheet Membrane Waterproofing. A reinforced asphalt, synthetic resin, or coal-tar based preformed sheet membrane shall be placed over the joints of precast concrete units in accordance with the Contract. All work performed shall be in accordance with the manufacturer's recommendations.

Membrane material shall meet the requirements of Subsection 726.11(c).

Waterproofing shall not be performed in wet weather or when the temperature is below 40°F, without the authorization of the Engineer.

The concrete surfaces that are to be waterproofed shall be reasonably smooth and free from projections or holes and shall be cleaned of dust and loose material. The surfaces shall be visibly dry prior to and during application of the membrane system.

540.11 GROUT.

(a) Surface Preparation. The fabricator must ensure that surfaces to be grouted are clean, oil-free, and roughened in accordance with the Plans. The surface to be grouted shall be thoroughly wetted, yet free of all standing water. Shear keys shall be saturated surface dry prior to grouting.

(b) Grout Mixes. Grout shall be used to fill shear keys, transverse tie anchor recesses, and dowel holes, level screw voids, and for fairing joints as detailed in the Contract or as ordered by the Engineer.

Grout shall be Mortar, Type IV meeting the requirements of Subsection 707.03. Additional aggregates shall not be added to the material during field mixing.

The Contractor shall submit a proposed grouting procedure, including a premix name brand, to the Engineer for their review and approval.

The Contractor, with the written permission of the Engineer, has the option to use ready-mixed mortar for the grouting process. However, the time from batching to completion of placement must not exceed 90 minutes. Ready-mixed mortar shall be used in small quantities as needed and shall not be re-tempered or used after it has begun to set.

Ready-mixed grout mix design shall be submitted to the Structural Concrete Engineer for approval. The mix design shall include test results that meet the requirements of Subsection 707.03(a)(1) and Subsection 707.03(a)(3). Tests on the mix design shall be performed by an AMRL-accredited lab in those test procedures.

Materials used for grouting must be sampled and tested in accordance with the VTrans *Materials Sampling Manual*. The cubes produced for testing conformance with strength requirements shall be field-cured with the field-placed grout. A minimum of six additional test cubes shall be produced to facilitate early breaks to determine when post-tensioning may proceed.

(c) Placing Grout. The grout shall be mixed using a mechanical mixer according to the manufacturer's recommendations and shall be readily pourable so that it completely fills the shape of the shear keys or holes, depending on the product being installed. The placement of the grout shall be continuous. The grouting of each shear key shall be completed in its entirety within a single working day.

Grout shall be placed between precast concrete structure components as required for fairing out any unevenness between adjacent components. Mortar, Type IV shall be used. The mortar shall be placed to the thickness necessary to eliminate unevenness, forming a smooth surface from the higher edges to the lower surface. The finished surface shall be feathered smoothly and be free of depressions or sharp edges.

(d) Curing Grout. In the absence of manufacturer curing recommendations, all exposed grout shall be cured for not less than three days by the wetted burlap method in accordance with the requirements of Section 501. Curing shall commence as soon as practical after grout placement.

540.12 POST-TENSIONING. Post-tensioning strands shall not be bonded to the concrete and shall be protected against corrosion as specified in the Contract.

Post-tensioning of strands shall not commence until a minimum compressive strength of 1,500 psi has been attained in the grout, as tested per the requirements of Subsection 540.11(b). If the design strength is met prior to completion of the required curing, the grout cure must be maintained during the post-tensioning operation.

Strands shall be stressed in the following sequence: Before grouting, the strands shall be pulled with a maximum force of 3.0 kips. After the grout has attained the required strength, the strands shall be pulled to the final design tension. Stressing shall begin by pulling the inner-most strands first, then proceeding symmetrically towards the member's ends. The inner strands shall be rechecked to ensure the strands still have the design tension.

In the case where the Plans call for top and bottom strands, the sequence shall be followed using an initial pull of 15.0 kips, top and bottom, followed by a sequence using the final design tension.

No loading of elements shall be allowed until post-tensioning is completed.

540.13 METHOD OF MEASUREMENT. The quantity of Precast Concrete Structure of the type and size specified to be measured for payment shall be on a lump sum basis. The lump sum shall include all of the precast concrete structure components in the complete and accepted work for each location specified in the Contract.

MSE wall panels will not be measured separately for payment, but will be considered in the measurement for the Mechanically Stabilized Earth (MSE) Wall item in the Contract.

540.14 BASIS OF PAYMENT. The accepted quantity of Precast Concrete Structure of the type and size specified will be paid for at the Contract lump sum price. Payment shall be full compensation for designing, detailing, fabricating, repairing, transporting, handling, and erecting the materials specified, for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. The Engineer may authorize progress payments in the following manner:

(a) A maximum of 25% of the Contract bid amount may be paid when the fabrication drawings have been approved by VTrans.

(b) In accordance with Section 106.09, stockpile payment may be authorized when the precast elements have met the requirements of Section 540.09 for shipping.

(c) After completion and acceptance of all work under this section, 100% of the quantity will be paid.

Furnishing and placing preformed sheet membrane waterproofing, including primer, mastic, polyurethane membrane sealant, and surface preparation, is considered incidental to Precast Concrete Structure.

Any grouting work, such as fairing out unevenness between adjacent precast concrete structure components and filling leveling screw holes, shear keys, transverse anchor recesses, and dowel holes, is considered incidental to the work for Precast Concrete Structure.

Payment will be made under:

Pay Item	Pay Unit
540.10 Precast Concrete Structure	Lump Sum

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SECTION 541 – STRUCTURAL CONCRETE

541.01 DESCRIPTION. This work shall consist of furnishing and placing Portland cement concrete for structures and incidental construction.

The Portland cement concrete may consist of a homogeneous mixture of cement, fine aggregate, coarse aggregate, water, admixtures, and pozzolans (when used), proportioned and mixed according to these specifications.

541.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Portland Cement.....701.02
High Early-Strength Portland Cement.....701.04
Portland-Pozzolan Cement.....701.05
Portland Blast-Furnace Slag Cement.....701.07
Fine Aggregate for Concrete.....704.01
Coarse Aggregate for Concrete.....704.02
Lightweight Coarse Aggregate for Structural Concrete.....704.14
Mortar, Type IV.....707.03
Preformed Joint Filler, Cork, and Asphalt-Treated Felt.....707.08
Polyvinyl Chloride (PVC) Waterstop.....707.10
Concrete Curing Material.....725.01
Air-Entraining Admixtures.....725.02(b)
Retarding Admixtures.....725.02(c)
Water-Reducing Admixtures.....725.02(e)
Water-Reducing and Retarding Admixtures.....725.02(f)
Water-Reducing, High Range Admixtures.....725.02(g)
Water-Reducing, High Range, and Retarding Admixtures.....725.02(h)
Accelerating Admixtures.....725.02(i)
Water-Reducing and Accelerating Admixtures.....725.02(j)
Specific Performance Admixtures.....725.02(k)
Mineral Admixtures.....725.03
Ground Granulated Blast-Furnace Slag (GGBFS).....725.03(c)
Polystyrene Insulation Board.....735.01
Blanket Insulation Material.....735.02
Pipe Insulation.....740.08
Water.....745.01

Precast concrete stay-in-place forms (prestressed deck panels) shall conform to the requirements of Section 510.

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541.03 CLASSIFICATION AND PROPORTIONING. The classes of concrete shown in Table 541.03A are included in these specifications and shall be used as shown on the Plans.

TABLE 541.03A – PORTLAND CEMENT CONCRETE CLASSES AND PROPERTIES

Concrete Class	Min. Cement (lbs/cy) [3]	Max. W/CM Ratio	Slump/Spread Range (in.) [1]	Air Content (percent)	Coarse Aggr. Gradation Table	28-Day Compressive Strength (psi) [2]	28-Day Mod. of Rupture (psi) [2]
AA	705	0.400	--	7.0 ± 1.5	704.02A	4,000	650
A	660	0.440	--	7.0 ± 1.5	704.02B	4,000	650
B	611	0.490	--	7.0 ± 1.5	704.02B, C	3,500	600
C	564	0.490	--	5.5 ± 1.5	704.02B, C	3,000	550
D	470	0.580	--	4.5 ± 1.5	704.02B, C	2,500	450
LW	TBD	0.440	--	7.0 ± 1.5	704.02B	3,000	--
Controlled Density (Flowable) Fill	TBD	TBD [4]	TBD [5]	10 (min.)	704.01A	125 (max.) [6]	--

[1] The mix shall not exhibit segregation at the slump/spread used at placement. If the Engineer suspects there is segregation, the Engineer will require a slump/spread test be performed by the Contractor to visually observe the characteristics of the mix. If, in the opinion of the Engineer, the mix does exhibit segregation, the load will be rejected and subsequent loads shall be tested for a minimum of three loads or until the problem is corrected.

If the Contractor needs a concrete with a slump/spread greater than 8 inches, the Contractor shall propose to the Engineer to use an SCC mix, which shall be submitted to the Engineer for review and acceptance.

[2] The listed 28-day compressive strength or modulus of rupture will serve as the basis of designing or approving the concrete mix.

[3] A mineral admixture may be used to replace a portion of the cement.

[4] The minimum amount of water shall be used to produce the desirable flow for the intended use without showing segregation.

[5] The slump/spread (flowability) shall be such that material can completely fill the voids or area as needed without segregation.

[6] A minimum of three cylinders per test age are required to constitute a test. If average strength at 28 days exceeds 115% of the maximum strength, then payment for item 541.45 will be 85% of the Contract bid price.

LW = Lightweight Concrete

(a) The maximum unit density of Class LW concrete shall be:

(1) Plastic: 120 pounds per cubic foot

(2) Dry: 115 pounds per cubic foot

Unless otherwise specified in the Contract, Class B concrete shall be used.

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The Contractor, following mix design criteria and procedures outlined by the Agency, shall submit the mix design, required data, and test results to the Structural Concrete Engineer for review and acceptance. For initial submittals, a minimum of two weeks shall be allowed for evaluation of the submitted mix design, test results and required data. No production of concrete for the project shall commence until the Structural Concrete Engineer has reviewed and accepted the concrete mix design.

(b) The mix design must contain the following information:

(1) Class of concrete

(2) Type of mix, conventional or SCC

(3) Specify if saturated surface dry or dry weights

(4) Name, source, specific gravities, and absorptions of aggregates

(5) Specified 28-day design compressive strength

(6) Cementitious content and the amount of each in pounds per cubic yard

(7) Specified air content and range

(8) Specified surface resistivity value

(9) Slump target and range for conventional concrete

(10) Spread minimum and maximum for SCC

(11) W/CM Ratio target

(12) Volumetric quantities of each material in the mix design

(13) Design unit weight of the mix

(14) Chemical admixtures (types, brand names, dosages)

A water-reducing, retarding, or water-reducing-retarding admixture shall be used for all Class AA, Class A, Class B, and Class LW concrete, unless otherwise authorized in writing by the Engineer. These admixtures may be used in Class C and Class D concretes when required or approved by the Engineer. The use of an accelerating or water-reducing- accelerating admixture to alter the setting characteristics of concrete mixtures shall be employed only with the approval of the Engineer.

The use of chlorides or admixtures containing chlorides is prohibited. All admixtures will be considered incidental to the work and included in the Contract unit price of the concrete.

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The concrete materials may be proportioned using the absolute volumes method in accordance with the requirements for each class as specified in Table 541.03A. The volumetric proportioning method such as that outlined in *ACI Standard 211.1*, or other approved volumetric proportioning methods shall be employed in the mix design.

Production activities shall operate so that no intentional deviations are made from the reviewed and accepted mix design. If test results indicate a failure to obtain the 28-day compressive strength as specified in Table 541.03A as tested in accordance with the requirements of *AASHTO T 22* or *AASHTO T 97*, changes to the mix design shall be made with no extra payment. Changes may include, but are not limited to, using additional cement, changing the source of cement or aggregates, using a water reducer or other additives, or, if necessary obtaining concrete from another supplier.

After the materials to be furnished by the Contractor have been approved, no proposed change in the source, proportions, or characteristics of the materials shall be made without the review and acceptance of the Engineer. No new materials shall be used until such materials and their proportions have been reviewed and accepted by the Engineer. In no case shall concrete from more than one batch plant be permitted on the same structure without prior written approval of the Engineer.

The Engineer may order concrete production and delivery suspended and a new mix or altered mix design submitted if components or final product material characteristics are determined to be out of tolerances, unsatisfactory, or if proposed changes in the source, proportions, or characteristics of the materials are proposed. No production of concrete for the project shall resume until the Engineer has reviewed and accepted the new or altered mix design. For evaluation, new mix design submittals shall be considered as initial mix design submittals.

The various classes of concrete shall have an air content by volume as specified. The entrained air may be obtained using an approved admixture.

The Contractor, at their option, or as required by the Structural Concrete Engineer, may substitute fly ash for Portland cement. The minimum substitution rate shall be 20.0% of the required Portland cement for concrete. The fly ash shall be substituted at a ratio of 1 pound of fly ash for 1 pound of Portland cement.

When any mineral admixture is incorporated into a standard class of concrete, necessary adjustments to the mix design shall be made by the Contractor and reviewed and accepted by the Engineer. Proportioning of the concrete mixtures containing mineral admixture shall be by the absolute volumes method in accordance with the requirements for each class as specified in Table 541.03A except that the listed W/CM ratio shall be based on total cementitious material (Portland cement and fly ash).

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The Contractor, at their option, or as required by the Structural Concrete Engineer, may substitute ground granulated blast-furnace slag (GGBFS), Grade 100 or 120, for Portland cement. The minimum substitution rate shall be 25.0% of the required Portland cement for concrete. The GGBFS shall be substituted at a ratio of one unit of GGBFS for one unit of Portland cement. Fly ash and GGBFS will not be permitted in the same concrete mixture.

The proportioning of the concrete mixture shall be by the absolute volumes method and in accordance with the requirements for each class of concrete as specified in Table 541.03A, except that the listed water-cement ratio shall be based on the total cementitious material (Portland cement plus GGBFS).

Strict adherence to the requirements of Subsection 541.07 is required when using concrete with mineral admixtures. The setting time may be retarded in cool weather. The Engineer, after consultation with the Agency's Structural Concrete Engineer, may require that the curing period, as designated in Table 541.17A, be extended.

541.04 BATCHING. Measuring and batching of materials shall be done at an approved batch plant. Batch plants shall have an inspection completed prior to the first concrete placement on an Agency project if it has been longer than 12 calendar months from the last inspection. Request for inspection and required documentation must be received by the Materials Section a minimum of 21 calendar days prior to the date of the requested inspection. All deficiencies shall be corrected and verified a minimum of 5 calendar days prior to the first concrete placement for any Agency project.

The batch plant shall meet the requirements of *AASHTO M 157*, except as modified in this specification, and shall be maintained in good repair at all times and shall be subject to a periodic inspection by an authorized representative of the Agency. The batch plant shall have an approved method of storing, measuring, and dispensing approved mineral admixtures.

All new or relocated concrete batch plants offered for Agency approval shall be equipped for semi-automatic batching and proportioning of all cementitious material, aggregates, water, and fly ash (when used) and for automatic insertion of admixtures. The plants shall be equipped to automatically and accurately record the quantity of all aggregates, cementitious material, and the water incorporated into each batch and shall identify and record the addition of the required admixtures.

Proper facilities shall be provided for the Engineer to inspect ingredients and processes used in the batching and delivery of the concrete. The Contractor shall, without charge, afford the Engineer all reasonable facilities for securing samples to determine whether the concrete is being furnished in accordance with these specifications. The batch room area, the producer shall provide the Inspector with a 24 inches × 18 inches horizontal working surface at sufficient height to sit at supplied with a seat, with adequate view of the batching controls, display, and power supply.

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The Contractor shall give the Engineer 24-hour notice of intent to place concrete so that arrangements can be made for laboratory inspection and control. Failure to give notice which causes postponement of placing operations shall not be reason for determining extension of Contract time per the requirements of Subsection 108.11.

(a) Semiautomatic Batch Plants. When actuated by a starting mechanism, the semiautomatic batch controller shall start the weighing operation of the materials and stop the flow automatically when the designated weight has been reached. It shall be interlocked to ensure that the discharge mechanism cannot be opened until the weight is within the tolerance specified in Subsection 501.04(d).

Water and admixtures may be batched in a weigh batcher or by volume in a volumetric device. When actuated, volumetric controls shall start the measuring operation and stop the flow automatically when the designated volume has been reached.

(b) Testing Laboratory. The Contractor shall provide a weatherproof building or room at the plant site for the use of Agency personnel as a testing laboratory. The Contractor shall attain and maintain a qualified laboratory status in accordance with the current edition of the Agency's Qualified Laboratory Program. Failure to comply with this program may result in suspension or revocation of acceptance testing at the facility.

The testing laboratory shall have a minimum gross internal area of 150 square feet with a layout providing a minimum internal width of 7 feet, in which to house and use the equipment specified. Should the Contractor elect to provide additional equipment relevant to testing of Portland cement concrete and materials, the gross inside floor area of the laboratory shall be increased in proportion to the area required to house and operate the additional equipment. If the additional equipment is to be operated on a bench, the length of bench sections shall also be proportionally increased.

Adequate ventilation, lighting, heating, and any necessary electrical or gas connections shall be provided. Proper sanitary toilet facilities with a lavatory shall be available for use by Agency personnel at the plant site. Dedicated private telephone and internet services shall be provided to the laboratory. The internet connection shall have a minimum download capacity of 3 Mbps without utilizing compression algorithms and the bandwidth speed shall be verified using an online speed test.

The laboratory shall be equipped with the following items and equipment:

1 Standard office desk, with lockable drawers or a separate lockable two-drawer file cabinet and chair

1 VTrans' Qualified Laboratory Binder with producer equipment calibration data

1 Set of bench sections at least 2 feet wide providing a minimum of 28 square feet of working area with under-counter shelving

1 Standard laboratory stool

1 Fully automatic electronic calculator with eight-digit capacity

1 Standard laboratory sink and faucet provided with an adequate supply of water meeting the requirements of Subsection 745.01. The sink shall drain to the outside of the laboratory

1 Bench brush

1 Floor brush

1 Motorized 8-inch sieve shaker with an adjustable timer. The sieve shaker's operation shall be conducted by means of lateral and vertical motion of the sieve accompanied by jarring action with the following 8-inch diameter sieves: 3/8 inch (9.50 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (0.600 mm), No. 50 (0.300 mm), No. 100 (0.150 mm), pan and cover

1 Mechanical aggregate shaker with an adjustable timer, a 1 cubic foot capacity, together with the following screens: 1-3/4 inch (43.0 mm), 1-1/2 inch (37.5 mm), 1 inch (25.0 mm), 3/4 inch (19.0 mm), 1/2 inch (12.5 mm), 3/8 inch (9.50 mm), 1/4 inch (6.30 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm) and pan. The aggregate shaker may be placed in a separate enclosed area that is shielded for dust and sound, is well-lighted, and is properly ventilated. There shall be a minimum of 5 feet of clear space measured from the front frame of the aggregate shaker outward, as well as a bench section measuring approximately 36 inches high, 24 inches deep, and 50 inches long located adjacent to the aggregate shaker

1 Square pointed shovel

5 Five gallon plastic buckets, with handles

1 Electronic balance with a minimum capacity of 50 pounds and accurate to 0.0002 pounds. If separate fine and coarse aggregate scales are to be used, the fine aggregate scale shall meet the requirements of *AASHTO M 231,* Table 2, Class G2, with a minimum capacity of 1.75 pounds and readable to 0.0002 pounds. The coarse aggregate scale shall meet the requirements of *AASHTO M 231,* Table 2, Class G5, with a minimum capacity of 50 pounds and readable to 0.002 pounds

1 Set of standard masses (weights) to use for verifying the accuracy of the electronic balance

2 Double-burner hot plates with variable temperature controls

3 Metal pans with a nominal size of 9 inches × 9 inches × 2 inches

5 Metal pans with a nominal size of 9 inches × 13 inches × 2 inches

1 Sample splitter with a 2-1/2 inch chute

1 10-inch blunted trowel

1 4 foot × 4 foot minimum heavy canvas for quartering samples

1 Brass wire-bristle brush

1 Pair of heat-resistant gloves (500°F, short-contact)

2 1-1/2 inch soft bristle paint brushes

Acceptable substitutes for these items and equipment may be made with the approval of the Structural Concrete Engineer.

Batching operations shall not begin until the testing laboratory has been approved as being in compliance with these specifications and all equipment and equipment calibration requirements of the current VTrans Quality Assurance Program and Qualified Laboratory Program documents. Removal of any equipment, except with written request and written approval of the Structural Concrete Engineer, will revoke any prior approvals and/or qualifications and require the termination of batching operations.

The building or room designated as a testing laboratory shall be maintained in a clean condition by the producer and kept free of all articles not necessary for the testing of materials. Cleaning supplies shall be furnished by the Contractor.

(c) Bins and Scales. The batch plant shall include bins, weighing hoppers, and scales with adequate separate compartments for fine aggregate and for each required separate size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided so that when required, the material may be added slowly in minute quantities and shut off with precision. Means of removing the overload of any one of the several materials shall be provided.

Hoppers shall be constructed to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments shall be configured to prevent spilling under any working condition. All batch plant structures shall be properly leveled and maintained in that condition within the tolerance required by the design of the weighing mechanism.

The scales for determining the mass (weight) of aggregate and cementitious material shall be comprised of a suitable system of levers or load cells. The levers or load cells will determine the mass (weight) consistently within 0.5% under operating conditions, with loads indicated either by means of a beam with balance indicator, a full-reading dial, or a digital read-out or display.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either using 50 pound weights or by other methods approved by the Structural Concrete Engineer. Weights shall be certified annually by the Division of Weights and Measures of the Agency of Agriculture, Food, and Markets. All exposed fulcrums, clevises, and similar working parts shall be kept clean.

When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. Poises shall be designed to be locked in any position to prevent unauthorized change of position. All weighing and indicating devices shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

The scales shall be serviced and their accuracy verified annually by a hopper-scale service person licensed by the Division of Weights and Measures. For Vermont plants, an Inspector representing the Division of Weights and Measures shall witness all testing conducted by the service person and will attach a seal to each hopper scale, provided it meets the current specifications, tolerances, and regulations adopted by the Division of Weights and Measures. Standard test weights used to determine the accuracy of hopper scales shall be certified yearly by the Division of Weights and Measures in accordance with their established standards.

The ready-mixed concrete producer shall hire a licensed hopper-scale service person for annual checking and service of scales. In addition, Vermont producers shall schedule an inspection with the Division of Weights and Measures between February 15th and April 30th of each year. After April 30th, Vermont plants without current seals affixed to the hopper scales will not be permitted to supply concrete to Agency projects, unless otherwise directed by the Engineer or until the seals are affixed.

Out-of-state concrete producers shall observe all annual hopper scale weighing and seal requirements of their respective states.

(d) Production Tolerances for Batching. For weighed ingredients, the accuracy of batching is determined by a comparison between the desired weight and the actual scale reading. For volumetric measurement of water and admixtures, accuracy is determined by checking the quantity either by weight on a scale or by volume in a calibrated container.

Admixture-dispensing systems shall, at a minimum, be annually calibrated by an admixture distributor representative. The admixture distributor representative shall check at least two volumes, with a check done at approximately 15% of the minimum and at 15% of the maximum manufacturer's recommended dosage range, or other targets as approved by the Structural Concrete Engineer.

Batching shall be conducted to accurately measure the desired quantities of materials within the tolerances specified in Table 541.04A.

TABLE 541.04A – CONCRETE PRODUCTION TOLERANCES FOR BATCHING

Material	Tolerance (%)
Cement	± 1
Water	± 1
Aggregates	± 2
Chemical admixtures	± 3
Mineral admixtures	+ 10, - 1

(e) Storage and Proportioning of Materials.

(1) Portland Cement. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved weighing device. The bulk cement-weighing hopper shall be properly sealed and vented to preclude dusting during operation. Facilities shall be provided for the sampling of cement at the batch plant, either from the storage silo or from the weighing hopper. It shall provide a sample that represents the true nature of the material being used. This device shall be a permanent installation located to allow for safe and easy access.

(2) Water. Water may be measured either by volume or by weight. When measurement is by meter, the water meter shall be so located that the measurements will not be affected by variable pressures and temperatures in the water supply line.

Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tanks.

All water metering methods shall be verified and calibrated on an annual basis or at any time there is a question of accuracy. All water added to the concrete at any point shall be through an approved metering method.

(3) Aggregates. Aggregate stockpiles shall be formed on hard, well-drained areas that prevent contamination from underlying material and accumulation of excessive moisture.

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Aggregates from different sources or of different gradations shall not be stockpiled together. Only rubber-tired equipment shall be permitted to operate on aggregate stockpiles.

Stockpiles shall be constructed as follows:

a. If the stockpile is to be made using mechanical equipment (front end loader, clam bucket, rock ladder, radial stacker, or other approved equipment), the stockpile shall be made in such a manner that segregation is kept to a minimum.

b. If the stockpile is to be made by dumping from trucks in multiple layers, each layer shall be approximately 4 feet in depth. Each layer shall be completely in place before commencing the next layer. Care shall be taken that successive layers do not "cone" down over the previous layer.

c. No equipment shall be used to haul aggregate over the stockpiled material except to deposit the material for the layer being placed. It shall be the responsibility of the Contractor to ensure that the aggregate is kept free from deleterious material or degradation.

Stockpiles shall be maintained in such a manner that twice the anticipated aggregate requirement for any Agency project placements will be on hand and available for sampling and testing at least 48 hours before mixing operations for the placements are scheduled to begin. The Engineer may modify this requirement when special aggregates are required.

Aggregates shall be handled from stockpiles or other sources to the batch plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates, produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. In case the aggregates contain high or non-uniform moisture content, storage or stockpile period more than 12 hours may be required by the Engineer.

Stockpiles being watered per the specifications or allowed through producer QC procedures shall be watered for a sufficient time to ensure consistent moisture throughout the stockpile. Aggregate stockpiles being watered shall be loaded in the bin within 1 hour of being batched.

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The Contractor shall conduct moisture content tests within 1.5 hours of the anticipated concrete batching time. If there is a visual difference in aggregate moisture appearance, aggregate moisture content will be tested again and new moisture test results shall be obtained and used as soon as possible. Material that has been stored in a storage bin for more than 10 hours shall be retested for moisture content. A minimum of one cubic yard of aggregate will be removed from the bottom of the storage bin. A minimum of one cubic yard of aggregate will then be removed and a moisture content sample taken.

Plants that employ moisture probes shall have them calibrated and verified a minimum of 24 hours prior to batching or as directed by the Structural Concrete Engineer. The procedure for checking the meter involves running aggregate over the probe and then collecting a portion of the aggregate on which to perform a moisture content test. If the difference between the meter and the tested moisture content is greater than 0.5%, then the meter must be calibrated.

d. Lightweight aggregate stockpiles shall be presoaked for a minimum period of 48 hours immediately prior to use. Soaking shall be accomplished by continuous sprinkling or other suitable means that will provide a uniform moisture content throughout the stockpile. The stockpile shall be allowed to drain for 12 to 15 hours immediately prior to use.

(4) Admixtures. The Contractor shall follow an approved procedure for adding the necessary amounts of admixtures to each batch. Admixtures shall be dispensed in such a manner that will ensure uniform distribution of the material throughout the batch within the required mixing period. Except as specified herein, all admixtures shall be added to the batch at the plant, unless otherwise authorized by the Structural Concrete Engineer.

Chemical admixture containers, metering equipment, and scales shall be calibrated annually by a qualified admixture distributor representative. Admixture calibration and verification shall be done at 15% of the high, at approximately the middle, and at 15% of the low recommended ranges for the admixture being dispensed by the system. The calibration and verification shall be done in the presence of an Agency representative when requested by the Agency.

All dispensers shall include visual inspection aids such as graduated transparent cylinders. A separate dispenser shall be provided for each liquid admixture. If the dispensing system does not provide visual inspection aids, then periodic verification tests shall be done at a frequency satisfactory to the Structural Concrete Engineer. Calibration and verification records shall be kept at the production facility for a minimum of one year. The producer shall do the calibration and verification of the metering systems when requested.

Storage and dispensing systems for liquid admixtures shall be equipped to allow thorough circulation or agitation of all liquid in the system. This shall be required prior to the first batching of concrete for Agency projects in any calendar year and periodically thereafter at intervals not to exceed 60 calendar days for the duration of the period the plant is supplying concrete for Agency projects.

If the plant has received a delivery of at least 25% of the volume of the storage container, this will be considered as a method of circulation or agitation. If the circulation method is used, the admixture shall be circulated until a complete exchange of admixture is achieved. If an agitation method is used, the method shall be subject to approval by the Structural Concrete Engineer. If an admixture does not need agitation, then the admixture manufacturer shall submit in writing stating this annually.

Storage and dispensing systems for liquid admixtures shall be maintained within the manufacturer's stated temperature and environmental conditions.

It shall be the responsibility of the Contractor to use the quantity of Agency-approved admixtures needed to obtain concrete meeting the requirements of the Contract. All admixtures will be approved by the Structural Concrete Engineer prior to incorporation into the mix.

a. Air-Entraining Admixture. Air-entraining admixture shall be used as required to obtain the specified air content.

b. Water-Reducing, Retarding, and Water-Reducing and Retarding Admixtures, Accelerators and Specialty Admixtures. Dosages shall be in the recommended range as stated by the Manufacturer, unless otherwise approved by the Manufacturer.

(5) Fly Ash or GGBFS. Fly Ash or GGBFS shall be stored at the batch plant in separate storage or holding bins or other approved holding containers and shall be protected from rain and moisture.

541.05 MIXING AND DELIVERY.

(a) General. Concrete may be mixed at the site of construction, at a central point, or wholly or in part in transit mixers. The production of concrete shall meet the requirements of *AASHTO M 157* with the following additional requirements:

(1) All concrete shall reach its final position in the forms within 1.5 hours after the cement has been added to the water. When the ambient air temperature is 60°F or above, the elapsed time may be reduced as necessary as directed by the Engineer or in accordance with the requirements of Subsection 541.07(a).

If, in the opinion of the Engineer, the concrete visual characteristics appear to be noticeably different from the last acceptance test or previous concrete for that pour, the Engineer may direct the Contractor to perform QC tests to confirm the concrete is within conformance to the specifications.

(2) Authorization by field inspection personnel must be obtained prior to the addition of water or admixtures at the project site. If water is added in excess of the specified maximum W/CM ratio amount at time of placement, the concrete shall not be used.

(3) Each load of concrete delivered at the job site shall be accompanied by a State of Vermont Batch Slip signed by the authorized Agency representative, if present, at the plant.

(4) The Contractor shall provide direct communication service from the site of the work to the batch plant that shall always be available to the Engineer during concrete operations. The cost of this service will be considered incidental to the work.

(5) When use of a Water-Reducing, High Range Admixture or Water-Reducing, High Range, and Retarding Admixture is specified for deck concrete, the Contractor shall submit, for the Engineer's approval, information about the admixture manufacturer, the admixture addition rate, and when the admixture is to be added to the mixture (i.e., at the plant, on project, or a combination thereof).

To obtain the required concrete characteristics, a representative from the concrete producer is required on the project to determine the final admixture dosage and water addition for each load of concrete. The dosage shall be applied by means of a dispenser, or by other means of accurately measuring volume as approved by the Engineer. The Contractor shall provide QC concrete testing personnel, with current ACI Concrete Field Testing Technician Grade I Certification, to confirm the concrete is within specifications for the required work.

(6) All concrete shall be discharged into the forms before 300 revolutions of the drum or blades, not including initial mixing revolutions. The total allowed number of revolutions may be increased as directed by the Engineer.

Mortar shall be mixed in an approved mixer at the site of placement or in transit mixers when approved by the Engineer. The Engineer will withdraw approval for use of transit mixers, if necessary, to ensure a quality product or if the rate of delivery cannot be coordinated with finishing requirements.

(b) Stationary Mixers. When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers that have a capacity of 10 cubic yards or less shall be not less than 60 seconds. For mixers that have a capacity of more than 10 cubic yards, the mixing time shall be determined by the concrete producer.

The time is valid provided that mixer efficiency tests prove the concrete is satisfactory for uniformity and strength. The plant shall be equipped with a timing device that will not permit the batch to be discharged before the predetermined mixing time has elapsed. Vehicles used in hauling shall comply with the requirements of Subsection 501.05(c).

(c) Transit Mixers. Transit mixers and agitators shall be subject to periodic inspections by an authorized representative of the Agency. Such equipment shall bear a currently dated inspection sticker supplied by the Agency indicating that the transit mixer or agitator conforms to the Agency's requirements.

Transit mixers shall be equipped with a water-measuring tank with a visible sight gauge for use when the water for the batch is supplied from the transit mixer tank. The gauge shall be clean and legibly graduated. Measuring tanks shall be provided with outside drain valves or other means to check their calibration. These should be easily opened for checking at any time.

No transit mixer or agitator shall be charged with the ingredients of the concrete unless an authorized Agency representative is present and authorizes it. This requirement may be waived by the Engineer if a batch weight slip accompanies the delivery vehicle to the site.

Electrically-actuated revolution counters shall be required on all transit mixers except on mixers charged at central mix plants and utilized as agitator trucks only.

If bagged mineral admixtures are being used, agitators, when loaded, shall also not exceed 80% of the manufacturer's rated mixing capacity or legal load restrictions and shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

The Engineer may require the Contractor to perform uniformity tests on a transit mixer or agitator. Two samples shall be taken. The first shall be after 15% of the load volume discharge and the second prior to 85% of the load volume discharge.

Slump and air content tests shall be performed on each sample. The maximum difference in air content between the two samples shall be 1%. For concrete with a specified slump of 4 inches or less, the maximum difference shall be 1 inch. For concretes with a specified slump greater than 4 inches, the maximum difference shall be 1-1/2 inches. If both conditions are not met, then the Contractor will be required to either modify the mixing procedure and/or batching sequence, or that transit mixer or agitator will not be allowed to deliver concrete to the project. The Contractor will be required to perform uniformity tests to confirm the changes have satisfactory results.

All mechanical details of the mixer or agitator such as water measuring and discharge apparatus, condition of the blades, speed of rotation of the drum, general mechanical condition of the unit and clearance of the drum shall be checked before a further attempt to use the unit will be permitted.

Mixers and agitators shall be kept free from accumulation of hardened concrete or mortar. The mixing blades shall be rebuilt or replaced when any part or section is worn 3/4 inch or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangements of blades shall be available to the Engineer at the plant at all times.

The mixing of concrete containing silica fume is very important and shall be mixed in accordance with the appropriate situation:

(1) When silica fume is added to the batch by bags or in bulk from a silo, each batch of concrete shall be mixed for not less than 125 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer.

(2) When silica fume is blended with cement or a combination of cement and mineral admixture at the cement plant prior to being delivered to the concrete plant, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer. If inconsistent test results are obtained, or the batch of concrete appears not to be completely mixed, the mixing revolutions shall be extended as necessary.

When a transit mixer or agitator is used for transporting concrete, mixing during transport shall be continuous and at the speed designated by the manufacturer of the equipment as agitating speed. Failure to do so is cause for rejection of the concrete.

Transit mixers and agitators assigned to a project shall not be used for other purposes until the desired work is completed at the site, and shall arrive at the project within the cycle that anticipated placement conditions dictate. The interval between loads shall be controlled in order that concrete in place shall not become partially hardened prior to placing succeeding batches. The plant capacity and transportation facilities shall be sufficient to ensure continuous delivery at the rate required.

Before discharging from a transit mixer that has been operating at agitating speed, the drum or blades shall be rotated approximately one minute at mixing speed. The same procedure shall apply to agitators if admixtures, water, or other ingredients are added to the mix in the field.

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If additional mixing water is required to maintain the specified slump and is added with the permission of the Engineer, a minimum of 20 revolutions of the transit mixer drum at mixing speed shall be required before discharge of any concrete. At no time shall the total water introduced into any mix exceed the maximum W/CM ratio specified in Table 541.03A.

Upon discharge of the concrete from the drum, enough water shall be charged into the drum to properly cleanse the drum. This water shall not be used as a part of the next succeeding batch but shall be discharged from the drum prior to the charging of the drum with the concrete ingredients. The drum shall be completely emptied before receiving materials for the succeeding batch. Re-tempering of concrete or mortar that has partially hardened, by remixing with or without additional materials, shall not be permitted.

541.06 FIELD TESTS. The Contractor shall provide assistance, equipment, materials, and curing for field sampling and testing as required by the Engineer. All costs shall be included in the Contract unit prices under Section 631. The Engineer shall perform all acceptance sampling and testing in accordance with the Agency's Quality Assurance Program. For bridge deck pours, the Contractor shall perform all on-site Quality Control (QC) sampling and testing. The person performing the QC sampling and testing shall have, as a minimum, current ACI Concrete Field Testing Technician Grade I Certification.

(a) Sampling. Sampling for tests shall be taken in accordance with the requirements of *AASHTO R 60* or other procedures approved by the Agency. Sampling will be done at point of placement or as close to it as practical.

(1) Changes. Any time that there is a change in admixture dosage outside of the allowable tolerances, whether modified at the batch plant or at the site, additional QC sampling and testing shall be performed on the modified load prior to incorporating the concrete into the work.

(2) Beginning of Load Sampling. Beginning of Load Sampling is sampling for QC testing purposes that is taken before 15% of the load has been discharged. Beginning of Load Sampling shall be performed as required by the Engineer, or as needed to ensure that the Concrete meets the Contract requirements at the point of placement. The QC personnel shall monitor the placement operation and adjust the mix accordingly to ensure that the material being incorporated into the work meets Contract requirements.

(b) Slump Tests. Slump tests shall be made in accordance with the requirements of *AASHTO T 119 M/ T 119*.

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(c) Air Content Tests. Air content tests shall be made in accordance with the pressure method specified in *AASHTO T 152*, for acceptance or rejection. The Chace meter may be used in conjunction with the pressure method of *AASHTO T 152* for monitoring other air content tests. A volumetric air meter shall be used for determining the air content of Class LW concrete in accordance with *AASHTO T 196 M/T 196*.

(d) Compressive Strength Tests.

(1) General. The number of compressive strength tests performed should be in accordance with the guidance given in the current edition of the VTrans *Materials Sampling Manual*. The Engineer may order additional tests as deemed necessary.

Compressive test cylinders shall be made in accordance with the requirements of *AASHTO T 23*, and tested for compressive strength in accordance with *AASHTO T 22*.

Test beams with dimensions of 6 inches x 6 inches x 20 inches shall be made in accordance with *AASHTO T 23*, and tested for flexural strength in accordance with *AASHTO T 97*. Beam molds for constructing test beams shall be reusable steel molds conforming to the requirements of *AASHTO T 23*.

(2) Categories of Testing.

a. Acceptance Testing. Acceptance testing utilizes specimens to determine the compliance with requirements for the project. All test cylinders used for quality acceptance testing shall be stored in an approved curing box until they are shipped to the Agency's Materials Section Central Laboratory.

b. Job Control Testing. Job control testing utilizes specimens to determine whether adequate curing procedures are being followed and for early form removal or early loading of structure. All job control specimens shall be stored on the structure and shall receive the same curing and protection from the elements as the concrete that they represent up until 24 hours before anticipated testing of specimens.

c. Specimen Curing Requirements. Specimen curing requirements shall be as stated in the specifications or as directed by the Engineer. If not specifically stated, the curing shall be as specified in Table 541.06A.

TABLE 541.06A – CONCRETE SPECIMEN CURING REQUIREMENTS

Testing Category	Number of Specimens	Curing Location
Acceptance	2	Curing box
Job control – applicable curing period	2	On structure

(e) Concrete Temperature. Concrete temperature tests shall be made in accordance with the requirements of *ASTM C 1064/C 1064 M*.

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541.07 WEATHER AND TEMPERATURE LIMITATIONS – PROTECTION OF CONCRETE. The temperature of the concrete just prior to placement in the forms shall not be less than 50°F nor more than 85°F. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits.

Placement and curing procedures shall be approved by the Engineer prior to actual placement.

(a) Hot Weather Concrete. Placement of concrete during hot weather may be limited by the Engineer based on an assessment of temperature, humidity, wind velocity, and sun radiation conditions.

No concrete shall be placed when the ambient air temperature is, or is expected to be, above 90°F. No Concrete, Class AA mix shall be placed when the ambient air temperature is, or is expected to be, above 85°F during the placement, except by written permission of the Engineer.

(b) Cold Weather Concrete.

(1) General. Cold weather concrete will be any concrete placed or cured when the ambient air temperature is expected to be below freezing at any point or below 40°F for a continuous 8-hour period. No concrete shall be placed when the ambient air temperature is lower than 10°F except by written permission of the Engineer. A cold weather concrete plan shall be submitted to the Engineer for their review and approval before any cold weather concrete is placed.

When placing cold weather concrete, the Contractor shall have adequate equipment that meets the approval of the Engineer for heating and protecting the materials and freshly-placed concrete. This equipment shall be on the job and ready to deploy prior to the commencement of concrete placing operations.

No concrete shall be placed in any superstructure or thin section under cold weather conditions.

(2) Heating of Materials. The heating equipment deployed for cold weather concrete placement shall be capable of heating the materials uniformly. Aggregates shall not be heated to a temperature exceeding 150°F. If water is heated to a temperature exceeding 140°F, the water shall be mixed with the aggregate before the cementitious material is added.

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The materials shall be heated in such a manner, for such a period of time, and in such quantity, as to produce concrete having a uniform temperature within the specified temperature range at the time of placement. Materials containing frost or frozen lumps shall not be used.

Stockpiled aggregates may be heated using dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. When aggregates are heated in bins, steam-coil or water-coil heating, or other methods that will not be detrimental to the aggregates, may be used.

(3) Antifreeze Compounds. Salts, chemicals, or other foreign materials shall not be used in the mix to lower the freezing point of the concrete.

(4) Preparation of Forms. Before placing concrete; any ice, snow, or frost shall be completely removed from the forms.

Concrete shall not be placed on any surface or in forms that are frozen, have surface temperatures below 32°F, or that contain frozen materials. The frozen surface or forms shall be completely thawed the day before the placement of the concrete and shall be kept continuously thawed until the concrete is poured. The temperature difference between forms or substrate and the plastic concrete shall not exceed 40°F.

(5) Housing. The Contractor shall furnish sufficient canvas with a supporting framework or other suitable type of housing to fully enclose and protect the structure when placing and curing cold weather concrete. The sidewalls and roofing of the protective housing shall be completely built before the placing of any concrete. The sidewalls for decks shall extend below and fully enclose the entire superstructure.

The protective housing shall be constructed independently of the forms and bracing and with adequate space to allow for form removal and the initial finishing of the concrete as required during the heating period. Joists shall be located to suitably support the housing roof with no sagging. The protective enclosure shall be constructed and heated to the proper temperature before placing any concrete.

When the temperature readings taken on or in the concrete indicate the temperature of the concrete may fall below 50°F, the Contractor shall, without exposing the concrete, immediately build the necessary enclosures around the area involved and supply heat to ensure curing conditions as specified in Subsection 541.17. The enclosure shall be removed when directed by the Engineer.

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(6) Heating the Enclosure. The enclosure shall be heated in such a manner that the temperature of the concrete and the enclosed air shall be kept above 50°F, and not more than 20°F above the concrete temperature, for the designated curing period. During this time, the concrete shall be kept continuously wet to provide proper curing. After the curing period, the temperature shall be gradually lowered to that of the surrounding atmosphere, taking at least 48 hours for the transition but at no time exceeding a 1°F change per hour.

When dry heat is used, a means of maintaining atmospheric moisture shall be supplied. The Contractor shall maintain adequate fire protection and shall provide personnel to keep the heating units in continuous operation. When concrete placement operations are in locations where water levels may fluctuate, the heating equipment supports shall be built so that the equipment can be raised and steam lines shall be placed above the probable high water level.

When using direct-fired or indirect-fired heaters, the enclosure shall be well-ventilated to avoid accumulation of carbon dioxide and carbon monoxide.

When using a hydronic heating system with heat-transfer fluid that circulates through a series of hoses, the heat-transfer hoses shall be laid on top of the vapor barrier, usually plastic sheeting, then covered with approved insulating materials or by other approved methods for retaining heat.

(7) Temperature Records. The Contractor shall provide an automatic temperature recorder to continuously record concrete curing temperatures and ambient air temperatures for the entire curing period. Recording thermometers shall be capable of measuring and recording temperatures within the range of 0°F to 200°F with maximum graduations of 5°F.

Temperature sensors shall be carefully placed within the curing enclosure or in the concrete to ensure that temperatures are measured at typical locations. The recorder's accuracy shall be certified once every 12 months, with the certificate displayed with each recorder. The Engineer may make random checks of each recorder.

On each recorder chart, the Engineer shall indicate the location of the representative concrete, the placement date, and start and finish times of the temperature record. At the completion of the curing period, the recorder charts shall be submitted to the Engineer.

A thermometer shall be employed that can display the current temperature with a maximum gradation of 1°F. The Inspector will use the thermometer to take periodic temperature measurements of the concrete and enclosure temperatures at varying locations.

When the Contractor places concrete at more than one location within the specified curing period or if the Engineer determines that monitoring of a single pour is necessary in multiple locations, additional monitoring and recording equipment shall be furnished to provide temperature records at each location.

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541.09 FORMS. The Contractor shall be responsible for, and shall make good, any injury arising from inadequate forms. The Engineer shall inspect and accept all forms prior to concrete placement.

Unless the Plans specifically allow for the use of stay-in-place forms, such forms shall not be used in the construction of any superstructure or bridge deck. Stay-in-place forms will only be allowed in the construction of substructure elements in locations where the Engineer agrees that removable formwork is impossible to use.

(a) Falsework. In general, falsework that cannot be founded upon a solid footing shall be supported by falsework piling. The Engineer may require the Contractor to employ screw jacks or hardwood wedges to correct any deflections, however slight, occurring in the falsework.

(b) Construction. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations, including vibration. Forms shall be constructed and maintained to prevent the opening of joints due to shrinkage of the lumber. Sealers and caulking as approved by the Engineer shall be used where forms abut structural steel members, such as top flanges of beams and girders, etc.

To ensure their easy removal, forms shall be filleted and chamfered at all sharp corners, unless otherwise shown on the Plans or directed by the Engineer, and shall be given a bevel or draft in the case of all projections, such as girders and copings.

Falsework and forms for slabs, beams, and girders shall be constructed to provide the camber shown on the Plans or ordered by the Engineer.

(c) Form Lumber. All face form lumber for exposed surfaces shall be concrete form exterior grade plywood, not less than five ply and with a minimum thickness of 3/4 inch. In computing stud spacing, plywood shall be considered 1-inch lumber if the grain of three of the plies runs perpendicular to the studs.

Form lumber for unexposed surfaces may be dressed tongue-and-groove, dressed shiplap, or square-edge sized four sides of uniform width and thickness, with a minimum thickness, after finishing, of 3/4 inch.

All form lumber shall be sound and free from loose or rotten knots, knotholes, checks, splits, or wanes showing on the surface that will be in contact with the concrete. Used face form lumber, having defects or patches which may produce work inferior to that resulting from new material, shall not be used.

Other form materials may be used with the permission of the Engineer.

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(d) Form Ties. Metal ties or anchorages within the forms shall be constructed to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. Wire ties shall be used only in locations where they will not extend through surfaces exposed in the finished work and then only when authorized.

The cavities shall be filled with cement mortar in accordance with the requirements of Subsection 541.16.

(e) Surface Treatment. All forms shall be treated with commercial form oil prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the concrete. Any material that will adhere to or discolor the concrete shall not be used.

(f) Metal Forms. The specifications for wood forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and oiling also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape throughout the concrete placement operations.

All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms that do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

(g) Removal of Forms.

(1) Deck Superstructure. The forms, or their supports, for any portion of a structure shall not be removed before the end of the 10-day cure period for the deck. Forms under beams or floor slabs may be removed upon approval of the Engineer after the concrete attains 85% of the minimum compressive strength as specified in Table 541.03A, but not prior to the end of the 10-day cure period.

(2) Substructure. The forms, or their supports, for any portion of a substructure shall not be removed without the approval of the Engineer. Forms under arches, pier caps, or other special design conditions may be removed upon approval of the Engineer after the concrete attains 85% of the minimum compressive strength as specified in Table 541.03A.

The removal of forms and supports may begin when the concrete is found to have the required strength. In no case shall the number of curing days be less than specified in Table 541.17A.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take up the stresses due to its own dead load.

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541.10 PLACING CONCRETE.

(a) Workforce. The Contractor shall always have sufficient skilled personnel during the concreting operations to properly place, consolidate, and finish the concrete. If, in the opinion of the Engineer, the Contractor does not have sufficient skilled personnel to handle the concrete properly, the Engineer may postpone the start of the concreting operations until the Contractor has remedied this situation.

(b) Pre-Placement Meeting. For deck pours, or as required by the Engineer, a pre-placement meeting shall be scheduled by the Contractor to take place at least 7 calendar days before concrete placement, and prior to the Trial Pour, if required. Attendees at the pre-placement meeting shall include, but not be limited to, the Contractor's Project Superintendent, the Engineer, the Agency's Structural Concrete Engineer, and the concrete producer.

The Contractor shall provide a placement plan that addresses, but is not limited to, the following topics:

(1) Time of concrete placement and amount

(2) Batch plant testing

(3) Delivery of concrete

(4) Method of concrete placement on the deck

(5) Consolidation and finishing of concrete

(6) QC testing of the plastic concrete

(7) Curing of the concrete

(8) How to avoid long delays for balance loads

(9) Screed, work bridge, and rail set-up

(10) Dry run schedule

(11) Contingency plans for long delays, break downs, weather events and other potential problems

(12) Crew size and responsibilities

(13) Available equipment

(14) Project layout including locations for all pumps, cranes, testing, cleanouts, staging, etc.

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(c) Placement Limitations. All concrete shall be placed in daylight, unless otherwise authorized in writing by the Engineer. Authorization to place concrete at any other time shall not be given unless an adequate lighting system is provided prior to beginning the concrete placement operations.

Concrete shall not be placed under adverse environmental conditions that the Engineer determines will interfere with acceptable placement and/or finishing operations.

Concrete shall not be placed until the depth and character of the foundation, the apparent adequacy of the forms and falsework, and the placing of the reinforcing steel have been approved by the Engineer. The interior of the forms shall be clean of all debris before concrete is placed.

The Contractor shall submit to the Engineer a schedule of batching, delivery, and placement prior to the beginning of the concreting operations. The Contractor shall comply with the requirements of Subsection 541.05.

Equipment and tools necessary for handling materials and performing all parts of the work shall meet the approval of the Engineer as to design, capacity, and mechanical condition and must be on the site before the work is started. Any equipment, in the judgment of the Engineer, that proves inadequate to obtain results prescribed shall be improved or new equipment substituted or added.

The Engineer may suspend the pour or reject the pour if the Contractor deviates from the accepted pour plan which will also include unacceptable delivery rates. The Contractor will not be allowed compensation due to the pour being suspended or rejected do to the Contractor deviating from the accepted pour plan or uncontrolled delivery rates.

For simple spans, concrete should be deposited by beginning at the lower end of the span and working toward the upper end. For continuous spans, where required by design considerations, the concrete placing sequence shall be as shown on the Plans.

Concrete shall not be deposited in the forms more than 4 feet from its final position.

The dropping of unconfined concrete more than 5 feet will not be permitted.

Concrete shall not be deposited in running water.

The rate of placing the concrete shall be so regulated that no excessive stresses are placed on the forms. Concrete in all slabs, decks girders, or ribs of arches shall be placed in one continuous operation, unless otherwise specified.

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Concrete shall be placed in continuous horizontal layers, the thickness of which shall not exceed 18 inches, unless otherwise directed by the Engineer. Each succeeding layer shall be placed before the underlying layer has taken initial set and shall be consolidated in a manner that will eliminate any line of separation between the layers. When it is necessary, due to any emergency, to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcing bars.

Flowable fill shall be applied to voids and other locations as specified in the Contract and as directed by the Engineer. Flowable fill shall be able to completely fill the existing voids.

If voids are discovered, the Engineer may direct the Contractor to submit a plan for filling the remaining voids. This work, including preparing and submitting the Plan and filling any remaining voids, will be at the Contractor's expense.

(d) Placement of Overlays. Unless otherwise shown on the Plans, existing expansion joints and dams shall be maintained through the overlay. A bulkhead equal in width to that of the joint shall be installed to the required grade and profile prior to placing the overlay material. Expansion dam treatment shall be as shown on the Plans.

(e) Screed Rails. Screed rails shall be placed and fastened in position to ensure finishing the new surface to the required profile. Supporting rails shall be anchored in such a manner as to provide horizontal and vertical stability. Screed rails shall not be placed to create a recess in the overlay surface and shall not be treated with form oil.

A construction dam or bulkhead shall be installed in case of major delay in placement. During minor delays of one hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

For a period of at least 12 hours before the placement of overlay material, the prepared surface shall be flooded with water. After removal of all free water, the overlay material shall be deposited on the damp surface and manipulated to coat the horizontal and vertical surfaces to be covered. The rate of progress shall be controlled to prevent the drying of previously deposited material.

(f) Use of Chutes. Chutes, troughs, and pipes used in placing concrete shall be arranged to avoid segregation of the materials and the displacement of the reinforcement and shall be approved by the Engineer. Aluminum chutes, troughs, or pipes will not be permitted.

All chutes, troughs, and pipes shall be kept clean and free of hardened concrete by thoroughly flushing with water after each run. Open troughs or chutes shall be either of metal or metal-lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

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Dropping of unconfined concrete more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

(g) Use of Vibrators. Unless otherwise specified, the concrete shall be consolidated with mechanical vibrators, of an approved type and design, operating within the concrete. When required, vibrating may be supplemented by hand-spading with suitable tools to ensure proper and adequate consolidation.

Vibrators shall be manipulated to work the concrete thoroughly around the reinforcement and imbedded fixtures and into corners and angles of the forms to produce surfaces free of imperfections. Vibrators shall not be used to cause concrete to flow or run into position instead of placing. The vibration at any point shall be of sufficient duration to accomplish consolidation but shall not be prolonged to the point where segregation occurs.

Vibrators shall have non-metallic or rubber-coated heads. Vibrating machines shall at no time be left running unattended in the concrete.

When it is necessary due to an emergency to discontinue the placing of a monolithic section, the use of vibrators shall cease. Vibrators shall not again be used until a sufficient depth of fresh concrete is placed to prevent any possibility of the effect of vibration on the concrete already in place and in no case shall this depth be less than 2 feet.

The number of vibrators used shall be ample to consolidate the incoming concrete immediately after it is deposited in the form. The Contractor shall have at least one spare vibrator in serviceable condition at the site of the structure in which more than 25 cubic yards of concrete are to be placed.

The vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute under load. The vibration shall be of sufficient intensity and duration to cause plasticity, settlement, and complete consolidation of the concrete without causing segregation. The vibrator shall visibly affect a mass of concrete of 2-inch slump over a radius of at least 18 inches.

(h) Blasting Operations. All blasting operations within 200 feet of any concrete work shall be completed prior to the placement of the concrete. Regardless of the above limitation on blasting operations, the Contractor shall be responsible for any damage resulting from blasting operations.

541.11 DEPOSITING CONCRETE UNDER WATER.

(a) General. Concrete shall not be deposited under water except as specified by the Contract or upon approval of the Engineer and shall be subject to the following specifications.

(1) The Contractor shall submit for the Engineer's review and acceptance a Portland cement concrete mix meeting all the submittal requirements outlined in Subsection 541.03.

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(2) Additional mix design requirements:

a. The mix shall contain a minimum of 600 pounds per cubic yard of cementitious material with a minimum of 25% GGBFS substitution, or a minimum of 20% Fly Ash substitution, or other approved mineral admixture substitution at an approved rate.

b. Air content shall be 4.5% ± 1.5% unless any portion of this concrete shall be subjected to freeze-thaw conditions, in which case the air content shall be 6% ± 1.5%.

c. The maximum W/CM ratio shall be 0.45. When a water-reducing, high-range admixture that meets the requirements of *AASHTO M 194 M/M 194,* Type F or Type G, has been included in the reviewed and accepted mix design, the concrete shall not demonstrate segregation at the proposed slump, as determined by the Engineer, but at no time shall the slump be less than 7 inches.

d. If needed for a cofferdam and/or seal design, the concrete shall provide a minimum 28-day design strength of 3,000 psi. Otherwise, minimum strength requirements for underwater concrete shall be as specified in the Contract.

(b) Placement. When placing concrete underwater, the Contractor shall use a tremie or an alternate method of conveyance, approved by the Engineer, which minimizes the mixing of fresh concrete and water. A tremie shall have a hopper at the top that empties into a watertight tube at least 10 inches in diameter.

The discharge end of the tube on the tremie shall include a device to seal out water while the tube is first filled with concrete. An inflatable ball will not be permitted. The device shall keep its shape and float without danger of deflation.

The placement shall be continuous to the elevations shown on the Plans and the resulting concrete shall be monolithic and homogeneous.

Concrete shall not be deposited in water that has a temperature of 35°F or below. When the water temperature is between 35°F and 40°F, the mixing water, the aggregates, or both shall be heated as specified in Subsection 541.07(b).

A tremie shall be constructed of heavy-gauge steel pipe and consist of watertight joints between the tremie sections with a diameter of not less than 10 inches. The tremie hopper shall have a capacity of at least 1/2 cubic yard. When a batch is dumped into the hopper, the flow of the concrete shall be induced by slightly raising the discharge tube, always keeping it in the concrete.

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Tubes shall be kept continuously submerged in concrete during discharge. The depth that the tube is submerged in concrete and the height of the concrete in the tube shall be sufficient to prevent water from entering the tube. The Contractor shall continuously monitor the difference in elevation between the top of the concrete and the end of the discharge tube.

Horizontal movement of discharge tubes through the concrete will not be allowed.

For minor quantities, at the sole discretion of the Engineer, a direct pumping method may be approved. If a direct pumping method is to be implemented, the pipe discharging the concrete shall consist of heavy-gauge steel sections. The Contractor shall demonstrate the ability to pump the concrete without the pump line surging or otherwise moving in the water.

Cylinders cured as field cure shall be cured at the same temperature as the water covering the concrete.

541.12 PUMPING. Where concrete is conveyed and placed by mechanically-applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The pump shall be capable of pumping concrete within the specified slump limits. The use of aluminum pipe as a conveyance for the concrete will not be permitted.

The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. The equipment shall be arranged so that no resulting vibrations may damage freshly placed concrete.

The pumping of Class LW concrete shall not be permitted.

541.13 CONSTRUCTION JOINTS.

(a) Construction Joint Locations. Joints shall be formed at the location shown on the Plans. Any variation or new location of joints shall require written permission of the Engineer. Feather edges at construction joints will not be permitted. Joints shall be formed with inset form work so that each layer of concrete will have a thickness of not less than 6 inches.

(b) Joining Fresh Concrete to Previously Set Concrete. When joining fresh concrete to concrete that has hardened, the surface of the set concrete shall be roughened in a manner that will not leave loosened particles or damaged concrete at the surface and be thoroughly cleaned of all laitance, loose, and foreign material. Immediately prior to placing of the new concrete, the surface shall be saturated with water.

When shown on the Plans or ordered by the Engineer, the surface shall be thoroughly coated with a very thin coating of mortar, neat cement grout, or approved bonding agent and all forms drawn tight against the face of the concrete. This coating shall not be allowed to dry out before being covered with fresh concrete.

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(c) Keys. Suitable keys shall be formed at construction joints. Unless otherwise directed by the Engineer, these keys shall be of the type and detail shown on the Plans.

(d) Filled Construction Joints. Filled construction joints shall contain a pre-formed cork joint filler or other pre-formed joint filler that may be shown in the Contract. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joints, that portion of the joint to be filled shall be formed with a separate material (other than the pre-formed joint filler) that can easily be removed prior to placement of the above indicated filler.

(e) Water Stops. Approved water stops shall be placed at locations shown on the Plans. They shall form continuous watertight joints.

(f) Bond Breakers. Bond breakers shall be made from asphalt-treated felt, pipe insulation, or tar emulsion as shown on the Plans.

541.14 EXPANSION JOINTS. All expansion joints shall be constructed according to details shown on the Plans.

(a) Filled Compression and Expansion Joints. Filled compression and expansion joints shall be made with a pre-formed self-expanding cork joint filler or other pre-formed joint filler that may be shown in the Contract. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joint, that portion of the joint to be filled shall be formed with a separate material (other than the expansion joint filler) that can easily be removed prior to placement of the above indicated filler.

(b) Special Types of Expansion Joints. Special types of expansion joints may be used when shown on the Plans or ordered by the Engineer.

541.15 PATCHING. Patching of existing concrete shall be accomplished with the type of material shown on the Plans. Type IV mortar shall be used where a non-shrink or expansive mortar is shown on the Plans. Patching of new concrete shall be as specified in Subsection 541.16(a)(1).

541.16 CONCRETE FINISHING.

(a) General. Unless otherwise specified, the surface of the concrete shall be finished immediately after form removal.

All concrete surfaces shall be given a dressed finish. If further finishing is required, exposed surfaces shall be given a rubbed finish. Other finish classes may be shown on the Plans for designated surfaces.

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(1) Dressed Finish. The dressed concrete finish work shall begin within 12 hours after removal of forms and shall continue until completed. All fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed.

On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar composed of the same type of cement and fine aggregate and mixed in the same proportions used in the grade of the concrete being finished.

Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured a minimum of 72 hours in accordance with Subsection 541.17. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint shall be left exposed to its full length with clean and true edges.

All surfaces that cannot be repaired to the satisfaction of the Engineer shall be "rubbed" as specified for a Rubbed Finish.

(2) Rubbed Finish. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set.

Surfaces to be finished shall be rubbed with a medium-coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of the same type of cement and fine sand mixed in proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(3) Float Finish. A float finish for horizontal surfaces shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be made uniform by longitudinal or transverse floating.

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When the concrete has hardened sufficiently, the surface shall be given a broom finish, burlap drag finish, or left smooth as determined by the Engineer.

(b) Finishing Bridge Deck.

(1) General. The Contractor shall follow the procedures and details for placing the deck in accordance with the pre-placement meeting. The procedure shall provide for adequate labor, equipment, and material supply to complete placement of concrete on the entire deck, or specified portion thereof. If, during the placement, unforeseen circumstances delay the progression of the pour to a point where the concrete begins to lose plasticity the Contractor shall be prepared to place a bulkhead, as directed by the Engineer.

A finishing machine shall be provided on all decks constructed with Class LW concrete regardless of length.

Approval of the method and equipment will not relieve the Contractor of full responsibility for obtaining the required surface finish.

Finishing shall continue until there remains no deviation greater than 1/8 inch when tested for trueness with a metal straightedge at least 10 feet in length. The Contractor shall furnish the straightedge. When a bituminous concrete surface is to be placed on a bridge deck, the deviation shall be not greater than 1/4 inch. When a sheet membrane is being applied, sharp ridges shall not be allowed.

Immediately after finishing has been completed, and as soon as all excess moisture has disappeared, the bridge deck shall be textured as specified in the Plans. Where bridge deck finish is not specified it shall be textured to a uniform gritty surface using a burlap, felt, or other drag satisfactory to the Engineer. Sidewalks and safety curbs shall receive their final finish with a fine bristled broom.

If the bridge deck concrete does not meet the above smoothness requirements, the Contractor shall remove high spots up to 1/2 inch high by means of grinding. Any other corrections shall be made only with the written approval of the Engineer. The use of bush hammers will not be allowed. No concrete shall be removed that will result in a concrete slab thickness less than that shown on the Plans.

Any deck that cannot be corrected by a method satisfactory to the Engineer shall be removed and replaced at the Contractor's expense.

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(2) Overall Length of Bridge Over 60 Feet. Bridge floors over 60 feet in length, or any deck using Class LW concrete, shall be struck off and finished by an approved self-propelled finishing machine. This machine will be supported on suitable rails and equipped with adjustable strike-off or finishing screeds capable of producing the required finish surface for the full width of the bridge from face-to-face of curbs.

Machines shall not be used until proper adjustments have been made and the adjustments have been checked and approved by the Engineer. Machines shall be kept in true adjustment for the duration of the deck placement.

Sufficient time shall be provided prior to beginning concreting operations for the finishing machine to be operated over the full length of the bridge deck segment to be placed. This test run shall be made with the screed adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement measured, and the controlling dimensions of slab reinforcement and forms checked.

After the concrete has been placed, it shall be struck off by a self-propelled finishing machine and the operation repeated as necessary to produce a uniformly consolidated, dense, smooth surface. The final passage of the finishing machine shall result in a uniform surface at the required grade and slope over its entire area.

At any time the screed machine does not advance in a 15-minute period due to delayed concrete delivery, mechanical breakdown or other problem, the Contractor shall immediately cover concrete that is under the screed machine past the leading edge of the concrete with wet burlap.

Just before concrete placement is to begin, the burlap will be removed, the screed machine will be moved back, fresh concrete added to the area that was directly under the screed to the leading edge and this area will be vibrated again. The screed machine may then be advanced forward to continue the placement.

The Contractor shall furnish a work bridge or bridges of an approved type, capable of spanning the entire width of the deck and supporting construction loads without deflection to the concrete slab surface.

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(3) Overall Length of Bridge 60 Feet and Less. Screed rails shall be rigidly set to grade and supported sufficiently on adjustable chairs to allow no deflection in the rails under operating conditions. Screed guides or chairs shall be supported on structural members where possible. Sufficient screed rails shall be provided so that all rails necessary for any one continuous pour may be preset and graded before the start of concreting operations. The removal of screed rails and exposed chairs shall be accomplished without walking in the fresh concrete.

The Contractor shall furnish a minimum of one work bridge of an approved type, capable of spanning the entire width of the deck and supporting construction loads without deflection to the concrete slab surface.

After the concrete is placed, it shall be struck off by one of the following methods:

a. A self-propelled concrete finishing machine used as specified in Subsection 541.16(b)(2) for concrete finishing on bridges longer than 60 feet.

b. A straight steel roller with a minimum diameter of 4 inches, at least 12 inches longer than the distance between screed strips, and equipped with handles at each end, which shall be rolled back and forth until the surface is smooth and even with all holes filled.

c. An approved mechanical vibrating screed exerting a force of not less than 12 pounds per foot, the vibrations of which shall be of not less than 6,500 vibrations per minute when checked by a vibration reed-type tester, uniform throughout its entire length and adjusted so as not to drive the aggregate more than 1/4 inch below the surface.

d. An approved wood, metal-shod template fitted with handles. If satisfactory results are not obtained with the type of screed selected, the Engineer may direct the use of another type of screed.

After the preliminary screeding, floats shall be operated with a combined longitudinal and transverse motion, planing off the high areas and floating the material removed into the low areas. Each pass shall lap the previous pass by 50% of the length of the float.

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541.17 CURING CONCRETE.

(a) General. Water for use in curing concrete shall conform to the requirements of Subsection 745.01. The effective cure time shall be only the time that the concrete has been maintained in a wet condition with the concrete surface temperature above 50°F. If the concrete is not maintained in a wet condition and/or the concrete surface temperature drops below 50°F, it shall not be counted as an effective cure time. The cure period will be extended 4 hours for every 1 hour the concrete is below 50°F, beginning when the concrete temperature is raised to or exceeds the minimum curing temperature.

Regardless of the curing medium specified, the entire surface of the newly placed concrete shall be kept damp. This shall be achieved by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The moisture shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate in a quantity sufficient to cause a flow or washing of the surface.

The atomized flow shall be applied continuously until the surfaces can be covered by the specified curing mediums. For bridge barriers, curbs, and sidewalks the curing method shall be applied within 15 minutes of the completion of the finishing process.

For bridge decks the curing method shall promptly follow the screed machine, within a maximum lag time of 10 minutes and without interruption.

Concrete components shall be cured for the times specified in Table 541.17A.

TABLE 541.17A – CURING TIMES FOR CONCRETE COMPONENTS

Type of Construction	Curing Methods (Subsection)	Effective Cure Time (Days)
Substructure	541.17(b)(1), (2), (3), (5), (7), (8)	7
Superstructure	541.17(b)(2), (8)	10 [1]
Retaining walls	541.17(b)(1), (2), (5), (6), (8)	7
Headwalls	541.17(b)(1), (2), (5), (6), (8)	7
Sidewalks, curbs, and gutters	541.17(b)(1), (2), (3), (5), (6), (7), (8)	7

[1] There shall be no activity on the superstructure during the cure period

(b) Curing Methods. All exposed surfaces of newly placed concrete shall be cured by one of the following specified methods:

(1) Water Curing. Curing with water shall be by continuously sprinkling or flooding of all exposed surfaces for the entire required curing period.

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(2) Burlap Curing. The entire exposed surface of the concrete shall be covered with two layers of approved burlap that has been pre-soaked with water. The burlap shall then be covered with a lapped layer of white polyethylene sheeting. Once the concrete superstructure has hardened sufficiently, a stream of water, applied with a soaker hose or similar device, shall be run continuously under the polyethylene sheeting until the cure period is complete.

(3) Sand Cover. The entire exposed surface of the concrete shall be covered with at least 3 inches of approved sand that shall be kept wet for the entire curing period.

(4) White Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white polyethylene sheeting, maintained and fastened to provide a nearly airtight condition in contact with the surface where possible. If, in the opinion of the Engineer, this cover is not adequately provided or maintained to ensure the proper conditions for the concrete cure, then the white polyethylene sheeting cure shall be terminated and another method substituted.

(5) White Burlap-Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white burlap-polyethylene sheeting. The burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All joints shall be lapped a minimum of 18 inches. The burlap shall be kept damp throughout the curing period.

(6) Membrane-Forming Curing Compounds. White-pigmented or fugitive-dye membrane-forming curing compounds may be used for curing concrete in minor drainage structures. All other uses of curing compounds shall be approved in writing by the Engineer. Only membrane-forming curing compounds approved by the Agency's Materials Section may be used.

When membrane curing is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. The concrete inside the forms shall be sealed immediately after the forms are removed and necessary finishing has been done.

The solution shall be applied in one or two separate applications. If the solution is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and ensure the direct application of the curing solution to the concrete surface to result in a uniform coverage of the surface area at the rate of 1 gallon of solution for every 150 square feet.

If rain falls on the newly-coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions equal in curing value to that specified above.

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Should the surface be subject to continuous injury or the use of curing compound results in a streaked or blotchy appearance, the method shall be stopped and water curing applied.

(7) White Polyethylene Sheeting with Sand Cover. This method may be used only when approved by the Engineer and shall conform to the requirements of Subsection 541.17(b)(4). The airtight condition shall be obtained by the addition of a uniform sand cover with a minimum depth of 2 inches.

(8) Pre-Dampened Cotton Mats. The entire exposed surface of the concrete shall be covered with a blanket of cotton mats that has been pre-dampened with water. The mats shall be maintained in a damp condition until the curing period is complete.

If, in the opinion of the Engineer, the Contractor's curing procedure is not producing an adequate cure, the Engineer may direct a change in the cure method at no additional cost to the Agency.

(c) Bridge Decks. For bridge decks, the curing method shall promptly follow the screed machine, within a maximum lag time of 10 minutes and without interruption. If this lag time cannot be met, then fogging of the area shall be performed in a manner that keeps the relative humidity above the evaporation rate of the concrete surface, but not so excessive that water begins to collect on the surface prior to texturing or other surface manipulating procedures.

541.18 LOADING OF CONCRETE. After the concrete has been placed and the finishing operations concluded, it shall not be walked on or disturbed in any manner, including removal of forms, for a minimum period of 18 hours. If retarder is used as an admixture, this minimum period may be extended as directed by the Engineer.

(a) Substructure. No backfill material shall be placed against a newly completed structure until the concrete has been cured in accordance with Table 541.17A, and until the field cured test cylinders have attained 85% of the compressive strength specified in Table 541.03A. However, the Contractor may erect forms for subsequent concrete placement on footings after 18 hours have elapsed from the time that the footing placement was completed, provided the concrete has sufficient strength to allow it to be worked on without damage, and proper cure is maintained.

Static loads, such as forms, reinforcing steel, or other materials necessary for construction, may be placed on any concrete after it has been in place 72 hours, or a compressive strength of 1,800 pounds per square inch has been obtained, provided proper curing is maintained. Superimposed loads from subsequent concrete pours will not be allowed on any substructure unit or section in place until the field cured test cylinders have attained 85% of the compressive strength specified by Table 541.03A, and provided curing of the supporting section is maintained in accordance with Table 541.17A.

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(b) Superstructure. Static loads, such as forms, granite curbing, cast-in-place concrete curb, and other materials necessary for deck construction, shall not be placed on deck concrete until the effective cure time specified in Table 541.17A is complete and the field-cured test cylinders for this concrete have attained 85% of the compressive strength specified in Table 541.03A.

The Contractor shall keep bridge floors free of all motor vehicles, transit mixers, and heavy construction equipment until the curing period is satisfactorily completed, the field-cured test cylinders for the bridge floor concrete have attained the compressive strength specified in Table 541.03A, and the field-cured test cylinders for the curb concrete have attained 85% of the compressive strength specified in Table 541.03A.

(c) Vertical Joints. Concrete shall not be placed against a vertical construction joint until the previously placed concrete has been in place a minimum of 72 hours.

The Contractor must not allow loads that are in excess of the legal loads permitted by the laws of the State to travel over the completed structure, except with written permission of the Engineer

541.19 METHOD OF MEASUREMENT. The quantity of Concrete, Class AA, A, B, C, D, LW, or Controlled Density (Flowable) Fill to be measured for payment will be the number of cubic yards of the class of concrete specified in the complete and accepted work, as determined by the prismoidal method using dimensions shown on the Plans or as directed by the Engineer, including the volume of superstructure precast concrete stay-in-place forms, but excluding the volume of steel or other stay-in-place forms and form filling materials.

No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel, expansion joint material, scuppers, weep holes, conduits, tops of piles, scoring, chamfers or corners, inset panels of 1-1/2 inches or less in depth, or any pipe less than 8 inches in diameter.

The quantity of Mortar, Type I or Mortar, Type IV to be measured for payment will be the number of cubic yards of the type of mortar specified in the complete and accepted work. The number of cubic yards will be based on sack count of cement used. One cubic yard of Type I or Type IV mortar is considered equivalent to 1,600 pounds of Portland cement.

541.20 BASIS OF PAYMENT. The accepted quantity of Concrete of the class specified, Mortar of the type specified, or Controlled Density (Flowable) Fill, will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for performing the work specified, including designing the mix, satisfactory finishing and curing, and for furnishing all forms, materials, including joint filler and bond breaker, labor, tools, admixtures, equipment, including automatic temperature recording units, trial batches, and incidentals necessary to complete the work.

The cost of heating materials and protecting the concrete against cold weather, and any additional cost for cement, will not be paid for separately but will be considered incidental to the Contract unit prices for Section 541 pay items.

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The cost of furnishing testing facilities and supplies at the batch plant and the setting of inserts, benchmarks, and bridge plaques furnished by the Agency will not be paid for separately but will be considered incidental to the Contract unit price of structural concrete.

Costs for all materials, labor and incidentals for steel or other stay-in-place forms and form filling materials will not be paid for separately, but will be considered incidental to the Contract unit prices for concrete.

Payment will be made under:

Pay Item	Pay Unit
541.21 Concrete, Class AA	Cubic Yard
541.22 Concrete, Class A	Cubic Yard
541.25 Concrete, Class B	Cubic Yard
541.30 Concrete, Class C	Cubic Yard
541.31 Concrete, Class D	Cubic Yard
541.40 Concrete, Class LW	Cubic Yard
541.45 Controlled Density (Flowable) Fill	Cubic Yard
541.55 Mortar, Type I	Cubic Yard
541.58 Mortar, Type IV	Cubic Yard

SECTION 542 – THIS SECTION RESERVED

SECTION 543 – CONTRACTOR-FABRICATED PRECAST CONCRETE STRUCTURE

543.01 DESCRIPTION. This work shall consist of manufacturing, transporting, handling, and erecting precast concrete structure components fabricated by the Contractor at a location other than a Precast Concrete Institute (PCI) or National Precast Concrete Association (NPCA) certified precast concrete facility.

543.02 MATERIALS. Materials shall meet the material requirements specified in Subsection 501.02, Subsection 507.02, and Subsection 540.02. Concrete shall meet the material requirements specified in Subsection 540.05.

543.03 GENERAL FABRICATION REQUIREMENTS. Unless noted otherwise herein, Contractor-Fabricated Precast Concrete (CFPC) shall meet the requirements of Section 501, Section 507, and Section 540.

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543.04 SUBMITTALS. As soon as practical after award of the Contract, all required information shall be prepared and submitted. Fabrication drawings and erection plans shall be submitted as separate submittals.

If the Contractor proposes a different configuration than what is provided in the Plans then a complete copy of the structural design calculations for the CFPC shall be submitted accompanying the construction drawings in accordance with Section 105. The design calculations shall substantiate that the proposed precast concrete satisfies the design parameters of the Contract. The applicable design code will be the latest edition of the *AASHTO LRFD Bridge Design Specifications* unless indicated otherwise in the Contract.

Fabrication drawings for the precast concrete shall be submitted in accordance with Section 105. In addition to the requirements for fabrication drawings in Section 105, the following shall be included:

(a) The concrete mix design in accordance with Subsection 540.04(a)

(b) Dimensions and tolerances of the sections to be fabricated

(c) The location of reinforcing steel, splices, welded wire fabric, mechanical bar connectors, and inserts. Reinforcing steel material lists, material designations, and bending details

(d) The type of surface finish and how the finish will be obtained

(e) The curing method, detailing sequence and duration in accordance with the requirements of Subsection 501.17

(f) The minimum required concrete strength for form removal

(g) The design of the lifting attachments, including the minimum required concrete strength to allow lifting. A professional engineer registered in the State of Vermont shall stamp calculations.

(h) Transportation, handling, and storage details along with calculations to substantiate the proposed CFPC units will not be cracked/damaged by handling and/or transport. A professional engineer registered in the State of Vermont shall stamp calculations.

(i) The installation procedures, including a detailed grouting procedure

543.05 INSPECTION. Materials furnished and the work performed herein shall be inspected by the Agency. The Agency will test all concrete incorporated into the work in accordance with Section 501. The Inspector shall have the authority to reject any material or work that does not meet the requirements of the specifications. Advance notification of at least 2 weeks shall be provided by the Contractor to the Agency's Engineer and the Structural Concrete Engineer concerning the proposed intention to commence work. A minimum notification of 5 working days shall be provided by the Contractor to the Agency's Engineer and the Structural Concrete Engineer to confirm the fabrication start date.

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Prior to placing any precast concrete elements produced under these specifications, all materials shall have all applicable certifications approved in accordance with Subsection 700.01.

543.06 FABRICATION.

(a) Forming Members. Forms and formwork shall meet the requirements of Subsection 501.09.

(b) Reinforcing Steel. Bar reinforcement shall be furnished and installed as per Section 507.

(c) Pre-Production Meeting. Unless the Engineer deems, in writing, that a pre-production meeting is unnecessary, then a pre- production meeting shall be held a minimum of 7 calendar days prior to beginning concrete placement. The pre-production meeting shall be attended by, as a minimum but not limited to, the crew supervisor, Contractor project manager, concrete producer, Engineer, Construction Structures Engineer, and Project Manager.

(d) Placing Concrete. Concrete placement shall be in accordance with Subsection 501.10 and as specified herein. Concrete shall not be deposited in the forms until the appropriate Agency representative has approved placement of the reinforcement, conduits, and anchorages.

(e) Curing. Curing shall meet the requirements of Subsection 501.17.

(f) Removal of Forms. Forms shall not be removed until the curing period has ended.

(g) Concrete Finishing. Finishing shall conform to the requirements of Subsection 501.16.

(h) Repairs/Patching. CFPC structure components that contain minor defects caused by manufacture or handling may be repaired at the manufacturing site. Minor defects are defined as holes, honeycombing, or spalls which are 6 inches or less in diameter and that do not penetrate deeper than 1 inch into the concrete. Surface voids or "bug holes" that are less than 5/8 inch in diameter and less than 1/4 inch deep need not be repaired. Repairs shall be made using a material from the Agency's *Approved Products List* for overhead and vertical concrete repair. The repair material shall be cured as specified by the manufacturer. Repairs shall be approved by the Engineer.

(i) Cracking. Cracks less than 0.01 inch in width shall be sealed by a method approved by the Engineer. Cracks in excess of 0.01 inch may be cause for rejection. At the Engineer's discretion, cracked CFPC structure components shall be repaired or replaced at the Contractor's expense.

(j) Dimensional Tolerances. All tolerances shall be in accordance with the latest editions of both *PCI MNL 116* and *PCI MNL 135,* or with the *National Precast Concrete Association (NPCA) Quality Control Manual for Precast Concrete*, unless otherwise noted in the Contract or as approved by the Engineer.

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(k) Marking. The date of manufacture, the production lot number, and the piece mark shall be clearly marked on each individual piece of precast concrete. The mark shall be in a location that will not be visible in the finished product.

(l) Production Site Handling. Units shall not be lifted, moved, or otherwise disturbed until the curing period is complete and the concrete has reached the minimum compressive strength required for lifting per the approved lifting attachment design.

543.07 HANDLING, STORAGE, AND SHIPPING. Each CFPC structure shall be handled, stored, and shipped in such a manner as to minimize chipping, cracks, fractures, discoloration, and excessive bending stresses. A unit damaged by handling, storage, or shipping shall be replaced at the Contractor's expense.

A CFPC structure shall not be installed until the respective unit has been inspected. This inspection shall verify that the pieces are free from defects, and that all specification requirements, including but not limited to those for compressive strength and tolerance requirements, have been achieved. In addition, a CFPC structure will not be considered for shipment until the completion of the cure period and the required strength has been attained as demonstrated by field cured cylinder breaks.

Field cured test cylinders for production site handling and shipping strength verification purposes shall be tested either at the Agency's Materials Section Central Laboratory or at an independent laboratory approved by the Engineer. An Agency representative shall witness all tests.

If an independent laboratory is proposed to be used to test the field cured cylinders, the Contractor shall submit documentation providing verification for the following:

(a) Calibration of the compression machine in accordance with of *ASTM C 39/C 39 M,* Section 5

(b) Compression machine meets the requirements of *ASTM C 39/C 39 M*

(c) Proficiency of the technician who will be performing the test methods

The State at any time reserves the right to perform an independent proficiency of the technician for the test methods used and review of the testing facility.

543.08 INSTALLATION METHODS, EQUIPMENT, AND ERECTION. Cranes, lifting devices, and other equipment for CFPC structure erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the CFPC structure components.

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Construction drawings for CFPC structure component erection shall be submitted in accordance with Section 105. The erection plan shall include the necessary computations to indicate the magnitude of stress in the units during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages.

Post tensioning shall comply with Subsection 540.12.

Submittal of the erection plan is for the Agency's documentation only and shall in no way be construed as approval of the proposed method of erection. The Contractor shall follow the erection plan as accepted.

543.09 GROUT. Grout shall be placed in accordance with the requirements of Subsection 540.11.

543.10 METHOD OF MEASUREMENT. The quantity of Contractor-Fabricated Precast Concrete Structure of the type and size specified to be measured for payment shall be on a lump sum basis. The lump sum shall include all of the CFPC structure components in the complete and accepted work for each location specified in the Contract.

543.11 BASIS OF PAYMENT. The accepted quantity of Contractor-Fabricated Precast Concrete Structure of the type and size specified will be paid for at the Contract lump sum price. Payment shall be full compensation for designing, detailing, fabricating, repairing, transporting, handling, and erecting the materials specified, for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any grouting work, such as fairing out unevenness between adjacent precast concrete structure components and filling leveling screw holes, shear keys, transverse anchor recesses, and dowel holes, is considered incidental to the work for Contractor-Fabricated Precast Concrete Structure.

Payment will be made under:

Pay Item	Pay Unit
543.10 Contractor-Fabricated Precast Concrete Structure	Lump Sum

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SECTION 544 – PREFABRICATED BRIDGE UNIT SUPERSTRUCTURE

544.01 DESCRIPTION. This work shall consist of manufacturing, transporting, and erecting concrete/steel composite Prefabricated Bridge Units (PBUs) as shown on the Plans.

The work under this section shall be performed in accordance with these provisions, the Plans, and Section 501, Section 506, Section 507, and Section 508.

544.02 MATERIALS. Materials shall meet the material requirements specified in Subsection 501.02, Subsection 506.02, Subsection 507.02, Subsection 508.02, and the following subsections:

Overhead and Vertical Concrete Repair Material.....780.02
Rapid Setting Concrete Repair Material.....780.03
Rapid Setting Concrete Repair Material with Coarse Aggregate.....780.04

544.03 GENERAL FABRICATION REQUIREMENTS. The structural steel furnished under this section shall be fabricated in a plant meeting the requirements of Subsection 506.03. After fabrication, the structural steel shall be transported to a location, approved by the Agency where the steel will be shop galvanized/metallized/painted, or where the remainder of the composite superstructure unit shall be fabricated.

The fabricator or Contractor constructing the reinforced concrete portion of the PBUs shall have demonstrated experience in forming, casting, curing, and finishing High Performance Concrete superstructure decks in accordance with Section 501.

544.04 SUBMITTALS. As soon as practical after award of the Contract, all required information shall be prepared and submitted. Fabrication drawings and erection plans shall be submitted as separate submittals.

Fabrication drawings for the PBUs shall be submitted in accordance with Section 105. In addition to the requirements for fabrication drawings in Section 105, the following shall be included:

(a) Structural steel: In accordance with Subsection 506.04

(b) Concrete:

(1) Dimensions and tolerances of the sections to be fabricated

(2) The location of reinforcing steel, splices, welded wire fabric, mechanical bar connectors, and inserts

(3) The type of surface finish and how the finish will be obtained

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(4) The curing method, detailing sequence and duration in accordance with the requirements of Subsection 501.17

(c) Reinforcing steel: Material lists, material designations, and bending details

(d) Temporary assembly plan and procedure

(e) Temporary support elevations

(f) Method of supporting the screed

(g) The design of the lifting attachments. A professional engineer registered in the State of Vermont shall stamp calculations.

(h) Transportation, handling, and storage details along with calculations to substantiate that the PBUs will not be cracked/damaged by handling and/or transport. A professional engineer registered in the State of Vermont shall all stamp calculations.

544.05 INSPECTION. Structural steel shall be inspected by the Agency in accordance with Subsection 106.04 and Section 506.

Concrete elements furnished and the work performed herein shall be inspected by the Agency. The Inspector shall have the authority to reject any material or work that does not meet the requirements of these specifications. Advance notification of at least 2 weeks must be provided by the Contractor to the Agency's Engineer and the Structural Concrete Engineer concerning the proposed intention to commence work. A minimum notification of 5 working days shall be provided by the Contractor to the Agency's Engineer and the Structural Concrete Engineer to confirm the fabrication start date.

Prior to placing any concrete elements produced under these specifications, all materials shall have all applicable certifications approved in accordance with Subsection 700.01.

544.06 FABRICATION.

(a) Forming Members. Forms and formwork shall meet the requirements of Subsection 501.09. Relative bearing elevations shall be within ± 0.01 feet of that shown on the Plans.

(b) Structural Steel. Structural steel shall be fabricated in conformance with Section 506. All diaphragms shown on the Plans shall be installed prior to placing any concrete formwork.

(c) Welding. All welding shall conform to the requirements of Subsection 506.10.

(d) Reinforcing Steel. Bar reinforcement shall be furnished and installed in conformance with Section 507.

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(e) Concrete. Concrete mix and proportioning shall meet the requirements of Subsection 501.03 for High Performance Concrete, Class PCD. Concrete shall be produced and tested in accordance with Subsection 501.04 through Subsection 501.07.

(f) Pre-Production Meeting. Unless the Engineer deems, in writing, that a pre-production meeting is unnecessary, then a pre-production meeting shall be held a minimum of 7 calendar days prior to beginning concrete placement. The pre-production meeting shall be attended by, but not be limited to, the crew supervisor, Contractor project manager, concrete producer, Engineer, Construction Structures Engineer, and Project Manager.

(g) Placing Concrete. Concrete placement shall conform to the requirements of Subsection 501.10.

Concrete shall not be deposited in the forms until the Agency representative has approved placement of the reinforcement and inserts. The concrete shall be vibrated internally, externally, or a combination thereof to the required consolidation. The vibrating shall be done with care and in such a manner that:

(1) Concrete is uniformly consolidated

(2) Displacement of reinforcement and inserts is avoided

(3) Acceptable finish surfaces are produced

(h) Curing. Curing shall meet the requirements of Subsection 501.17.

(i) Removal of Forms. Forms shall not be removed until the curing period has ended.

(j) Concrete Finishing. Finishing shall conform to the requirements of Subsection 501.16.

(k) Dimensional Tolerances.

(1) Geometry of PBU.

a. Length (each unit): ± 3/4 inch (Adjacent unit lengths shall not vary by more than 3/4 inch)

b. Width: ± 3/8 inch

c. Deck thickness: + 3/8 inch, - 1/4 inch

d. Deviation from diagonals: ± 3/4 inch (horizontal)

e. Deviation from end squareness or skew: ± 3/4 inch (horizontal)

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f. Girder spacing: ± 1/2 inch (within a unit)

g. Horizontal alignment: ± 3/8 inch (Deviation from straight line parallel to the centerline of the unit)

h. Insert location: ± 3/8 inch

(2) Reinforcing.

a. Spacing: ± 1 inch (non-cumulative)

b. Cover (Top and bottom mat): ± 1/4 inch

(3) Field Installation.

a. Vertical deviation between units prior to closure pour concrete placement shall not exceed 1/4 inch.

b. Deviation in joint width between units shall be ± 1/2 inch.

(l) Acceptance of Units. Individual precast units will not be accepted for any of the following reasons:

(1) Fractures or cracks passing through the deck

(2) Camber that does not meet the requirements in the approved fabrication drawings

(3) Honeycombed open texture

(4) Dimensions not within the allowable tolerances as specified

(5) Separation of the concrete deck from the steel girders

(6) Defects that indicate proportioning, mixing, and molding not in compliance with the specifications

(7) Damaged ends where such damage would prevent making a satisfactory joint

(8) Units with cracks within any part of the concrete that are greater than 0.03 inches in width

(9) Significant damage to the units during transportation, erection, or construction as determined by the Engineer

(10) Units not fabricated in accordance with the Contract

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(m) Repairing/Patching. Units that contain minor defects caused by manufacture or handling may be repaired at the manufacturing site. Minor defects are defined as holes, honeycombing, or spalls which are 6 inches or less in diameter and do not penetrate deeper than 1 inch into the concrete. Surface voids or "bug holes" that are less than 5/8 inch in diameter and less than 1/4 inch deep need not be repaired. Repairs shall be made using an overhead and vertical concrete repair material satisfactory to the Engineer. The repair material shall be cured as specified by the manufacturer. Repairs shall be approved by the Engineer.

(n) Cracking. Crack widths less than 0.01 inch in width shall be sealed with a penetrating sealer using Agency approved materials and procedures. Crack widths measuring 0.01 inch to 0.03 inch in width shall be epoxy injected using Agency approved materials and procedures. At the Engineer's discretion, cracked members shall be repaired or replaced at the Contractor's expense.

(o) Labeling. Each unit shall be clearly and permanently labeled on the underside of the deck (in the vicinity of the upstation end diaphragm) with the following information:

(1) Manufacturer

(2) Date of manufacture

(3) Mark number

(p) Production Site Handling. Units shall not be lifted, moved, or otherwise disturbed until the curing period is complete and the concrete has reached full design strength.

(q) Pre-Assembly. The units shall be pre-assembled at the fabrication location to assure proper match between adjacent units before shipping to the project site, to the satisfaction of the Agency.

(r) Shipping. Units shall not be shipped until the minimum 28-day strength is attained and they have been stamped by the Agency. A 48-hour advance notice of the loading and shipping schedule shall be provided to the Engineer. The units shall be secured on the vehicle in order that no fatigue cracking will occur during transport. The Contractor shall secure the necessary hauling permits.

544.07 HANDLING. PBUs shall be handled, stored, and shipped in such a manner as to minimize chipping, cracks, fractures, discoloration, and excessive bending stresses. Units damaged by handling, storage, or shipping shall be replaced at the Contractor's expense.

Field cured test cylinders for production site handling and shipping strength verification purposes shall be tested either at the Agency's Materials Section Central Laboratory or at an independent laboratory approved by the Engineer. An Agency representative shall witness all tests.

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If an independent lab is proposed to be used to test the field cured cylinders, the Contractor shall submit documentation providing verification for the following:

(a) Calibration of the compression machine in accordance with *ASTM C 39/C 39 M,* Section 5

(b) Compression machine meets the requirements of *ASTM C 39/C 39 M*

(c) Proficiency of the technician who will be performing the test methods

The State at any time reserves the right to perform an independent proficiency of the technician for the test methods used and review of the testing facility.

544.08 INSTALLATION.

(a) General. The PBUs shall be fabricated in accordance with the applicable sections of the specifications for each respective item. Construction procedures and permissible variations other than those contained herein shall be submitted for approval.

(b) Erection Plan. Cranes, lifting devices, and other equipment for erecting PBUs shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the PBUs.

The Contractor shall submit construction drawings in accordance with Section 105 for the methods and sequence of PBU erection, the temporary bracing, and the equipment to be used for the erection. The erection plan shall include the necessary computations to indicate the magnitude of stress in the segments during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed. The erection plan shall contain provisions for all stages of construction, including temporary stoppages.

The PBUs may be used to support equipment prior to placement of the closure pour concrete only with written permission of the Engineer. The proposed use of the PBUs for support of equipment shall be detailed in the erection plan.

Submittal of the erection plan is for the Agency's information only, and shall in no way be construed as approval of the proposed method of erection. Unless otherwise directed by the Engineer, the Contractor shall follow the erection plan as submitted.

(c) Erection of Units. Erection of units shall not proceed until substructure concrete has been cured for the minimum length of time specified in the Plans or appropriate specifications. Units shall be installed to the correct line and grade as shown on the approved drawings and as indicated in the approved erection procedure. Prior to setting units and to avoid torsion stresses, bearing elevations within a given PBU shall be adjusted to match relative elevations used during the deck casting operations. After all the units are erected, they shall be inspected to ensure the correctness of their location.

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(d) Matching Elevation of Units During Erection. Adjacent units shall match elevation within 1/4 inch vertically (along longitudinal edges) and 1/4 inch vertically at the end of units.

(e) Filling and Sealing Longitudinal Joints. Prior to placement of closure pour concrete or grout material, the surface of the joint shall be free of any material, such as oil, grease, or dirt, which may prevent bonding of the sealing materials.

(f) Sealing of Lifting Holes. After the units are in their final locations, a bonding agent shall be applied and the lifting holes filled with a Mortar, Type IV. A removable form shall be provided at the bottom surface of the deck to retain the grout.

(g) Loading. Units may be loaded upon erection and before the joints are sealed only with written permission of the Engineer and in accordance with the approved erection procedure. Once the joints are sealed, no further loading or unloading of the units will be allowed until joint material has properly and finally cured and as approved by the Engineer.

(h) Final Repairs. After the installation work is complete, remaining concrete defects, holes for inserts, and lifting holes shall be repaired as indicated and approved by the Engineer.

(i) Grout. Grout shall be placed in accordance with the requirements of Subsection 540.11.

544.09 METHOD OF MEASUREMENT. The quantity of Prefabricated Bridge Unit Superstructure to be measured for payment will be the number of linear feet installed in the complete and accepted work. Measurement shall be the end to end length of the structural steel girder along centerline per unit.

544.10 BASIS OF PAYMENT. The accepted quantity of Prefabricated Bridge Unit Superstructure will be paid for at the Contract unit price per linear foot. Payment will be full compensation for detailing, fabricating, repairing, quality control testing, transporting, handling, and installing the materials specified, including concrete, reinforcing steel, structural steel, shear connectors, mechanical connectors, and shims; for designing and installing lifting devices and any other material contained within or attached to the members; for any grouting work required; for furnishing and implementing the erection plan; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
544.10 Prefabricated Bridge Unit Superstructure	Linear Foot

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SECTION 546 – PRE-EXCAVATION OF ABUTMENT PILES

546.01 DESCRIPTION. This work shall consist of drilling a hole to remove all subsurface material and backfilling in designated areas to provide suitable pile placement or driving conditions.

546.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Sand Borrow and Cushion 703.03

546.03 CONSTRUCTION REQUIREMENTS. The pre-excavation of abutment piles shall consist of augering, pre-boring, or some other means of excavation to produce an excavation to the depth and diameter specified in the Contract. The excavation shall be maintained to allow for backfilling with sand in accordance with the Contract. Temporary casing is considered an acceptable option.

Unless otherwise specified in the Plans, the entire pre-excavation shall be filled with sand and the temporary casing shall be removed prior to installing piles.

546.04 DEFINITIONS.

(a) Earth. In addition to the definition of earth in Subsection 101.02, cobbles, boulders, and densely packed gravel will be considered excavation of earth.

(b) Rock. All excavation of bedrock as determined by the Engineer.

546.05 METHOD OF MEASUREMENT. The quantities of Pre-Excavation of Abutment Piles, Earth and Pre-Excavation of Abutment Piles, Rock to be measured for payment will be the total number of linear feet of excavation to the depth specified in the Contract or as ordered by the Engineer, measured to the nearest linear foot.

(a) Earth. Where Structure Excavation and Pre-excavation of Abutment Piles, Earth occur jointly or separately at the same location, measurement for Pre-excavation of Abutment Piles, Earth will be made only below the lower limits of Structure Excavation.

(b) Rock. The quantity of Pre-excavation of Abutment Piles, Rock to be measured for payment will be below the top surface of bedrock as determined by the Engineer.

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546.06 BASIS OF PAYMENT. The accepted quantities of Pre-Excavation of Abutment Piles, Earth and Pre-Excavation of Abutment Piles, Rock will be paid for at the Contract unit price per linear foot. Payment will be full compensation for furnishing, transporting, storing, and installing the materials specified including the sand, for performing required excavation, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
546.10	Pre-Excavation of Abutment Piles, Earth	Linear Foot
546.20	Pre-Excavation of Abutment Piles, Rock	Linear Foot

SECTION 550 – THIS SECTION RESERVED

SECTION 555 – THIS SECTION RESERVED

SECTION 575 – THIS SECTION RESERVED

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SECTION 580 – STRUCTURAL CONCRETE REPAIR

580.01 DESCRIPTION. This work shall consist of the removal and disposal of delaminated and unsound concrete from an existing superstructure or substructure and its replacement with new Portland cement concrete or an approved patching material.

This section shall be used in conjunction with Section 501 or Section 541, whichever is applicable to other concrete items in the Contract. Where both specifications are used, Section 501 shall be used for this work. Anything not specifically addressed in this section relative to concrete shall be governed by Section 501 or Section 541, as applicable.

580.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Overhead and Vertical Concrete Repair Material.....780.02
Rapid Setting Concrete Repair Material.....780.03
Rapid Setting Concrete Repair Material with Coarse Aggregate.....780.04
Polymer Concrete Repair Material.....780.05

Coarse Aggregate for Concrete shall meet the requirements of Table 704.02A.

Concrete Repair Materials shall meet the requirements of Section 780.

High Performance Concrete shall meet the applicable requirements of Subsection 501.02 through Subsection 501.19 and Concrete (Class AA, Class A, and Class B) shall meet the applicable requirements of Subsection 541.02 through Subsection 541.19. Where further references in this specification are made to concrete, they shall mean that class or corresponding class of concrete described in the governing concrete specifications.

580.03 PROPORTIONING AND MIXING. All concrete repair materials shall be mixed with a mechanical mixer at the project site in accordance with the manufacturer's recommendations on the project packaging, one bag (unit) at a time. The product shall not be extended with sand or gravel, except for Rapid Setting Concrete Repair Material with Coarse Aggregate and Polymer Concrete Repair Material when mixed with approved aggregates in conformance with the manufacturer's recommendations.

At no time shall the recommended water content be exceeded, nor shall any mixture be re-tempered by adding water and/or remixing once the material has reached initial set.

Rapid Setting Concrete Repair Material with Coarse Aggregate shall be mixed with approved materials in the proportions designated by the manufacturer or by the Structural Concrete Engineer. When Rapid Setting Concrete Repair Material with Coarse Aggregate is used on a project, the Contractor shall submit three 4-inch diameter test cylinders to the Agency's Materials Section, Structural Concrete Unit for information for the first quantity of 25 bags (units) of material or less used on the project. Thereafter, three more test cylinders shall be submitted for each increment of 100 bags of material used on the project.

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580.04 SURFACE PREPARATION FOR REPAIRS, OVERLAYS, AND MEMBRANES. Surfaces to be repaired or overlaid shall be chipped back to sound concrete as directed by the Engineer using approved hand or mechanical methods.

When removing unsound portions of an existing structure in preparation for repair, the edges of all areas to be repaired shall be saw cut in straight lines to a minimum depth of 1 inch.

After complete removal of unsound concrete, the entire area to be patched or overlaid, and all exposed steel which will have concrete placed against or around it, including metal plate expansion joints, scuppers, finger plate expansion joints, reinforcing steel, etc., shall be abrasive blast-cleaned to remove contaminants and laitance a maximum of 24 hours prior to placing the new concrete. The area shall be vacuumed or flushed using high-pressure air or water to remove all loose particles, dust, and debris.

Air or water used for cleaning shall be free of oil and other contaminants. After blast-cleaning, once the concrete is wet, whether from flushing or rain, the concrete must be kept wet until the placing of concrete materials. If the concrete is allowed to dry out or the 24-hour time limit has lapsed, the entire area shall be blast-cleaned and vacuumed or flushed again.

Following concrete removal, additional surface preparation for the application of Overhead and Vertical Concrete Repair Material shall be as recommended on the product packaging by the manufacturer.

Where Rapid Setting Concrete Repair Material, Rapid Setting Concrete Repair Material with Coarse Aggregate, or Polymer Concrete Repair Material is to be used, concrete surfaces shall be thoroughly blast cleaned and prepared as recommended by the manufacturer.

Concrete bridge decks or other surfaces designated by the Engineer to be prepared for application of a waterproofing membrane shall be ground to a smooth uniform surface by either a hand-held grinder or a wheel mounted grinder unit specifically designed for the purpose. Ridges or areas of unevenness designated by the Engineer shall be ground so that no surface deviation greater than 1/16 inch remains.

580.05 FORMS. The forms shall be constructed in such a manner that the final concrete surface has the same architectural score marks and exterior face appearance as the original surface.

For additional requirements for forms see either Subsection 501.09 or Subsection 541.09.

580.06 PLACING CONCRETE. The Contractor shall comply with the requirements of Subsection 501.07 or Subsection 541.07 as well as Subsection 501.10 or Subsection 541.10 for this work.

In addition, the following is applicable to concrete repair:

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(a) Portland Cement Concrete. When Epoxy Bonding Compound is not specified on the Plans, the prepared concrete surface shall be flooded with water for at least one hour prior to fresh concrete placement, standing water shall be removed, and a neat cement paste shall be brushed into the surface. The cement shall (meeting the requirements of *AASHTO M 85,* Type II) and water shall be mixed to a thick latex paint consistency. The neat cement paste shall not be allowed to dry out before it is covered with fresh concrete.

(b) Concrete Repair Material. The moisture condition of the prepared concrete surface, the use of bonding agents and the placement of Overhead and Vertical Concrete Repair Material, Rapid Setting Concrete Repair Material, Rapid Setting Concrete Repair Material with Coarse Aggregate, or Polymer Concrete Repair Material shall be as recommended by the manufacturer of the product being placed.

(c) Alternate Methods of Repair. The Contractor may propose an alternate means of repairing vertical and overhead surfaces. The alternate may include, but is not limited to, the use of pneumatically-applied materials. Should the Contractor choose an alternate method of repair, the written approval of the Structures Engineer shall be obtained prior to beginning work utilizing the alternate method.

580.07 CURING CONCRETE. In addition to the requirements of Subsection 501.17 or Subsection 541.17, the following requirements shall apply to concrete repair:

A membrane-forming curing compound may be used to cure the repairs made with concrete, provided the patched areas are covered with white polyethylene sheeting after the curing compound is applied. White polyethylene sheeting shall conform to the requirements of Subsection 725.01(c). The type of curing compound shall be approved by the Engineer prior to its use. The curing period for patches made with concrete shall be seven days regardless of the curing method chosen.

Concrete patches may be cured in accordance with the requirements of Subsection 501.17(b) or Subsection 541.17(b), Parts (1), (2), (3), (5), and (7) only. If the method used does not produce the desired results, alternate curing procedures may be required by the Engineer. Evidence of improper cure could be a dry surface, a cracked or cracking surface, or a streaked or blotchy appearance of the surface.

Overlay concrete shall be cured in accordance with the requirements of Subsection 501.17(b) or Subsection 541.17(b), Parts (1), (2), (5), and (7) only.

Concrete repair materials shall be cured in accordance with the manufacturer's recommendations on the product packaging or specification sheet.

580.08 METHOD OF MEASUREMENT. The quantity to be measured for payment of Repair of Concrete Superstructure Surface, Class I or Class II will be the number of square yards of repaired concrete surfaces.

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Repair of Concrete Superstructure Surface, Class I, shall include the removal of concrete from the surface of existing concrete to a maximum depth as determined by the top of the top bars of the top mat of existing reinforcing steel.

Repair of Concrete Superstructure Surface, Class II, shall include removal of concrete from the surface of the existing concrete to a maximum depth as determined by the top of the top bars of the bottom mat of reinforcing steel. The minimum depth removed under this item shall be 3/4 of an inch (± 1/4 inch) below the bottom bars of the top mat of reinforcing steel.

The quantity to be measured for payment of Concrete Substructure Surfaces, Class I or Class II, will be the number of square yards of repaired substructure surfaces, whether they are flat, vertical, or overhead.

Repair of Concrete Substructure Surface, Class I shall include removal of concrete from the plane of the original concrete surface to a maximum depth as determined by the outside face of the first mat of reinforcing steel.

Repair of Concrete Substructure Surface, Class II shall include removal of concrete from the plane of the original concrete surface to a maximum depth of 6 inches measured from the plane of the original surface. The minimum depth removed under this item shall be 3/4 of an inch (± 1/4 inch) beyond the inside face of the first mat of reinforcing steel.

The quantity to be measured for payment of Repair of Concrete Superstructure Surface, Class III, will be the number of cubic yards of concrete removed. Repair of Concrete Superstructure Surface, Class III, shall include removal from the top of the existing concrete surface to the bottom of the concrete deck (i.e., full depth removal).

The quantity to be measured for payment of Repair of Concrete Substructure, Class III, will be the number of cubic yards of concrete removed. Repair of Concrete Substructure Surface, Class III, shall include removal from the face of the existing concrete surface to a depth greater than 6 inches.

The quantity to be measured for payment for Surface Preparation for Membrane will be the number of square feet of prepared surface. Payment will be made for surface preparation of existing surfaces, with no deductions made for areas of new patches.

The quantity to be measured for Rapid Setting Concrete Repair Material, Overhead and Vertical Concrete Repair Material, Rapid Setting Concrete Repair Material with Coarse Aggregate and Polymer Concrete Repair Material will be the number of cubic feet of material mixed for use, as approved by the Engineer. The volume will be computed on the basis of the quantity identified as being contained in the product packaging.

The quantity to be measured for payment of Concrete, Class AA Overlay will be the number of square yards of finished surface complete in place. The limits of removal shall be as specified for Repair of Concrete Superstructure Surface, Class II or Class III as determined by the Engineer.

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580.09 BASIS OF PAYMENT. The accepted quantities will be paid for at the Contract unit prices for the Pay Items specified, which price shall be full compensation for performing the work specified, including surface preparation as specified, satisfactory completion of curing, and the furnishing of all forms, materials, including joint filler, labor, tools, admixtures, equipment, and incidentals necessary to complete the work.

The cost of heating or cooling materials and protecting the concrete against cold weather and any additional cost for cement shall be included in the Contract unit price for the applicable concrete repair item in the Contract.

The unit price bid for Repair of Concrete Superstructure Surface, Class I, Repair of Concrete Superstructure Surface, Class II and Repair of Concrete Superstructure Surface, Class III will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA or an acceptable alternate as approved by the Engineer.

The unit price bid for Repair of Concrete Substructure Surface, Class I and Repair of Concrete Substructure Surface, Class II will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA or an acceptable alternate as approved by the Engineer, such as pneumatically applied concrete.

The unit price bid for Repair of Concrete Substructure Surface, Class III will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA, Class A, Class B, or an acceptable alternate as approved by the Engineer.

The accepted quantity of Surface Preparation for Membrane will be paid for at the Contract unit price per square foot, which price shall be full compensation for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Rapid Setting Concrete Repair Material, Overhead and Vertical Concrete Repair Material, Rapid Setting Concrete Repair Material with Coarse Aggregate, and Polymer Concrete Repair Material will be paid for at the Contract unit price bid per cubic foot, which price shall be full compensation for furnishing, transporting, storing, handling, and placing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The unit price bid for Concrete, Class AA Overlay will be full compensation for the removal and replacement of concrete. Replacement concrete shall be Concrete, Class AA.

Duplicate payment will not be made for preparation of concrete surfaces in any area. For example, if an area is originally prepared as Class I and the Engineer orders a change to the Class II depth, the area will be paid as Class II.

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Payment will be made under:

Pay Item	Pay Unit
580.10 Repair of Concrete Superstructure Surface, Class I	Square Yard
580.11 Repair of Concrete Superstructure Surface, Class II	Square Yard
580.12 Repair of Concrete Superstructure Surface, Class III	Cubic Yard
580.13 Repair of Concrete Substructure Surface, Class I	Square Yard
580.14 Repair of Concrete Substructure Surface, Class II	Square Yard
580.15 Repair of Concrete Substructure Surface, Class III	Cubic Yard
580.16 Surface Preparation for Membrane	Square Foot
580.17 Rapid Setting Concrete Repair Material	Cubic Foot
580.18 Overhead and Vertical Concrete Repair Material	Cubic Foot
580.19 Concrete, Class AA Overlay	Square Yard
580.20 Rapid Setting Concrete Repair Material with Coarse Aggregate	Cubic Foot
580.21 Polymer Concrete Repair Material	Cubic Yard

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DIVISION 600

INCIDENTAL CONSTRUCTION

SECTION 601 – CULVERTS AND STORM DRAINS

601.01 DESCRIPTION. This work shall consist of the construction, cleaning, and reconditioning or reconstruction of culverts and storm drains, hereinafter referred to as pipe.

601.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type II.....707.02
Rubber Gaskets.....707.11
Reinforced Concrete Pipe.....710.01
Reinforced Concrete Pipe End Sections.....710.02
Corrugated Polyethylene Pipe.....710.03
Corrugated Polypropylene Pipe.....710.07
Corrugated Steel Pipe, Pipe Arches, and Underdrains.....711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains.....711.02
Polymeric Coated Corrugated Steel Pipe and Pipe Arches.....711.03
Coal-Tar Based Coating.....711.05

All units in each pipe or pipe arch installation, including elbows, end sections, coupling bands, and reducer units, shall be of the same material, except that corrugated steel pipe end sections shall be used with polymeric coated corrugated steel pipe and pipe arches.

When either corrugated steel pipe or pipe arches with 5 inch × 1 inch corrugations are shown on the Plans, the Contractor may substitute pipe or pipe arches of the same thickness with 3 inch × 1 inch corrugations at no additional compensation.

601.03 GENERAL. Care shall be exercised when unloading pipe from delivery trucks and moving pipe to its final position. If the Engineer rejects damaged pipe, new pipe shall be furnished by the Contractor at no additional cost to the Agency.

Unless otherwise directed by the Engineer, the Contractor shall provide for the temporary diversion of water to permit the installation of the pipe in a reasonably dry trench.

The location of all pipe installations shall be approved by the Engineer.

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Where existing pipe is to be retained or re-laid and it becomes damaged due to the fault of the Contractor, it shall be replaced with new pipe at the Contractor's expense.

Aluminum, aluminized, or aluminum-zinc alloy coated pipe that is to be in contact with concrete or mortar shall have the contact surfaces thoroughly coated with an approved barrier coating recommended by the pipe manufacturer or approved by the Agency's Materials Section. Such coating shall be dry before installation.

Where the protective coating has been removed from the metal, either by cutting, burning, welding, placing, or any other means, it shall be repaired by thoroughly cleaning with a wire brush and treating the damaged areas as follows:

(a) In accordance with *AASHTO M 36*

(b) In accordance with *AASHTO M 245* for damaged polymeric coating

601.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe.

The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, unsuitable foundation material encountered below the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures, or other specified or approved material.

Ledge rock, rocky or gravelly soil, hard pan, or other unyielding foundation material encountered at the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures to a width equal to the inside diameter of the pipe plus 24 inches and to a minimum depth of 12 inches below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

601.05 PLACEMENT. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

Placement shall begin at the outlet end. The bottom of the pipe shall be in contact with the bedding throughout its full length. Bell or grooved ends of rigid pipes and the outside circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of riveted pipe shall be at the sides.

The handling holes in concrete pipes shall be filled with a precast plug, sealed, and covered with mastic or mortar.

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601.06 JOINING PIPE.

(a) Concrete Pipe. Concrete pipe shall be of bell and spigot or tongue and groove design, or as specified. Pipe sections shall be joined so that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be made with Portland cement mortar, Portland cement grout, rubber gaskets, or any one type as specified and approved by the Engineer. Joints in concrete pipe should be thoroughly wetted before mortar or grout is applied.

Mortar joints shall be made with an excess of mortar to form a bead around the outside of the pipe and finished smooth on the inside. For grouted joints, molds or runners shall be used to retain the poured grout. Rubber ring gaskets shall be installed so as to form a flexible, watertight seal.

When Portland cement mixtures are used, the completed joints shall be protected against rapid drying by suitable curing materials and protected from freezing until adequate set and strength have been reached, as determined by the Engineer.

The first three sections, at ends of culverts that are not restrained by drop inlets or catch basins, shall be connected at the springline on each side of the pipe to restrain movement of the sections. If an end section is used, it shall be one of the three sections to be connected.

The connecting devices shall be at least 12 feet in length when used with 7-1/2 foot minimum length sections and at least 10 feet in length when used with 6 foot minimum length sections. Each device shall be securely anchored to the pipe, with minimum slack in the device and the joints. The anchoring points shall be a minimum of 18 inches from the end of the pipe sections and the flared end sections. Each end of the device shall be anchored with a 1-inch bolt with a nut and washer, or its equivalent, through the section wall.

Each device shall be a steel strap with an effective cross-sectional area of 0.23 square inches for all pipe 48 inches in diameter or smaller. For pipe larger than 48 inches in diameter, the required steel area for restraining devices shall be as shown on the Plans.

Alternate designs of restraining devices and anchoring hardware will be considered for approval if they provide equivalent restraining properties and durability.

Restraining devices shall be placed on the outside of the pipe. Any bending of the device for proper installation shall be done by the cold bending method. Holes in the pipe and end sections, required for the anchor bolts, may be drilled in the field.

(b) Metal Pipe. Metal pipes shall be firmly joined by coupling bands.

Pipes with an effective diameter greater than 36 inches shall be joined by coupling bands that fully engage the second full corrugation from the end of each pipe.

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Pipes on steep grades (greater than 14%) will be joined either by 24 inch wide coupling bands or by bands additionally equipped with silo rods or cables for positive attachment.

In all cases, ends of pipes joined by coupling bands shall be as close together as the corrugations will allow.

(c) Corrugated Polyethylene Pipe. Corrugated polyethylene pipe shall be joined by a system designed and approved by the pipe manufacturer. Couplings and fittings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.

(d) Corrugated Polypropylene Pipe. Corrugated polypropylene pipe shall be joined by a system designed and approved by the pipe manufacturer. Couplings and fittings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.

601.07 BACKFILLING. Installed pipe will be inspected and approved before any backfill is placed. Any pipe found to be damaged or out of alignment shall be removed and replaced or re-laid without additional compensation.

Unless otherwise shown on the Plans or directed by the Engineer, the backfill material shall be fine selected compactable soil from excavation when available, or Granular Backfill for Structures. This material shall be placed to a height of 24 inches over the pipe. No stones more than 3 inches in diameter shall be placed in contact with the pipe. Rock fill or boulders shall not be placed within 24 inches of the outside of the pipe.

The backfill material shall be placed in 6-inch-thick layers and compacted in accordance with Subsection 203.11(d) using a mechanical tamper. Care shall be exercised to thoroughly compact the material under the haunches of the pipe. The backfill shall be placed evenly on both sides of the pipe for its full length.

In embankment sections the fill shall be compacted for a width on each side of the pipe equal to at least twice the horizontal inside diameter of the pipe or 12 feet, whichever is less. Fill at the sides of the pipe may be compacted by operating compaction equipment longitudinally parallel with the pipe, provided care is taken to avoid displacement or injury to the pipe.

All pipe shall be protected by a cover of fill 4 feet thick before heavy equipment or traffic is permitted to cross during construction. Whenever this cover extends above the subgrade, the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the details shown on the Plans or as directed by the Engineer. Any deviation from this practice shall have prior approval by the Engineer. However, compliance with the 4-foot protective cover requirement shall not relieve the Contractor of any responsibility concerning damage to the pipe.

601.08 CLEANING OF CULVERTS. Pipe culverts at the locations shown on the Plans, or as directed by the Engineer, shall have the silt, debris, and other material removed and disposed of by methods that do not damage the pipe.

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With the approval of the Engineer, all or part of a pipe designated to be cleaned in place may be removed, cleaned, and re-laid in accordance with these specifications. In these cases, the Contractor shall furnish all material required to replace damaged pipes and joints, perform all excavation and backfill, and re-lay the pipe, all at the Contract unit price for Cleaning Culvert Pipe, In-Place.

However, if the Engineer determines that the pipe must be replaced, through no fault of the Contractor, replacement will be paid for under the appropriate Contract items.

601.09 METHOD OF MEASUREMENT. The quantities of culverts and storm drains to be measured for payment will be the number of linear feet used in the complete and accepted work, as shown on the Plans or ordered by the Engineer. No allowance will be made for "growth" in length at joints when this increase exceeds the ordered length.

When it is necessary to cut pipe in the field, the quantity of pipe to be measured for payment will be the length necessary, rounded up to the next whole foot increment.

The quantity of Re-Laying Pipe Culverts to be measured for payment will be the number of linear feet of re-laid pipe in the complete and accepted work.

The quantities of pipe elbows and end sections to be measured for payment will be the number of each size and type of unit installed in the complete and accepted work.

The quantity of Cleaning Culvert Pipe, In-Place to be measured for payment will be the total length of pipe for each pipe acceptably cleaned, as determined along the flow line of the pipe. The cost to clean material from pipes as the result of on-project construction activities shall be at the Contractor's expense.

601.10 BASIS OF PAYMENT. The accepted quantities of culverts and storm drains of the type and size specified will be paid for at the respective Contract unit price per linear foot.

The accepted quantity of Re-Laying Pipe Culverts will be paid for at the Contract unit price per linear foot.

The accepted quantities of pipe elbows and end sections of the type and size specified will be paid for at the respective Contract unit price each.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified to include bituminous or other coating, coupling bands, joint material, cutting when necessary, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill operations and the disposal of excavated material (excess or unsuitable for backfill), will be paid for separately and in accordance with Section 204.

Anchor bolts, required in the construction of headwalls, will not be paid for separately but will be considered incidental to the Contract unit price for the pipe on which they are required.

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The accepted quantity of Cleaning Culvert Pipe, In-Place will be paid for at the Contract unit price per linear foot for the specified size of pipe. Payment will be full compensation for cleaning the pipe; for excavating, backfilling, and re-laying the pipe, if necessary; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
601.0000 to 601.0199	CSP	Linear Foot
601.0200 to 601.0399	CAAP	Linear Foot
601.0400 to 601.0599	PCCSP	Linear Foot
601.0600 to 601.0799	PCCSP(PI)	Linear Foot
601.0800 to 601.0899	RCP	Linear Foot
601.0900 to 601.0999	CPEP	Linear Foot
601.2000 to 601.2199	CSP(SL)	Linear Foot
601.2200 to 601.2399	CAAP(SL)	Linear Foot
601.2400 to 601.2599	PCCSP(SL)	Linear Foot
601.2600 to 601.2799	CPEP(SL)	Linear Foot
601.2800 to 601.2999	CPPP(SL)	Linear Foot
601.3000 to 601.3199	CSPA	Linear Foot
601.3200 to 601.3399	CAAPA	Linear Foot
601.3400 to 601.3599	PCCSPA	Linear Foot
601.3600 to 601.3799	PCCSPA(PI)	Linear Foot
601.4000 to 601.4199	CSPA(SL)	Linear Foot
601.4200 to 601.4399	CAAPA(SL)	Linear Foot
601.4400 to 601.4599	PCCSPA(SL)	Linear Foot
601.5000 to 601.5199	CSP Elbow	Each
601.5200 to 601.5399	CAAP Elbow	Each
601.5400 to 601.5599	PCCSP Elbow	Each
601.5600 to 601.5799	PCCSP Elbow (PI)	Each
601.5800 to 601.5899	CPEP Elbow	Each
601.5900 to 601.5999	CPPP Elbow	Each
601.6000 to 601.6199	CSPES	Each
601.6200 to 601.6399	CAAPES	Each
601.6800 to 601.6899	RCPES	Each
601.7000 to 601.7099	CPEPES	Each
601.7100 to 601.7199	CPPPES	Each
601.8000 to 601.8199	CSPAES	Each
601.8200 to 601.8399	CAAPAES	Each
601.99	Re-Laying Pipe Culverts	Linear Foot
601.995	Cleaning Culv. Pipe, In-Place [0 to 24 In., Incl.]	Linear Foot
601.996	Cleaning Culv. Pipe, In-Place [Greater than 24 In.]	Linear Foot

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SECTION 602 – MASONRY

602.01 DESCRIPTION. This work shall consist of furnishing materials and constructing walls, and other masonry of the types and sizes specified, or rebuilding, repairing, or repointing of existing masonry.

602.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Stone for Masonry.....706.01
Stone for Masonry Facing.....706.02
Mortar, Type II.....707.02
Mortar, Type IV.....707.03
Bar Reinforcement.....713.01

Materials for Rebuilt Stone Masonry and Repairing Stone Masonry shall be approved by the Engineer prior to use. New stone, as required, shall match as closely as practical the existing stone masonry color, texture, and size. If required to match the existing stone masonry, chemical treatment processes to aid in providing stone of similar color shall be investigated by the Contractor.

Concrete for headwalls shall meet the requirements of Section 541 for Concrete, Class B.

Dowels shall be in accordance with the requirements of Subsection 713.01(a), unless otherwise specified on the Plans.

Backfill material shall meet the requirements of Section 204 for Granular Backfill for Structures.

602.03 MIXING OF MORTAR. The fine aggregate and cement shall be mixed in a clean, tight container until a mixture of uniform color is produced, after which clean water shall be added in such quantity as to form a mortar with the consistency of stiff paste. If desired, the Contractor will be permitted to use a batch mixer of an approved size and type. Mortar which has been mixed for more than 45 minutes shall not be used, and re-tempering of mortar will not be permitted.

602.04 PLACING OF STONE. The placing and shaping of stone shall be the same for dry or cement masonry, however, dry masonry shall be placed without the use of mortar.

The bed shall be clean and well moistened just prior to the placement of the stone. The stone shall be thoroughly saturated with water, well bedded into the mortar and carefully settled in place before the mortar has set. No spalls will be permitted in the bed. Joints and beds shall not average over 1 inch in thickness.

The masonry shall be laid in full mortar beds to the lines shown on the Plans and in approximately level courses. The bottom or foundation courses shall be composed of large selected stones.

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All courses shall be laid with bearing beds parallel to the natural bed of the materials. The larger stone shall be used near the bottom and the smaller stone near the top of the masonry, the latter corresponding, as nearly as possible, to the minimum thickness of the masonry at its top.

The construction of stone masonry will not be permitted in freezing weather or when frost is in the stone, except by written permission of the Engineer and subject to conditions as the Engineer may require.

In walls where the thickness is over 4 feet, the stones used as headers for holding in the heart of the wall shall extend not less than 4 feet into the core and shall occupy not less than 20% of the front and back surface area of the wall.

In walls where the thickness is 4 feet or less, the stones used as headers shall extend entirely through the wall.

The break in joints of the stone shall be at least 6 inches on the exposed faces of the wall and the backing stones shall be laid so that the joints are broken. The rear face of the wall shall present an approximately plane surface.

The stone shall be roughly squared on joints, beds, and faces, and shall be pitched to line, at all angles and ends of walls. All shaping or dressing of stones shall be done before the stone is laid in the wall, and no dressing or hammering that would tend to loosen the stones already set will be permitted after their placement. Any stone around which the bond has become broken shall be removed, the mortar shall be thoroughly cleaned from the bed and joints, and the stone shall be reset in fresh mortar.

602.05 WEEP HOLES. Weep holes shall be constructed as shown on the Plans or as ordered by the Engineer.

602.06 REBUILT STONE MASONRY AND REPAIRING STONE MASONRY.

(a) General.

(1) Rebuilt Stone Masonry. The stone masonry of the existing substructure and wingwalls shall be mapped, removed, and rebuilt as indicated and specified in the Contract.

Following backfill excavation, the existing stones, tree stumps, roots, and other foreign matter shall be removed in the areas shown on the Plans or where directed by the Engineer. The existing stones shall be reset in their original locations, removing any gaps that occurred due to previous damage to the walls. Rebuilt Stone Masonry shall match securely into adjacent masonry.

(2) Repairing Stone Masonry. Earth, minor vegetation, and other foreign matter shall be removed and cavities in the stone substructure and wingwalls filled as indicated and specified in the Contract.

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(b) Construction Requirements.

(1) Rebuilt Stone Masonry. The work shall be performed by a stone mason who is highly knowledgeable and experienced in the construction of dry stone masonry walls and fascia. The Contractor's stone mason performing the work must demonstrate at least five years of experience in the construction of dry stone masonry walls. Documentation of experience, including a list of previous projects and references, shall be submitted to the Engineer prior to commencement of the work.

The existing stone masonry in the areas of reconstruction shall be mapped out and documented. Each stone size and location shall be noted. The Contractor, prior to stone removal, shall submit documentation to the Engineer for approval.

Special care and precautions shall be taken during removal and storage of the existing stone masonry to ensure that the stone is not damaged.

All stones shall be carefully removed in the areas shown on the Plans. The Contractor shall shore the remaining portions of the walls to ensure that they do not shift during construction.

The existing stones shall be replaced in their original locations, removing any gaps that occurred due to previous damage to the walls. All joints in the reconstructed stone walls shall be no larger than 3/4 inch between stones. Any existing stones that are not suitable for replacement or missing shall be replaced by the Contractor with stones of similar size and appearance.

(2) Repairing Stone Masonry.

a. Examination. The Contractor and Engineer shall jointly examine the abutments and wingwalls to field verify the extent of the work.

All work shall be performed by stonemasons with a minimum of three years of experience with similar work.

(b) Repair. Gaps between horizontal faces of existing stones less than 1 inch shall not be repaired. The size of these gaps shall equal the approximate diameter of a 7/8-inch steel dowel.

Gaps between horizontal faces of existing stones between 1 inch and 6 inches shall have small stone blocks added, with the depth of the blocks as large as possible for good bearing. The minimum width of said blocks shall be 4 inches.

Gaps between horizontal faces of existing stones greater than 6 inches shall have crushed gravel and stone blocks added. The crushed gravel shall be placed at the back of the stone and compacted in place up to 12 inches of the exposed wall face. The crushed gravel shall be compacted by tamping rods or other methods acceptable to the Engineer. Stone blocks shall then be added to achieve a tight fit. New stone blocks shall not extend beyond the face of the stone wall.

602.07 POINTING AND REPOINTING. All joints shall be filled with mortar, well driven in, and finished with an approved pointing tool for a distance of 1/2 inch back from the surface of the stone.

When joints are in old masonry, they shall be cleaned of all loose mortar and dirt for a depth in from the face of the wall of at least twice the width of the joint and moistened.

All mortar shall be cleaned from the face of the stones after the pointing is completed and the work has cured for a period of three days.

602.08 DOWELS AND TIES. Where required, bonding of various portions of the work shall be accomplished with dowels and ties of the shapes and dimensions shown on the Plans or approved by the Engineer. They shall be placed, as shown or required, in the stone so as to clear the bed of the succeeding course.

Dowel holes shall be drilled into each stone, to match dowels already set, before the stone is placed. No drilled holes will be permitted in the exposed top surfaces.

602.09 BACKFILLING. Spaces excavated for masonry structures, but not occupied by these structures, shall be backfilled. The backfill shall be placed in horizontal layers of not more than 6 inches in depth. Each layer shall be thoroughly compacted by means of air or mechanical tampers in a manner approved by the Engineer.

602.10 METHOD OF MEASUREMENT. The quantities of Cement Masonry and Dry Masonry to be measured for payment will be the number of cubic yards used in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or ordered by the Engineer.

The quantities of Stone Masonry Facing and Repointing Masonry to be measured for payment will be the number of square yards performed in the complete and accepted work, measured as follows:

(a) The quantity of Stone Masonry Facing will be the height of the front face plus the width of the capstones times the length of the stone masonry facing. No deductions will be made for weep holes, drain pipes, or other openings with an area of less than 2 square feet.

(b) The quantity of Repointing Masonry will be the total surface area of the masonry repointed.

The quantity of Rebuilt Stone Masonry to be measured for payment will be the number of cubic yards of stone masonry rebuilt in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or as determined by the Engineer.

The quantity of Repairing Stone Masonry to be measured for payment will be the number of square yards of stone masonry repaired in the complete and accepted work, measured as the total surface area of the repaired masonry.

602.11 BASIS OF PAYMENT. The accepted quantities of Cement Masonry, Dry Masonry, Stone Masonry Facing, and Repointing Masonry will be paid for at the Contract unit price per cubic yard or square yard for the item specified. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The dowels and ties required for constructing stone masonry facing will not be paid for separately but will be considered incidental to the Contract unit price per square yard for Stone Masonry Facing.

Excavation will be paid for as Trench Excavation, unless otherwise shown on the Plans.

The accepted quantity of Rebuilt Stone Masonry will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for mapping, documenting, and removing existing stone masonry; furnishing new stone as needed; furnishing, transporting, handling, and placing the materials specified; backfilling when not paid under a separate Contract item; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation adjacent to Rebuilt Stone Masonry and disposal of excess or unsuitable excavated material will be paid for at the Contract unit price per cubic yard for Structure Excavation. Excavation shall be backfilled with material acceptable to the Engineer. When Granular Backfill for Structures is required for backfill material, it will be paid for at the Contract unit price per cubic yard.

The accepted quantity of Repairing Stone Masonry will be paid for at the Contract unit price per square yard. Payment will be full compensation for removing material specified from the face of stone masonry; filling cavities; furnishing, transporting, handling, and placing the materials specified; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
602.15 Cement Masonry	Cubic Yard
602.20 Dry Masonry	Cubic Yard
602.25 Stone Masonry Facing	Square Yard
602.30 Repointing Masonry	Square Yard
602.35 Rebuilt Stone Masonry	Cubic Yard
602.40 Repairing Stone Masonry	Square Yard

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SECTION 604 – DROP INLETS, CATCH BASINS, AND MANHOLES

604.01 DESCRIPTION. This work shall consist of the construction, rehabilitation, adjustment, or decommissioning of drop inlets, catch basins, and manholes; and the furnishing and placing of cast iron or precast concrete covers.

604.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Granular Backfill for Structures.....704.08
Clay or Shale Sewer Brick.....705.01(c)
Concrete Masonry Blocks.....705.02
Precast Drop Inlets, Catch Basins, and Manholes 705.04
Mortar, Type II.....707.02
Mortar, Type IV 707.03
Reinforced Concrete Pipe 710.01
Bar Reinforcement.....713.01
Welded Wire Reinforcement 713.05
Structural Steel.....714.02
Gray Iron Castings .....715.01(b)
Ductile Iron Castings .....715.01(c)

Unless otherwise specified, cast-in-place concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Controlled Density (Flowable) Fill shall conform to the requirements of Section 541.

Pipe stubs for precast reinforced concrete curb drop inlets shall meet the requirements of Section 601.

The term "cast iron," as used in these specifications, or in various Contract items, when used in conjunction with covers and frames, shall be understood to mean "gray iron castings or ductile iron castings." Covers and frames shall be gray iron castings or ductile iron castings.

Steps or ladder rungs in drop inlets, catch basins, or manholes shall be plastic, complying with all applicable OSHA dimensional and structural requirements. Unless otherwise shown on the Plans, the rungs shall be cast into the fresh concrete, except that for precast units, the rungs may be grouted into preformed voids with a non-shrink grout approved by the Engineer after the concrete has cured.

604.03 GENERAL CONSTRUCTION REQUIREMENTS. The excavation shall be to the depth shown on the Plans or ordered by the Engineer, and carefully shaped and graded.

The bases for drop inlets, catch basins, and manholes may be either precast or cast-in-place concrete.

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For construction of drop inlets, catch basins, or manholes, the bricks used on top of the concrete to adjust the top to the correct elevation shall meet the requirements of Subsection 705.01(c).

Unless directed otherwise by the Engineer, when adjusting the elevation of the tops of existing drop inlets, catch basins, sewer manholes, or manholes, the Contractor shall remove all existing bricks and replace them with new bricks meeting the requirements of Subsection 705.01(c) as part of the work and costs included in the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes, or the Contract item Changing Elevation of Sewer Manholes.

Channels, inverts, and floor areas for sewer manholes shall be constructed of brick and mortar or Class C concrete conforming to Section 541. Inverts shall have the exact shape of the sewer to which they are connected and any change in size or direction shall be gradual and even. All construction of sewer manholes must be carried out to ensure watertight work. Any leaks in manholes shall be repaired to the satisfaction of the Engineer, or the entire structure shall be removed and rebuilt. Leakage testing shall be performed in accordance with Subsection 628.08.

Prior to rehabilitating or changing the elevation of any drop inlet, catch basin, or manhole, the Contractor shall completely clean out the interior of the unit, including cleaning at least 12 inches but not more than 24 inches into any openings in the walls for inspection to determine the extent of the work that will be required.

Except for components cast using the dry cast process, precast concrete components shall not have the forms removed until a minimum compressive strength of 2,000 psi has been achieved. Precast components shall not be moved until two hours after they have been cast and until a minimum compressive strength of 2,000 psi has been achieved.

Reinforced precast sections shall not be shipped from the manufacturing facility until the eighth calendar day from the date of manufacture, except when the supplier provides test results demonstrating that the design strength has been achieved.

604.04 CONSTRUCTION OF DROP INLETS, CATCH BASINS, AND MANHOLES.

(a) Concrete Drop Inlet, Catch Basin, or Manhole. The concrete walls shall be constructed on the approved base to the lines, grades, and dimensions shown on the Plans or directed by the Engineer.

The required courses of brick shall be placed on top of the concrete to the elevation shown on the Plans or directed by the Engineer. After the bricks are laid, the joints on the inside of the brick masonry shall be neatly pointed.

The top section may be precast or cast-in-place.

The cast iron frame shall be set in the concrete tops as shown on the Plans. When tops are precast, they shall be placed in a full mortar bed. The grate or cover shall be properly placed in the frame.

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(b) Precast Reinforced Drop Inlet, Catch Basin, or Manhole. The precast reinforced concrete risers shall be set reasonably close to line and grade on the previously placed concrete base. The top section shall be capped with courses of mortared brick.

The cast iron frame shall be placed in a full mortar bed on the brick masonry and the cast iron cover or grate shall be placed on top of the frame.

(c) Precast Reinforced Concrete Pipe Drop Inlet. The precast reinforced concrete pipe sections shall be set on a concrete base as shown on the Plans or as directed by the Engineer.

A precast concrete cover or a cast iron grate shall be placed as shown on the Plans.

(d) Precast Reinforced Concrete Curb Drop Inlet. The precast reinforced concrete curb drop inlet shall be set to the line and grade as shown on the Plans or as directed by the Engineer.

The brick masonry, concrete top, and grate shall conform to the requirements of Subsection 604.04(a).

(e) Changing Elevation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered or adjusted in elevation of the existing top shall be reconstructed to the required grade using the existing grates, frames, covers, or tops as specified. If the existing grates, frames, covers, and/or tops are not suitable for reuse, this Contract item shall not be used.

Should any grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor's expense.

The existing structure shall be dismantled sufficiently to allow elevation adjustment as shown on the Plans or as directed by the Engineer. The existing grates, frames, covers, or tops to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor.

Granite or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board required shall meet the requirements of Subsection 729.06. Bituminous fillet shall conform to the applicable requirements of Section 406, for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete curb and granite curb shall conform to the applicable requirements of Section 616. The cost of this curb replacement will not be paid for directly, but will be considered incidental to Changing Elevation of Drop Inlets, Catch Basins, or Manholes.

Where the unit is to be raised and the change in elevation is less than 2 inches, concentric structural steel rings of nominally 1/2 inch thick material properly welded to the frame may be used.

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The Contract unit price bid for Changing Elevation of Drop Inlets, Catch Basins, or Manholes shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks to provide room to accomplish the work, and shall also include all costs of backfilling around the elevation reset unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

If excavating through paved surfaces is required, the edges of the excavated area shall be saw cut to a minimum depth of 1-1/2 inches.

(f) Cast Iron Cover with Frame. The covers with frames shall be properly installed at the locations shown on the Plans or directed by the Engineer.

Covers for sanitary sewer manholes shall have the word "SEWER" cast into the top surface. Covers for storm sewer manholes shall have the word "STORM" cast into the top surface.

(g) Grates. The grates shall be properly installed at the locations shown on the Plans or directed by the Engineer.

(h) Sanitary Sewer Manhole. Sanitary sewer manholes shall be precast sewer manholes of the type and diameter shown on the Plans and shall meet the requirements of Subsection 705.04 except that all barrel joints shall contain an O-ring seal. Steps shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other watertight sealant meeting the approval of the sewer line owner. All joints between pipes and the manhole shall be made using an approved watertight boot.

(i) Changing Elevations of Sewer Manholes. Existing sewer manholes that are to be altered or adjusted shall be reconstructed in accordance with Subsection 604.04(e), except that all exterior surfaces disturbed by the necessary reconstruction shall be coated or recoated with a watertight sealant approved by the sewer line owner. Necessary steps, pipe joints, and barrel joints shall conform to the requirements of Subsection 604.04(h).

The Contractor may be required to provide a specific step to match the existing steps as part of the work and costs included in this Contract item.

(j) Rehabilitation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered, adjusted, or reconstructed shall be constructed to the required grade using existing grates, frames, covers, or tops, if useable, as specified.

This work shall belong to one of three classes. Class I shall include all work down to a depth of 3 feet. Class II shall include all work greater than 3 feet in depth down to a depth of 6 feet. Class III shall include all work greater than 6 feet in depth.

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If the existing grates, frames, covers, or tops are suitable for reuse, but the remainder of the top requires replacement, the Contractor shall carefully remove the frame from the existing top and cast a new top utilizing the existing grate, frame, or cover. If the existing grates, frames, covers, or tops are unsuitable for reuse, new ones shall be furnished as required. Unless otherwise specified, the replacement shall match the existing grate, frame, or cover in size and design.

Should any useable, existing grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor's expense.

The existing structure shall be dismantled sufficiently to allow rehabilitation as shown on the Plans for completed drop inlets, catch basins, and manholes. Any existing grate, frame, cover, or top to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, concrete, reinforcement, steps, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor as directed by the Engineer.

If the rehabilitation proceeds to a point where the culverts or other pipes entering and/or exiting the unit are within the area of rehabilitation and/or replacement, the necessary pipe stubs and collars, to connect the existing piping to the rehabilitated unit, shall be provided and installed by the Contractor. If the Contract includes a Contract item for the pipe, the pipe stubs will be paid for under the appropriate Section 601 or Section 605 Contract item in the Contract. If the Contract does not include a Contract item for the pipe, the pipe stubs and collar will not be paid for directly, but will be considered incidental to Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III, as appropriate.

Granite, bituminous, or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board shall meet the requirements of Subsection 616.09. Bituminous fillet shall conform to the applicable requirements of Section 406 for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete, bituminous, and granite curb shall conform to the applicable requirements of Section 616. The costs of this curb replacement will not be paid for directly, but will be considered incidental to Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I; Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II; or Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III, as appropriate.

Where the unit is to be raised and the change in elevation is less than 2 inches, concentric structural steel rings of nominally 1/2 inch thick material properly welded to the frame may be used.

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The Contract unit price bid for Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks, to provide room to accomplish the work, and shall also include all costs of backfilling around the rehabilitated unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

Unless otherwise directed by the Engineer, the Contractor shall saw all pavements to a minimum depth of 1-1/2 inches.

(k) Rehabilitation of Sewer Manholes. Rehabilitation of sewer manholes shall consist of removing the existing top with cover, with or without frame, and rehabilitation of the existing unit to a safe and useful structure, satisfactory to the Engineer. If necessary, this Contract item shall include the complete reconstruction of the sewer manhole to current standards.

This work shall consist of replacing broken or deteriorated bricks, mortar, concrete, reinforcement, frames, and covers with new materials. New barrel sections shall be precast of the type and diameter existing or as shown on the Plans and shall meet all requirements of Subsection 705.04 except that all barrel joints shall contain an O-ring.

Steps, if required, shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other water-tight sealant meeting the approval of the sewer line owner. All joints between pipes and the manholes shall be made using an approved watertight boot.

604.05 CURING AND PROTECTION. After the masonry work is completed, it shall be kept moist and protected from the elements in a satisfactory manner for a period of at least 48 hours. Concrete shall be cured in accordance with Subsection 541.17.

Precast concrete shall be cured using membrane curing compound. The curing compound shall be applied to the concrete surface after finishing, as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. When the curing compound cannot be applied as specified herein, the manufacturer shall instead immediately begin wet curing the unit until curing compound can be applied. When this method is used in conjunction with the dry-cast process, the curing room shall be kept at 100% humidity until a minimum compressive strength of 2,000 psi has been obtained.

When the forms are removed prior to seven days, the exposed concrete surfaces shall be wet with water within one-half hour of form removal and shall be kept wet until the curing compound is applied. Before application, the concrete shall be allowed to reach a uniformly damp appearance with no free water on the surface, and then the compound shall be applied immediately.

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Precast concrete drainage components shall not be subjected to freezing temperatures prior to attaining the specified 28-day compressive strength. Components which are exposed to freezing before reaching the required 28-day compressive strength shall be rejected without further cause. Any additional testing on the rejected components as determined by the Engineer to gain acceptance will be at the expense of the manufacturer.

604.06 BACKFILLING. Backfilling shall not begin until the end of the curing period. Backfill material shall be approved by the Engineer and placed in layers not exceeding 6 inches in depth. Each layer shall be thoroughly tamped using mechanical tampers. Special care shall be taken to ensure adequate compaction around the inlet and outlet pipes.

604.07 DECOMMISSION DROP INLETS. Drop inlets shall be decommissioned as detailed and at the locations shown on the Plans. Decommissioning shall include saw-cutting existing pavement as necessary, excavating to the required depth to remove the cover, removal and disposal of covers and grates, filling the drop inlet with Controlled Density (Flowable) Fill and backfilling as necessary.

Pavement shall be saw-cut to minimize damage to the adjacent pavement and shall be kept to the minimum required to decommission the drop inlet. Inlets and outlets of culverts within the drop inlets to be decommissioned shall be covered in such a manner to prevent the Controlled Density (Flowable) Fill from entering the culverts.

Controlled Density (Flowable) Fill shall completely fill all voids within the drop inlet. The drop inlet shall be backfilled with Granular Backfill for Structures in accordance with Section 204.

604.08 CAP DROP INLET. Drop inlets shall be capped as detailed and at the locations shown on the Plans. Capping shall include saw-cutting existing pavement as necessary, excavating to the required depth to remove the top portions of the drop inlet, placing a steel plate and backfilling.

Pavement shall be saw-cut to minimize damage to the adjacent pavement and shall be kept to the minimum required to cap the drop inlet. The steel plate shall be securely placed to the satisfaction of the Engineer and shall be in accordance with Subsection 714.02. The drop inlet shall be backfilled with Granular Backfill for Structures and in accordance with Section 204.

604.09 METHOD OF MEASUREMENT. The quantities of new structures to be measured for payment will be the number of units of the respective types used in the complete and accepted work. Cast Iron Grates or Cast Iron Cover with Frames, and Cast Iron Grates, when used and not included in a specific unit, will be measured as the number of each type specified.

The quantity of Changing Elevation or Rehabilitating of Drop Inlets, Catch Basins, or Manholes, Decommission Drop Inlet, or Cap Drop Inlet to be measured for payment will be the number of units modified, decommissioned, or capped in the complete and accepted work.

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604.10 BASIS OF PAYMENT. The accepted quantities of new Drop Inlets, Catch Basins, or Manholes will be paid at the Contract unit price per each for each of the specified types. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including concrete, concrete risers, top sections, reinforcing steel, steps, mortar, brick, frames, grates, covers, base sections, coatings, pipe stubs, weep holes, underdrain ends, curb board, and bituminous fillets, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes will be paid for at the Contract unit price each for the specified unit or class. Payment will be full compensation for all necessary cleaning of the interior of the unit to determine the extent of the work; for excavating, cutting of pavement, and backfilling; for removing deteriorated materials and designated materials; for furnishing all materials, including backfill material, concrete, concrete risers, top sections, reinforcing steel, steps, concrete block, brick, mortar, frames, grates, covers, coatings, pipe stubs, weep holes and underdrain ends required for reconstructing the unit as shown on the Plans or directed by the Engineer; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Decommission Drop Inlet and Cap Drop Inlet will be paid for at the Contract unit price for each. Payment will be full compensation for saw-cutting the existing shoulder surfaces; performing any required excavation; protecting the remaining portions of the drop inlet and drainage components; covering inlets and outlets of existing culverts; furnishing and placing steel plates; furnishing and placing Controlled Density (Flowable) Fill; backfilling; and for furnishing all labor, tools equipment, and incidentals necessary to complete the work.

Excavation shall be paid for in accordance with Section 204.

Excavation associated with the rehabilitation or changing elevation of existing drop inlets, catch basins, and manholes will not be paid for separately, but will be considered incidental to the appropriate Contract items.

Backfill material for backfilling around elevation adjusted and rehabilitated drop inlets, catch basins, and manholes shall meet the requirements of Subsection 704.08, unless otherwise directed by the Engineer.

The items Sanitary Sewer Manhole, Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, Class II, and Class III are mutually exclusive. Only one of these Contract items will be paid at any designated location.

The item Changing Elevation of Drop Inlets, Catch Basins, or Manholes will include adjusting the elevation of an existing top, including replacement of deteriorated bricks and mortar, only.

The item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit down to a maximum depth of 3 feet below the elevation of the upper surface of the unit top.

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The item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 3 feet to a maximum depth of 6 feet below the elevation of the upper surface of the unit top.

The item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 6 feet below the elevation of the upper surface of the unit top.

The items Cast Iron Grate with Frames, Cast Iron Cover with Frames, and Cast Iron Grates, when used and not included in a specific unit, will be paid for at the Contract unit price per each for each type installed in the complete and accepted work.

Payment will be made under:

Pay Item		Pay Unit
604.10	Concrete Catch Basin with Cast Iron Grate	Each
604.11	Concrete Manhole with Cast Iron Cover	Each
604.18	Precast Reinforced Concrete Drop Inlet with Cast Iron Grate	Each
604.20	Precast Reinforced Concrete Catch Basin with Cast Iron Grate	Each
604.21	Precast Reinforced Concrete Manhole with Cast Iron Cover	Each
604.22	Sanitary Sewer Manhole	Each
604.25	Precast Reinforced Concrete Pipe DI with Cast Iron Grate	Each
604.26	Precast Reinforced Concrete Pipe DI with Concrete Cover	Each
604.30	Precast Reinforced Concrete Curb DI with Cast Iron Grate	Each
604.40	Changing Elevation of Drop Inlets, Catch Basins, or Manholes	Each
604.412	Rehab. Drop Inlets, Catch Basins, or Manholes, Class I	Each
604.415	Rehab. Drop Inlets, Catch Basins, or Manholes, Class II	Each
604.418	Rehab. Drop Inlets, Catch Basins, or Manholes, Class III	Each
604.42	Changing Elevation of Sewer Manholes	Each
604.45	Cast Iron Grate with Frame, Type A	Each
604.46	Cast Iron Grate with Frame, Type B	Each
604.47	Cast Iron Grate with Frame, Type D	Each
604.48	Cast Iron Grate with Frame, Type E	Each
604.49	Cast Iron Grate, Type C	Each
604.55	Cast Iron Cover with Frame	Each
604.56	Cast Iron Cover with Frame, Sewer	Each
604.60	Cap Drop Inlet	Each
604.65	Decommission Drop Inlet	Each

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SECTION 605 – UNDERDRAINS

605.01 DESCRIPTION. This work shall consist of constructing drainage systems using underdrains, underdrain outlets, flushing basins, and risers.

605.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Granular Backfill for Structures.....704.08
Drainage Aggregate 704.16
Corrugated Polyethylene Pipe.....710.03
Polyvinyl Chloride (PVC) Plastic Pipe.....710.06
Corrugated Steel Pipe, Pipe Arches and Underdrains 711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains 711.02
Gray Iron Castings .....715.01(b)
Geotextile for Underdrain Trench Lining 720.05

This sentence deleted.

If the Contract does not specify a particular type of underdrain or carrier pipe, the Contractor may furnish underdrain and carrier pipe of the diameter indicated and in any one of the following materials:

(a) Perforated corrugated steel

(b) Perforated corrugated aluminum alloy

(c) Perforated corrugated polyethylene

(d) Perforated PVC plastic

Each system of underdrain, carrier pipes, and underdrain risers shall be constructed of the same material.

605.03 PROTECTION OF MATERIALS. Corrugated polyethylene or PVC plastic pipe stored on the job site prior to use shall be protected from prolonged exposure to sunlight. The Engineer may require impact or other strength tests of the pipe prior to installation when ultraviolet light degradation is suspected.

605.04 INSTALLATION.

(a) Excavation. Trenches for underdrain shall be excavated to the dimensions and grade shown on the Plans or as directed by the Engineer. The surface of the trench shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile.

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Trenches for carrier pipe shall be excavated to a width 24 inches greater than the inside diameter of the pipe. Proper bedding material shall be provided where excavation is in solid rock or other unyielding material.

(b) Placing Geotextile. The geotextile fabric shall be placed loosely with no wrinkles or folds. Care shall be taken to ensure direct contact with the soil such that there are no voids between the geotextile and the trench. The geotextile shall be overlapped a minimum of 12 inches at the top of the trench. Additional overlap or anchoring may be required as determined by the Engineer. The upstream geotextile shall be overlapped over the downstream. Drainage aggregate shall be placed to a depth of 6 inches to provide a bed and uniform slope for underdrain pipe placement.

(c) Placing Underdrain. The underdrain pipe shall be placed in the center of the trench and firmly embedded in the drainage aggregate. Placing shall be started at the outlet end and proceed toward the inlet end. The underdrain shall be placed with the perforations down, unless otherwise directed by the Engineer.

The joints between sections shall be made by fitting the ends as tightly as practical. Corrugated steel or aluminum alloy underdrain shall be joined with an approved coupling. Polyethylene or PVC plastic underdrain shall be joined with approved fittings.

Inlet ends of all underdrain pipe installations shall be closed with suitable plugs to prevent entry of soil material.

Underdrain flushing basins, consisting of corrugated steel or aluminum alloy pipe of the length and diameter shown on the Plans, and cast iron cover shall be installed at locations shown on the Plans or as directed by the Engineer.

Underdrain risers shall be installed as shown on the Plans or as directed by the Engineer.

(d) Placing Carrier Pipes. Carrier pipes used in an underdrain system shall be placed on a firm bed and joined in the same manner as underdrain, non-perforated pipe shall be used.

(e) Backfill. After an underdrain pipe installation has been inspected and approved, material meeting the requirements of drainage aggregate shall be placed to a height of 12 inches above the top of the underdrain and the layer compacted. Care shall be taken not to displace the underdrain pipe. The remainder of the backfill material shall be placed in uniform layers of not more than 6 inches in thickness and thoroughly compacted by use of air or mechanical tampers.

After inspection and approval of a carrier pipe installation, the trench shall be backfilled with suitable material placed in layers not more than 6 inches in thickness and thoroughly compacted. Unless otherwise specified, this material shall be from trench excavation.

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The backfill material shall not be placed directly in the trench by dumping from haul vehicles or by pushing material into trenches by bulldozers, graders, or other equipment. Placing shall be limited to the use of hand shovels, backhoes, front end loaders, or other similar types of equipment as approved by the Engineer.

(f) Flushing. Prior to the acceptance of the project, each underdrain system shall be thoroughly flushed with water to remove any accumulation of silt, sand, or other debris

605.05 METHOD OF MEASUREMENT. The quantity of the specified size of Underdrain or Carrier Pipe to be measured for payment will be the number of linear feet installed in the complete and accepted work. When it is necessary to cut underdrain or carrier pipe in the field, the quantity of underdrain or carrier pipe to be measured for payment will be the length necessary, rounded up to the next largest 2 foot increment.

The quantity of Underdrain Flushing Basin to be measured for payment will be the number of units installed in the complete and accepted work including the corrugated pipe and the cast iron cover.

605.06 BASIS OF PAYMENT. The accepted quantities of each type and size of Underdrain or Carrier Pipe will be paid at the respective Contract unit price per linear foot.

Underdrain Flushing Basins will be paid at the respective Contract unit price for each. Underdrain used for vertical stand pipes at flushing basin locations or risers will be paid as Underdrain Carrier Pipe.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified, including coupling bands and fittings, drainage aggregate, geotextile fabric, and the necessary backfill material to an elevation 7 feet above the flowline, and for furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation for all underdrain, carrier pipe, flushing basins, vertical stand pipes, and risers will be paid for as Trench Excavation.

Payment will be made under:

Pay Item	Pay Unit
605.10 Underdrain Pipe, 6 Inches	Linear Foot
605.11 Underdrain Pipe, 8 Inches	Linear Foot
605.13 Underdrain Pipe, 12 Inches	Linear Foot
605.20 Underdrain Carrier Pipe, 6 Inches	Linear Foot
605.21 Underdrain Carrier Pipe, 8 Inches	Linear Foot
605.23 Underdrain Carrier Pipe, 12 Inches	Linear Foot
605.95 Underdrain Flushing Basin	Each

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SECTION 607 – ROADWAY PATROL MAINTENANCE

607.01 DESCRIPTION. This work shall consist of the maintenance of any section of roadway that is open to public travel and the maintenance of detours in a reasonably smooth and passable condition. The work shall be limited to those roadways within the construction area and any detours shown on the Plans or as directed by the Engineer.

607.02 SCOPE OF WORK. Roadway patrol maintenance shall include only the leveling and smoothing of sections of the roadway or detours within the construction areas that are not subject to the influence of the Contractor's operations.

This work shall be performed by means of a road grader or other approved equipment. Snow shall be removed by use of an approved grader or other approved plowing equipment. The material and equipment required to maintain the roadway and the furnishing and spreading of sand necessary for winter maintenance shall be included in the Contract unit price for Roadway Patrol Maintenance, unless otherwise directed by the Engineer.

607.03 METHOD OF MEASUREMENT. The quantity of Roadway Patrol Maintenance to be measured for payment will be the number of hours actually worked in performing Roadway Patrol Maintenance.

607.04 BASIS OF PAYMENT. The accepted quantity of Roadway Patrol Maintenance will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
607.10 Roadway Patrol Maintenance	Hour

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SECTION 608 – EQUIPMENT RENTAL

608.01 DESCRIPTION. This work shall consist of furnishing, operating, and supervising the use of equipment for performance of work shown on the Plans, in accordance with these specifications or as directed by the Engineer.

608.02 GENERAL REQUIREMENTS. Equipment shall be maintained in good mechanical condition and shall be operated by capable and experienced operators.

Equipment that is to operate on paved surfaces shall be equipped with rubber tires or smooth street plates. Tracked equipment used to draw any other equipment shall be of a type that will not damage the work being done and has sufficient power to operate the drawn equipment effectively.

Equipment used under this section shall meet the following specific requirements as to type, size, capacity, power, or dimensions

In determining whether a particular piece of equipment is classified as Type I, II or III in Subsection 608.02(a), Subsection 608.02(c), Subsection 608.02(d), or Subsection 608.02(f), the make and model number shall be referenced against an equipment guide book.

Whenever certain size equipment is requested by the Engineer and the Contractor supplies a larger size, payment will be for the size requested.

(a) Bulldozer. The tractor shall be a crawler type furnished with an angle type blade and power operated controls. The machine shall be classified by size as follows:

(1) Type I. Type I bulldozers shall have a net engine or flywheel power rating of less than 150 horsepower.

(2) Type II. Type II bulldozers shall have a net engine or flywheel power rating of not less than 150 horsepower.

(b) Grader. The power grader shall be self-propelled with pneumatic tire wheels, power-operated controls, and a wheel base of at least 18 feet.

(c) All Purpose Excavator. The machine shall be a hydraulic excavator and may be self-propelled, truck-mounted, or crawler-mounted. It shall include all attachments required by the Engineer to efficiently perform the work for which it is rented. The machine shall be classified by size as follows:

(1) Type I. Type I all-purpose excavators shall have a rated bucket capacity of at least 1/2 cubic yard but less than 1 cubic yard.

(2) Type II. Type II all-purpose excavators shall have a rated bucket capacity of not less than 1 cubic yard.

(d) Power Broom. Power broom shall provide a sweeping path of not less than 80 inches and be capable of maintaining a speed of 4 miles per hour when sweeping. Sweeping shall take place at locations and times directed by the Engineer. The disposal of all sweepings shall meet with the approval of the Engineer. All hand labor required in connection with sweeping operations shall be incidental.

(1) Type I. Type I power brooms shall be self-propelled or a towed type including the tow vehicle.

(2) Type II. Type II power brooms shall consist of furnishing a pickup sweeper and accessory equipment and utilizing it for removal of earth and/or other dust producing materials from paved surfaces for allaying dust conditions. This equipment shall include suitable provisions for the application of water ahead of the sweeping brooms to prevent dusting, for the pickup, internal storage and removal of sweepings, and for the cleaning of areas of heavy accumulation beyond the capacity of the sweeper.

(3) Type III. Type III power broom shall be a regenerative type air sweeper capable of removing and containing all micron-sized fine dust particles from the designated surface.

(e) Truck. The truck may be the highway type or off-highway type with a minimum capacity of 6-1/2 cubic yards. The capacity of the truck shall be determined by three-dimensional measurement of the body. All off-highway type trucks are restricted unless otherwise approved by the Engineer.

(f) Loader. The loader may be the wheel or crawler type, straight or articulated, and shall be furnished with a standard bucket. The machine shall be classified by size as follows.

(1) Type I. Type I loaders shall have a rated bucket capacity of at least 1 cubic yard but less than 4 cubic yards.

(g) Truck-Mounted Attenuator. A truck-mounted attenuator (TMA) is a crash cushion designed to smoothly decelerate an impacting vehicle. The TMA may be mounted on either trailers or trucks; the unit on which the TMA is mounted must weigh at least 10,000 pounds, with a heavier unit being preferable. The unit on which the TMA is mounted shall be used as a barrier vehicle as described in the MUTCD. All such attenuators shall meet Test Level 3 (TL-3) criteria as defined in *NCHRP Report 350* or the current *AASHTO Manual for Assessing Safety Hardware* (*MASH*), and its latest revisions.

The Contractor shall provide the type of TMA, date of manufacture, and the current FHWA's eligibility letter for the truck-mounted attenuator to the Engineer for approval prior to installation. The TMA shall be placed in accordance with the Contract and as directed by the Engineer. Prior to use, the Contractor shall provide the type of attenuator, date of manufacture, and FHWA's eligibility letter for the truck-mounted attenuator to the Engineer.

(h) Truck-Mounted Attenuator, Advanced Warning Vehicle/Protection Vehicle (AWV/PV). Truck-mounted attenuator, AWV/PV shall consist of a truck-mounted attenuator meeting the requirements of Subsection 608.02(g) and be equipped with a changeable message sign in accordance with the *MUTCD*. The changeable message sign shall be mounted to be clearly visible to the traveling public and shall be capable of being controlled from inside the cab of the vehicle, with capable controls including, but not limited to, turning the sign on and off, changing between preset messages, and inserting new messages when approved by the Engineer.

608.03 METHOD OF MEASUREMENT. The Engineer will issue Written Orders to the Contractor for work to be performed by the specified equipment.

The quantity of equipment to be measured for payment will be the number of hours each piece of equipment actually worked, including necessary travel time within the project limits.

608.04 BASIS OF PAYMENT. The accepted quantity of the specified equipment will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified; for furnishing, operating, and supervising the use of this equipment, including fuel, repairs, attachments, and transportation of the equipment to and from the project; and for furnishing all labor, tools, other equipment, and incidentals necessary to complete the work.

The Contract unit price for the items Truck-Mounted Attenuator and Truck-Mounted Attenuator AWV/PV shall also include all costs of furnishing the unit on which the attenuator is mounted, solely for the attenuator.

Payment will be made under:

Pay Item	Pay Unit
608.10 Bulldozer Rental, Type I	Hour
608.11 Bulldozer Rental, Type II	Hour
608.15 Power Grader Rental	Hour
608.25 All Purpose Excavator Rental, Type I	Hour
608.26 All Purpose Excavator Rental, Type II	Hour
608.30 Power Broom Rental, Type I	Hour
608.31 Power Broom Rental, Type II	Hour
608.32 Power Broom Rental, Type III	Hour
608.37 Truck Rental	Hour
608.40 Loader Rental, Type I	Hour
608.45 Truck-Mounted Attenuator	Hour
608.50 Truck-Mounted Attenuator, AWV/PV	Hour

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SECTION 609 – DUST AND ICE CONTROL

609.01 DESCRIPTION. This work shall consist of treating traveled areas to control dust or reduce ice hazard on the project.

609.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Water 745.01
Calcium Chloride 746.01

609.03 DUST CONTROL WITH WATER. Water shall be applied to traveled areas as the Engineer may designate. The number of applications and the amount of water used shall be based upon field and weather conditions and as ordered in writing by the Engineer.

The equipment for water application shall be equipped with an adequate shutoff valve control in the cab and shall be approved by the Engineer. The equipment shall be available at all times in readiness to perform the work at any time, including Sundays and holidays, upon Written Order of the Engineer.

609.04 DUST AND ICE CONTROL WITH CALCIUM CHLORIDE. Calcium chloride shall be applied in such a manner and by such devices that uniform distribution is obtained over the entire area on which it is ordered by the Engineer.

Unless otherwise authorized in writing by the Engineer, calcium chloride shall be applied at the rate of one- half pound per square yard for dust and ice control. It shall not be used on surfaces on which bituminous material will be applied, unless directed by the Engineer.

When used on granular surfaces on which bituminous material will be applied, the surface shall be reworked by grading or other means to ensure that the surface is sufficiently free of excess calcium chloride as determined by the Engineer.

609.05 METHOD OF MEASUREMENT. The quantity of Dust Control with Water to be measured for payment will be the number of thousands of gallons (MGAL) of water actually used in the complete and accepted work. The Contractor shall provide equipment meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Dust and Ice Control with Calcium Chloride to be measured for payment will be the number of tons of calcium chloride actually used in the complete and accepted work. When calcium chloride is delivered in bulk, the quantity will be determined from load tickets.

609.06 BASIS OF PAYMENT. The accepted quantity of Dust Control with Water will be paid for at the Contract unit price per thousand gallons (MGAL). The accepted quantity of Dust and Ice Control with Calcium Chloride will be paid for at the Contract unit price per ton. Payment will be full compensation for furnishing, measuring the load, transporting, handling, and placing the material specified, including any reworking of granular surfaces as specified, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

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Payment will be made under:

Pay Item	Pay Unit
609.10 Dust Control with Water	MGAL
609.15 Dust and Ice Control with Calcium Chloride	Ton

SECTION 612 – THIS SECTION RESERVED

SECTION 613 – STONE FILL AND RIPRAP

613.01 DESCRIPTION. This work shall consist of furnishing and placing protective materials.

613.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Sand Borrow	703.03
Gravel Filter for Slope Stabilization	704.07
Stone for Riprap, Heavy Type	706.03(a)
Stone for Riprap, Light Type	706.03(b)
Stone for Stone Fill, Type I	706.04(a)
Stone for Stone Fill, Type II	706.04(b)
Stone for Stone Fill, Type III	706.04(c)
Stone for Stone Fill, Type IV	706.04(d)
Environmental Stone (E-Stone)	706.07

Stone Fill, Culvert Lining and Stone Fill, Stream Bed Material shall consist of E-Stone fill of the type specified in the Plans, supplemented with material excavated from the channel and/or the tailings of a topsoil screening operation. Bed material shall be approved by the Engineer and the Agency of Natural Resources prior to use. Similar sized river sediment is an acceptable alternative as is a mixture of angular material and river sediment.

613.03 PREPARATION. The areas to be protected shall be constructed and graded to the lines shown on the Plans or as directed by the Engineer and, if a fill area, shall be compacted. All slopes shall be maintained to the neat lines shown on the Plans prior to the placing of filter or bedding material, stone fill, or riprap.

613.04 PLACING.

(a) Stone Fill. The specified stone fill shall be placed as shown on the Plans in a manner that will result in a reasonably well graded surface. Care shall be taken in the placing to avoid displacing the underlying material. Stone Fill placed inside of a closed structure shall be placed such that the structure is not damaged.

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The stones shall be so placed and distributed that there will be no segregation of either the larger or smaller sizes of stone.

Rearrangement of the stone fill by hand labor or mechanical equipment may be required to obtain the specified results.

When stone fill and gravel filter are to be placed as part of an embankment, the protective materials shall be placed concurrently with the construction of the embankment, unless otherwise directed by the Engineer.

Where stone fill is to be placed under water, methods shall be used that will minimize segregation and ensure that the required thickness of protective material will be obtained.

Once all material has been placed, the Contractor shall slowly wet the stream to minimize the effects of the initial sediment pulse. Every attempt shall be made to minimize the movement of sediment downstream of the site. Sand Borrow shall be added to seal the bed and prevent subsurface flow as directed by the Engineer. There shall be no subsurface flow upon Final Inspection.

(b) Riprap. The stones shall be placed on the prepared slope or gravel filter so that there will be a minimum of space between the stones. The depth of each stone shall be equal to the thickness of the course shown on the Plans. The voids between the stones shall be chinked with smaller stones to produce a relatively smooth and uniform surface.

613.05 METHOD OF MEASUREMENT. The quantities of Stone Fill and Riprap of the type specified to be measured for payment will be the number of cubic yards of the material specified installed in the complete and accepted work, measured within the limits shown on the Plans or as directed by the Engineer.

613.06 BASIS OF PAYMENT. The accepted quantities of Stone Fill and Riprap of the type specified will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for furnishing, transporting, mixing, and placing the specified material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation required for placing stone fill, riprap, and the gravel filter or bedding material will be paid for at the Contract unit price per cubic yard for the same type of excavation removed directly above the face of the protective materials, except that when no other type of excavation has been removed, excavation will be paid for under an appropriate excavation Contract item.

Unless otherwise shown on the Plans, the filter blanket will be paid for under Gravel Filter for Slope Stabilization.

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Payment will be made under:

Pay Item	Pay Unit
613.05 Stone Fill, Culvert Lining	Cubic Yard
613.06 Stone Fill, Stream Bed Material	Cubic Yard
613.10 Stone Fill, Type I	Cubic Yard
613.11 Stone Fill, Type II	Cubic Yard
613.12 Stone Fill, Type III	Cubic Yard
613.13 Stone Fill, Type IV	Cubic Yard
613.15 Riprap, Heavy Type	Cubic Yard
613.16 Riprap, Light Type	Cubic Yard

SECTION 614 – THIS SECTION RESERVED

SECTION 616 – CURBS AND GUTTERS

616.01 DESCRIPTION. This work shall consist of the construction, resetting, or removal of curbs and gutters.

616.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Performance-Graded Asphalt Binder (Prepared from Petroleum)	702.02
Emulsified Asphalt	702.04
Sand Borrow and Cushion	703.03
Mortar, Type I	707.01
Mortar, Type IV	707.03
Joint Sealer, Hot Poured	707.04(a)
Preformed Joint Filler, Cork, and Asphalt-Treated Felt	707.08
Preformed Joint Filler, Bituminous Type	707.14(a)
Timber Preservative	726.01
Vertical Granite Curb	729.01
Granite Slope Edging	729.03
Precast Reinforced Concrete Curb	729.04
Bituminous Concrete Curb	729.05
Treated Timber Curb	729.06

All cast-in-place concrete for curbing and gutters shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for Portland cement of 20% fly ash or 25% Ground Granulated Blast-Furnace Slag (GGBFS).

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Bituminous material for curbs, gutters, and traffic islands of the type specified by the Engineer shall meet the requirements of Section 406.

616.03 GRANITE CURBING AND SLOPE EDGING.

(a) Excavation. Excavation shall be made to the required depth. The base material on which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material that shall be thoroughly compacted.

(b) Installation. Shall be installed in conformance with the line and grade shown on the Plans. All space under the curbing shall be filled and thoroughly tamped with material meeting the requirements of the material for the bed course.

(c) Joints. The curb and slope edging shall be laid and fitted so there will be no open joints exceeding 1 inch between stones. Joints between stones shall be carefully filled with Mortar, Type I and neatly pointed on the top and exposed front portions. After pointing, the stone shall be satisfactorily cleaned of all excess mortar and the joints kept moist until the mortar has set.

(d) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 6 inches in depth.

616.04 THIS SUBSECTION RESERVED.

616.05 REPOINTING GRANITE BRIDGE CURB. The existing mortar bed and vertical curb joints shall be repointed as shown on the Plans. Mortar shall meet the requirements of Subsection 707.01.

616.06 CAST-IN-PLACE CONCRETE CURB.

(a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).

(b) Forms. Forms shall be of wood or metal, straight or curved as required, free from warp and shall be in accordance with Subsection 541.09. Form construction shall be such that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete.

(c) Mixing and Placing. Compaction of concrete placed in the forms shall be by spading or other approved methods. Forms shall be left in place for 24 hours or until the concrete has set sufficiently so that they can be removed without injury to the curbing. Upon removal of the forms, the exposed curbing face shall be finished in accordance with Subsection 541.16(a).

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(d) Sections. Curbing shall be constructed in sections having a uniform length of 10 feet, unless otherwise specified. Sections shall be separated by open joints 1/8 inch wide except at expansion joints.

(e) Expansion Joints. Expansion joints shall be formed using a preformed joint filler having a thickness of 1/4 inch. They shall be constructed at 20 foot intervals or as directed by the Engineer.

(f) Curing. Curbs shall be cured in accordance with Subsection 541.17.

(g) Backfilling. After the concrete has set sufficiently, the spaces in front and back of the curb shall be filled to the required elevation with layers of not more than 6 inches of the same material as the bedding and thoroughly tamped.

(h) Curb Machine. With the approval of the Engineer, the curb may be constructed by a curb-forming machine.

616.07 PRECAST CONCRETE CURB.

(a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).

(b) Installation. Precast concrete curb shall be installed in accordance with Subsection 616.03(b).

(c) Joints. The curb sections shall be placed and fitted so that there will be no open joints between them exceeding 1/8 inch in width. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 20 feet. Expansion joints shall be filled with preformed joint filler having a thickness of 1/4 inch.

Joints in the curb at concrete deck joints shall be treated as shown on the Plans.

The Contractor shall protect the curb against damage or discoloration of the exposed surfaces until completion of the Contract.

(d) Backfilling. The space in front and back of the curb shall be filled and compacted in layers not exceeding 6 inches with the same material as the bedding, unless otherwise specified.

616.08 BITUMINOUS CONCRETE CURB.

(a) General. The plant and equipment necessary for this work shall be in conformance with the requirements of Section 406.

(b) Preparation of Bed. The bituminous concrete curb shall be placed on bituminous concrete pavement or another hard surface. The surface shall be thoroughly cleaned of all dirt, dust, sand, or other loose material and treated with a tack coat of emulsified asphalt applied at a rate of from 6 to 13 ounces per square yard prior to placing the curb. All exposed surfaces not to be treated shall be protected against spattering of the bituminous material.

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(c) Placing. After the tack coat has cured and become tacky, the mix for the curb shall be placed with an automatic bituminous concrete curb laying machine approved by the Engineer. The machine shall form curbing that is uniform in texture, shape, and density.

The Engineer may permit the construction of curbing by means other than the automatic curber or machine, when short sections or sections with short radii are required, or for such other reasons as may be warranted. The resulting curbing shall conform in all respects to the curbing produced using the machine.

(d) Sealing. After the curb has been in place for 7 calendar days, the exposed surface shall be treated with two coats of emulsified asphalt or tar emulsion.

616.09 TREATED TIMBER CURB. The treated timber, bituminous fillet, and granular material behind the curb shall be installed as shown on the Plans. The fillet will be sealed as specified in Subsection 616.08(d).

616.10 REMOVING AND RESETTING CURB.

(a) Salvage of Curbing. The Contractor shall carefully remove, store, and clean any curbing specified for resetting. Any existing curbing to be reset that is lost, damaged, or destroyed as a result of the Contractor's operations, or failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced at the Contractor's expense.

(b) Placing. Excavation, setting joints, and backfilling shall be in accordance with specifications for the type of curb being removed and reset.

(c) Cutting and Fitting. Cutting, fitting, or dressing may be necessary to install the curbing at the locations directed.

(d) Joints. All sections shall be placed so that the maximum opening between sections is not more than 1 inch wide for the entire top and face. Any dressing of the ends of the curbing necessary to meet this requirement shall be done by the Contractor.

Joints shall be filled completely with mortar and kept moist until the mortar has been set.

(e) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 6 inches in depth.

616.11 REMOVAL OF EXISTING CURB. The Contractor shall remove existing curb at locations shown on the Plans or as directed by the Engineer. When shown in the Contract that the curb will remain the property of the State or municipality, the Contractor shall exercise care to avoid damage to the curb during removal. Salvaged curb shall be carefully and neatly stacked with wooden spacers at locations specified in the Contract or as directed by the Engineer.

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616.12 BITUMINOUS CONCRETE GUTTERS AND TRAFFIC ISLANDS.

(a) General. The plant and equipment necessary for this work shall conform to the requirements of Section 406.

(b) Preparation of Bed. The bed upon which the bituminous concrete surface is to be placed shall be thoroughly compacted to the lines, grades, and shape shown on the Plans or directed by the Engineer. In the case of gutters, all soft, yielding, or unsuitable material below the bed shall be removed and replaced with suitable material and compacted to a firm, smooth surface.

(c) Construction of Gutter. The bituminous concrete shall be laid in two courses. Each course shall be rolled with a roller weighing at least 150 pounds. The finished gutter shall be uniform in appearance, free from irregularities, and present a smooth surface.

All joints adjacent to pavements, curbs, and structures shall be coated with emulsified asphalt.

616.13 METHOD OF MEASUREMENT. The quantities of Granite Slope Edging; Vertical Granite Curb; Vertical Granite Curb, Mountable; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified; Treated Timber Curb; and Removing and Resetting Curb to be measured for payment will be the number of linear feet installed in the complete and accepted work, as determined along the face of the finished curb.

The quantity of Repointing Granite Bridge Curb to be measured for payment will be the number of gallons of mortar applied in the completed and accepted work, measured to the nearest gallon.

The quantities of Bituminous Concrete Gutters and Traffic Islands to be measured for payment will be the number of tons installed in the complete and accepted work, as determined from the load tickets.

The quantity of Removal of Existing Curb to be measured for payment will be the number of linear feet removed in the complete and accepted work, measured along the face of the curb in its original position.

616.14 BASIS OF PAYMENT. The accepted quantities of Granite Slope Edging; Vertical Granite Curb; Vertical Granite Curb, Mountable; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified; Treated Timber Curb; Removing and Resetting Curb; and Removal of Existing Curb will be paid for at the Contract unit price per linear foot of curb placed, removed, or removed and reset.

The accepted quantity of Repointing Granite Bridge Curb will be paid for at the Contract unit price per gallon. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantities of Bituminous Concrete Gutters and Traffic Islands will be paid for at the Contract unit price per ton.

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Payment will be full compensation for furnishing, transporting, handling, and placing the specified materials, including all excavation, providing, placing and compacting backfill material when not otherwise specified, mortar for the bed and joints of curbs, joint material for curbs and gutters, anchors for bridge curbs, cleaning, cutting, fitting, dressing or stockpiling of curb, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Tack, prime, or seal coats of bituminous material required for the construction of Bituminous Concrete Curb of the type specified and Treated Timber Curb will not be paid for separately but will be considered incidental to the Contract unit price for the specific item.

The bituminous fillet shown on the Plans to be placed in front of timber curb will not be paid for separately but will be considered incidental to the Contract unit price for Treated Timber Curb.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for separately but will be considered incidental to Removing and Resetting Guardrail or Removal and Disposal of Guardrail, as appropriate.

When shown on the Plans, concrete radius curb installed in conjunction with vertical granite curb will be measured and paid for as Vertical Granite Curb.

Foundation materials for Bituminous Concrete Gutters and Traffic Islands will be paid for separately as specified in the Contract.

Payment will be made under:

Pay Item		Pay Unit
616.20	Granite Slope Edging	Linear Foot
616.21	Vertical Granite Curb	Linear Foot
616.215	Vertical Granite Curb, Mountable	Linear Foot
616.225	Repointing Granite Bridge Curb	Gallon
616.25	Precast Reinforced Concrete Curb, Type A	Linear Foot
616.26	Precast Reinforced Concrete Curb, Type B	Linear Foot
616.27	Cast-in-Place Concrete Curb, Type A	Linear Foot
616.28	Cast-in-Place Concrete Curb, Type B	Linear Foot
616.305	Bituminous Concrete Curb, Type A	Linear Foot
616.315	Bituminous Concrete Curb, Type B	Linear Foot
616.35	Treated Timber Curb	Linear Foot
616.40	Removing and Resetting Curb	Linear Foot
616.41	Removal of Existing Curb	Linear Foot
616.47	Bituminous Concrete Gutters and Traffic Islands	Ton

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SECTION 617 – MAILBOXES

617.01 DESCRIPTION. This work shall consist of the removal and relocation of existing mailboxes to permanent locations. The work shall include the replacement of any non-conforming boxes, supports, or attachment hardware.

As used in this section, the term "mailbox" shall include the actual box, post or other support, and attachment hardware.

617.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Timber Preservative, Type IV.....726.01
Wood Posts .....750.01(c)

Brackets and platforms shall be made of galvanized steel sheets. Holes shall be neatly punched or drilled.

Fasteners shall be galvanized and meet the requirements of *ASTM A 307*.

New boxes must meet the approval of the U.S. Postal Service.

617.03 GENERAL. Mailboxes designated to be relocated shall be carefully removed and reinstalled as shown on the Plans. Any materials in the existing mailbox installation which do not conform to the Plans or Subsection 617.02 shall be replaced with new, conforming materials. Materials not reused shall remain the property of the owner.

It is the Contractor's responsibility to ensure that each completed relocation has the approval of the mail carrier.

617.04 RELOCATION. Posts may be set in holes or they may be driven if the posts or any attached anti-twist devices are not damaged. The installed posts shall be plumb and placed to the depth shown on the Plans. The space around the posts set in holes shall be backfilled with suitable granular material in 6 inch layers. The backfill material shall be thoroughly tamped.

Mailboxes shall be attached to the posts using the mountings and hardware shown on the Plans. All fasteners shall be drawn sufficiently tight to ensure that the mailboxes do not pivot or otherwise move.

Existing nameplates shall be attached to any new mailboxes. Names and rural box numbers lettered on existing mailboxes shall be copied onto new mailboxes using good commercial-quality stick-on letters acceptable to the Engineer.

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617.05 METHOD OF MEASUREMENT. The quantity of Remove and Reset Mailbox to be measured for payment will be the number of each type (Single or Multiple Support) relocated in the complete and accepted work, as determined by the Engineer.

The quantity of Remove and Replace Mailbox to be measured for payment will be the number of each type (Single or Multiple Support) relocated in the complete and accepted work, as determined by the Engineer.

617.06 BASIS OF PAYMENT. The accepted quantity of Remove and Reset Mailbox and Remove and Replace Mailbox of the type specified will be paid for at the Contract unit price each. Payment will be full compensation for removing the existing mailbox, installing the mailbox in its permanent location, excavating as necessary, backfill, and furnishing all new materials including mailbox, supports, support hardware, and lettering and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any temporary relocation of mailboxes due to project construction will not be paid under this section. The costs of this temporary work will be considered incidental to other Contract items.

Pay Item	Pay Unit
617.10 Remove and Reset Mailbox, Single Support	Each
617.12 Remove and Reset Mailbox, Multiple Support	Each
617.15 Remove and Replace Mailbox, Single Support	Each
617.17 Remove and Replace Mailbox, Multiple Support	Each

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SECTION 618 – SIDEWALKS

618.01 DESCRIPTION. This work shall consist of the construction of bituminous or Portland cement concrete sidewalks and curb ramps.

618.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Emulsified Asphalt.....702.04
Preformed Joint Filler, Cork, and Asphalt-Treated Felt 707.08
Preformed Joint Filler, Bituminous Type 707.14
Detectable Warning Surface 751.08

Concrete for sidewalks shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for Portland cement of 20% fly ash or 25% GGBFS.

The type of bituminous materials for sidewalks shall be as specified in the Plans or as directed by the Engineer. The material shall meet the requirements of Section 406.

618.03 PORTLAND CEMENT CONCRETE SIDEWALK.

(a) Excavation and Foundation. Excavation shall be made to the required depth and to a width that will permit placing of bed course material and the installation and bracing of the forms. Bed course material shall be placed as shown on the Plans. When the depth of bed course required exceeds 6 inches, two layers of approximately equal depth shall be placed, and each layer thoroughly compacted so that it is hard and unyielding. The wetting of bed course material may be necessary to obtain the required compaction.

(b) Forms. Forms shall meet the applicable requirements of Subsection 541.09. Forms shall be wood or metal and shall extend for the full depth of the concrete. All forms shall be straight or curved as required and free from warp.

(c) Placing Concrete. The forms and foundation shall be wetted immediately prior to the placing of the concrete.

The concrete shall be deposited within the forms to such a depth that, after being consolidated and finished, it is of the full thickness required. The concrete shall be consolidated using a method approved by the Engineer.

(d) Finishing. The surface shall be finished with a wooden float or mag. No plastering will be permitted. The edges shall be rounded with an edger having a radius of 1/4 inch. Before the concrete has taken its initial set, it shall be tested for waves or irregularities with a straightedge at least 10 feet long. Deviations of 1/4 inch or more, either above or below the general contour of the surface, shall be immediately remedied.

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The surface of the sidewalk, after the floating and screeding process is completed, shall be finished with a broom of a type approved by the Engineer, drawn over the surface parallel to the transverse joints.

(e) Joints. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 20 feet.

Expansion joints shall be formed around all appurtenances such as manholes, utility poles and other obstructions extending into and through the sidewalk. Preformed joint filler with a thickness of 1/4 inch shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the sidewalk.

Between the expansion joints, the sidewalk shall be divided at intervals of 5 feet by dummy joints formed by a jointing tool or other acceptable means to provide grooves approximately 1/8 inch wide and at least 33% of the total sidewalk depth.

When the sidewalk is constructed next to a concrete or granite curb, asphalt-treated felt shall be placed between the sidewalk and curb for the total depth of the sidewalk.

(f) Curing. Concrete shall be cured in accordance with Subsection 541.17. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time until 85% of the design strength has been attained as demonstrated by field-cured cylinders.

(g) Backfilling. After sidewalk construction has been completed, the space on each side shall be backfilled to the required elevation with suitable material as shown on the Plans or as directed by the Engineer.

618.04 BITUMINOUS CONCRETE SIDEWALK.

(a) Excavation and Foundation. Excavation and foundation shall conform to the requirements of Subsection 618.03(a).

(b) Forms. Where no headers, curbing, or other suitable supports are provided, grade control forms shall be installed when hand methods are utilized to assist in obtaining proper alignment and adequate compaction of the sidewalk course. The alignment and grade of all forms set shall be approved by the Engineer immediately prior to placing any material against them. The forms shall be cleaned thoroughly each time they are used. String or wire lines staked to grade will not be accepted as a substitute for grade control forms. When a suitable abutting curb or header is available and is approved by the Engineer as being in conformity with the intended grade, it may be utilized as a grade control form.

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(c) Placing Bituminous Sidewalk Material. Bituminous sidewalk material shall be placed on the compacted bed course as directed by the Engineer by either mechanical or hand spreading methods in a manner that the required depth will result after rolling. When placing over an existing surface, the surface shall be cleaned and emulsified asphalt applied before the bituminous concrete is placed.

(d) Compaction. Compaction shall be accomplished by means of a hand operated or power roller of a type and mass acceptable to the Engineer. In areas inaccessible to the roller, hand tamping will be permitted. In any case, the bituminous sidewalk material shall be uniformly compacted and shall present a smooth, even surface.

618.05 DETECTABLE WARNING SURFACE. Detectable Warning Surface shall be one of the Detectable Warning Surfaces on the Agency's *Approved Products List*.

(a) General. Detectable Warning Surfaces shall be furnished and installed as indicated in the Contract and in conformance with *ADA Accessibility Guidelines*.

(b) Handling. Detectable Warning Surface materials shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.

(c) Installation. The Detectable Warning Surface shall be installed in accordance with all applicable supplier and manufacturer requirements and recommendations for environmental conditions, surface preparation, installation procedures, curing procedures, and materials compatibility.

The Contractor is responsible for removing any material spatters. The Contractor shall repair any damage to the surface resulting from either installation or clean-up of surface materials. This work shall be performed at no additional cost to the State.

618.06 METHOD OF MEASUREMENT. The quantity of Portland Cement Concrete Sidewalk to be measured for payment will be the number of square yards of the specified depth of sidewalk installed in the complete and accepted work.

The quantity of Bituminous Concrete Sidewalk to be measured for payment will be the number of tons of material installed in the complete and accepted work, as determined from load tickets.

The quantity of Detectable Warning Surface to be measured for payment will be the number of square feet of approved material installed in the complete and accepted work.

618.07 BASIS OF PAYMENT. The accepted quantities of Portland Cement Concrete Sidewalk will be paid for at the Contract unit price per square yard for the specified depth. The accepted quantity of Bituminous Concrete Sidewalk will be paid for at the Contract unit price per ton. The accepted quantity of Detectable Warning Surface will be paid for at the Contract unit price per square foot. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including expansion joint material, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

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The cost of cleaning an existing surface before placing a Bituminous Concrete Sidewalk and the application of emulsified asphalt will not be paid for directly but will be considered incidental to the Bituminous Concrete Sidewalk.

Bed course material will be paid for under the appropriate Section 301 Contract item.

Excavation, unless otherwise specified, will be paid for under the appropriate Section 203 Contract item.

Payment will be made under:

Pay Item	Pay Unit
618.10 Portland Cement Concrete Sidewalk, 5 Inch	Square Yard
618.11 Portland Cement Concrete Sidewalk, 8 Inch	Square Yard
618.15 Bituminous Concrete Sidewalk	Ton
618.30 Detectable Warning Surface	Square Foot

SECTION 619 – MARKERS

619.01 DESCRIPTION. This work shall consist of furnishing and placing boundary markers, marker posts, and bollards and removing and resetting of existing property markers.

619.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Crushed Gravel for Subbase	704.05
Mortar, Type I	707.01
Bar Reinforcement	713.01
Wood Posts and Offset Blocks for Rail, Guardrail, Barriers, and Guide Posts	728.01(a)
Steel Posts and Anchors	751.01(a)

Paints, Stains and Traffic Marking Materials shall meet the requirements of Subsection 708.01.

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

619.03 PLACING.

(a) General. Boundary markers, marker posts, and bollards of the dimensions shown in the Contract shall be placed vertically in holes to the depths indicated and shall be backfilled with suitable material placed and compacted in layers not more than 6 inches in depth.

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Marker posts and bollards may be driven if suitable caps and driving equipment are used to prevent damage to the post.

Yielding marker posts shall be 6-1/2 feet long and shall be embedded to a depth of 3 feet in the ground.

(b) Boundary Markers. When the marker point falls on ledge, a steel rod marker shall be placed in a hole of the diameter and depth shown on the Plans or as directed by the Engineer. The rod shall be securely wedged into the hole and cut off to the required elevation. The space around the rod shall be filled with Type I mortar.

(c) Bollards. Bollards shall be installed as shown on the Plans or as directed by the Engineer.

(d) Removing and Resetting Property Markers. Prior to the removal of any property marker, the Contractor shall verify that the Engineer has located and properly referenced the marker location. The Contractor shall remove, properly identify, and store the property markers to be reset prior to beginning any other construction in the immediate vicinity.

If the property marker is to be installed at a new location, the hole after removal shall be properly backfilled with suitable material. Each property marker shall be reset at the location directed and shall be 6 inches above the ground, sidewalk, or other surface unless otherwise directed by the Engineer.

When the marker point falls on ledge and the use of a steel rod marker is directed by the Engineer, it shall be set in accordance with Subsection 619.03(b).

619.04 METHOD OF MEASUREMENT. The quantity to be measured for payment will be the number of in-place Markers, Bollards, or Posts and the number of Property Markers removed and reset in the complete and accepted work.

619.05 BASIS OF PAYMENT. The accepted quantity of each type of Marker, Bollard, or Post, and Property Markers removed and reset will be paid for at the Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including object markers, paint, locking devices, excavation, backfill, mortar, concrete, and subbase, and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

The Contract unit prices for the items of Wood Marker Posts, Steel Marker Posts, and Yielding Marker Posts will also include the costs of removing the remaining portion of the existing marker post, when the designated new marker post is used as a replacement of an existing marker post.

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Payment will be made under:

Pay Item	Pay Unit
619.10 Boundary Markers	Each
619.14 Bollards	Each
619.15 Wood Marker Posts	Each
619.17 Yielding Marker Posts	Each
619.20 Removing and Resetting Property Markers	Each

SECTION 620 – FENCES

620.01 DESCRIPTION. This work shall consist of the construction of fences and gates.

620.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type I	707.01
Woven Wire Fence	727.01
Chain-Link Fence	727.02
Snow Barrier Fence	727.05
Plank Rail Fence	727.06
Posts and Post Accessories	728.01
Hardware for Cable, Steel Beam, and Thrie Beam Rail	728.03(a)
Grounding Electrodes	752.15

When chain-link fence is specified in the Plans but the material is not, the Contractor may elect to use galvanized, vinyl coated, or aluminum coated steel fabric for the fence as long as it conforms to the design shown on the Plans.

The materials for snow barrier shall conform to the requirements of this subsection and the details shown on the Plans.

The Contractor may use preformed 1/16 inch × 3/8 inch flat aluminum wire bands to attach the chain-link fabric to the galvanized pipe support framework. The bands shall be made of 5052-H32 Alloy having a minimum tensile strength of 30 ksi, and an approved closure, as an alternate to the stainless steel clips shown on the Plans.

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

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620.03 GENERAL. All trees, brush, and other obstructions which interfere with proper grade, alignment, and construction of fences shall be removed and disposed of as specified in Section 201, unless otherwise directed by the Engineer. Modification of the alignment may be made as directed by the Engineer to preserve valuable trees or other features.

Posts shall be set plumb at the spacing and depth shown on the Plans and, when used for property line fence, shall be erected parallel to and 6 inches inside the right-of-way line. The wire shall be placed on the far side of the posts with respect to the transportation facility.

Existing fences shall be connected to new fences as shown on the Plans. Corner posts with braces for every direction of strain shall be placed at the junction with existing fences, and the wire in both fences shall be properly fastened to the posts.

In no case shall the fence be connected to a structure.

620.04 ERECTION OF WOVEN WIRE FENCE. Where the ground is too soft to hold the post firmly and in depressions where stresses will tend to pull posts from the ground, a second post shall be installed to such depth as necessary and the two posts tied together securely as shown on the Plans.

Wood posts shall be set with the large end down in previously dug holes and backfilled with approved material. When tops of treated posts are cut as shown on the Plans or directed by the Engineer, the cut end shall be treated with two coats of copper napthenate solution.

Steel posts shall be set with anchor plates down, except that when set in rock the anchor plates shall be omitted. When driving posts, the tops shall be protected by driving caps.

When bedrock is encountered, steel posts shall be used instead of wood posts. The posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so that they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the holes re-drilled before installing the posts in the usual manner.

The fence shall be braced as shown on the Plans or directed by the Engineer, with one brace at each end post, including end posts at gates and two braces at each intermediate post, or pull post, and at corner posts where the change in horizontal alignment is in excess of 15°.

The posts and braces for steel corner, end, and pull posts shall be set in concrete as shown on the Plans. The concrete may be mixed by hand.

The woven wire fence shall be stretched taut and attached to the posts so that the bottom wire is approximately 3 inches above the ground.

When wood posts are used, each horizontal wire shall be fastened to the posts with No. 9 gauge galvanized or aluminum-coated staples 1-1/2 inches long. When steel posts are used, each horizontal wire shall be fastened to the posts with aluminum bars, galvanized steel bars, or No. 11 gauge rust-resistant spring wire clips. Instead of the fasteners, posts equipped with fastening studs approximately 1/2 inch high and 2-1/4 inches apart may be used.

620.05 ERECTION OF CHAIN-LINK FENCE. Posts shall be set in concrete bases of the dimensions shown on the Plans.

Where the ground is too soft to firmly hold the line, end, corner, pull, or gate posts, a post of sufficient length shall be used to obtain stability as directed by the Engineer.

Where rock is encountered, the posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the hole re-drilled before installing the posts in the usual manner.

The wire fabric shall be properly stretched, without sags or buckles, and attached to the posts as shown on the Plans. Tension wires shall be installed top and bottom as indicated. After erection, any galvanized parts or fittings that have been abraded so that the base metal is exposed shall be painted with two coats of an approved coating.

Any abrasions on aluminum-coated steel chain-link fence and the contacting surface of aluminum alloy, or aluminum-coated steel chain-link fence with concrete, stone, or masonry shall be thoroughly coated with an approved coating. Abraded areas shall receive a second coat of aluminum paint. The paint shall be allowed to dry thoroughly before installation of the fence.

Where chain-link fence is used in the areas of bicycle paths, the top selvedge shall be knuckled.

620.06 PLANK RAIL FENCE. Plank Rail Fence shall be install as shown on the Plans.

620.07 SNOW BARRIER FENCE. Snow Barrier shall be installed as detailed and at the locations shown on the Plans. The wire fabric for the snow barrier shall be 1 inch square mesh. The bottom and top selvedges shall be knuckled.

The snow barrier mesh shall be installed on the traffic side of the snow barrier framework.

620.08 REMOVING AND RESETTING FENCE. Existing fence and posts shall be carefully removed at locations shown on the Plans. Any material damaged while being removed, hauled, or stored and during the process of resetting, due to carelessness on the part of the Contractor as determined by the Engineer, shall be replaced with new materials at the Contractor's expense.

The posts shall be reset in the same manner as posts for new fence and to the same depth and spacing of the fence before removal.

The material used for fencing between posts shall be securely fastened to the posts in their new locations as shown on the Plans for the type of fence being installed.

620.09 REMOVAL OF EXISTING FENCE. Existing fence and posts shall be removed at locations shown on the Plans. When fence is to be salvaged for future use, the Contractor will exercise care during removal to prevent damage and will stockpile the fence at locations indicated in the Contract or as directed by the Engineer. When fence is not to be salvaged, it shall become the property of the Contractor and will be removed from the project area in a manner acceptable to the Engineer.

620.10 GATES. The gates shall be of the design shown on the Plans and shall be completed in a neat and professional manner. The gate hold backs and center stops shall be set in concrete similar to the design and specifications for chain-link fence line posts. The top rail of the gates shall be level along the entire top of the gates.

620.11 METHOD OF MEASUREMENT. The quantity of Fence of the type and size specified to be measured for payment will be the number of linear feet installed in the complete and accepted work. Measurement will be along the top of the fence from outside to outside of end posts for each continuous run of fence. Measurement will include fence at bracing assemblies but not at gates.

The quantity of Gate of the type and size specified to be measured for payment will be the number of linear feet of clear distance between gate posts in the complete and accepted work.

The quantity of Bracing Assembly for Chain-Link Fence of the type and size specified to be measured for payment will be the number of bracing assemblies installed for end, gate, corner, and pull posts in the complete and accepted work.

The quantity of Brace for Woven Wire Fence of the type specified to be measured for payment will be the number of braces installed in the complete and accepted work. If double braces are installed on a post, two units will be measured for payment.

The quantity of Removing and Resetting Fence and Removal of Existing Fence to be measured for payment will be the number of linear feet of fence in its original position, measured outside of its end posts for each continuous run of fence, including gates.

620.12 BASIS OF PAYMENT. The accepted quantities of Fence and Gate installed or removed and reset, will be paid for at the Contract unit price per linear foot of the type and size specified.

Bracing Assembly and Braces will be paid for at the Contract unit price for each type specified.

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Removing and Resetting Fence will be paid for at the Contract unit price per linear foot.

Removal of Existing Fence will be paid for at the Contract unit price per linear foot. Payment will include compensation for stockpiling or disposal, as appropriate.

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The costs of clearing and grubbing, excavation, backfilling, concrete bases, brace plates, anchor plates, electrical grounding, drilling of rock, grouting of holes, extra length posts, and countersunk posts will not be paid for directly but will be considered incidental to the Contract items involved.

Payment will be made under:

Pay Item	Pay Unit
620.11 Chain-Link Fence, 4 Feet	Linear Foot
620.12 Chain-Link Fence, 6 Feet	Linear Foot
620.13 Chain-Link Fence, 8 Feet	Linear Foot
620.15 Gate for Chain-Link Fence, 4 Feet	Linear Foot
620.16 Gate for Chain-Link Fence, 6 Feet	Linear Foot
620.17 Gate for Chain-Link Fence, 8 Feet	Linear Foot
620.20 Bracing Assembly for Chain-Link Fence, 4 Feet	Each
620.21 Bracing Assembly for Chain-Link Fence, 6 Feet	Each
620.22 Bracing Assembly for Chain-Link Fence, 8 Feet	Each
620.25 Woven Wire Fence with Steel Posts	Linear Foot
620.26 Woven Wire Fence with Wood Posts	Linear Foot
620.30 Drive Gate for Woven Wire Fence	Each
620.40 Steel Brace for Woven Wire Fence	Each
620.41 Wood Brace for Woven Wire Fence	Each
620.45 Plank Rail Fence	Linear Foot
620.50 Removing and Resetting Fence	Linear Foot
620.55 Removal of Existing Fence	Linear Foot
620.75 Snow Barrier Fence	Linear Foot

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SECTION 621 – TRAFFIC BARRIERS

621.01 DESCRIPTION. This work shall consist of the furnishing, assembling, removing, repairing and/or resetting of traffic barriers.

621.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Emulsified Asphalt.....702.04
Grease Rustproofing Compound.....708.04
Coatings for Wood.....708.05
Wire Rope or Cable.....713.03
Galvanizing.....726.08
Posts and Post Accessories.....728.01
Rail Elements.....728.02
Hardware.....728.03
Concrete Anchors.....728.05
Flat Sheet Aluminum.....750.03
Retroreflective Sheeting.....750.08

Reinforcing steel shall meet the requirements of Section 507.

Materials for Removing and Resetting Guardrail, Replace Guardrail Post Assembly, Replace Guardrail Beam Unit, and Adjust Height of Guardrail shall consist of the acceptable rails, posts, offset blocks, bolts, and other hardware of the existing guardrail together with the necessary new replacement parts. The new replacement parts shall match as close as possible the existing components they replace.

All welding shall conform to the requirements of Subsection 506.10.

621.03 FABRICATION DRAWINGS. The fabricator of guardrail approach sections furnished under this section shall submit detailed fabrication drawings in accordance with Section 105.

621.04 POSTS AND OFFSET BLOCKS. Posts may be set in holes, or they may be driven if suitable caps and driving equipment are used to prevent damage to the posts. The installed posts shall be plumb, accurately aligned, spaced as shown on the Plans, and placed to the full depth indicated. Round posts shall be set or driven with the larger post cross-section facing downward. The space around the posts shall be backfilled with suitable material in 6 inch layers and tamped thoroughly with air or mechanical tampers.

Posts for Steel Backed Timber Guardrail may be driven or installed into pre-drilled holes. The dimensions of the pre-drilled hole shall not exceed the dimensions of the post by more than 1 inch. If impenetrable material is encountered while placing the post, the pre-drilled hole shall be enlarged to provide not less than 6 inches of clearance on all sides and a minimum depth of 2-1/2 feet and the post shall be set in concrete, the type as approved by the Engineer, to within 6 inches of the top of the hole. The remaining 6 inches shall be backfilled with a suitable material and compacted to the satisfaction of the Engineer.

The guardrail designated to be removed and reset shall be carefully removed, temporarily stored when necessary, and reinstalled at the new location. Materials damaged or lost shall be replaced with new material by the Contractor without compensation. The new materials shall be equal to or better than the material of the existing guardrail.

Guardrail posts and anchors shall be installed prior to placing the adjacent top course of pavement unless otherwise directed by the Engineer.

621.05 RAIL ELEMENTS.

(a) Beam Rail. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.

(b) Cable Rail. Cable guardrail shall be installed as shown on the Plans.

Splicing of cable will be permitted when necessary, but no single piece of cable shall be less than 50 feet in length.

(c) Steel-Backed Timber Rail. Timber rails shall be cut to produce a close fit at all joints. Field cuts shall be treated with an approved material as determined by the Engineer.

621.06 ENERGY ABSORPTION ATTENUATOR. Energy Absorption Attenuators, permanent or temporary, shall be installed at the locations shown in the Plans or as approved by the Engineer and per the manufacturer's recommendations. Installation of any traffic barrier requiring protection with an Energy Absorption Attenuator shall not begin until the complete Energy Absorption Attenuator is on the project site and ready to be installed. Attenuators shall be a minimum of Test Level 3 for posted speed limits greater than 40 mph and a minimum of Test Level 2 for posted speed limits of 40 mph and less, in accordance with *NCHRP Report 350* or the current *AASHTO Manual for Assessing Safety Hardware* (*MASH*) and its latest revisions.

(a) Permanent. Energy Absorption Attenuators, Permanent shall be one of the energy absorption attenuators on the Agency's *Approved Products List* identified for permanent use.

(b) Temporary. It shall be the Contractor's responsibility to maintain all in service energy absorption attenuators, Temporary in accordance with the manufacturer's recommendations. Any damage identified to affect the performance of the attenuator, as determined by the Engineer, shall be repaired immediately in accordance with the manufacturer's recommendations or replaced with the spare Energy Absorption Attenuator, Temporary as necessary.

A single spare Energy Absorption Attenuator, Temporary, of each type installed, shall be on the project site while any Energy Absorption Attenuator, Temporary is in service and shall be ready to be installed in the case an Energy Absorption Attenuator, Temporary needs to be replaced or repaired. In the case a spare Energy Absorption Attenuator, Temporary has been used, completely or in part, the Contractor shall replace all used components of the spare so that a fully functioning spare is available within 48 hours of the use of any spare.

Energy Absorption Attenuators, Temporary shall be removed from the project upon determination, by the Engineer, it is no longer needed and shall remain the property of the Contractor.

Liquid and/or sand filled Energy Absorption Attenuators, Temporary shall not be used between December 1st and April 15th.

Any Energy Absorption Attenuator, Temporary manufactured prior to January 1, 2020 shall meet the applicable Test Level criteria as defined in *NCHRP Report 350*, *MASH 2009* or *MASH 2016*. Any Energy Absorption Attenuator, Temporary manufactured on January 1, 2020, or later, shall meet the applicable Test Level criteria as defined in *MASH 2016*. The Contractor shall provide the type of Energy Absorption Attenuator, Temporary, date of manufacture and the current FHWA eligibility letter for the Energy Absorption Attenuator, Temporary to the Engineer for approval prior to installation.

621.07 TEMPORARY TRAFFIC BARRIER. Temporary Traffic Barrier shall be installed at the locations shown in the Plans or as directed by the Engineer and per the manufacturer's recommendations. The barrier shall be one of the barriers included under *FHWA Roadside Hardware Policy and Guidance* for crashworthy longitudinal barriers, at the Contractor's discretion, unless otherwise specified. The type of temporary traffic barrier shall be provided to the Engineer prior to use. All Temporary Traffic Barrier, including corresponding connections, shall meet Test Level 3 (TL-3) criteria as defined in *NCHRP Report 350*, or the *AASHTO Manual for Assessing Safety Hardware* (*MASH*) and its latest revisions. The appropriate resource shall be determined as described in the *MASH* publication.

Temporary traffic barrier components shall be in a condition satisfactory to the Engineer prior to placement on the project and maintained as such until removed from the project.

Temporary Traffic Barrier shall be removed from the project when no longer needed and shall remain the property of the Contractor. The area from which the barrier was removed shall be restored to a satisfactory condition where and when no other construction activities are intended.

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621.08 REMOVE AND RESET TEMPORARY TRAFFIC BARRIER. Temporary traffic barrier and required appurtenances shall be removed and reset as shown on the Plans or as ordered in writing by the Engineer.

621.09 TERMINALS. Terminals shall be installed at the locations shown on the Plans and as detailed on the Plans or per the manufacturer's recommendations. New Traffic Barrier installations shall be protected by a terminal the same day the Traffic Barrier is installed and may be protected permanently as shown on the Plans or temporarily as approved by the Engineer. Temporary Terminals shall not be in place more than 48 hours and will be considered incidental to other Traffic Barrier items.

All new terminal installations shall include a permanent identification of the year of installation and model identified on the Agency's *Approved Products List* or the Standard Drawing used. Payment will be incidental to the traffic barrier items.

(a) Manufactured Terminal Section, Tangent. Manufactured Terminal Sections, Tangent shall be one of the Manufactured Terminal Sections on the Agency's *Approved Products List*.

(b) Manufactured Terminal Section, Flared. Manufactured Terminal Section, Flared shall be one of the Manufactured Terminal Sections on the Agency's *Approved Products List*.

621.10 ANCHORS. Anchors shall be installed at the locations shown on the Plans. Backfill material shall be placed in layers of not more than 6 inches and shall be thoroughly compacted by use of a mechanical tamper, to the satisfaction of the Engineer.

Cable, when required, shall be drawn taut and fastened securely to the anchor assemblies as shown on the Plans and adjusted to equalize the stresses.

621.11 DELINEATION. Delineation devices shall consist of Flat Sheet Aluminum and Retroreflective Sheeting of the design shown on the Plans and shall be securely fastened to traffic barriers or guide posts as shown on the Plans or as directed by the Engineer.

621.12 FIELD PAINTING. Galvanized components that have been cut, abraded, or damaged such that base metal is exposed shall be repaired with two coats in accordance with Subsection 726.08, and paint when specified on the Plans.

Wherever guardrail panels are nested, the surfaces on both panels that will be in contact with each other shall be coated with grease rustproofing compound. Overlapping at splices shall not be considered nesting.

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621.13 REPLACEMENT, ADJUSTMENT, REMOVAL, AND DISPOSAL OF GUARDRAIL OR GUIDE POSTS. Guardrail installations which are to remain in place will be inspected by the Engineer for damage, unsuitability, and conformance to current guardrail standards. The Engineer will mark guardrail components which are to be replaced. The guardrail shall then be checked for height conformance.

Those sections in which height over an extensive portion of the section is greater than 31 inches or less than 27-3/4 inches shall be adjusted to a nominal height of 29 inches ± 1 inch.

Sections which in general conform for height but have many variations due to erosion or filling of the shoulder from normal mechanisms shall have the shoulder graded to the proper typical before being checked for height conformance. After adjustment is complete, the existing rail shall conform to current design standards for height as appropriate for the type of guardrail being adjusted.

Guardrail height adjustments shall be made to reflect guardrail height at final grade. The Contractor shall repair or replace all damaged or missing components. Components shall be repaired or replaced as determined by the Engineer and in accordance with the Plans or per current standards, as applicable.

The finished appearance of the rehabilitated rail shall be a continuous smooth line without abrupt dips over the entire section, to the satisfaction of the Engineer.

Offset blocks designated for replacement shall be replaced in-kind. Materials shall be in conformance with the applicable requirements of Subsection 728.01 for either wood, steel, or alternative offset blocks.

Cable guardrail repair shall be performed in accordance with the Plans or as directed by the Engineer.

Unless otherwise specified in the Contract, material to be removed shall become the property of the Contractor. Materials removed from service shall be removed from the State right-of-way limits at the end of each work day, unless otherwise approved by the Engineer. Materials removed shall be disposed of in accordance with applicable local, State, and Federal regulations.

Unless otherwise indicated, anchors which are designated for removal and disposal, not removal and salvage, may have the anchor or anchor block abandoned in place with the anchor rod cut in such a manner that no portion of the anchor assembly is within 1 foot of the ground, shoulder, or roadway surface.

If posts or anchors are removed from an area where there is no other excavation or embankment work, the resulting holes shall be backfilled with suitable material matching as closely as possible the surface, subbase and other materials in both type and depth. The backfill shall be placed in layers not more than 6 inches in depth, thoroughly compacted using a mechanical tamper, and the area seeded in accordance with Section 651.

Existing materials to be salvaged shall be protected from damage and/or loss by the Contractor during construction operations. Materials lost or damaged shall be replaced with new materials by the Contractor without compensation. New materials shall be equal to, or better than, the materials in the existing guardrail.

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621.14 METHOD OF MEASUREMENT. The quantity of Cable Guardrail to be measured for payment will be the number of linear feet installed in the complete and accepted work, measured from center-to-center of end posts. The distance from end posts to the anchors will not be included for payment. The measured quantity of Cable Guardrail will be multiplied by factors as specified in Table 621.14A.

TABLE 621.14A – CABLE GUARDRAIL POST SPACING FACTORS

Post Spacing	Factor
16 ft	1.0
12 ft	1.1
6 ft	1.5
4 ft	1.8

The quantities of Cable Guardrail Hook Bolt, Galvanized and Cable Guardrail Splice Unit to be measured for payment will be the number each unit installed in the complete and accepted work.

The quantity of Replacement of Guardrail Cable to be measured for payment will be the number of linear feet installed in the complete and accepted work.

The quantities of Traffic Barrier Delineator and Steel Beam Guardrail Offset Block to be measured for payment will be the number of each component replaced in the complete and accepted work.

The quantity of Steel Backed Timber Guardrail to be measured for payment will be the number of linear feet installed in the complete and accepted work, measured from end to end along the face of rail, including terminal sections. The measured length will be multiplied by a factor of 1.4 for a post spacing of 5 feet.

The quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail to be measured for payment will be the number of linear feet of each kind specified installed in the complete and accepted work, measured center to center of end posts to which rail is attached. The measured quantity will not include those portions of the installation within the pay limits for Manufactured Terminal Section or Terminal Connector for Steel Beam Guardrail. Where terminal end sections are installed, an additional 2 feet of guardrail will be included for each end section. W-beam to Thrie beam transition sections will be paid for as an equal length of Thrie beam guardrail.

The measured quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail will be multiplied by factors as specified in the Table 621.14B.

TABLE 621.14B – BEAM GUARDRAIL POST SPACING FACTORS

Post Spacing	Factor
6 ft 3 in.	1.0
4 ft 2 in.	1.2
3 ft 1-1/2 in.	1.4

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The quantity of Box Beam Guardrail to be measured for payment will be the number of linear feet installed in the complete and accepted work, measured from center to center of end posts. An additional 1 foot of guardrail will be allowed for each overhang.

The quantities of Terminal Sections, Terminal Connectors, Terminals, Anchors, Approach Sections, and Guide Posts to be measured for payment will be the number of units of each type specified, installed in the complete and accepted work.

The quantities of Energy Absorption Attenuator, Temporary and Energy Absorption Attenuator, Permanent to be measured for payment will be the number of each unit installed in the complete and accepted work. The spare Energy Absorption Attenuator, Temporary will not be measured for payment since supplying a spare on the project will be considered incidental to the Energy Absorption Attenuator, Temporary item.

The quantity of Remove and Reset Guardrail to be measured for payment will be the number of linear feet reset in the complete and accepted work, measured in accordance with the type of guardrail specified.

The quantity of Replace Guardrail Post to be measured for payment will be the number of individual posts replaced in the complete and accepted work.

The quantity of Replace Guardrail Beam Unit to be measured for payment will be the number of 12.5-foot rail panels replaced. Those rail panels that are longer or shorter than 12.5 feet in length shall be converted to an equivalent number of 12.5-foot rail panels. The quantity of Replace Guardrail Beam Unit will not be factored for post spacing.

Minor repairs and replacement of parts for anchorage devices, such as tightening nuts, adjusting turn buckles, replacing nuts and/or bolts, rethreading rod ends, etc. will be considered incidental to the other Section 621 pay items in the Contract.

The quantity of Adjust Height of Guardrail to be measured for payment will be the number of linear feet of adjusted guardrail complete in place measured from center to center of the end posts to which the rail elements are attached. Payment will not include measurement of any rail element or anchorage which extends beyond the last post to which the rail elements are attached, nor will any factor based on post spacing distances be applied to the measured distance.

The quantity of Removal and Disposal of Guardrail to be measured for payment will be the number of linear feet removed in the complete and accepted work, measured from end post to end post to which rail was attached.

The quantity of Removal and Disposal of Guide Posts to be measured for payment will be the number of posts removed in the complete and accepted work.

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The quantity of Temporary Traffic Barrier to be measured for payment will be the number of linear feet installed and removed in the complete and accepted work, measured from end to end of each installation, including terminals.

The quantity of Remove and Reset Temporary Traffic Barrier to be measured for payment will be the number of linear feet removed and reset, measured from end-to-end of the allowable length, including Energy Absorption Attenuators as needed, as described herein, as shown on the Plans or as directed by the Engineer.

Any barrier removed and not reset will not be measured for payment under this item, but will be considered incidental to the original installation of the barrier. No measurement for payment will be made for barrier that is removed and reset for the convenience of the Contractor, for minor adjustments of 2 feet or less in any direction, or for any removal and resetting that was not approved by the Engineer.

621.15 BASIS OF PAYMENT. The accepted quantities of Guardrail, new or reset, permanent or temporary, will be paid for at the Contract unit price per linear foot.

The accepted quantities of Cable Guardrail Hook Bolt, Galvanized, and Cable Guardrail Splice Unit will be paid for at the Contract unit price per each.

The accepted quantity of Replacement of Guardrail Cable will be paid for at the Contract unit price per linear foot.

The accepted quantities of Traffic Barrier Delineator and Steel Beam Guardrail Offset Block will be paid for at the Contract unit price for each.

The accepted quantity of Manufactured Terminal Section, Flared or Tangent, will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, detailing, transporting, handling, and installing the terminal sections used, including but not limited to excavation, backfill, re-grading the installation area as necessary, delineation devices, restraining devices, hardware, and preservative treatment, and for furnishing all labor, tools, equipment, and incidentals necessary for installing a complete and properly functioning unit.

The accepted quantities of Terminal Connectors, Anchors, Approach Sections, and Guide Posts will be paid for at the Contract unit price for each for the Contract item specified.

The accepted quantity of Removal and Disposal of Guardrail will be paid for at the Contract unit price per linear foot. Removed guardrail that is not reset will be paid for as Removal and Disposal of Guardrail.

The accepted quantity of Removal and Disposal of Guide Posts will be paid for at the Contract unit price for each.

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Payment for Removal and Disposal of Guardrail and Removal and Disposal of Guide Posts will include full compensation for removing and disposing of materials, and for restoration of the old site when required.

Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified removing and disposing of damaged guardrail component(s), and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. For Steel Backed Timber Guardrail, enlarging holes as necessary for placement of posts, furnishing and placing concrete fill and backfill material, and compacting backfill to the satisfaction of the Engineer will not be paid for separately, but will be considered incidental to the unit price bid for Steel Backed Timber Guardrail.

The accepted quantity of Energy Absorption Attenuator, Permanent or Temporary will be paid for at the Contract unit price for each. Payment will be full compensation for fabricating, furnishing, transporting, handling, and installing the materials required including all hardware, any necessary manufacturer's supervision, the furnishing of all labor, tools, equipment, and incidentals necessary for installing the attenuator, complete and in place. Payment for Energy Absorption Attenuator, Temporary will further be full compensation for maintaining, repairing, or replacing the attenuator as necessary while it is in service, and for removing and disposing of the attenuator when it is no longer needed.

(a) Payment for Energy Absorption Attenuator, Temporary will be made as follows:

(1) The initial 70% of the Contract unit price will be paid when the attenuator is installed and functioning to the satisfaction of the Engineer.

(2) The remaining 30% of the Contract unit price will be paid when the Engineer has determined that the attenuator is no longer required for use at the original installed location.

Payment for Remove and Reset Guardrail will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new hardware when necessary, reinstalling at the new locations, furnishing and applying stain, paint, and preservative material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will also include removing and replacing anchors and terminal ends when required. Replacing panels, offset blocks and posts will not be paid for under this item but under the applicable Contract item.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for directly, but will be considered incidental to Remove and Reset Guardrail and Removal and Disposal of Guardrail.

The accepted quantity of Replace Guardrail Post, whether for cable, steel beam, or box beam rail, will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated post and hardware; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing the replacement post and/or backup plate if required; new bolts, nuts and/or washers and any other necessary hardware; steel strapping as necessary; stain, paint, and preservative; and for furnishing all labor, tools, equipment, and incidentals necessary for the work.

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The accepted quantity of Replace Guardrail Beam Unit, whether for steel beam or box beam rail, will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated beam panel; for furnishing, transporting, handling, and installing the replacement components needed, including new rail beam units of the required length, replacement backer plates if required and not covered under another Contract item, new reflectors or other delineation if required and not part of the item Replace Guardrail Post Assembly, and new bolts, nuts, and/or washers and any other necessary hardware; for drilling holes as required to complete the installation of the replacement panel; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Adjust Height of Guardrail will be paid for at the Contract unit price per linear foot. Payment will be full compensation for adjusting the height of the existing guardrail to conform to current standards; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing necessary cable terminal hardware, turn buckles, tension springs, splicing units, steel strapping, stain, paint, preservatives, and all other components which are necessary to make the adjusted guardrail a complete installation and which are not part of any other pay item in the Contract; for disposing of removed components which are not reused; and for furnishing the labor, tools, equipment, and incidentals necessary to complete the work. Replacing panels, offset blocks and posts will not be paid for under this item but under the applicable Contract item.

The accepted quantity of Temporary Traffic Barrier will be paid for at the Contract unit price per linear foot. Payment will be full compensation for furnishing and installing barrier and any required terminals or protective end devices, and for removal and site restoration where required.

(b) Payment for Temporary Traffic Barrier will be made as follows:

(1) 50% of the accepted quantity upon the satisfactory installation of the barrier.

(2) 50% of the accepted quantity upon the final removal of the barrier.

The accepted quantity of Remove and Reset Temporary Traffic Barrier will be paid for at the Contract unit price per linear foot. Payment will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new parts when necessary, reinstalling at the new locations, reinstalling required terminals or energy absorption attenuators, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will also include removing and replacing anchors.

(c) Payment for Remove and Reset Temporary Traffic Barrier will be made as follows:

(1) 50% of the accepted quantity upon the removal of the originally installed barrier.

(2) 50% of the accepted quantity upon the satisfactory reinstallation of the barrier.

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Payment will be made under:

Pay Item		Pay Unit
621.17	Cable Guardrail	Linear Foot
621.173	Cable Guardrail Hook Bolt, Galvanized	Each
621.174	Cable Guardrail Splice Unit	Each
621.175	Replacement of Guardrail Cable	Linear Foot
621.18	Steel Backed Timber Guardrail	Linear Foot
621.20	Steel Beam Guardrail, Galvanized	Linear Foot
621.205	Steel Beam Guardrail, Galvanized, w/8 Feet Posts	Linear Foot
621.206	Steel Beam Guardrail, Galvanized/Nested	Linear Foot
621.207	Steel Beam Guardrail, Galvanized/Nested, w/8 Feet Posts	Linear Foot
621.21	HD Steel Beam Guardrail, Galvanized	Linear Foot
621.215	HD Steel Beam Guardrail, Galvanized, w/8 Feet Posts	Linear Foot
621.216	HD Steel Beam Guardrail, Galvanized/Nested	Linear Foot
621.217	HD Steel Beam Guardrail, Galvanized/Nested w/8 Feet Posts	Linear Foot
621.218	Traffic Barrier Delineator	Each
621.219	Steel Beam Guardrail Offset Block	Each
621.25	Thrie Beam Guardrail	Linear Foot
621.30	Box Beam Guardrail	Linear Foot
621.50	Manufactured Terminal Section, Flared	Each
621.51	Manufactured Terminal Section, Tangent	Each
621.53	Terminal Connector for Steel Beam Guardrail	Each
621.56	Energy Absorption Attenuator, Temporary	Each
621.575	Energy Absorption Attenuator, Permanent	Each
621.60	Anchor for Steel Beam Rail	Each
621.61	Anchor for Steel to Box Beam Transition	Each
621.65	Anchor for Cable Rail	Each
621.70	Guardrail Approach Section, Galvanized, Type I	Each
621.71	Guardrail Approach Section, Galvanized, Type II	Each
621.72	Guardrail Approach Section, Galvanized 2 Rail Box Beam	Each
621.725	Guardrail Approach Section, Galvanized 3 Rail Box Beam	Each
621.73	Guardrail Approach Section, Galvanized 4 Rail Box Beam	Each
621.737	Guardrail Approach Section, Galvanized HD Steel Beam	Each
621.738	Guardrail Approach Section, Galv. HD Steel Beam w/8 Feet Posts	Each
621.746	Guardrail Approach Section to Concrete Bridge Railing, TL-2	Each
621.747	Guardrail Approach Section to Concrete Bridge Railing, TL-3	Each
621.748	Guardrail Approach Section to Conc. Comb. Bridge Railing, TL-3	Each
621.75	Remove and Reset Guardrail	Linear Foot
621.76	Replace Guardrail Post Assembly	Each
621.77	Replace Guardrail Beam Unit	Each
621.79	Adjust Height of Guardrail	Linear Foot

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Pay Item		Pay Unit
621.80	Removal and Disposal of Guardrail	Linear Foot
621.81	Removal and Disposal of Guide Posts	Each
621.85	Guide Posts	Each
621.90	Temporary Traffic Barrier	Linear Foot
621.95	Remove and Reset Temporary Traffic Barrier	Linear Foot

SECTION 622 – INSULATION BOARD

622.01 DESCRIPTION. This work shall consist of furnishing and installing extruded and/or expanded polystyrene insulation board on a prepared surface.

622.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Sand Borrow and Cushion 703.03
Polystyrene Insulation Board 735.01

Skewers shall conform to the requirements of the insulation manufacturer.

622.03 PREPARATION OF SURFACE. The surface shall be prepared as follows:

(a) The surface on which insulation board is to be placed shall be shaped as shown on the Plans. Any unsuitable material shall be replaced with satisfactory material. The surface shall be compacted to attain at least 95% of the maximum dry density and the in-place moisture content shall be not more than 2% above the optimum moisture content, as determined by *AASHTO T 99,* Method C.

(b) When sand borrow is required, it shall be spread and compacted to a minimum depth of 3 inches just prior to the placement of the insulation board.

(c) Compaction shall be performed in accordance with Subsection 203.11(d).

622.04 PLACEMENT OF INSULATION. The insulation board shall be placed and secured as follows:

(a) The boards shall be placed in such a manner that the transverse joints will be staggered. If two layers of insulation are used, the second shall be placed to cover the joints of the first layer.

(b) Means will be provided to ensure a straight alignment of the boards.

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(c) A minimum of two skewers, as approved by the Engineer, shall be used to hold each insulation board in place. The skewers shall be driven at an angle of less than 90° from the horizontal until flush with the surface of the insulation boards. Skewers shall be used for each layer when more than one layer of material is used.

622.05 PLACEMENT OF MATERIAL ON THE INSULATION BOARD. Special care shall be taken that the equipment used in placing the material does not operate directly upon the installed insulation board.

The first layer of material shall be placed to a minimum depth of 8 inches, loose measurement, by dumping in piles and then moving it forward onto the insulation board by approved equipment. The first layer of material shall be compacted to the satisfaction of the Engineer. The compaction of subsequent layers shall be made with the same construction procedures required for the type of material being placed.

Any insulation board that becomes displaced or damaged prior to or during placing of the material shall be repositioned or removed and replaced with new board at the Contractor's expense.

622.06 METHOD OF MEASUREMENT. The quantity of Insulation Board to be measured for payment will be the number of thousand feet board measure (MFBM) installed in the complete and accepted work, based on the nominal dimensions of material. No allowance will be made for waste.

622.07 BASIS OF PAYMENT. The accepted quantity of Insulation Board will be paid for at the Contract unit price per thousand feet board measure (MFBM). Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, except that sand will be paid for at the Contract unit price per cubic yard for sand borrow under Contract item Sand Borrow.

Payment will be made under:

Pay Item	Pay Unit
622.10 Insulation Board	MFBM

SECTION 623 – THIS SECTION RESERVED

SECTION 624 – THIS SECTION RESERVED

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SECTION 625 – SLEEVES FOR UTILITIES

625.01 DESCRIPTION. This work shall consist of the furnishing and installation of sleeves for public or private utilities. Sleeves are hereby defined as encasements for utility lines and are also known as ducts, casings, and conduits.

625.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Emulsified Asphalt.....702.04
Brick.....705.01
Mortar, Type II.....707.02
Mortar, Type IV.....707.03
Joint Sealer, Hot Poured.....707.04(a)
Preformed Joint Filler, Cork, and Asphalt-Treated Felt.....707.08
Polyvinyl Chloride (PVC) Waterstop.....707.10
Asphaltic Plug Joints for Bridges.....707.15
Reinforced Concrete Pipe.....710.01
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe.....710.05
Polyvinyl Chloride (PVC) Plastic Pipe.....710.06
Corrugated Steel Pipe, Pipe Arches, and Underdrains.....711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains.....711.02
Plastic Pipe, Flexible.....740.01
This material list item deleted.
Polyethylene Plastic Pipe and Fittings (HDPE) Electrical Conduit.....752.08(b)

Bituminous concrete pavement shall conform to the requirements of Section 406.

Steel bar reinforcement shall conform to the requirements of Section 507.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All wood blocks used as skids shall be oak or maple Structural Lumber #2 Grade or better.

All prefabricated casing spacers shall be designed for the intended application and be of the centered or restrained type.

Stainless steel strapping shall meet the requirements of *ASTM A 666*.

Sleeves for power and communication lines shall be nonmetallic.

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Steel sleeves shall conform to *ASTM A 53/A 53 M* and wall thickness shall be compatible with the specified bury depth.

Carrier pipes shall have restrained joints to allow for future removal of the pipe without having to de-couple the pipe joints.

Casing end seals shall be of masonry construction. Modular wall and pipe seals shall be stainless steel hardware or prefabricated casing end seals with stainless steel bands.

625.03 INSTALLATION. Sleeves installed by the boring and jacking or directional drilling methods shall be installed as specified in the Contract, in accordance with standard industry practices, or as approved by the Engineer. Sleeves installed by open-cut methods shall be installed using the same methods specified for culverts as in Section 601, as specified in the Contract, or as directed by the Engineer. All pipes shall be positively joined.

Unless otherwise specified, any sleeve installed for future use is to be fitted with plugs or caps at both ends and shall contain a suitable pull wire or pull cord accessible from both ends.

Carrier pipe for water, sewer, and gas greater than 2 inches in diameter shall be installed in a sleeve that is at least 12 inches larger than the diameter of the carrier pipe.

Utility pipe for power, cable, and phone greater than 2 inches in diameter shall be installed in a conduit that is at least 4 inches larger than the diameter of the utility pipe.

For utilities 2 inches and smaller, the inside diameter of sleeves shall be as specified in Table 625.03A.

TABLE 625.03A – INSIDE SLEEVE DIAMETERS FOR CARRIER OR UTILITY PIPE

Carrier or Utility Pipe	Inside Sleeve Diameter (inches)
Power lines	4
Telephone lines	4
Cable TV lines	4
Water pipes	6
Water service lines, 3/4 inch – 1 inch	4
Sewer pipes	6
Gas pipes	6
Fiber optic cables	4

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625.04 METHOD OF MEASUREMENT. The quantity of Sleeves for utilities to be measured for payment will be the number of linear feet installed in the complete and accepted work.

625.05 BASIS OF PAYMENT. The accepted quantity of Sleeves for utilities will be paid for at the Contract unit price per linear foot. Payment will be full compensation for fabricating, furnishing, transporting, handling, saw-cutting, and placing all materials, including pull wire and end caps, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Blocking (skids), casing spacers, end seals, stainless steel straps, bituminous concrete pavement, Portland cement concrete pavement, reinforcing steel, emulsion, subbase materials, brick end walls, and other materials required in conjunction with sleeves will be considered incidental to Sleeves for Utilities.

Excavation and backfill of trenches and boring or jacking pits for the placement of Sleeves for Utilities will be considered incidental to Sleeves for Utilities.

Payment will be made under:

Pay Item	Pay Unit
625.10 Sleeves for Utilities	Linear Foot

SECTION 626 – THIS SECTION RESERVED

SECTION 627 – THIS SECTION RESERVED

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SECTION 628 – SANITARY SEWER SYSTEMS

628.01 DESCRIPTION. This work shall consist of the construction or reconstruction of sanitary sewer lines and appurtenances.

628.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Granular Backfill for Structures.....704.08
Rubber Gaskets 707.11
Reinforced Concrete Pipe 710.01
Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe.....710.05
Polyvinyl-Chloride (PVC) Plastic Pipe 710.06
Ductile Iron Pipe, Cement Lined 740.07

Concrete shall conform to the requirements of Section 541 for Concrete, Class B, unless otherwise specified.

Sleeves shall conform to the requirements of Section 625.

628.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing sanitary sewer facilities without prior written approval of the Engineer.

When existing underground utilities not scheduled for removal or abandonment are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All materials that are damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled to avoid shock. Pipes having factory-applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be safely stored in a safe manner at places provided by the Contractor and approved by the Engineer.

The Contractor's attention is called to the fact that sewer pipe and fittings are comparatively brittle. Care shall be taken in handling and laying to avoid damaging the pipe and fittings.

The locations of all pipes shall be approved by the Engineer.

628.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe. Where feasible, trench walls shall be vertical.

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The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with granular backfill for structures.

Where ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation materials are encountered in the trench excavation at the normal grade of the pipe bed, the trench shall be excavated to a width equal to the inside diameter of the pipe plus 24 inches, and to a depth of 12 inches below the pipe grade. This area shall be backfilled with granular backfill for structures.

The length of trench to be opened at one time shall be kept within reasonable limits unless otherwise permitted or directed by the Engineer.

No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

During construction, the Contractor shall conduct operations to prevent at all times the accumulation of water, ice, and snow in excavations or near excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used to drain excavations.

Where pipes are to be placed in an embankment, excavation for the pipe shall be made after the embankment has been completed to the specified height above the designed grade for those pipes shown on the Plans.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

628.05 BEDDING FOR PIPE. The bed shall be prepared in accordance with Subsection 601.04 unless otherwise specified.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

628.06 LAYING PIPE. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

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The laying shall begin at the outlet end and the lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects and no pipe or fittings shall be laid which are known to be defective. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

The pipe shall be laid to conform to the lines and grades shown on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The sewers and manholes shall be made as nearly watertight as practicable and leakage measurements shall be made wherever possible.

For sewer force mains, concrete reaction blocking shall be provided as detailed at all bends deflecting 22.5° or more. At the Contractor's option, retainer glands may be used at bends instead of concrete blocking. Retainer glands shall also be provided at all joints within three pipe lengths each side of the bends.

628.07 JOINING PIPE. Sewer pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Sewer pipe with pre-molded gaskets shall be driven completely home and the gasket checked for proper positioning. Where poured joints are used, the pipe shall be properly positioned and the joint completely filled with joint sealer in accordance with the accepted practice for that type of sewer joint. The sealer shall be allowed to cool completely before the runner is removed.

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Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gauges shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

Any fittings showing a crack, and any fitting or pipe that has received a severe blow which may have caused a fracture, even though no fracture can be seen, shall be marked as rejected and removed at once from the work.

Sewer pipe shall be cut by means of a handsaw, "metal-inserted" abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

628.08 TESTING OF SYSTEM. The Contractor shall provide all necessary equipment and instrumentation required for proper completion of the flushing and testing. Quality of water, testing procedures, and method of disposal of water shall be approved by the Engineer. Prior to testing, the system shall be flushed with water to remove construction debris.

All tests shall be made in the presence of the Engineer. Preliminary tests made by the Contractor without being observed by the Engineer will not be accepted. The Engineer will be notified at least eight hours before any work is to be inspected or tested.

All defects in the system shall be corrected and retested until acceptable to the Engineer. Repairs shall be made to achieve the standard of quality specified for the entire system.

Sections of the system may be tested separately, but any defect that may develop in a section previously tested and accepted shall be promptly corrected and retested.

Test data shall be recorded on a form acceptable to the Engineer. A copy of all test data shall be submitted to the Engineer at the completion of testing.

All piping shall be tested in accordance with the following test methods, in addition to any test required by State and local codes or building authorities:

(a) Gravity Sewer Testing.

(1) General. The Contractor shall have the option of using the air test or water test for testing sewers. Manholes must be tested by a water test.

The maximum sewer length to be tested at one time shall be that length between any two successive manholes.

Pipe trenches shall be backfilled prior to performing the test.

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All service laterals, stubs, and fittings shall be plugged or capped and adequately braced to withstand thrust forces.

The depth of groundwater above the pipe section to be tested shall be determined.

Portions of sewer lines in conflict with water mains shall be tested as ordered by the Engineer.

(2) Air Testing. Low pressure air testing shall be conducted in accordance with the following procedures:

a. Each end of the test section shall be plugged, capped, and braced. Necessary safety precautions shall be taken to prevent blowouts and possible injury.

b. An air hose shall be connected to a tapped plug used for an air inlet. The hose shall be connected to the air control equipment, which shall include valves and pressure gauges. These shall allow air to enter the sewer test line, monitor air pressure in the sewer, shut off air, and provide pressure reduction and 0 to 10 psi relief. The monitoring pressure gauge shall have a range of 0 to 14.5 psi with divisions of 0.10 psi, and an accuracy of 0.05 psi.

c. The air compressor and air supply shall be connected to the test line and the test section filled slowly until a constant pressure of 3.5 psi is maintained.

d. A pressure above 3 psi shall be maintained for at least five minutes to allow the temperature to stabilize. A check for leaks shall be made and if any are found, the pressure shall be released and the fitting replaced or repaired.

e. After the stabilization period, the pressure shall be adjusted to 3.5 psi and the air supply disconnected.

f. Measure and record the time interval for the test line pressure to drop from 3 to 2.5 psi.

g. If the groundwater table is above the pipe, increase above test pressures 0.6 psi for every 1 foot the groundwater is above the invert of the pipe.

h. The minimum time required for a pressure drop of 0.6 psi using the air test shall be 75 seconds per inch of diameter of the main sewer being tested.

i. Any line tested that does not hold the minimum specified pressure for the specified time will be considered to have failed the pressure test and shall be repaired and retested. The Contractor may have the option of conducting a water test in accordance with these specifications if the air test has failed.

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(3) Exfiltration Test. An exfiltration test measures the amount of water leaking out of the sewer while maintaining a low pressure on the entire sewer being tested.

The exfiltration test procedure shall be as follows:

a. A tapped plumbers plug should be inserted in the downstream manhole inlet sewer. The water supply connection is made at this point, but never directly from a public water supply system or hydrant.

b. A stand pipe shall be tightly connected at the upstream end of the sewer. The height of the stand pipe shall be as directed but, in all cases, it shall be 24 inches higher than any point in the sewer or 24 inches higher than the highest known groundwater table, whichever is higher, and shall be not higher than 25 feet above the lowest point in the section being tested.

c. Water shall be added at the downstream connection to avoid air pockets. The line shall be filled to the elevation designated in the stand pipe. A manhole may be used as a stand pipe. The Engineer may require the manholes to be tested independently in accordance with procedures specified in this subsection.

d. The line shall be allowed to stand with water for at least four hours in order that air may escape and absorption may take place.

e. The lines shall be filled to the reference mark, and the drop or loss that occurs during a 15-minute period shall be measured. The minimum head shall be maintained throughout the test, adding any volume of water required and including that volume in the leakage measurements. The test shall be repeated as directed.

f. The reading shall be recorded, and the leakage shall be recorded as gallons per inch of pipe diameter per mile of sewer per 24-hour day.

g. Allowable leakage shall be 100 gallons/inch/mile/day.

(4) Infiltration Test. If the groundwater table is at least 24 inches above the entire sewer section to be tested, the Engineer may allow the Contractor to perform an infiltration test.

a. The infiltration test procedure shall be as follows:

b. The upstream end of the section shall be plugged or taped.

c. The measuring device shall be installed in the downstream end. If a V-notch weir is used, it must be installed to maintain a watertight seal between the weir and the interior surface of the pipe. The weir shall meet the approval of the Engineer.

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d. Sufficient time shall be allowed for infiltrating water to develop a steady, uniform flow.

e. The reading shall be recorded as gallons per inch of pipe diameter per mile of sewer per 24-hour day.

f. Allowable leakage shall be 100 gallons/inch/mile/day.

(b) Manhole Leakage Test. Each manhole shall be tested by means of a water or vacuum test.

If the water test was used on the sewer line and the manhole was tested with the sewer, and the line passed, the Engineer may not require an independent manhole test. In any case, there shall be no visible leakage into the base or walls of a completed manhole.

All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blowout.

The manhole shall then be filled with water to the top of the cone section. With the approval of the Engineer, a period of time may be permitted to allow for absorption. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and the measuring time of at least four hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be recorded as gallons per vertical foot of depth per 24-hour day.

Allowable leakage for each manhole shall not exceed 1 gallon/foot/day. If leakage exceeds the allowable rate, repairs shall be made as approved by the Engineer and the manhole retested.

If the Contractor elects to backfill prior to testing, the testing shall be at the Contractor's own risk, and it shall be incumbent upon the Contractor to determine the reason for any failure of the test. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Engineer that the groundwater table is below the bottom of the manhole throughout the test.

If the groundwater table is above the highest joint in the manhole, and if there is no leakage into the manhole as determined by the Engineer, this test can be used to evaluate the water-tightness of the manhole. However, if the Engineer is not satisfied, the Contractor shall lower the groundwater table and carry out the test as described above.

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(c) Pressure Pipe Testing. The following procedure shall be used:

(1) General. All force mains shall pass the hydrostatic pressure test and the leakage test described below.

Prior to testing, all anchors and braces shall be installed. All concrete thrust blocks and restraints shall be in place and cured for at least seven days. All buried pipes shall be backfilled. Suitable test plugs shall be installed and air release valves shall be installed at the high points.

(2) Hydrostatic Pressure Test. The following procedure shall be used:

a. All air release valves shall be opened and the pipe shall be filled with water at a rate not to exceed the venting capacity of the air release valves.

b. The water pressure shall be raised to 150% of the designed operating pressure and adjusted to the lowest point of the section being tested.

c. The pressure shall be maintained for ten minutes and for an additional period as is required for the Engineer to complete inspection; however, the manufacturer's suggested time duration at the test pressure should not be exceeded.

d. Any defects noted shall be repaired and the test repeated.

e. Upon successful completion of the hydrostatic test, the leakage test will be performed.

(3) Leakage Test. The following procedure shall be used:

a. The water pressure in the section shall be brought up to the designed operating pressure and adjusted to the lowest point of the section. This pressure shall be maintained within a maximum variation of 5% for the test duration of two hours minimum. Testing shall be in conducted in accordance with *AWWA C600*.

b. The amount of leakage shall be measured by means of a water meter installed on the supply side of the pump, and the leakage recorded as gallons per hour.

c. The allowable leakage is as follows:

1. No leakage will be allowed for exposed piping; buried piping with flanged, threaded, or welded joints; or buried pipe in conflict with potable water lines.

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2. Leakage for buried pipe with slip-type or mechanical joints shall not exceed the rate determined by the following formula:

$$L = 0.00102 \times N \times D \times \sqrt{P}$$

where:

L = Maximum allowable leakage (gallons/hour)

N = Number of gasketed joints in the line under test

D = Nominal internal diameter of the pipe (inches)

P = The average test pressure on the line being tested (psi gauge)

628.09 BACKFILLING.

(a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.

(b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps and stones over 1 inch in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

(c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 12 inches over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take all necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

(d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, masses of roots, individual roots more than 18 inches long or 1/2 inch thick, or stones greater than 50 pounds or larger than 6 inches in the widest dimension.

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If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 12 inches thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction and shall conform to the requirements of Subsection 203.11(d).

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.

Backfill material shall be compacted to maximum dry density percentages specified in Table 628.09A and the in-place moisture content shall be not more than 2% above the optimum moisture content, as determined by *AASHTO T 180,* Method C.

TABLE 628.09A – MAXIMUM DRY DENSITY FOR BACKFILL

Backfill Location	Maximum Dry Density (%)
Around all structures, under roadway paving, shoulders, and embankments	95
All other areas	90

628.10 HOUSE CONNECTIONS. In general, the Engineer will require new house connections for each existing residential and commercial structure. The actual location of each new house connection shall be determined in the field by the Engineer.

Stub-outs for future connections shall be a minimum of 24 inches long and shall have ends closed with suitable approved plugs specially made for the purpose. All joints and spaces shall be thoroughly filled with mortar. Plugs shall be installed so as to be readily removable without damage to the pipe when future connections are made.

628.11 MANHOLES. Manholes shall conform to the requirements of Section 604.

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628.12 TRANSFER OF EXISTING SYSTEM TO NEW SYSTEM. The Contractor shall maintain existing sewage flows during construction of the new sanitary sewer systems and during connection of the new system to the existing system. The Contractor shall submit and receive approval of a detailed construction schedule and procedure for transferring service from the existing system to the new system prior to beginning work on the system.

Prior to making the connection, the Contractor shall notify the Owner and the Engineer in writing three calendar days in advance of the date when the Contractor will be ready to complete the work.

After this connection is made, the Contractor shall divert the sewage flow to the new sewer, transfer the house services from the existing system to the new sewer, and abandon the existing system as shown on the Plans or directed by the Engineer.

Where existing manholes and other underground structures are to be abandoned, the Contractor shall remove the frame and cover, remove the top a minimum of 24 inches below subgrade or final slope grade, whichever is greater, plug the pipes with Class C concrete, and backfill with suitable material. Frames and covers shall remain the property of the owner of the system. material placed in the manholes and other structures shall be compacted to the requirements of the surrounding subgrade material.

628.13 WATER MAIN – SEWER SEPARATION. Where water mains and sewer lines are in the same area as a result of work under the Contract, parallel installations or crossings of such installations shall conform to the requirements as specified in the latest revision of the "10 States Standards" *Recommended Standards for Water Works* and *Recommended Standards for Wastewater Facilities*, as well as the standards of the Vermont Drinking Water and Groundwater Protection Division, and as specified below.

In addition, all reconstruction or relocation of existing water or sewer facilities shall be as approved by the utility owner. Such approval shall be obtained for scheduling, materials, and configuration of the reconstruction or relocation.

(a) Parallel Installation. Under normal conditions, water mains shall have a separation of at least 10 feet horizontally from sewers, storm drains, or manholes whenever possible, with the distance measured edge-to-edge.

When local conditions prevent a horizontal separation of 10 feet, a water main and sewer may be laid closer to each other provided that:

(1) Special written approval is obtained from the Agency of Natural Resources.

(2) The bottom of the water main is at least 18 inches above the top of the sewer main.

(3) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to ensure that it is watertight prior to backfilling.

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(b) Crossings. Under normal conditions, water mains crossing house sewers, storm sewers, or sanitary sewers shall be laid above the sewer line with a separation of at least 18 inches between the bottom of the water main and the top of the sewer pipe.

When local conditions prevent such a vertical separation, the following construction shall be used:

(1) Sewers passing over or under water mains shall be constructed of materials and joints that are equivalent to water main standards of construction, such as cast or ductile iron pipe with push-on or mechanical joints, or approved equal.

(2) Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking of the water mains.

(3) The length of water pipe shall be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

The Contractor shall assume the responsibility of identifying all crossings that may exist. All crossings, whether identified by the Engineer or the Contractor, shall be constructed in accordance with these specifications and as approved by the Engineer.

628.14 METHOD OF MEASUREMENT. The quantity of Sewer Pipe of the type and size specified to be measured for payment will be the number of linear feet of sewer line installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Re-Laying Sewer Pipe to be measured for payment will be the number of linear feet of sewer pipe re-laid in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Transfer to New System, Sanitary Sewer to be measured for payment will be on a unit basis for each transfer performed in the complete and accepted work.

628.15 BASIS OF PAYMENT. The accepted quantity of Sewer Pipe of the type and size specified will be paid for at the Contract unit price per linear foot. Payment shall be full compensation for furnishing, transporting, handling, installing, and testing the materials specified; for making all necessary connections; and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

The accepted quantity of Re-Laying Sewer Pipe will be paid for at the Contract unit price per linear foot. Payment shall be full compensation for furnishing all labor, equipment, tools, and incidentals necessary for re-laying sewer pipe at the locations specified in the Contract and as directed by the Engineer.

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Excavation, including backfill, and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic yard for Trench Excavation of Earth or Trench Excavation of Rock, as specified in Section 204. When material is required to replace poor foundation material below the normal grade of the pipe it will be paid for as Granular Backfill for Structures. Concrete shown on the Plans or directed by the Engineer will be paid for as Concrete, Class B, unless otherwise specified. Sheeting left in place will be paid for as incidental to the appropriate excavation Contract item.

The accepted quantity of Transfer to New System, Sanitary Sewer will be paid for at the Contract lump sum price bid. Payment will be full compensation for furnishing all labor, materials, equipment, tools, and incidentals suitable for effecting the transfer of systems as specified. Items for payment under this lump sum amount include, but are not limited to, maintenance of existing sewage flows, excavation and location of the new connection point, diversion of sewage flow from the connection point, associated pumping/dewatering of connection area, making the physical connection including all fittings and appurtenances, transfer of sewage flow to the new system, abandonment of existing system, and furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
628.28 Ductile Iron Sewer Pipe, Cement-Lined	Linear Foot
628.30 Re-Laying Sewer Pipe	Linear Foot
628.35 PVC Sewer Pipe	Linear Foot
628.42 Transfer to New System, Sanitary Sewer	Lump Sum

SECTION 629 – WATER SYSTEMS

629.01 DESCRIPTION. This work shall consist of the construction or re-construction of water lines and appurtenances.

629.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Granular Backfill for Structures	704.08
Plastic Pipe, Flexible	740.01
Plastic Pipe, Rigid (PVC)	740.02
Copper Tube, Seamless	740.04
Ductile Iron Pipe, Cement-Lined	740.07
Chlorine Solution	742.01

Crushed stone bedding shall meet the requirements of Subsection 704.02 for Coarse Aggregate for Concrete.

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Concrete shall be Class B, unless otherwise specified, and shall conform to the requirements of Section 541.

Sleeves shall conform to the requirements of Section 625.

Crushed stone used for pipe bedding shall meet the gradation requirements of Table 704.02B.

Ductile iron fittings shall be so-called compact or short-bodied fittings.

The Engineer will approve corporation stops for use on a project after consultation with the utility owner but prior to the stops being ordered by the Contractor.

629.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing water facilities without prior written approval of the Engineer.

When existing underground utilities, which are not scheduled for removal or abandonment, are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

Any work associated with existing water lines or appurtenances shown on the Plans to be removed or abandoned in place shall be performed as an incidental item of construction.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All such material that is damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled to avoid shock. Pipe having factory-applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be stored in a safe manner at locations selected by the Contractor and approved by the Engineer.

The Engineer will approve the location of all pipes.

629.04 EXCAVATION. Where the pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe. The bedding and backfill material under and around the pipe shall be compacted per the applicable material specification. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width.

Ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation material encountered at the normal grade of the pipe bed shall be removed and replaced with Granular Backfill for Structures. The width of the pipe bed shall be equal to the inside diameter of the pipe plus 24 inches. The minimum depth shall be 12 inches below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

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No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

The Contractor shall always conduct operations to prevent the accumulation of water, ice, and snow in excavations or near excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used for drainage of excavations.

Where pipes are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to a height of 3 feet plus one pipe diameter above the designed grade of the pipe.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

629.05 BEDDING FOR PIPE. Ductile iron pipe shall be laid on suitable soil and backfilled and compacted to the centerline of the pipe with select material. Select material shall be sand, gravel, or suitable material excavated from the trench, and free from rocks, foreign materials, and frozen earth.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

629.06 LAYING PIPE. Installation of all water lines shall be in accordance with latest revisions of *ANSI/AWWA C 600,* "10 States Standards" *Recommended Standards for Water Works* and *Recommended Standards for Wastewater Facilities,* the standards of the Vermont Drinking Water and Ground Water Protection Division, and as specified.

Pipe laying shall begin at the outlet end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects, and no pipe or fittings that are known to be defective shall be laid. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

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The pipe shall be laid to conform to the lines and grades indicated on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a closed joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be driven home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped."

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The use of concrete reaction blocking shall be limited to caps, tees, hydrants, and bends of 22.5° and greater. Blocking shall be placed only on the sides of each fitting in the direction of thrust and not underneath for use as a foundation or support. All other bends less than 22.5° shall be restrained by use of retainer glands at each bend and at all joints within three pipe lengths on each side of the bend.

Separation of water mains and sewers shall conform to the requirements of Subsection 628.13.

629.07 JOINING PIPE. Water pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gauges shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

The electrical conductivity of the pipeline and attached services shall be maintained at all joints, couplings, valves, and fittings through the use of three brass wedges at each joint, or with conduction straps. No couplings shall be made at any point on the pipeline or attached services without incorporating provisions to maintain electrical conductivity.

Any fittings showing a crack, and any fitting or pipe which has received a severe blow that may have caused a fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

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Water pipe shall be cut by means of a handsaw, "metal-inserted" abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

629.08 SETTING OF VALVES AND FITTINGS. Valves, fittings, plugs, and caps shall be set and joined to pipe in the manner specified above for laying and joining pipe.

A valve box or masonry pit shall be provided for every valve.

A valve box shall be provided for every valve that has no gearing or operating mechanism or in which the gearing or operating mechanism is fully protected with a gear case. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or other such level as directed by the Engineer.

A masonry valve pit shall be provided for every valve that has exposed gearing or operating mechanisms. The valve nut shall be readily accessible for operation through the opening in the manhole, which shall be set flush with the surface of the finished pavement or such other level as specified by the Engineer. Pits shall be constructed to permit minor valve repairs and afford protection to the valve and pipe from impact where they pass through the pit walls.

Mains shall be drained through drainage branches or blow-offs to dry wells from which the water can be pumped. Drainage branches, blow-offs, air vents, and appurtenances shall be provided with valves and shall be located and installed as shown on the Plans.

Drainage branches or blow-offs shall not be connected to any sewer, submerged in any stream, or be installed in any other manner that will permit back siphonage into the distribution system.

All dead ends of new mains shall be closed with plugs or caps; such dead ends shall be equipped with suitable blow-off facilities.

Corporation stops shall, in all instances, be tapped into the main on the side in a horizontal position or in such a position as will provide a minimum of 5 feet of cover over the connecting service line. The main shall be tapped by skilled workers and the stop installed in accordance with the manufacturer's recommendations at the locations shown on the Plans or as directed the Engineer. The stops may be installed later, at which time the main may be tapped under pressure. All defective taps shall be repaired or replaced at the Contractor's expense.

Prior to installation, the Contractor shall thoroughly clean all exposed portions of any valves, removing all labels and all traces of foreign substance using only a cleaning solution approved by the manufacturer of the valve and being careful to avoid all damage to surfaces and coatings.

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629.09 SETTING OF HYDRANTS. Hydrants shall be located as shown on the Plans or as directed so as to provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians.

When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap is less than 6 inches or more than 12 inches from the gutter face of the curb.

When set in the lawn space between the curb and the sidewalk, or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within 6 inches of the sidewalk.

All hydrants shall stand plumb and shall have their nozzles parallel with, or at right angles to, the curb, with the pumper nozzle facing the curb, except that hydrants having two hose nozzles 90° apart shall be set with each nozzle facing the curb at an angle of 45°. Hydrants shall be set to the established grade, with nozzles at least 12 inches above the ground, as shown or as directed by the Engineer.

Each hydrant shall be connected to the main with a 6 inches or larger branch controlled by an independent gate valve, unless otherwise specified.

If, as determined by the Engineer, the waste opening of any hydrant will be below the normal sub-surface water elevation, the waste opening shall be securely plugged and no drainage pit will be required.

Wherever a dry-barrel hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 6 inches above the waste opening in the hydrant, and 12 inches around the elbow. No drainage system shall be connected to a sewer.

Wherever a dry-barrel hydrant is set in clay or other impervious soil, a drainage pit 24 inches wide × 24 inches long × 3 feet deep shall be excavated below each hydrant and backfilled with coarse gravel or crushed stone mixed with coarse sand, and compacted under and around the elbow of the hydrant to a level of 6 inches above the waste opening. No drainage pit shall be connected to a sewer.

629.10 ANCHORAGE. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with stone slabs or concrete backing, or the hydrant shall be tied to the pipe with suitable metal tie rods, clamps, or retainer glands as shown on the Plans or directed by the Engineer.

All plugs, caps, tees, and bends, unless otherwise specified, shall be provided with a reaction backing, or movement shall be prevented by attaching suitable metal rods or clamps as shown or specified.

Concrete reaction backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown on the Plans or directed by the Engineer. The backing shall, unless otherwise shown or directed, be placed in such a manner as to contain the resultant thrust forces in such a way that the pipe and fitting joints will be accessible for repair.

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A metal harness of tie rods, clamps, or retainer glands of adequate strength to prevent movement may be used instead of concrete backing, as directed by the Engineer. Steel rods or clamps shall be galvanized or otherwise rustproofed, or shall be painted as shown or directed by the Engineer.

629.11 PRESSURE AND LEAKAGE TESTS. Except as otherwise directed, all pipelines shall be tested. Pipelines laid in excavation or bedded in concrete shall be tested prior to field painting. Pipe to be insulated shall be tested prior to installing insulation.

The Contractor shall furnish all gauges, testing plugs, caps, and all other necessary equipment and labor to perform leakage and pressure tests in sections of an approved length. Each valved section or a maximum length of 1,000 feet of pipe shall be tested. The Contractor shall provide and bear the costs of any additional taps to the waterline necessary to perform the pressure and leakage test between valves.

All water required for testing shall be potable. All testing shall be conducted in the presence of the Engineer.

The Contractor shall make the necessary provisions to tap the pipe at the high point to release all air and shall plug the pipe after completing the test. Hydrants or blow-offs located at high points may be used for air release instead of taps if approved by the Engineer.

For the pressure test, the Contractor shall develop and maintain for two hours, 150% of the working pressure measured in pounds per square inch. Failure to hold the designated pressure for the two-hour period will constitute a failure of the section tested.

The leakage test shall be performed for a duration of two hours, only after the pressure test has been satisfactorily completed. During the leakage test, the Contractor shall measure the quantity of water required to maintain the maximum operating pressure of the main. Leakage shall not exceed allowable values for leakage presented in Table 6B of the latest revision of *ANSI/AWWA C 600*. All testing shall be conducted in accordance with the latest revision of *ANSI/AWWA C 600*.

Should any section of pipe fail either the pressure or leakage test, the Contractor shall do everything necessary to locate and repair or replace the defective pipe, fittings, or joints at no expense to the Agency.

If for any reason the Engineer should alter the foregoing procedure, the Contractor shall remain responsible for the tightness of the line within the above requirements.

629.12 DISINFECTING. Before being placed in service, the pipeline, valves, hydrants, etc., shall be chlorinated in accordance with the latest revision of *ANSI/AWWA C 651*. The entire procedure of chlorinating the pipes shall be approved by the Engineer two weeks prior to the time the work is to be done. The methods to be employed shall be fully satisfactory to the Engineer before they are applied. The location of chlorination and sampling points is to be determined by the Engineer in the field.

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The general procedure for chlorination shall be to first flush out the lines until all dirty or discolored water has disappeared, then to apply the chlorine in approved dosages through a tap at one end of the line while water is being drawn at the other extremity of the line until the entire line contains chlorine solution. The chlorine solution shall remain in the pipeline for a period of 24 hours.

Within 24 hours following the chlorination period, all treated water shall be flushed from the lines or portions thereof at their extremities and replaced with water from the distribution system.

Special disinfecting procedures shall be used as directed by the Engineer where the above outlined method is not practical, and when making connections to existing mains. The Contractor shall provide all necessary apparatus, materials, and labor for disinfecting the mains and shall make the required taps for this purpose. Disinfection of the mains shall be under the immediate direction of the Engineer during all phases of the work.

Prior to being placed in operation for domestic use, all new portions of the system shall be flushed, pressure tested, disinfected, and flushed again. Following this procedure, at least two water samples shall be collected from representative sample points and sent to the Vermont Department of Health Laboratory or other testing laboratory approved by the Vermont Department of Health, for bacteriological testing. Passing sample results are required before the system may be placed on line for drinking. Sample bottles shall be obtained from the same laboratory.

629.13 HOUSE CONNECTIONS. Service lines disrupted within the construction limits shall be replaced as ordered by the Engineer. The actual location of each ordered house connection shall be determined in the field by the Engineer.

All service lines shall be seamless copper water tube from the corporation stop to the curb stop. The copper tubing shall be attached to the corporation stop and curb stop in a manner satisfactory to the Engineer. Sufficient slack shall be left adjacent to the corporation stop and curb stop to prevent damage to the copper tubing by movement of the pipeline. Care shall be exercised in the placing and laying of copper tubing to be sure that the pipe does not have kinks or lie directly on sharp stones or ledge which would cause damage to the pipe. The Contractor shall place at least 6 inches of selected material as approved by the Engineer, adjacent to, above, and below the tubing.

In making cuts in copper service pipe, a cutter or tool designed for tube cutting must be used. The tubing shall be reamed, and after placing the coupling nut on the pipe, the pipe shall be flanged, using a flanging tool designed particularly for this purpose, and connected. A compression fitting may also be used.

All services shall be tested for leakage, and in all instances, the corporation stops shall be left in the open position upon completion of the installation.

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The Contractor shall install the curb stop and the curb box at the end of the service line, usually at the approximate property line, or as shown on the Plans and connect the stop to the water main with new copper tubing. The curb box shall be installed vertically and centered over the operating key, with the elevation of the top adjusted to conform to the finished grade. The Contractor shall adequately support the box during backfilling to maintain its vertical alignment. The Contractor shall also ensure that the curb box does not rest on the curb stop owner's services and furnish any adapters and/or special couplings needed for these connections.

Any necessary piping from the curb stop to the existing service shall match the existing service line, unless otherwise directed by the Engineer. If no service exists, the Contractor shall furnish a curb stop for connection to a copper service line.

Iron pipe threads shall be supplied under the tube nuts of curb stops and corporation stops.

629.14 BACKFILLING.

(a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.

(b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps or stones over 1 inch in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

(c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 12 inches over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

(d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation, or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, or stones larger than 6 inches in the widest dimension.

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If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 6 inches thick or as approved by the Engineer. Previously placed or new material shall be moistened by sprinkling, if required, to ensure proper bond and compaction and shall conform to the requirements of Subsection 203.11(d).

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.

Backfill material shall be compacted to the maximum dry density percentage specified in Table 629.14A and the in-place moisture content shall be not more than 2% above the optimum moisture content, as determined by *AASHTO T 180,* Method C.

TABLE 629.14A – MAXIMUM DRY DENSITY FOR BACKFILL

Backfill Location	Maximum Dry Density (%)
Around all structures, under roadway paving, shoulders, and embankments	95
All other areas	90

629.15 THIS SUBSECTION RESERVED.

629.16 WATER SYSTEM TRANSFER. The Contractor shall maintain existing water service during construction of the new water distribution systems and during the connection of the new system to the existing system. The Contractor shall submit to the system owner, and where required, to The State of Vermont Drinking Water and Ground Water Protection Division, a detailed construction schedule and procedure for transferring service from the existing system to the new system and shall receive approval(s) of the submittal prior to beginning work on the system.

Prior to making the transfer, the Contractor shall notify the owner and the Engineer 3 calendar days in advance, in writing, that the system is ready to be transferred.

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After the new connection is made, the Contractor shall divert the water to the new water main, disinfect the system, transfer affected individual service lines to the new water main, and abandon the existing system as shown on the Plans or directed by the Engineer.

629.17 METHOD OF MEASUREMENT. The quantity of Water Pipe to be measured for payment will be the number of linear feet of the size, type, and class specified installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Extension Service Box and Curb Stop measured for payment will be the number of units of each installed in the complete and accepted work.

The quantity of Valves, Hydrants, and Tapping Sleeves to be measured for payment will be the number of units of each size and type specified installed in the complete and accepted work.

The quantity of Meter Pit measured for payment will be the number of units of each installed in the complete and accepted work including all interior piping and appurtenances.

The quantity of Corporation Stop to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Expansion Assembly to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Transfer to New System, Water System to be measured for payment will be on a lump sum basis for each transfer in the complete and accepted work.

The quantity of Crushed Stone Bedding to be measured for payment will be the number of tons of material installed in the complete and accepted work, as determined by load tickets.

629.18 BASIS OF PAYMENT. The accepted quantity of Adjust Elevation of Valve Box, Relocate Hydrant, or Remove Hydrant will be paid for at the Contract unit price per each. Payment will be full compensation for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantities of Water Pipe will be paid for at their Contract unit price per linear foot. Payment will be full compensation for furnishing, transporting, handling, installing, testing, and disinfecting the materials specified, including fittings and clamps; for making all necessary connections; for furnishing and placing the concrete or other materials for reaction backing or furnishing and installing tie rods, clamps, and restrained joints; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

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The accepted quantities of Extension Service Box and Curb Stop units, Valves, Hydrants, Tapping Sleeves, and Expansion Assembly will be paid for at their respective Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, installing, and testing all materials, including fittings and clamps, for painting hydrants and constructing drainage pits; for furnishing and placing concrete or stone slabs for reaction backing or furnishing and installing tie rods and clamps; and for all other costs incidental to the work including any cost involved for shipping, rental, or royalty charges, or for manufacturer's supervision in conjunction with the special work of installing valves.

The accepted quantity of Meter Pit will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing all materials, tools, labor, and equipment suitable for installing the meter pit. The unit price includes, but is not limited to, reinforced concrete, concrete fill, wall sleeves and caulking, insulation, control system, hatch and ladder, interior piping and fittings, pipe supports, gate valves, flow meter or other measuring device, and all other costs incidental to the work including any manufacturer's supervision in conjunction with the special work of installing valves and meters.

The accepted quantity of Corporation Stop will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, and connecting the stops and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Transfer to New System, Water System will be paid for at the Contract unit price per lump sum. Payment will be full compensation for performing all work items as directed by the Engineer to abandon existing mains, including but not limited to cutting and capping existing mains and laterals, closing existing valves and curb stops, removing existing valve boxes and curb boxes, and removal of any existing main which conflicts with the construction necessary to complete the transfer to the new system, including disinfection; for providing specialized labor, materials, tools, and equipment for effecting the transfer of systems as specified, and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantity of Crushed Stone Bedding will be paid for at the Contract unit price per ton. Payment will be full compensation for furnishing, transporting, handling, placing, and grading the material as specified and for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic yard as Trench Excavation of Earth or Trench Excavation of Rock under Section 204. When material is required to replace poor foundation material below the normal grade of the pipe, it will be paid for as Granular Backfill for Structures.

The utility owner will provide the services of a professional engineer to oversee construction of the waterline, to ensure that State requirements are met and to sign and stamp all paperwork required by the Water Supply Division of the Department of Environmental Conservation, Agency of Natural Resources. The professional engineer shall advise the Engineer, and the Engineer will provide direction to the Contractor.

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Payment will be made under:

Pay Item	Pay Unit
629.20 Adjust Elevation of Valve Box	Each
629.23 Seamless Copper Water Tube	Linear Foot
629.24 Ductile Iron Water Pipe, Cement-Lined	Linear Foot
629.25 Extension Service Box and Curb Stop	Each
629.26 Gate Valve	Each
629.27 Gate Valve with Valve Box	Each
629.28 Hydrant	Each
629.29 Relocate Hydrant	Each
629.30 Remove Hydrant	Each
629.31 Meter Pit	Each
629.32 Plastic Water Pipe, Flexible	Linear Foot
629.33 Plastic Water Pipe, Rigid	Linear Foot
629.35 Tapping Sleeve and Valve with Valve Box	Each
629.39 Corporation Stop	Each
629.40 Expansion Assembly	Each
629.42 Transfer to New System, Water System	Lump Sum
629.54 Crushed Stone Bedding	Ton

SECTION 630 – UNIFORMED TRAFFIC OFFICERS AND FLAGGERS

630.01 DESCRIPTION. This work shall consist of furnishing uniformed traffic officers (UTOs) and flaggers for the handling of traffic in, around, and through work zones. Wherever used in this section, the term "flaggers" shall mean "highway flaggers." UTOs and flaggers collectively are also referred to as traffic control personnel. UTOs and flaggers shall be used to control and protect the traveling public and workers during construction operations as directed by the Engineer. Flaggers and UTOs shall conform to the requirements of the Contract and the current edition of the *MUTCD* and its latest revisions.

630.02 GENERAL.

(a) Standard Procedures. The Contractor shall designate a person responsible for coordinating traffic control personnel in accordance with the reviewed for conformance traffic control plan and as directed by the Engineer.

Traffic Control Personnel determined by the Engineer to be ineffective in their duties as specified herein, shall be removed by the Contractor from all traffic control on the project. The Contractor shall immediately comply with the directive from the Engineer and shall suspend operations as necessary until a replacement, meeting the qualifications as specified herein, can be provided. Such a suspension of operations shall not be considered as a basis for a Claim or an extension of time.

(b) Safety Apparel. Traffic control personnel shall wear safety apparel in accordance with the most current edition of the *MUTCD* and its latest revisions. Traffic control personnel deemed to have unsuitable safety apparel by the Engineer shall be considered ineffective and shall be removed.

When operating during nighttime hours, between sunset and sunrise, traffic control personnel shall wear safety apparel meeting or exceeding performance Class 3 requirements of *ANSI/ISEA 107*, including Class E pants or gaiters.

(c) Communication. The Contractor shall equip all traffic control personnel on the project with two-way radios capable of maintaining all necessary communication within the work zone. The traffic control personnel shall use these radios to maintain communication and coordination whenever distance, noise, intervening operations, dust, and/or other conditions make it difficult or impossible to communicate on a line-of-sight basis and/or whenever the use of two-way radios is ordered by the Engineer. The Contractor shall always keep sufficient spare batteries, parts, and complete units on the project so that no individual performing traffic control is without a working two-way radio for a period longer than 10 minutes.

Without exception, when two-way radios are required and a person performing traffic control is without a working two-way radio for more than 10 minutes, that person will either be supplied with a working two-way radio or be considered ineffective, removed in the manner set forth in Subsection 630.04, and replaced with a person with a working two-way radio.

630.03 UNIFORMED TRAFFIC OFFICERS (UTOs).

(a) Requirements. A UTO shall be a law enforcement officer who has law enforcement authority at the location where the services are provided.

UTOs shall wear a uniform approved by their law enforcement department with an exposed badge that clearly identifies them as a law enforcement officer. When operating outside the vehicle, the UTO shall wear safety apparel in accordance with Subsection 630.02.

UTOs shall be accompanied by a law enforcement vehicle with operating blue or blue and white law enforcement signal lamps as permitted under *23 V.S.A. § 1252*. The signal lamps on a UTO's law enforcement vehicle shall be in operation when and where required by the approved Traffic Control Plan or as directed by the Engineer.

Law enforcement vehicles shall not be parked within 25 feet of the centerline of a railroad track.

(b) Equipment. When operating on the project during nighttime hours, between sunset and sunrise, UTOs shall be equipped with hand-held, lighted signals that display a red light suitable for directing traffic.

(c) Duties. UTOs shall perform the following duties in accordance with the Contract or as directed by the Engineer.

(1) Promoting voluntary compliance, by motorists, with speed and other rules of the road through an obvious presence. This may include the presence of marked law enforcement vehicles displaying law enforcement signal lamps, the presence of a UTO in or near the highway, and/or signage indicating their presence. This presence is generally stationary, with a law enforcement vehicle serving as an advanced warning signal and the UTO usually positioned outside the vehicle, to direct or control traffic as necessary.

(2) Directing and controlling traffic, including at intersections with non-functioning or malfunctioning signals.

(3) Serving as a Flagger.

630.04 FLAGGERS.

(a) Requirements. The Contractor shall verify that Flaggers meet the following requirements. Flaggers shall have successfully completed a 4-hour training course taught by a certified instructor within the last 24 months and shall carry proof of training at all times when on the project. Certified instructors shall have successfully completed one of the following courses:

(1) Associated General Contractors of VT Traffic Control Technician/Flagger Trainer Course

(2) American Traffic Safety Services Association Flagger Instructor Training Course

(3) National Safety Council Flagger Instructor Course

(b) Equipment. Flaggers shall be equipped with a STOP/SLOW paddle signaling device as detailed in Part 6E.03 of the *MUTCD*.

(c) Duties. Flaggers shall be used to stop and release traffic within a designated work zone or where the entrance or exit of construction equipment or other construction activity constitutes a hazard to the traveling public or as directed by the Engineer. Flaggers shall not be used to direct traffic at intersections.

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630.05 METHOD OF MEASUREMENT. The quantities of Uniformed Traffic Officers and Flaggers to be measured for payment will be the number of hours for each as authorized by the Engineer. No additional allowance will be made for premium time (overtime), and no allowance or payment will be allowed for the required four-hour training.

630.06 BASIS OF PAYMENT. The accepted quantities of Uniformed Traffic Officers and Flaggers will be paid for at the Contract unit price per hour. Payment will be full compensation for hiring, training, transporting, and supervising; for furnishing clothing, badges, vehicles, law enforcement signal lamps, signs, lighting devices, reflectorized equipment; for providing all taxes and insurance; and for furnishing all radios and other equipment, materials, and incidentals necessary to perform this work.

When the items for Uniformed Traffic Officers or Flaggers are not included in the Contract, or when Uniformed Traffic Officers or Flaggers are employed by the Contractor without authorization by the Engineer, the costs will not be paid for directly but will be considered incidental to all other Contract items.

Payment will be made under:

Pay Item	Pay Unit
630.10 Uniformed Traffic Officers	Hour
630.15 Flaggers	Hour

SECTION 631 – FIELD OFFICE

631.01 DESCRIPTION. This work shall consist of furnishing, erecting, equipping, and maintaining Field Offices and testing equipment. The work shall include cleaning, supplying utility services, office furniture, equipment, and supplies as required for the exclusive use of the Agency engineering staff at locations approved by the Engineer. Upon completion of the project, the Field Office(s), furniture, accessories, and equipment provided shall remain the property of the Contractor.

The testing equipment and supplies are furnished for the use of the Agency during the term of the Contract and shall be subject to use by Agency personnel to conduct tests of any materials at any location as directed by the Engineer. Equipment furnished for testing of protective coatings will be used by the Engineer as required by the Contract.

631.02 FIELD OFFICES.

(a) General. Field Offices shall be available solely to the representatives of the State and the Federal Government throughout the duration of use for the respective type of Field Office, and shall be removed when released by the Engineer. Field Offices and equipment shall always be maintained in working condition to the satisfaction of the Engineer, including adequate supplies.

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Field Offices shall not be located within any Operating Railroad right-of-way.

All Field Offices shall meet the following requirements:

(1) Foundation. Field Offices shall be constructed on a firm foundation that will remain vibration free and that will not be adversely affected by frost action or water runoff.

(2) Design. Field Offices shall be a commercial-type Field Office trailer of standard commercial quality, or a building, in good condition as determined by the Engineer with a minimum width of 10 feet. They shall have a minimum of two means of egress equipped with dead bolt locks and a minimum 4 foot × 4 foot deck with steps and railings in accordance with the VOSHA *Safety and Health Regulations for Construction*.

The Contractor shall provide the Engineer with three sets of keys. The Contractor shall not access the Field Office without approval of the Engineer.

For the commercial-type Field Office trailer, Field Offices shall have a minimum of four side windows, one front window, and one rear window. Standard buildings shall have sufficient windows to the satisfaction of the Engineer. All windows shall be glassed and screened with provisions for opening and locking and equipped with adjustable louvered blinds.

Field Offices shall have a lighting system capable of providing a minimum of 50 foot-candles on all work surfaces and shall have a minimum 400 W exterior security light.

(3) Electrical Service. Field Offices shall be equipped with a 110 V AC, 60 Hz, single-phase electrical system with service entrance equipment suitable for power company attachment and with at least twelve properly positioned interior electrical duplex outlets. The materials and installation methods of all electrical wiring, connections, switches, and grounds shall conform to the provisions of the *National Electrical Code* and shall be in accordance with all State and local electrical ordinances.

The Contractor shall be responsible for arranging the connection of the electrical service to the Field Office.

(4) Communications Services. Field Offices shall have independent telephone and internet services such that both can be used simultaneously without impacting functionality. Internet service shall have a minimum download speed of 3 Mbps and a minimum upload speed of 1 Mbps. Jacks for connection to internet and telephone services shall be located at each end of the Field Office for both services.

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When telephone and/or internet service is not practical, as determined by the Engineer, services may be omitted from the Field Office.

The Contractor shall be responsible for establishing all connections for communications services and maintaining communications services throughout the duration the Field Office is in use.

(5) Temperature Control. Field Offices shall have heating and cooling systems capable of maintaining a temperature of 68°F at all times. Field Offices shall have thermostats capable of controlling and displaying the interior temperature.

(6) Sanitary Facilities. Sanitary facilities consisting of a flush toilet, chemical toilet, or other approved type, including a waterless hand sanitizer, shall be furnished by the Contractor with proper sewage disposal as is necessary to comply with the requirements and regulations of the State and local Boards of Health and VOSHA. Sanitary facilities shall have adequate facilities for washing hands.

A potable water system consisting of a sink with a faucet within the office, with a continuous supply of pressurized clean potable water, shall be supplied for the duration of the project. When clean potable water is not available, a commercial bottled drinking water system shall be installed in the Field Office complete with necessary disposable drinking cups (8 oz. size or larger), cup dispenser, and continuous water supply furnished for the duration of the project. The system shall supply both hot and cold water. The system and the bottled water shall be furnished by a commercial water service on a regular basis agreeable to the Engineer.

(7) Office Equipment. All Field Offices shall contain the following standard commercial-quality office equipment, with substitutions allowed upon approval of the Engineer:

1 Standard office desk a minimum of 60 inches wide × 30 inches deep and with drawers, locks, and keys

4 Ergonomic office chairs with adjustable lumbar support, adjustable height, and rolling casters

2 Adjustable height drafting stools

1 Secure, four-drawer, legal-size file cabinet, fire-resistant (rated to withstand a one-hour fire) with lock and two keys

1 Telephone with touch tone dial, compatible with the local telephone service available and capable of receiving and storing messages

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2 30-gallon trash cans with trash bags

1 Electric clock having a dial face at least 8 inches in diameter

1 First aid kit conforming to the latest revision of *ANSI/ISEA Z 308.1*

1 Halon fire extinguisher, equal in fire-fighting capacity to a 5-pound carbon dioxide fire extinguisher, or as needed in accordance with OSHA requirements

1 Outdoor thermometer, weatherproof, easy to read, and having a minimum scale range of -40°F to 120°F in graduations of 2°F

Field Offices shall be provided with ventilation and gas connections as required.

The Contractor shall furnish all labor and materials for winterizing Field Offices.

(b) Field Office, Engineers. Field Office, Engineers shall be available for use 7 calendar days prior to any work commencing, including erection of construction approach signing, until 30 calendar days after final inspection of the project, unless otherwise directed by the Engineer.

In addition to Subsection 631.02(a), Field Office, Engineers shall meet the following requirements:

(1) Size. Field Office, Engineers shall have a minimum floor space of 360 square feet.

(2) Office Equipment. Field Office, Engineers shall contain the following standard commercial quality office equipment, with substitutions allowed upon approval of the Engineer:

1 Rain gauge

1 Standard drafting table a minimum of 72 inches wide × 37-1/2 inches deep

1 Storage cabinet a minimum of 36 inches wide × 24 inches deep × 24 inches high

1 Storage locker or closet of sufficient size for secure storage of surveying equipment

1 Printer/scanner/copier combination unit, inkjet minimum and color when deemed necessary by the Engineer, with a minimum tray capacity of 50 sheets and a minimum print speed of 10 sheets per minute. The combination unit shall be capable of handling 11 × 17-inch sheets. The combination unit shall be compatible with Microsoft Windows 7 and later versions and shall have wired and wireless network capabilities.

The printer/scanner/copier combination unit shall have an anti-static vinyl dust cover and a stand of sufficient size and strength to support the unit. Supplies for the printer/scanner/copier shall include 8-1/2 × 11-inch paper, 11 × 17-inch paper, and ink or toner in black and color as applicable.

All furnished equipment shall be maintained in good working order. Replacement equipment shall be provided within 48 hours for all equipment that is damaged, stolen, or becomes inoperative in any way.

The Contractor shall provide training to the Engineer in the use of the furnished equipment.

(c) Field Office, Soils and Materials. Field Office, Soils and Materials shall be available for use from the day the Contractor commences any work requiring the testing of soils and materials until 30 calendar days after acceptance of the project, or upon release by the Engineer.

In addition to Subsection 631.02(a), Field Office, Soils and Materials shall meet the following requirements:

(1) Size. Field Office, Soils and Materials shall have a minimum floor space of 240 square feet.

(2) Office Equipment. Field Office, Soils and Materials shall contain the following standard commercial quality office equipment with substitutions allowed upon approval of the Engineer.

1 Bench top cabinet, approximately 36 inches high and 24 inches wide with a minimum bench area of 32 square feet and a minimum storage area of 32 square feet using a suitable combination of fully-enclosed shelf space and drawers

1 Sink with gooseneck faucet located within the office, with a continuous supply of pressurized, clean, potable water for the duration of the project

(3) Testing Equipment and Supplies. Field Office, Soils and Materials shall contain the following testing equipment and supplies at a minimum with substitutions allowed upon approval of the Engineer.

1 Balance scale with a 20-pound minimum capacity accurate to 0.2 ounces

1 Scale with a 2-pound minimum capacity accurate to 0.004 ounces

1 Double-burner electric hot plate with variable temperature controls

1 Electric motorized sieve shaker, with either rocking and tapping action or circular and tapping action, with a capacity of at least six sieves, cover, and 8-inch diameter pan, confined in a dust-retaining enclosure

1 Set of U.S. Standard Sieves, brass, 8-inch diameter, full height, woven wire, meeting the requirements of *ASTM E 11*. The required sieves are as follows:

1	4 inch (100.0 mm)	1	3-1/2 inch (90.0 mm)
1	3 inch (75.0 mm)	1	2-1/2 inch (63.0 mm)
1	2 inch (50.0 mm)	1	1-3/4 inch (43.0 mm)
1	1-1/2 inch (37.5 mm)	1	1 inch (25.0 mm)
1	3/4 inch (19.0 mm)	1	5/8 inch (16.0 mm)
1	1/2 inch (12.5 mm)	1	3/8 inch (9.50 mm)
2	No. 4 (4.75 mm)	2	No. 8 (2.36 mm)
2	No. 10 (2.00 mm)	2	No. 16 (1.18 mm)
2	No. 30 (0.600 mm)	2	No. 40 (0.425 mm)
2	No. 50 (0.300 mm)	2	No. 100 (0.150 mm)
4	No. 200 (0.075 mm)	3	8-inch sieve pans
3	8-inch sieve covers		

(4) Additional Equipment. Additional equipment and supplies will include the following items:

2 Pairs of safety gloves, 14 inches in length and capable of withstanding temperatures up to 1,110°F

1 Brush, brass (wire bristle)

1 Broom, standard floor type

1 Shovel, round-pointed with D-handle

1 Shovel, square-pointed with D-handle

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2 Heavy canvas sheets, 4 feet long × 2-1/2 feet wide, for quartering samples

10 Aluminum moisture cans, 3-1/2 inches in diameter × 2 inches deep

2 Paint brushes, soft bristle, 2 inch

4 Table brushes, 2 inches × 8 inches

1 Mason's trowel, pointed, 8 inch

4 Plastic dish pans, 14 inches long × 12 inches wide × 5 inches deep

8 Cake pans, 9 inches long × 9 inches wide × 2 inches deep

1 Grain scoop, 6 inch

1 Spatula with 10 inch × 1-1/8 inch blade

2 Mixing spoons, heavy duty plated steel, 12 inches long

4 Microwaveable pans a minimum of 8 inches long × 8 inches wide × 2 inches deep

1 Compaction mold, 4 inches in diameter and meeting the requirements of *AASHTO T 99*

1 Rammer, 5-1/2 pounds in weight and meeting the requirements of *AASHTO T 99*

1 Straightedge, steel and meeting the requirements of *AASHTO T 99*

1 Density apparatus consisting of a sand cone and baseplate and meeting the requirements of *AASHTO T 191*

2 One-gallon mason jugs with standard "G" mason jar top threading with covers

1 Carrying box, cushioned, for the two one-gallon mason jugs

2 One-gallon metal cans with moisture-proof friction covers and handles (similar to paint cans)

1 Two-pound rubber mallet with 10-inch handle

1 Storage box to of adequate size to contain the compaction testing equipment

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Standard Ottawa Sand meeting the requirements of *ASTM C 778,* Section 3.1 shall be supplied in the amount of approximately 100 pounds of sand for every 50,000 cubic yards of embankment.

A microwave oven that meets the following requirements:

a. A minimum rating of 500 Watts

b. A digital display of power level and time

c. A minimum internal volume of approximately 0.7 cubic feet. The interior dimensions shall be approximately 11 inches long × 11 inches wide with by an acceptable height. The interior dimensions shall be of adequate size to accept the microwaveable pans listed in this subsection.

d. A minimum of ten adjustable power levels

When compaction testing in accordance with *AASHTO T 180* is required, the following additional equipment shall be supplied by the Contractor:

1 Rammer, 10 pounds in weight and meeting the requirements of *AASHTO T 180*

All the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes. All calibration records shall be available to the Engineer.

Equipment provided for Testing Equipment, Concrete, Testing Equipment, Bituminous or Testing Equipment, Grout, when such equipment is also in the Contract, will not be considered common to the testing equipment for Field Office, Soils and Materials and is not to be used as such.

631.03 THIS SUBSECTION RESERVED.

631.04 THIS SUBSECTION RESERVED.

631.05 TESTING EQUIPMENT, CONCRETE. The following equipment shall be provided to perform concrete field tests:

1 Cylinder test set meeting the requirements of *AASHTO T 23*

1 Slump test set meeting the requirements of *AASHTO T 119 M/T 119*

1 Platform beam scale sensitive to 0.01 pounds with a minimum capacity of 100 pounds

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1 Wheelbarrow, steel "contractor's grade"

1 Shovel, square-pointed with D-handle

1 Pressure air meter meeting the requirements of *AASHTO T 152* and all accessory items required for use with the particular design of apparatus used. Accessory items shall include a flat, rectangular, metal plate at least 1/4 inch thick, a glass or acrylic plate at least 1/2 inch thick, or a wire reinforced glass plate at least 1/4 inch thick with a length and width at least 2 inches greater than the diameter of the measuring bowl of the air meter with which it is to be used

1 Concrete curing box of standard commercial quality and designed to maintain an internal water temperature of 70°F ± 10°F and 100% humidity. One or more curing boxes shall be supplied to meet specimen requirements for the project.

1 Straightedge, a minimum of 10 feet long

For testing Class LW concrete, the following additional testing equipment shall be provided:

1 Volumetric air meter meeting the requirements of *AASHTO T 196 M/T 196*, supplied with a wooden carrying case, syringe, tamping rod, measuring vessel, and baffle

1 One-unit weight measure meeting the requirements of *AASHTO T 121 M/T 121*, supplied with a flat, rectangular, metal plate at least 1/4 inch thick, a glass or acrylic plate at least 1/2 inch thick, or a wire reinforced glass plate at least 1/4 inch thick with a length and width at least 2 inches greater than the diameter of the measuring bowl of the air meter with which it is to be used

All the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any concrete.

When the Contractor places concrete at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

When the equipment to be provided for concrete testing is required by the Contract, it will not be considered common to the equipment for gradation testing, compaction testing, or bituminous concrete testing and is not to be used as such.

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631.06 TESTING EQUIPMENT, BITUMINOUS. The following equipment shall be provided:

1 Straightedge, a minimum of 16 feet long

1 Straightedge, 10 feet in length

1 Shovel, round-pointed with D-handle

1 Thermometer, electronic hand-held with a digital display visible under all lighting conditions, a temperature range of -60°F to 1,200°F in increments of 2°F, automatic zero adjustment, and low battery indication, with instruction manual. The unit shall be completely self-contained and shall not require any external probes or other attachments to perform the required functions.

1 Probe thermometer

1 Micrometer with a capacity of 0 to 1 inch and calibrated in 0.1 mils

1 Building level with case. The level shall be a 48-inch electronic model, with bubble indicators, digital readout with a range of 0° to 90° degrees in 0.1° increments, percent slope from 0% to 100% in 0.1% increments, and pitch in inches of rise per foot of run. The level shall have the capability of being recalibrated.

1 Mechanical measuring wheel with a minimum wheel circumference of 3 feet and a sealed counter capable of measuring a minimum of 9,999 feet

1 Relative humidity pen

Black duct tape and tar paper or asphalt-treated felt shall be supplied in adequate amounts for the Engineer to perform necessary thickness and moisture testing.

All the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placement of any bituminous concrete or pavement markings.

When the Contractor places bituminous concrete or pavement markings at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

When the equipment to be provided for bituminous concrete testing is required by the Contract, it will not be considered common to equipment for gradation testing, compaction testing, or concrete testing and is not to be used as such.

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631.07 TESTING EQUIPMENT, PROTECTIVE COATINGS. The following equipment shall be provided:

1 Psychrometer kit with wet-bulb and dry-bulb thermometers for measuring dew point, meeting the requirements of *ASTM E 337,* Method B, with a range from 34°F to 110°F and an accuracy of ± 1°F. As a minimum the psychometer kit shall include matching thermometers with conversion charts and a thermometer for measuring the surface temperature of a steel object.

1 Thickness probe, electronic dry film, meeting the requirements of *ASTM D 7091*. The probe shall be capable of measuring a range of 0 to 60 mils with an accuracy of ± 2%.

1 Adhesion testing kit meeting the requirements of *ASTM D 3359,* Adhesion by Tape Test, Method A. As a minimum the adhesion testing kit shall include a cutting tool, a cutting guide, tape, rubber eraser, and an illuminated magnifier.

1 Surface profile kit meeting the requirements of *ASTM D 4417,* Method C. The surface profile kit shall include coarse and extra coarse tapes as specified in Section 6.3 with a minimum of one roll (100 pieces) of tape for each range, plus extras as required.

All the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The equipment furnished shall have been calibrated within one year or shall have appropriate means of being calibrated in the field.

631.08 TESTING EQUIPMENT, GROUT. For testing mortar, flowable fill, and other combinations of sand and cement, the following additional testing equipment shall be provided:

Specimen molds meeting the requirements of *AASHTO T 106 M/T 106*. The number of molds shall be sufficient to perform both the acceptance testing required for the Contract item and any necessary control of work testing. Each specimen mold shall be capable of producing 3 individual cubes.

1 Trowel having a steel blade 4 to 6 inches in length, with straight edges

1 Tamper meeting the requirements of *AASHTO T 106 M/T 106*

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any grout.

When the Contractor places grout at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

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When the equipment to be provided for grout testing is required by the Contract, it will not be considered common to the equipment for gradation testing, compaction testing, concrete testing, or bituminous concrete testing and is not to be used as such.

631.09 METHOD OF MEASUREMENT. The quantity of each type of Field Office and/or Testing Equipment to be measured for payment will be on a lump sum basis for each type specified and used on the project.

The quantity of Field Office Communications to be measured for payment will be to the nearest hundredth of a dollar for all communication services supplied. The Agency will include in the proposal a quantity of dollars for all communication services required. However, the Contractor will be reimbursed the actual costs of providing the communication services as evidenced by the paid bills submitted to the Engineer. **This sentence deleted.**

631.10 BASIS OF PAYMENT. The accepted quantity of each type of Field Office and/or Testing Equipment will be paid for at the Contract lump sum price for the specified item type. Payment will be full compensation for performing the work and furnishing all materials, labor, tools, equipment, and incidentals necessary to provide, construct, install, maintain, and remove the type of field office and/or testing equipment specified, including the installation, removal and connection of communications lines and waste removal. Replacement of equipment that becomes unsuitable and providing supplies that become exhausted will not be paid for directly but will be considered incidental to the Contract item they are furnished under.

Payment for this work will be made as follows:

(a) The first 25% will be paid after each specified office and/or equipment unit has been installed on the project in full working order.

(b) The second payment of 25% will be paid when 33% of the anticipated construction time has expired.

(c) The third payment of 25% will be paid when 67% of the anticipated construction time has expired.

(d) The fourth and final payment of 25% will be paid upon completion and acceptance of the project.

The quantity of Field Office Communications to be paid will be the total dollar value of all communications bills, paid by the Contractor, for providing all telephone and internet services supplied to the field office(s). The total will be limited to the total of paid communications bills submitted to the Engineer.

The cost of furnishing separate telephone lines, including installation and removal, will not be paid for directly, but will be considered incidental to the appropriate Field Office item. The monthly service charges will be paid under Field Office Communications. Payment for this work will be made upon receipt of each paid communications bill submitted to the Engineer.

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Payment will be made under:

Pay Item	Pay Unit
631.10 Field Office, Engineers	Lump Sum
631.11 Field Office, Soils and Materials	Lump Sum
631.16 Testing Equipment, Concrete	Lump Sum
631.17 Testing Equipment, Bituminous	Lump Sum
631.18 Testing Equipment, Protective Coatings	Lump Sum
631.19 Testing Equipment, Grout	Lump Sum
631.26 Field Office Communications (N.A.B.I.)	Dollar

SECTION 632 – RAILROAD FLAGGERS

632.01 DESCRIPTION. This work shall consist of maintaining Operating Railroad traffic and coordinating with the Agency and the Operating Railroad for inspection and review of the Contractor's work in conjunction with construction operations. A Railroad Flagger shall be requested any time construction operations will be within 25 feet of the nearest rail or within the Operating Railroad right-of-way, whichever is furthest.

632.02 GENERAL REQUIREMENTS. A Railroad Flagger shall be a person who is furnished, employed, and qualified by the Operating Railroad. When, as stipulated in the Contract, or in the opinion of the Engineer and the Operating Railroad, the construction work would cause hazard to the safe operation of trains and other facilities in the Operating Railroad right-of-way, including signal and communication lines, the Operating Railroad will furnish the necessary qualified employees to protect their trains and other facilities.

The Contractor shall provide advanced notice to the Operating Railroad prior to the commencement of any work, or any portion of the work, over or adjacent to the Operating Railroad right-of-way, so that necessary arrangements can be made by the Operating Railroad to protect Operating Railroad traffic.

Railroad Flaggers shall be required whenever the Contractor is performing work over, under, or adjacent to the Operating Railroad tracks or right-of-way such as excavation, sheeting, shoring, erection, or removal of forms; handling material. Railroad Flaggers shall be required whenever equipment is used which by swinging over or by failure could foul the track, or when any other type of work is being performed that, in the opinion of the Engineer or the Operating Railroad, requires such service.

The Contractor shall be required to plan, coordinate, and organize the work effort in a way that shall absolutely minimize the use and number of Operating Railroad protective personnel required. The Agency and the Operating Railroad will review and approve all Contractor work schedules prior to the commencement of work and prior to the assignment of protective personnel. Misuse of these protective services by the Contractor due to inadequate work procedures will not be allowed and shall be sufficient cause for the Agency to require the Contractor to bear all inappropriate costs.

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Operating Railroad train crews necessary for the operation of Contractor-scheduled work trains or Contractor-owned or leased locomotive equipment shall not be paid by the Agency under this section, as all such costs will be considered incidental to the Contractor's work and therefore shall be entirely borne by the Contractor.

632.03 CONSTRUCTION REQUIREMENTS. The Contractor shall obtain verification of the time and schedule of track occupancy from the Operating Railroad before proceeding with any construction or demolition work over, under, within, or adjacent to the Operating Railroad right-of-way.

All work to be done under, upon, or over the Operating Railroad right-of-way shall be performed by the Contractor in a manner satisfactorily to the Engineer and shall be performed at such times and in such manner as to not interfere with the movement of trains or traffic upon the tracks. The Contractor shall use all necessary care and precaution to avoid accidents, delay, or interference with the trains or other property.

The Contractor shall conduct the work and handle equipment and materials so that no part of any equipment should foul an operated track or wire line without the written permission of the Operating Railroad.

When it is noted that the work will foul an operating track, the Contractor shall give the Operating Railroad written notice 15 calendar days in advance so that, if approved, arrangements can be made for proper protection of the railroad.

632.04 SUBMITTALS.

(a) At the preconstruction meeting, the Contractor shall submit for approval by the Agency a detailed description of proposed methods for accomplishing the construction work required under the Contract, to include methods for protecting Operating Railroad traffic. Approval by the Agency shall not serve in any way to relieve the Contractor of complete responsibility for the adequacy and safety of the proposed methods.

(b) Prior to beginning work, the Contractor shall submit for the approval of the Engineer a detailed description of the procedures for work to be performed over, under, within, or adjacent to the Operating Railroad right-of-way. Work shall not proceed until the proposed procedures have been approved by the Agency.

632.05 METHOD OF MEASUREMENT. The quantity of Railroad Flaggers to be measured for payment will be in a quantity of dollars for the specified flagging and protective services provided.

632.06 BASIS OF PAYMENT. A value in dollars has been included in the bid proposal for flagging and protective services. Payment for Railroad Flaggers will be for reimbursing the Contractor for the actual invoice amounts paid to the Operating Railroad by the Contractor for flagging and protective services. The Contractor's overhead will not be reimbursed.

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The dollar amount will be adjusted to the actual amount paid to the Operating Railroad for flagging and protective services, after review and approval of paid invoices. No additional payment will be made under this item. All other costs for coordination and Railroad Flaggers in accordance with these provisions will be considered incidental.

If the Contract is not completed within the specified time limit for completion of the Contract (or authorized extended time), no payment will be made for any costs incurred beyond the specified time of completion.

Payment will be made under:

Pay Item	Pay Unit
632.10 Railroad Flaggers (N.A.B.I.)	Dollar

SECTION 633 – CRITICAL PATH METHOD (CPM) SCHEDULE

633.01 DESCRIPTION. This work shall consist of developing and furnishing a Critical Path Method (CPM) Schedule, including narratives, updates, and revisions for the duration of the Contract.

If item 633.10 CPM Schedule is included in the Contract, the provisions of this section shall supersede those of Subsection 108.03(a).

633.02 SUBMISSIONS.

(a) Scheduling Contract Work. The Contractor is responsible for the scheduling of all Contract work, which shall include, but is not limited to subcontracted work, complete and acceptable submissions, work component fabrications, and delivery of materials. The schedule shall include allowance for time for all aspects of the work including sufficient time for VTrans to perform its functions as indicated in the Contract, including but not limited to acceptance inspection and/or testing, and review and acceptance/approval of any submittals required in the Contract.

(b) Gantt Chart. The schedule shall be a Gantt chart prepared with Microsoft Project. Provide the following items with each schedule submission:

(1) An electronic copy in Microsoft Project format with run date and version of the schedule.

(2) A PDF illustrated in color, depicting no more than 50 activities on each 11 inch × 17 inch sheet, and with each sheet including title, project name and number, match data for diagram correlation, and a key.

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(3) A four-week, look-ahead narrative to provide a more detailed plan of upcoming work highlighting the near-term priorities. Indicate the anticipated workdays per week, number of shifts per day, number of hours per shift, crew sizes, and assumed resources. If the project requires a closure, identify any changes in anticipated resources, or work schedule during the closure period.

(c) CPM Schedule. The CPM schedule shall include the following items:

(1) Activities that describe the essential features of the work, activities that might delay Contract completion, and which activities are on the critical path.

(2) The planned start and completion dates for each activity and the duration of each activity stated in work days. Field activities more than 15 work days in duration shall be broken into two or more activities distinguished by location or some other logical feature. This estimated figure shall include considerations for permit limitations, seasonal limitations, and any other anticipated delays.

(3) When the project contains a defined closure period of a minimum of 24 hours and up to a maximum of 28 calendar days, the duration for work within the closure period shall be shown in hours instead of days. Except for cure times, the maximum duration of each activity within the closure period shall be limited to 12 hours.

(4) The finish-to-start relationships among activities, without leads or lags unless justified in the narrative, and approved by the Engineer.

(5) Distinct columns showing predecessors, successors, duration, actual start, and actual finish for each activity.

(6) Project suspension or work inactivity that is 3 calendar days or longer.

(7) Dates related to the procurement of materials, equipment, and articles of special manufacture. Any anticipated delays due to the procurement schedule shall be included.

(8) Dates related to the submission of working drawings, Plans, and other data specified for review or approval by the Agency.

(9) Key milestone dates specified in the Contract including but not limited to; Notice to Proceed, interim completion, permit restriction dates, and the Contract completion date. These shall be the only constraints in the schedule logic unless others are justified in the logic and approved by the Engineer.

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(10) Activities related to Agency or third-party reviews and inspections.

(d) High-Value Contracts. For Contracts with an original Contract amount in excess of $8,000,000.00, the following additional information shall be shown on the CPM schedule:

(1) Each Contract bid item identified with at least one activity, except for items paid by the lump sum, lump unit, hour, or dollar, Section 641 pay items, and Section 653 pay items.

(2) Each compensable activity shall identify the applicable Contract item(s), along with the total quantity intended to be placed during that activity.

633.03 BASELINE SCHEDULE. The CPM Schedule submittal shall be received by the Engineer a minimum of 7 calendar days prior to the preconstruction meeting. The Engineer and Contractor may review the schedule at the preconstruction meeting. Any requested information and a revised schedule shall be submitted within 7 calendar days after receiving the Engineer's request.

The Engineer shall be allowed 21 calendar days to review the schedule and provide a response. The Engineer will review the schedule by assessing the schedule's compliance with these provisions and conformance with the Contract requirements. By accepting the schedule, the Engineer does not modify the Contract in any way. The baseline schedule shall be accepted before the Notice to Proceed. The accepted schedule will be used as the baseline schedule for the remainder of the project.

The schedule shall define and sequence activities to accurately describe the project and to meet Contract requirements for scope of work, phasing, accommodations for traffic, and interim and project completion dates. The schedule shall begin with the date of Contract execution.

633.04 SCHEDULE UPDATES. The schedule shall be updated during active construction at the end of every other biweekly estimate period (update period) and when directed by the Engineer. Projects with short duration closures are of particular importance as the project float will be limited. The Contractor shall promptly inform the Engineer of any schedule delays or changes that occur during these periods.

The Engineer shall be allowed 10 calendar days to review the update for compliance with these provisions and provide a response. Include the following items with each update:

(a) The actual start dates of each activity started.

(b) The actual finish dates of each activity finished, or remaining durations of activities started but not yet completed.

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(c) A narrative report describing progress during the update period, shifts in the critical activities from the previous update, sources of delay, potential problem areas, work planned for the next update period, and changes made to the schedule. Changes include additions, deletions, or revisions to activities due to the issuance of a Contract revision, changes to an activity duration, changes to relationships between activities, or changes to the planned sequence of work or the method and manner of its performance.

(d) The original schedule shown as a baseline.

633.05 REVISIONS. Schedule revisions shall be submitted within 10 calendar days after occurrence of any of the following:

(a) A written request to revise the schedule from the Engineer.

(b) A delay (actual or projected) to scheduled milestones or project completion dates.

(c) When actual progress falls behind the most recent schedule accepted by the Engineer, either by falling more than two weeks behind schedule or by 5% of the total Contract time, the Contractor shall immediately inform the Engineer in writing.

The Engineer may require the Contractor to submit a revised schedule. Neither the Engineer's acceptance of such revised schedule nor any Agency feedback regarding the revised schedule shall be construed as an approval of the revised schedule, nor should it be construed as the Agency's dictation of the Contractor's means and methods.

(d) Issuance of Change Orders/Supplemental Agreements that by adding, deleting, or revising activities, changes the planned sequence of work or the method and manner of its performance.

(e) Issuance of Change Orders/Supplemental Agreements that add time to the Contract.

(f) The Contractor shall participate in progress meetings at the request of the Engineer to review and discuss the updated schedule information including any activity delay, coordination requirements, Change Orders, potential delays, and other relevant issues.

The Engineer shall review the revised schedule for compliance with these provisions, and provide a response within 10 calendar days.

633.06 FLOAT. Any float in the schedule is to be credited to the project only.

633.07 FAILURE TO SUBMIT SCHEDULE. Failure to submit a schedule (i.e., original baseline schedule, required updates, revisions, and when requested by the Engineer) in accordance with these provisions may be grounds for suspension of partial payments, as identified in Subsection 109.08, until a satisfactory schedule meeting the requirements of these provisions is received by the Engineer.

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633.08 METHOD OF MEASUREMENT. The quantity of CPM Schedule to be measured for payment will be the number of each CPM Schedule (i.e., original baseline schedule, required updates, revisions, and when requested by the Engineer), accepted by the Engineer through the duration of the Contract.

633.09 BASIS OF PAYMENT. The accepted quantity of CPM Schedule will be paid for at the Contract unit price for each. Payment will be full compensation for preparing and submitting a schedule as specified, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
633.10 CPM Schedule	Each

SECTION 634 – EMPLOYEE TRAINEESHIP

634.01 DESCRIPTION. This work shall consist of providing on-the-job training for qualified employees in accordance with applicable approved training programs.

634.02 GENERAL. The training requirements specified herein supersede *FHWA-1273 Required Contract Provisions, Federal-Aid Construction Contracts*, Part II, Subparagraph 6b, and implements *23 U.S.C § 140(a)*.

The Contractor shall provide on-the-job training aimed at developing full journeyman qualifications in the type of trade, craft, or job classification involved.

The training program shall be carried out in accordance with a training schedule and curriculum devised to give the employee an understanding of the trade, craft, or skill together with instructions in safety operations and performance of the actual specialty covering all aspects of the work involved. The training program shall be one approved by the Agency and the U.S. Department of Transportation.

The required number of employee traineeship hours to be provided by the Contractor is shown in the Contract. If a Contractor subcontracts a portion of the work, the Contractor shall determine how many, if any, of the trainees are to be trained by the Subcontractor. However, the Contractor shall retain the primary responsibility for meeting the training requirements specified herein.

634.03 PROCEDURE. The procedures followed in carrying out the training shall be consistent with the approved training program for the particular trade, craft, or skill and the trainee shall be employed insofar as practical in a useful and constructive manner assisting in the work on the project until such time as the Contractor deems the trainee as being qualified to operate independently in the field in which the trainee has been trained. The Contractor shall then give the trainee a certificate of satisfactory completion of apprenticeship training specifying the field of accomplishment.

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The Contractor shall maintain payroll records and training records in a manner acceptable to the Engineer as to provide all the information necessary to properly and adequately support progress and final payment for this item, as well as to show the status of training accomplishment.

It is normally expected that a trainee will begin training on the project as soon as feasible after start of work utilizing the skill involved, and remain on the project as long as training opportunities exist in the work classification or until the training program has been completed. It is not required that all trainees be on board for the entire length of the Contract. The Contractor will have fulfilled the requirements of this item if they have provided acceptable training to the number of trainees specified. The number trained shall be determined based on the total number enrolled on the project for a significant period.

634.04 TRAINEES. The number of trainees shall be distributed among the work classifications based on the Contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment. Where feasible, 25% of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

Prior to commencing construction, the Contractor shall submit to the Engineer for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed on the project that is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided herein.

634.05 RECRUITMENT. Training and upgrading of minorities and women toward journeymen status is a primary objective of this item. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g. by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent that such persons are available within a reasonable area of recruitment.

The Contractor will be responsible for demonstrating the steps taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with the requirements of this item. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

634.06 TRAINING PROGRAM. The minimum length and type of training for each classification will be as established in the training program selected by the Contractor and approved by the Engineer. The Federal Highway Administration (FHWA) shall approve a program if it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyman status in the classification concerned by the end of the training period.

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Apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, shall also be considered acceptable provided they are being administered in a manner consistent with the equal employment obligations of Federal-Aid highway construction Contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program.

It is the intent of these provisions that training is to be provided in the construction crafts rather than clerk-typists or administrative positions. Training is permissible in lower level management positions, such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the FHWA division office.

Some offsite training is permissible if the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

The Contractor may be eligible for reimbursement for training persons more than the number of hours specified in the Contract. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other sources do not specifically prohibit the Contractor from receiving other reimbursement. Reimbursement for offsite training indicated above may only be made to the Contractor where the Contractor does one or more of the following and the trainees are concurrently employed on a Federal-Aid project: contributes to the cost of the training, provides the instruction to the trainee, or pays the trainee's wages during the offsite training period.

The Contractor shall furnish the trainee a copy of the program the Contractor will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

Trainees will be paid at least 60% of the appropriate minimum journeyman's rate specified in the Contract for the first half of the training period, 75% for the third quarter of the training period, and 90% for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on the project. In that case, the appropriate rates approved by the Department of Labor or Transportation about the existing program shall apply to all trainees being trained for the same classification who are covered by these provisions. In no case will the Contractor pay trainees less than the prevailing rate for labor as shown in the Contract wage decision.

634.07 SANCTIONS FOR NON-COMPLIANCE. If the Vermont Agency of Transportation finds the Contractor or Subcontractor in non-compliance with the terms of this item, it shall do the following:

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(a) Issue a Show Cause Notice and notify the Contractor in writing that within 30 calendar days a written plan outlining the steps that will be taken to bring the Contractor into compliance must be submitted to the Vermont Agency of Transportation by the Contractor. In the event the Contractor fails or refuses to submit the plan within the specified period, or if the Contractor does not exercise the corrective actions outlined in the plan, the Agency will commence enforcement proceedings under *Executive Order 11246,* as amended. Such actions could include:

(1) The recovery by the Agency from the Contractor of 1/10 of 1% of the Contract award amount or $1,000.00, whichever sum is greater, as liquidated damages for each week the Contractor fails or refuses to comply. If a Subcontractor is in non-compliance, the recovery by the Agency from the Contractor, to be assessed by the Contractor as a back charge against the Subcontractor of 1/10 of 1% of the subcontract price, or $500.00, whichever sum is greater, in the nature of liquidated damages, for each week that such party fails or refuses to comply; and/or

(2) The suspension of any payment or part thereof due under the Contract until the Contractor or Subcontractor can demonstrate compliance with the terms of the Contract; and/or

(3) The termination or cancellation of the Contract, in whole or in part, unless the Contractor or Subcontractor can demonstrate within a specified time compliance with terms of the Contract; and/or

(4) The denial to the Contractor or Subcontractor of the right to participate in any future Contracts awarded by the Agency for a period of up to three years.

(b) If at any time after the imposition of sanctions one and two above, the Contractor can demonstrate compliance with the requirements of this item, the Contractor may request the Agency to suspend the sanctions conditionally, pending a final determination by the Agency as to whether the Contractor is in compliance. Following the final determination, the Agency will either lift the sanctions or impose them.

(c) The above sanctions for non-compliance will also apply to the *Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)*.

634.08 METHOD OF MEASUREMENT. The quantity of Employee Traineeship to be measured for payment will be the number of hours completed in the complete and accepted work.

634.09 BASIS OF PAYMENT. The accepted quantity of Employee Traineeship will be paid for at the Contract unit price per hour. Payment will be full compensation for furnishing all tools, equipment, supervision, and incidentals necessary to provide complete training for each trainee.

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If, in the judgment of the Contractor, a trainee becomes proficient enough to qualify as a journeyman before the end of the prescribed training period, and the Contractor so employs such trainee, full credit and full payment to the Contractor will be made if the period of training given, plus the length of employment as a journeyman in the classification for which trained, are equal to, or more than, the training period specified in the approved training program.

If the period of training given plus the period employed as a journeyman does not equal or exceed the training period specified in the approved training program, the Contractor will be paid the Contract amount for each hour the trainee was trained and employed as a journeyman by the Contractor.

In the event of partial employee traineeship, the Contractor will be paid for each hour the trainee was trained and employed as a trainee by the Contractor.

Payment will be made under:

Pay Item	Pay Unit
634.10 Employee Traineeship	Hour

SECTION 635 – MOBILIZATION/DEMOBILIZATION

635.01 DESCRIPTION. This work shall consist of preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to and from the project site; for the establishment and removal of all Contractor's field offices, buildings, and other facilities necessary for work on the project; and for all other work and operations that must be performed or costs incurred prior to beginning work and upon completion of Contract items. It shall also include compensation for any costs associated with demobilization, project clean up, establishment of vegetation, and completion of all work that is not associated with acceptance of a specific pay item.

635.02 METHOD OF MEASUREMENT. The quantity of Mobilization/Demobilization to be measured for payment will be on a lump sum basis.

635.03 BASIS OF PAYMENT. The accepted quantity of Mobilization/Demobilization will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

For the purposes of computing payment under the Contract item Mobilization/Demobilization, the adjusted Contract price will be a summation of all items bid, excluding the amount bid specifically for the Mobilization/Demobilization item.

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Partial payments will be made as follows:

(a) The first payment of 50% of the lump sum price for Mobilization/Demobilization or 5% of the adjusted Contract price, whichever is less, will be made with the first biweekly estimate as determined by work on other Contract items.

(b) The second payment of 40% of the lump sum price for Mobilization/Demobilization or 5% of the adjusted Contract price, whichever is less, will be made on the first estimate following the completion of 10% percent of the Contract, excluding Mobilization/Demobilization.

(c) Payment of any remaining amount bid for Mobilization/Demobilization will be made after the acceptance date.

Payment will be made under:

Pay Item	Pay Unit
635.11 Mobilization/Demobilization	Lump Sum

SECTION 636 – THIS SECTION RESERVED

SECTION 641 – TRAFFIC CONTROL

641.01 DESCRIPTION. This work shall consist of establishing and maintaining traffic control measures to protect the traveling public, including bicyclists and pedestrians, and construction operations.

The requirements for Uniformed Traffic Officers (UTOs) and Flaggers used in conjunction with Traffic Control shall be as specified in Section 630.

641.02 GENERAL CONSTRUCTION REQUIREMENTS. The Contractor shall establish traffic controls to divert traffic from the area of construction operations during working hours in accordance with the Contract or as authorized by the Engineer. Working hours shall be as specified in Subsection 104.04A and Subsection 104.04B. Should the Contractor desire to divert traffic after sunset or before sunrise, a written request shall be submitted to the Engineer. In the request, the Contractor shall justify the request and detail the enhanced safety procedures the Contractor proposes to provide and pay for to protect the safety of the traveling public and project personnel. The request shall be submitted at least three weeks prior to the date the Contractor plans to divert traffic outside of normal working hours as defined in the Contract.

When work is in progress within an interchange area, no more than one ramp at a time may be closed to traffic. Traffic service that would be eliminated by the closing of a ramp shall be maintained elsewhere as specified in the Contract or authorized by the Engineer.

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During hours other than working hours, all highway facilities, including sidewalks, shall be open to the unrestricted flow of traffic, unless otherwise specified. Traffic control devices, equipment, and materials shall be removed from the traveled way, auxiliary lanes, ramps, and shoulders. Traffic signs related to traffic control for construction operations shall be removed, covered, or turned so they are not readable from the highway. All equipment and materials shall be stored outside of the travel lanes, shoulders, and clear zone for the facility.

(a) Traffic Control. When the Contract includes the Traffic Control pay item, the Plans will contain an Agency-designed traffic control plan. The Contractor may implement the Agency-designed plan or submit an alternate traffic control plan for the project. When the Contractor will implement an Agency-designed traffic control plan, written certification shall be submitted to the Engineer indicating that traffic control will be performed in accordance with the Agency design. An alternate plan may be for the entire traffic control plan of the project or for revisions to various phases of the Agency's design in the Plans, including the specific location of the lanes where the traffic will be maintained. Any alternate plan submitted shall conform to the latest edition of the *MUTCD*.

For an alternate traffic control plan, construction drawings shall be submitted in accordance with Section 105. The submitted alternative plan shall include complete construction details, including all aspects of traffic control, to the same extent provided in the Agency design. The Contractor shall allow the Agency 30 calendar days to review the proposed plan for conformance before it is to be implemented.

(b) Traffic Control, All-Inclusive. When the Contract includes the Traffic Control, All-Inclusive pay item, the Contractor shall design and submit a site-specific traffic control plan in accordance with Section 105. The submitted site-specific plan shall include, for each phase of construction requiring a significant change in temporary traffic control, a narrative description of the proposed temporary traffic control for each phase, including pedestrian accommodations where appropriate, and the major work activities to be completed in each phase.

The submitted site-specific plan shall also include a layout for each phase of construction showing existing lane configurations, existing traffic control devices (signs, signals, and pavement markings), driveways, ramps, and highway intersections, and the location of all proposed temporary traffic control devices, Flaggers, and UTOs. All pertinent dimensions, such as taper lengths, sign spacing, temporary lane widths, and distances from existing traffic control devices shall be labeled.

641.03 TRAFFIC CONTROL DEVICES. All traffic control devices shall conform to the requirements of the Contract and the latest edition of the *MUTCD*. Traffic control devices required in the performance of this work may include but are not limited to; lane markings, barricades, signs with yielding posts or portable supports, reflectorized drums, traffic cones, delineators, Portable Arrow Boards, Portable Changeable Message Signs, traffic signal lights, and street lighting. In addition, flashing warning lights may be required by the Engineer for use on signs and barricades to improve visibility.

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All temporary construction signs shall meet the following requirements:

(a) Where sign installations are not protected by guardrail or other approved traffic barriers, all sign stands and post installations shall meet the requirements of *NCHRP Report 350* or the *AASHTO Manual for Assessing Safety Hardware* (*MASH*) and its current revisions. The appropriate resource shall be determined as described in the *MASH* publication.

(b) As a minimum, roll-up sign material shall have *ASTM D 4956,* Type VI, fluorescent orange retroreflective sheeting.

(c) All post-mounted signs and solid substrate portable signs shall have *ASTM D 4956*, Type VII, Type VIII, or Type IX fluorescent orange retroreflective sheeting.

(d) All retroreflective sheeting on traffic cones, barricades, and drums shall be at a minimum *ASTM D 4956,* Type III sheeting.

(e) All stationary signs shall be mounted on two 3 lb/foot flanged channel posts or 2 inch square steel inserted in 2-1/4 inch galvanized square steel anchors. No sign posts shall extend over the top edge of the sign installed on said posts.

(f) Construction signs shall be installed so as to not interfere with nor obstruct the view of existing traffic control devices, stopping sight distance, and corner sight distance from drives and town highways.

The location of traffic control devices shall be adjusted in the field as directed by the Engineer to provide for maximum visibility and usefulness. Traffic control devices shall be kept clean so they are always clearly visible. All signs of the same type (roll-up or post-mounted) shall be composed of the same retroreflective material. The Contractor shall conduct inspections of both daytime and nighttime operations daily to ensure proper placement and operation of all traffic control devices.

When protected by guardrail, these devices shall be placed outside the deflection distance of the particular guardrail in use.

Traffic cones shall be orange, at least 28 inches high, and shall be spaced as shown on the Plans. They shall be weighted or nailed for stabilization. Tires may be used to stabilize the cones only if they have been circumferentially sliced to a minimum of 50% of their original thickness.

Portable Changeable Message Signs (PCMSs) shall be used with a maximum of two phases, each consisting of a maximum of three lines of eight characters.

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Each PCMS unit shall be tamper-resistant. The control cabinet shall be locked when not in use. Each PCMS shall also have a security system that will only allow access if a code or password is entered. The default code or password shall be changed upon deployment of the PCMS by the Contractor. PCMS boards featuring remote access shall also be password protected.

Portable Arrow Boards (PABs) shall conform to Type C Portable Arrow Board requirements in the *MUTCD*.

The Contractor shall operate and maintain the PCMSs or PABs as recommended by the manufacturer. The locations of the units and the messages to be used shall be as specified in the traffic control plan shown in the Plans or as directed by the Engineer. The Contractor shall supply the Engineer with the name and telephone number of the Contractor's responsible person in charge of the placement, maintenance, and repair of the PCMSs or PABs and their components for the duration of the Contract.

If Portable Changeable Message Sign and/or Portable Arrow Board pay items are included in the Contract, the Contractor shall maintain one spare PCMS unit, or a PAB unit if no PCMS unit is being utilized, on site to replace a non-operational unit if necessary. If any unit becomes non-operational during use, and a replacement unit is not available, the Contractor shall provide Flaggers or other approved traffic control methods until the unit is repaired or replaced, at no additional cost to the Agency. Non-operational units shall be repaired or replaced as soon as possible, but no later than twenty-four hours after the Engineer determines that repairs or replacement are necessary.

Time lost due to failure to correct deficient traffic control devices will not be considered justifiable cause for granting an extension of time in accordance with Section 108.

641.04 PERSONNEL. Personnel involved with the placement and use of traffic control devices shall receive orientation and explanation of the requirements of the *MUTCD* and the special project requirements prior to working on the project. The orientation and explanation are the Contractor's responsibility.

641.05 SPEED ZONE ENACTMENT. If the traffic control plan included in the Plans is based on a recommended speed limit reduction, or if a speed limit reduction is requested by the Contractor, the Agency will obtain the necessary permit for this speed reduction. In either case, the Contractor shall provide the Agency with a written plan of work and a detailed sketch of the work zones that will be the basis for the permit application. The Contractor shall allow three weeks for the permit to be processed. The traffic control plan shall not be implemented until the permit is approved.

Speed zones, if used, should be a maximum of 10 mph below existing posted speeds. Temporary speed limit certificates must be approved by the Chief Engineer.

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641.06 METHOD OF MEASUREMENT. The quantity of Traffic Control and Traffic Control, All-Inclusive to be measured for payment will be on a lump sum basis for providing traffic control in the complete and accepted work.

The quantities of Portable Changeable Message Sign and Portable Arrow Board to be measured for payment will be the number of each type of unit specified and used on the project. A unit shall consist of the designated sign panel or board complete with controller, power supply, fuel, backup power supply, and trailer, installed, maintained, and removed as indicated on the Plans and directed by the Engineer.

The quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental to be measured for payment will be the number of days of the type specified, as authorized in writing by the Engineer.

641.07 BASIS OF PAYMENT.

(a) Traffic Control and Traffic Control, All-Inclusive. The accepted quantity of Traffic Control and Traffic Control, All-Inclusive will be paid for at the Contract lump sum price. Payment will be full compensation for designing, preparing, implementing, inspecting, maintaining, and removing the applicable traffic control plan and specified traffic control devices, and for furnishing all labor (including traffic patrol vehicle operators, if used by the Contractor), tools, materials, equipment, and incidentals necessary to complete the work.

Partial payments for Traffic Control and Traffic Control, All-Inclusive will be made as follows:

(1) The first 15% of the Contract lump sum price will be paid upon receipt of written certification from the Contractor that traffic control will be performed in accordance with the Agency-designed traffic control plan, or upon approval of the Contractor's traffic control plan.

(2) The remaining 85% of quantity payments will be paid on a prorated basis for the estimated duration of the Contract work remaining.

(b) Portable Changeable Message Sign and Portable Arrow Board. The accepted quantities of Portable Changeable Message Sign and Portable Arrow Board will be paid for at the Contract unit price for each. There will be no payment for any spare units, as they shall be considered incidental to the unit(s) being utilized and paid for through the Contract.

Partial payment for Portable Changeable Message Sign and Portable Arrow Board will be made as follows:

(1) The first 50% of quantity payments will be made upon the erection of complete Portable Changeable Message Sign(s) and Portable Arrow Board(s) as specified in Subsection 641.06.

(2) The remaining 50% of quantity payments will be paid on a prorated basis for the estimated duration of the Contract work remaining.

The accepted quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental will be paid for at the Contract unit price per day. The minimum quantity for payment shall be five days.

Payment for the accepted quantities of Portable Changeable Message Sign, Portable Arrow Board, Portable Changeable Message Sign Rental, and Portable Arrow Board Rental shall be full compensation for furnishing, operating, maintaining, transporting, and installing the unit specified, for removing the unit when it is no longer needed, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When both pay items are in the Contract, a Portable Changeable Message Sign used as a Portable Arrow Board will be paid for at the Contract price for a Portable Arrow Board.

Payment will be made under:

Pay Item	Pay Unit
641.10 Traffic Control	Lump Sum
641.11 Traffic Control, All-Inclusive	Lump Sum
641.15 Portable Changeable Message Sign	Each
641.16 Portable Arrow Board	Each
641.17 Portable Changeable Message Sign Rental	Day
641.18 Portable Arrow Board Rental	Day

SECTION 643 – THIS SECTION RESERVED

SECTION 646 – RETROREFLECTIVE PAVEMENT MARKINGS

646.01 DESCRIPTION. This work shall consist of furnishing and placing retroreflective markings, including temporary markings, and necessary signing on roadway pavement and other surfaces.

646.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Polyurea Pavement Markings	708.08(a)
Epoxy Paint	708.08(b)
Waterborne Traffic Paint	708.08(c)
Glass Beads	708.09(a)
Premium Optics	708.09(b)
Wet Recoverable and Wet Reflective Optics	708.09(c)

Thermoplastic Pavement Markings, Type A .....708.10(a)
Thermoplastic Pavement Markings, Type B .....708.10(b)
Line Striping Targets .....708.12(a)
Pavement Marking Mask .....708.12(b)
Pavement Marking Tape, Type A .....754.03(a)
Pavement Marking Tape, Type B .....754.03(b)
Pavement Marking Tape, Type C .....754.03(c)

Pavement marking materials furnished shall be the ones shown on the Plans or listed in these specifications as being acceptable for the project. The Contractor may submit alternate materials for approval in accordance with Subsection 646.11.

646.03 CLASSIFICATION. Retroreflective pavement markings are hereby classified as Waterborne Paint Pavement Markings, Durable Pavement Markings, Temporary Pavement Markings, and Other Related Markings.

646.04 APPLICATION OF MARKINGS, GENERAL.

(a) Placement of Markings. Roadway surfaces shall be clean and dry at the time of application of pavement markings. The Engineer will inspect the pavement to determine if conditions are suitable for the placement of markings. The Engineer will check the pavement for cleanliness, moisture content, and temperature; and will check ambient air conditions. The Engineer will make the final determination as to the suitability of project conditions for the application of pavement markings. Where required, the Contractor shall clean the surface to be marked to the satisfaction of the Engineer to provide for an acceptable bond between the marking and the pavement or surface.

Pavement markings shall be applied only during daylight hours unless otherwise specified in the Contract, and in accordance with the manufacturer's recommendations. Weather conditions must be sufficient to allow the placement and curing of the pavement marking material without violating the manufacturer's requirements.

All markings shall be applied in a neat and professional manner. The lines shall be sharp and clear with no feathered edging or fogging, and precautions shall be taken to prevent tracking by tires of the marking equipment. Adequate quantities of the material shall be applied to assure constant thickness of marking material. Glass beads shall be delivered at a velocity that is at least 60% of ground speed for the application device. Markings shall be applied parallel to the roadway centerline or as shown on the Plans with no unsightly deviations.

After application, markings shall be protected from crossing vehicles for a time at least equivalent to the drying time of the marking material used. Markings shall be protected from the moment of application until they are sufficiently dry to bear traffic without damage to the marking, tracking, or adhering to vehicle tires.

Any pavement marking materials spilled or tracked on the roadway surfaces shall be removed by the Contractor to the satisfaction of the Engineer and at no additional cost to the State. The method of removal shall be acceptable to the Engineer and not injurious to the roadway or other surfaces.

All temporary pavement markings, including line striping targets when used, shall be applied so that at the end of each working day all centerlines, edge-line, island markings, gore markings, lane lines, special markings, etc. are in place on all paved surfaces where traffic will be maintained. During paving and milling, work shall be scheduled so that the pavement markings are complete immediately after the paving and milling operations cease for the day. All required markings shall be completely placed before dusk.

When line striping targets (LSTs) are not shown on the Plans but are used as a short-term substitute for other temporary pavement markings, they shall be placed as directed by the Engineer and will be paid for as the equivalent quantity of temporary pavement marking for which the LSTs are substituted. However, if it becomes necessary to replace those temporary LSTs with either more LSTs or the actual temporary pavement markings designated for that particular location, no further payment for the temporary pavement markings at that particular location will be made.

At all times, the Contractor shall have on hand on the project all necessary materials, equipment, and labor to place any and all necessary interim pavement markings, including temporary line striping targets, required by the Plans or as directed by the Engineer. The markings shall be paid for under the appropriate Contract items.

Failure on the part of the Contractor to comply with the provisions of this part of the specifications may result in all progress payments being withheld until the required work is performed to the satisfaction of the Engineer.

(b) Equipment, General. The pavement marking equipment shall meet the approval of the Engineer and shall be maintained in working condition at all times. The pavement marking equipment shall be of standard commercial manufacture of the type capable of satisfactorily applying the designated material at required application temperatures, rates, and manufacturer's recommended application practices.

For long line markings, each machine shall be capable of applying two separate stripes, either solid or dash, at the same time. Each applicator shall be equipped with satisfactory cutoffs that will apply broken, dashed, or dotted lines automatically.

Each applicator shall have a mechanical bead dispenser that will operate simultaneously with the applicator and distribute the beads in a uniform pattern at the rate specified over the entire surface area of the marking. The bead placement device shall maximize bead embedment in the marking material. Each applicator shall also be equipped with suitable line guides.

Equipment for application shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Equipment shall include adequate process controls to regulate the application of marking materials and maintain required temperatures, pressures, and delivery speed of components in the pavement marking.

The pavement marking equipment shall be operated in accordance with recommendations of the equipment manufacturer, unless otherwise directed by the Engineer. Operating speeds shall be such as to provide uniformity and the specified wet or dry film thicknesses.

The application equipment shall be so constructed as to ensure continuous uniformity in the dimensions of stripes. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying dashed and dotted lines. The equipment shall be capable of applying varying widths of traffic markings.

Pavement marking vehicles shall operate in the lane for traffic moving in the same direction; they shall not encroach into the lane for opposing traffic flow. Exceptions to this requirement shall be approved in writing by the Engineer.

Equipment to be used for determining temperature, moisture, and material thickness including, but not limited to, a thermometer and a micrometer are specified in Subsection 631.06.

(c) Weather Limitations.

(1) At the time of application of painted markings, the temperature of the surface to be painted shall be a minimum of 50°F and the ambient air temperature shall be 50°F and rising. Ambient hygrometric conditions required for drying within a 20-minute period shall exist or painting shall be suspended.

(2) At the time of application of durable pavement markings, the pavement surface and ambient air temperatures shall be as per the manufacturer's published specified application temperatures, and the dew point shall be 5°F or more below the ambient air temperature. If the manufacturer's published recommendations are unavailable, the pavement surface and ambient air temperatures shall be a minimum of 50°F.

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(3) If weather conditions do not permit the application of durable markings prior to November 15th, paint will be applied in accordance with this section and Section 708.

(4) When it is in the public interest, the Engineer may authorize the application of pavement markings under conditions that vary from these limitations or the manufacturer's published recommendations.

(d) Layout and Control. Once the wearing course has been placed, the Engineer will establish the layout for the permanent centerline traffic markings, including passing zones, breaks for town highways and side roads, and any other items required for the centerline markings. The Contractor shall be responsible for laying out all non-centerline markings. The pattern of painted, durable, or temporary markings shall be as follows, unless otherwise shown in the Contract or directed by the Engineer.

(1) Centerline Markings. Centerline markings shall be positioned at the geometric center of the roads or as shown in the Plans. Solid (barrier) lines and dash lines shall start and end at points shown on the Plans or as directed by the Engineer. A dash line shall consist of 10 foot ± 12 inch line segments, and 30 foot ± 12 inch spaces. The spacing between a double barrier line and between a barrier line and a dash line shall be the same width as the lines. The width of centerlines shall be as shown on the Plans, ± 1/4 inch.

(2) Edge Line Markings. Edge line markings shall be applied along both edges of the road, as shown on the Plans or as directed by the Engineer. Edge lines shall be discontinued through intersections of paved public side roads, unless otherwise shown on the Plans. The width of edge lines shall be as shown on the Plans, ± 1/4 inch.

(3) Dotted Line. Dotted lines shall be positioned as shown on the Plans or as directed by the Engineer. A dotted line shall consist of 36 inch ± 2 inch line segments, and 108 inch ± 2 inch spaces, unless otherwise specified in the Contract. The width of dotted lines shall be as shown on the Plans, ± 1/4 inch.

(4) Control. The Contractor shall provide the necessary horizontal and longitudinal control to keep all longitudinal lines within 2 inches of their designated locations.

In addition, on tangents, the Contractor shall not allow longitudinal lines to vary from either side of a straight line by more than 1 inch in 100 feet.

646.05 ACCOMMODATION AND PROTECTION OF TRAFFIC. Marking operations shall be conducted in a manner that minimizes traffic disruptions. Adequate safety measures shall be provided for both the construction workers and the traveling public.

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Details not shown on the Plans shall be in conformity with the *MUTCD*. The Contractor shall provide adequate warning signs and traffic control measures for the accommodation and protection of traffic, as shown on the Plans or as directed by the Engineer. Placement of pavement markings may be suspended at the discretion of the Engineer during peak traffic hours, or at any time, when in the Engineer's judgment, traffic is being unduly hampered, delayed by the work or when traffic interferes with the quality of work.

All equipment and devices necessary for the application of pavement markings and protection thereof, and for the protection of the traveling public shall be as usually required for work of this type, as shown on the Plans or as directed by the Engineer, and shall be furnished by the Contractor.

646.06 WATERBORNE PAINT PAVEMENT MARKINGS. Retroreflective waterborne paint pavement markings shall be applied by a method in which the liquid paint is applied to the road surface and the glass beads are immediately applied on the paint and firmly embedded therein. The application procedure shall provide a retroreflective marking, with a night visibility satisfactory to the Engineer. The material shall be applied in a smooth uniform coat, free from thin places or films of excessive thickness.

Liquid tanks on paint application equipment shall be equipped with mechanical agitators. Beads shall be conditioned to provide a smooth uniform rate of release. All materials shall be maintained in the condition recommended by the marking manufacturer prior to and at the time of marking.

The markings shall be applied at a rate to create a uniform wet film in-place minimum thickness as follows, unless otherwise specified in the Contract:

(a) 20 mils for pavement constructed under the same Contract as the markings, with a minimum application rate of 80 square feet per gallon.

(b) 15 mils for all other pavement surfaces, with a minimum application rate of 105 square feet per gallon.

Apply glass beads uniformly across the width of the line at a rate of 8.0 pounds per gallon of paint. The Contractor shall provide the Engineer and the Materials Section with the optic drop on rates of all optic materials and daily binder application rates.

Application shall be in accordance with the manufacturer's requirements.

646.07 DURABLE PAVEMENT MARKINGS. Durable pavement markings shall be used at those locations shown on the Plans or directed by the Engineer. Durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, and polyurea paint. Durable pavement markings shall be installed within two weeks of the placement of the wearing course.

Where possible and where applicable, a 2-inch gap should be maintained between thermoplastic pavement markings and parallel joints in bituminous concrete pavement. This requirement is secondary to the alignment controls specified in Subsection 646.04(d).

The Contractor shall select a combination of optics that conform with Subsection 708.09(a), Subsection 708.09(b), and/or Subsection 708.09(c) that will meet the specified retroreflectivity requirement for the type of marking being applied. The Contractor shall provide the Engineer and the Materials Section with the daily optic drop on rates of all optic materials and daily binder application rates. The Contractor shall perform all quality control activities and provide to the Engineer daily all retroreflectivity measurements collected.

The Agency will perform all acceptance testing activities. For long lines and dashed lines, if the average retroreflectivity fails to meet the minimum retroreflectivity requirements, or if 25% of the individual tests fail to meet the minimum retroreflectivity requirements, the entire length represented by the evaluation section shall be re-marked and re-tested until in compliance, at no additional cost to the Agency.

(a) Pavement Marking Tape, Type A. Pavement Marking Tape, Type A, when used as a final durable marking, shall be applied in a recess as defined in Subsection 646.09, and shall be applied in accordance with the manufacturer's requirements.

(b) Pavement Marking Tape, Type B. Pavement Marking Tape, Type B, when used as a final durable marking, shall be applied in a recess as defined in Subsection 646.09, and shall be applied in accordance with the manufacturer's requirements.

This subpart deleted.

This subpart deleted.

(c) Epoxy Paint. Epoxy paint application shall be in accordance with the manufacturer's recommendations. Mixing of the epoxy reagents shall be complete prior to the placement of the marking. Failure of the epoxy to set to a hard condition shall be grounds for rejection.

Epoxy paint shall be applied at a rate to create a uniform wet film in place minimum thickness as follows, unless otherwise specified in the Contract:

(1) 28 mils for bonded wearing course constructed under the same Contract as the markings, with a minimum application rate of 55 square feet per gallon.

(2) 20 mils for all other pavement surfaces, with a minimum application rate of 80 square feet per gallon.

Initial dry retroreflectivity minimums shall be 300 millicandelas per square meter per lux for yellow markings and 400 millicandelas per square meter per lux for white markings.

(d) Extruded Thermoplastic. The thermoplastic pavement marking compound shall be extruded onto the pavement surface in a molten state. The temperature of the material shall not exceed the manufacturer's recommended heating temperature or rate of temperature increase. The surface shall be properly prepared for receipt of the marking material, including surface roughness, cleanliness, and moisture levels. The surface shall be primed when the manufacturer's recommendations require priming.

Thermoplastic markings shall be applied at a rate to create a uniform hot film in place minimum thickness of 105 mils unless otherwise specified in the Contract with a minimum application rate of 15 square feet per gallon.

Following an application of glass beads to the marking surface, and upon cooling to normal pavement temperatures, the resultant marking shall be an adherent retroreflective stripe of the specified thickness and width that is capable of resisting deformation by traffic.

(1) Thermoplastic Application Equipment. Thermoplastic application equipment shall be approved by the Engineer prior to the start of work.

Thermoplastic material shall be applied to the pavement surface by the extrusion method, wherein the bottom of the extrusion shoe is the pavement and the top and other three sides are contained by, or are part of, suitable equipment for maintaining the temperature and controlling the flow of material. The fourth side contains the extrusion opening.

The ribbon extrusion method will not be permitted for the application of thermoplastic material.

The equipment used for the placement of thermoplastic pavement markings shall be of two general types:

a. Mobile Applicator Equipment. The mobile applicator shall be defined as truck-mounted equipment designed to apply thermoplastic by the extrusion method. The unit shall be equipped to apply the thermoplastic material at temperatures exceeding 400°F, and at the widths and thicknesses specified herein. The mobile unit shall be capable of operating continuously and/or installing a minimum of 3.8 miles of longitudinal markings in an eight-hour day.

The mobile unit shall be equipped with extrusion shoes and shall be capable of simultaneously marking edge lines and/or two centerline stripes. The extrusion shoes shall be closed, heat-jacketed or suitably insulated units, and shall hold the molten thermoplastic at a temperature between 400°F and 435°F.

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The mobile unit shall be capable of extruding a line from 4 inches to 8 inches wide, with a uniform hot film in-place thickness of 105 mils, and of generally uniform cross-section. Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe, in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation.

The mobile unit shall be equipped with an electronic and programmable line pattern control system, or mechanical system, to be capable of applying dashed, dotted, or solid lines in any sequence and through any extrusion shoe in any cycle length.

b. Portable Applicator Equipment. The portable applicator shall be defined as hand-operated equipment specifically designed for placing thermoplastic installations such as crosswalks, stop bars, legends, arrows, and short lengths of lane lines, edge lines, and centerlines. The portable applicator shall be capable of applying thermoplastic markings by the extrusion method.

It is intended that the portable applicator will be loaded with hot thermoplastic composition from the melting kettles or that the material will be melted by an integral "melting stack" when so equipped. The portable applicator shall be equipped with all the necessary components, including a material storage reservoir, bead dispenser, extrusion shoe and heating accessories.

The portable applicator shall be capable of holding the molten thermoplastic at a temperature between 400°F and 435°F, and of extruding a line from 4 inches to 8 inches wide in 2-inch increments, with a uniform hot film in-place minimum thickness of 105 mils, and of generally uniform cross-section.

Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe, in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation. If a machine, as manufactured, cannot be equipped with gauges at the extrusion shoe, the Engineer may approve an alternate method of monitoring the composition temperature at the point of deposition.

(2) Application Requirements.

a. Primer. Bituminous concrete primer shall be applied to pavements older than two years at the application rates and procedures recommended by the thermoplastic material manufacturer. Primer shall be applied under such conditions, at such rates and thicknesses, and of a type as is recommended by the thermoplastic material manufacturer.

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b. Application Temperature. Thermoplastic composition shall be applied at a temperature range between 400°F and 435°F or in accordance with the manufacturer's recommendations.

c. Extruded Markings. All extruded markings shall be applied at the specified width and at a uniform hot film in-place thickness between 100 and 110 mils exclusive of any drop-on glass beads.

d. Optics.

1. Glass beads meeting the requirements of *AASHTO M 247,* Type I, shall be incorporated into the intermix of the thermoplastic composition at a rate of between 30% and 40% by weight of the combined material.

2. Initial dry retroreflectivity minimums shall be 300 millicandelas per square meter per lux for yellow markings and 400 millicandelas per square meter per lux for white markings.

e. Gaps and Overlaps. When applying durable diagonal pavement markings that are to be enclosed within durable long line borders, the Contractor shall apply the diagonals in such a manner as to allow a maximum of a single overlap and no gaps between the diagonals and the long lines.

(e) Preformed Thermoplastic. Preformed thermoplastic markings shall be one of the Thermoplastic Pavement Markings, Type B listed on the Agency's *Approved Products List*.

(f) Polyurea Paint. Application of polyurea paint shall be in accordance with the manufacturer's recommendations.

Polyurea paint shall be applied at a rate to create a uniform wet film in-place minimum thickness as follows, unless otherwise specified in the Contract:

(1) 28 mils for bonded wearing course constructed under the same Contract as the markings, with a minimum application rate of 55 square feet per gallon.

(2) 20 mils for all other pavement surfaces, with a minimum application rate of 80 square feet per gallon.

Initial dry retroreflectivity minimums for surface-applied polyurea shall be 300 millicandelas per square meter per lux for yellow markings and 400 millicandelas per square meter per lux for white markings. Initial dry retroreflectivity minimums for recessed polyurea shall be 600 millicandelas per square meter per lux for yellow markings and 800 millicandelas per square meter per lux for white markings.

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646.08 TEMPORARY PAVEMENT MARKINGS. Temporary pavement markings are classified as temporary pavement marking tape (removable), pavement marking mask, line striping targets (LSTs), and traffic paint with glass beads. Unless otherwise indicated in the Contract, the Contractor may choose any of the above as being acceptable for temporary pavement markings.

(a) Pavement Marking Tape, Type C. This tape for pavement markings is classified as temporary and is removable and shall be installed in accordance with the manufacturer's requirements.

(b) Pavement Marking Mask. Black or other compatible pavement color pavement marking mask is classified as removable. It shall be installed in accordance with the manufacturer's requirements.

(c) Line Striping Targets. Line striping targets are intended to be substitutes for pavement markings for not longer than 14 calendar days. Line striping targets shall be maintained and replaced as needed or as directed by the Engineer, until replaced by a temporary or permanent pavement marking.

Line striping targets of the color shown on the Plans or directed by the Engineer shall be installed as described below or as directed by the Engineer.

For solid longitudinal pavement markings, line striping targets shall be placed at 10-foot intervals. For double centerline markings, line striping targets shall be paired. For dashed pavement markings, line striping targets shall be placed in groups of three spaced at 5 feet, with the groups separated by 30-foot spaces, or as determined by the Engineer.

Line striping targets shall not be used to delineate passing zones on two-lane non-divided highways.

Line striping targets shall be installed in accordance with the manufacturer's requirements. Line striping targets shall not be nailed to the surface.

(d) Paint. Temporary paint applied on the base or intermediate courses of pavement shall have a minimum thickness of 8 mils. Beads shall be applied at a rate of 3 pounds per gallon of paint.

All paint used for temporary markings shall be held to the same alignment and horizontal control standards as specified in Subsection 646.04.

Temporary markings on the wearing course of pavement that remain in place for fewer than 14 calendar days shall be Temporary Pavement Marking Tape or Line Striping Targets. Paint will not be permitted for use as a temporary marking which remains in place for fewer than 14 calendar days on the wearing course of pavement.

646.09 OTHER RELATED MARKINGS.

(a) Pavement Marking Recess. Recessed pavement markings shall be installed as specified for permanent markings. The recess shall be a uniform depth across the width of the marking. The recess shall be controlled such that the depth meets the requirements of Table 646.09A.

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The bottom of the recess shall have a smooth, flat finished surface. The use of gang-stacked diamond cutting blades is required for asphalt pavement surfaces. The spacers between blade cuts shall be such that there will be less than a 10 mil rise in the finished groove between the blades.

Recesses shall be clean, dry, and free of laitance, oil, dirt, grease, paint, or any other foreign contaminants prior to application of the pavement markings. The Contractor shall re-clean grooves, as necessary, prior to application of any primer or permanent markings. Depth plates shall be provided by the Contractor to assure that desired groove depth is achieved.

TABLE 646.09A – PAVEMENT MARKING RECESS DEPTH

Marking Material	Recess Depth (mils)
Thermoplastic	140 – 160
Polyurea	90 –110
Epoxy	90 –110
Permanent tape	As recommended by the manufacturer

(b) Painted Curbs and Islands. Where a painted curb or painted island is called for, the existing curb or island shall be blast cleaned or wire brushed to remove scale, dirt, grass, etc. to the satisfaction of the Engineer, prior to painting. This cleaning work will not be paid for directly, but will be considered incidental to either Painted Curb or Painted Island.

Paint shall be applied at a rate of 100 to 115 square feet per gallon with glass beads applied at a rate of 6 pounds per gallon. All paint shall be applied within the manufacturer's allowable application temperatures.

Retroreflective paint shall be applied by a method in which the liquid material is applied to the curb or island surface and the glass beads are immediately applied to the material and firmly embedded therein, and which shall provide a retroreflective marking, with a night visibility satisfactory to the Engineer. The material shall have a minimum wet film thickness of 15 mils, unless otherwise specified, and be applied in a smooth, uniform coat, free from thin areas or excessively thick films.

Beads shall be applied uniformly over the entire painted surface area at the specified rate.

646.10 SUBSTITUTION OF MARKING MATERIALS. If the durable markings cannot be placed under suitable environmental conditions, paint shall be applied as specified in Subsection 646.06 at no cost to the Agency. Where it can be determined that through no fault of the Contractor the durable markings cannot be applied under suitable environmental conditions, paint may be applied for durable marking of the types indicated on the Plans where appropriate and as directed by the Engineer.

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Regardless of the circumstance under which paint is applied after an unsuitable environmental condition determination, durable markings of the types indicated on the Plans shall be applied as soon as suitable environmental conditions permit during the following Spring. These durable markings shall be measured and paid for in accordance with Subsection 646.13 and Subsection 646.14.

646.11 ALTERNATE MARKING MATERIALS. If the Contractor wishes to use pavement markings or markers that are not specified in this section, the Contractor shall submit samples, technical data, installation instructions and, if applicable, removal instructions to the Engineer for approval at least 30 calendar days before the date the markings or markers are to be placed.

The Engineer, after consultation with the Materials Manager, will approve or disapprove the use of the submitted products within the 30-calendar day period. The Contractor should be prepared to place approved markings on the proper date, even if the submittal is disapproved.

646.12 REMOVAL OF EXISTING PAVEMENT MARKINGS. Existing markings shall be obliterated in such a manner and by such means that a minimum of pavement scars are left and all the existing markings are removed, e.g. by grinding a square or rectangle on the pavement to remove a letter or arrow, or grinding a large rectangle to remove a word so that the outline of the letter, symbol, or word is not ground into the pavement and therefore still legible even though the marking has been removed. Painting over existing markings is not an acceptable method of removal.

The work shall be completed to the satisfaction of the Engineer. Masking of lines in intermediate duration activities shall be completed according to the Plans or as directed by the Engineer.

646.13 METHOD OF MEASUREMENT. The quantity of pavement marking edge lines and centerlines of the types and sizes specified to be measured for payment will be the number of linear feet applied in the complete and accepted work, as measured along the centerline of the pavement stripe. The number of linear feet of open spaces in a dashed or dotted line will not be measured for payment.

The quantity of Waterborne Paint Pavement Markings of the types and sizes specified per Subsection 646.10 through no fault of the Contractor and applied on the project to be measured for payment will be the quantity determined per the measure for the Durable Pavement Marking specified, multiplied by a factor of 1.5 to determine the accepted quantity for payment.

The quantity of Stop Bar of the type specified to be measured for payment will be the number of linear feet applied in the complete and accepted work, as measured along the centerline of the pavement stripe. The quantity of Letter or Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work.

A unit will consist of one letter or one symbol. For example, the six-letter word “SCHOOL” would be measured as six units and a handicapped symbol would be measured as one unit. For arrow symbols, each arrow symbol and associated stem shall be paid as one unit.

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The quantity of Crosswalk Marking of the type specified to be measured for payment will be the number of linear feet applied from curb-to-curb in the complete and accepted work, as measured along the center of the crosswalk.

The quantity of Railroad Crossing Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work. A unit will consist of three "stop bars," two "Rs," and one "X" for one traffic lane in one direction of travel.

This paragraph deleted.

The quantity of Line Striping Targets to be measured for payment will be the number of individual targets installed on the pavement and removed when no longer needed.

The quantity of Painted Curb to be measured for payment will be the number of linear feet applied in the complete and accepted work, as measured along the centerline of the pavement stripe.

The quantity of Painted Island to be measured for payment will be the number of square feet of the top of an island painted in the complete and accepted work.

The quantity of Removal of Existing Pavement Markings to be measured for payment will be the number of square feet of markings removed or total area in square feet of symbol or letter removed in the complete and accepted work, as determined by the Engineer.

The quantity of Pavement Marking Mask to be measured for payment will be the number of square feet of existing marking masked in the complete and accepted work.

646.14 BASIS OF PAYMENT. The accepted quantity of Pavement Marking edge lines and centerlines of the types and sizes specified will be paid for at the Contract unit prices per linear foot.

The accepted quantity of Waterborne Paint Pavement Markings of the types and sizes specified per Subsection 646.10 and measured for payment will be paid for at the corresponding Contract unit prices for Temporary Pavement Markings.

The accepted quantity of Stop Bar of the type specified will be paid for at the Contract unit price per linear foot.

The accepted quantity of Letter or Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Crosswalk Marking of the type specified will be paid for at the Contract unit price per linear foot.

The accepted quantity of Railroad Crossing Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Painted Curb will be paid for at the Contract unit price per linear foot.

The accepted quantity of Painted Island will be paid for at the Contract unit price per square foot.

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The Contract unit price for recessed pavement marking items will also include all labor, equipment, tools, and incidentals necessary for the placement of the recess and any necessary cleaning, drying, or conditioning of the recess prior to placement of the marking.

The Contract unit price for pavement marking items that are used as temporary pavement markings, including tape, paint, and line striping targets, as specified in Subsection 646.08 will also include all costs of removal of those temporary markings, if removal is required by construction procedures, shown on the Plans, or directed by the Engineer. The costs of maintaining marking capability for interim pavement markings at all times will not be paid for directly, but will be considered incidental to the pavement marking items in the Contract.

This paragraph deleted.

This paragraph deleted.

The accepted quantity of Line Striping Targets will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, removing, and disposing of the targets and the "Do Not Pass" signs, posts, and sleeves, if used. Payment will be full compensation for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Line Striping Targets replaced at the direction of the Engineer within the first 14 calendar days shall be paid for at the Contract unit price for each. If Line Striping Targets remain in place on the roadway for longer than 14 calendar days, no payment will be made for Line Striping Targets.

The accepted quantity of Removal of Existing Pavement Markings will be paid for at the Contract unit price per square foot. Payment will be full compensation for removing the markings and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. No payment will be made for removal of temporary paint markings installed and removed under the Contract.

The accepted quantity of Pavement Marking Mask will be paid for at the Contract unit price per square foot. Payment will be full compensation for obliterating existing markings with a masking material, for removing the masking material when it is no longer required as directed by the Engineer, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

"Do Not Pass" signs will not be paid for directly but will be considered incidental to the Contract item Line Striping Targets.

The Contractor is responsible for supplying necessary materials and equipment recommended by the manufacturer to determine the surface moisture condition of the pavement. The costs for supplying this material and equipment are paid for under the appropriate Contract item specified in Section 631.

Payment will be made under:

Waterborne Paint Pavement Markings:

Pay Item		Pay Unit
646.200 to 646.209	4 Inch White Line	Linear Foot
646.2100 to 646.2119	4 Inch Yellow Line	Linear Foot
646.2140 to 646.2149	6 Inch White Line	Linear Foot
646.2150 to 646.2159	6 Inch Yellow Line	Linear Foot
646.220 to 646.229	8 Inch White Line	Linear Foot
646.230 to 646.239	8 Inch Yellow Line	Linear Foot
646.240 to 646.249	12 Inch White Line	Linear Foot
646.250 to 646.259	12 Inch Yellow Line	Linear Foot
646.260 to 646.269	24 Inch Stop Bar	Linear Foot
646.300 to 646.309	Letter or Symbol	Each
646.310 to 646.319	Crosswalk Marking	Linear Foot
646.320 to 646.329	Railroad Crossing Symbol	Each

Durable Pavement Markings:

Pay Item		Pay Unit
646.400 to 646.409	Durable 4 Inch White Line	Linear Foot
646.410 to 646.419	Durable 4 Inch Yellow Line	Linear Foot
646.420 to 646.429	Durable 6 Inch White Line	Linear Foot
646.430 to 646.439	Durable 6 Inch Yellow Line	Linear Foot
646.440 to 646.449	Durable 8 Inch White Line	Linear Foot
646.450 to 646.459	Durable 8 Inch Yellow Line	Linear Foot
646.460 to 646.469	Durable 12 Inch White Line	Linear Foot
646.470 to 646.479	Durable 12 Inch Yellow Line	Linear Foot
646.480 to 646.489	Durable 24 Inch Stop Bar	Linear Foot
646.490 to 646.499	Durable Letter or Symbol	Each
646.500 to 646.509	Durable Crosswalk Marking	Linear Foot
646.510 to 646.519	Durable Railroad Crossing Symbol	Each

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Temporary Pavement Markings:

Pay Item		Pay Unit
646.600 to 646.605	Temporary 4 Inch White Line	Linear Foot
646.610 to 646.615	Temporary 4 Inch Yellow Line	Linear Foot
646.620 to 646.625	Temporary 6 Inch White Line	Linear Foot
646.630 to 646.635	Temporary 6 Inch Yellow Line	Linear Foot
646.640 to 646.645	Temporary 8 Inch White Line	Linear Foot
646.650 to 646.655	Temporary 8 Inch Yellow Line	Linear Foot
646.660 to 646.665	Temporary 12 Inch White Line	Linear Foot
646.670 to 646.675	Temporary 12 Inch Yellow Line	Linear Foot
646.680 to 646.685	Temporary 24 Inch Stop Bar	Linear Foot
646.690 to 646.695	Temporary Letter or Symbol	Each
646.700 to 646.705	Temporary Crosswalk Marking	Linear Foot
646.710 to 646.715	Temporary Railroad Crossing Symbol	Each
This pay item deleted.		
646.76	Line Striping Targets	Each

Other Related Markings:

Pay Item		Pay Unit
646.81	Painted Curb	Linear Foot
646.82	Painted Island	Square Foot

Marking Removal:

Pay Item		Pay Unit
646.85	Removal of Existing Pavement Markings	Square Foot
646.86	Pavement Marking Mask	Square Foot

SECTION 648 – THIS SECTION RESERVED

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SECTION 649 – GEOTEXTILE FABRIC

649.01 DESCRIPTION. This work shall consist of furnishing and placing geotextiles in underdrain trenches, under embankments, for embankment reinforcement, under riprap and stone fill, behind retaining structures, over roadbed subgrades, between railbed and roadbed subgrades, and beneath pavement overlays.

649.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Geotextile for Roadbed Separator.....720.02
Geotextile Under Railroad Ballast.....720.03
Geotextile Under Stone Fill.....720.04
Geotextile for Underdrain Trench Lining.....720.05
Geotextile for Filter Curtain.....720.06

Geotextiles shall conform to the following:

(a) Where sewn seams are used, the Contractor shall furnish the manufacturer's wide strip tensile test results as part of the certification. The results must verify that the seam meets or exceeds the specified average minimum roll values for the grab tensile strength of the geotextiles, or wide strip tensile strength for reinforcement applications.

(b) Field seams, where used, shall be in accordance with the manufacturer's recommendations.

649.03 GENERAL. The rolls of geotextile shall be protected against damage and deterioration until incorporated into the project. The geotextile shall be dry at the time of installation. The geotextile shall be rejected if, at the time of installation, it has defects, deterioration, or damage as determined by the Engineer.

649.04 INSTALLATION.

(a) General. The surface receiving the geotextile shall be prepared to a smooth condition, free of obstructions, depressions, and debris, unless otherwise directed by the Engineer. The geotextile shall not be dragged on the ground or mishandled in any way. The geotextile shall be placed loosely and without wrinkles so that placement of the overlying material will not tear the geotextile. The geotextile shall be lapped as specified at the ends and sides of adjoining sheets.

In addition to the above general requirements, the following specific requirements shall be followed for the specified application:

(1) Geotextile Placement on Slopes. The geotextile sheets shall be placed with the machine direction oriented perpendicular to the slope. When the geotextile is placed on slopes steeper than 1:6 (V:H), the upper sheets shall lap over the top of the lower sheets. The laps shall be securely anchored to the ground surface with pins or stakes as necessary to prevent slippage and tearing of the geotextile.

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As specified by the geotextile manufacturer or as directed by the Engineer, placement of fill material on the geotextile shall start at the toe of the slope and proceed upward.

(2) Geotextile Placement for Stream Bank Protection. Where geotextiles are placed under water, or in an area where water will flow, the geotextile shall be placed with its machine direction parallel to the direction of water flow. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the top of the downstream sheet. The geotextile shall be adequately secured to prevent slippage.

As the geotextile is placed under water, the backfill material shall be placed on it to the required thickness. The geotextile placement shall not progress more than 50 feet ahead of the backfill placement.

(3) Underdrains. When a geotextile is specified to line an underdrain trench, the geotextile shall be placed to conform loosely to the shape of the trench.

(4) Geotextiles Under Stone Fill. Geotextiles under riprap or stone fill shall be constructed in accordance with the details shown on the Plans and the following requirements. The Contractor shall demonstrate to the satisfaction of the Engineer that the combination of the stone fill drop height and the thickness of any sand cushion, when specified or required, are adequate so as not to puncture or damage the geotextile when placing the riprap or stone fill. Where a sand cushion is used, it shall be a minimum of 6 inches thick, unless otherwise directed by the Engineer. In addition, the stone fill drop height limits specified in Table 649.04A apply.

TABLE 649.04A – MAXIMUM STONE FILL DROP HEIGHT

Type of Stone Fill	Maximum Drop Height (inches)	
	Onto Geotextile	Onto Sand Cushion Blanket
Type I	36	36
Type II, III, IV or Riprap	0	12

After placement of the stone fill or riprap, all voids that allow the geotextile to be seen shall be satisfactorily backfilled so that the geotextile is completely covered.

(5) Roadbed Subgrade and Railroad Ballast Separation. The subgrade shall be prepared in accordance with Section 203. Construction vehicles shall be limited in size and weight such that rutting of the initial lift placed above the geotextile is no greater than 3 inches deep. Ruts shall not be graded off but shall be filled with material specified by the Engineer such that a minimum 8 inches of cover is kept over the geotextile. Turning of vehicles on the first lift of cover material shall not be permitted. The Contractor shall not use vibratory rollers on the first lift if pumping or distortion of the subgrade occurs, as determined by the Engineer.

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(6) Filter Curtain. When used to contain sediments or pollutants from a work area that is adjacent to or under water, the fabric shall be installed to completely enclose the portion of the work area that will be under water. The Contractor shall design and construct the curtain to deflect and withstand any existing current or wave action, to be anchored continuously along the bottom, to be effective at any anticipated water level, and to prevent the escape of all sediments or pollutants into the main stream or body of water.

The design, construction, and maintenance plan for the filter curtain installation shall be approved by the Engineer before installation of the filter curtain begins.

The Contractor shall repair or replace damaged or otherwise ineffective filter curtains as ordered by the Engineer. The Contractor shall remove material accumulated behind the filter curtain as directed by the Engineer.

The Contractor shall remove the filter curtain and all supporting and anchoring material prior to acceptance of the project, unless otherwise directed by the Engineer.

(b) Protection of Geotextile. The Contractor shall not permit traffic or construction equipment to travel directly on the geotextile. The geotextile shall always be protected during construction operations from contamination by surface runoff and construction activities. The geotextile shall be covered with the specified cover material as soon as possible; uncovered conditions shall not exceed 7 calendar days.

Specified cover material shall be placed on the geotextile in such a manner that the geotextile is not torn, punctured, or shifted. The minimum cover layer shall be 8 inches thick or twice the maximum aggregate size, whichever is thicker, before construction equipment is allowed over the area of the geotextile. The Contractor shall not permit end-dumping of aggregates from trucks directly on the geotextile.

(c) Repair of Geotextile. All geotextile that is torn, punctured, or contaminated during construction shall be repaired or replaced by the Contractor. The repair shall consist of a patch of the same type of geotextile placed over the affected area. The patch shall overlap the existing geotextile a minimum of 36 inches from the edge of any part of the rupture. Where geotextile seams are required to be sewn, all damaged sheets shall be repaired as required by the manufacturer's recommendations, unless otherwise shown in the Contract or as directed by the Engineer.

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(d) Overlaps. The minimum overlap requirements for geotextiles are as specified Table 649.04B.

TABLE 649.04B – MINIMUM GEOTEXTILE OVERLAP DISTANCES

Geotextile Location	Minimum Overlap Distance (inches)
Underdrain trench lining	12
Under Type I and II Stone Fill	24
Under Type III and IV Stone Fill or Riprap	36
Roadbed subgrade stabilization	36
Under railroad ballast	36

In the event the Engineer determines that the specified overlap is not sufficient, the overlap shall be increased to provide adequate coverage or the geotextile shall be sewn together in the field. If field-sewn, the requirements in Subsection 649.04(e) shall apply.

(e) Field Seams. Field seams shall be sewn with polymeric thread, consisting of polypropylene, polyester, or Kevlar, and shall be as resistant to deterioration as the geotextile being sewn. The thread shall be of a contrasting color with the geotextile being sewn, and the seams shall be made such that the stitches are exposed for inspection when the geotextile is placed.

(1) Stitching Equipment. The stitching equipment shall be such that it will provide an acceptable lock-type stitch, as recommended by the geotextile manufacturer and approved by the Engineer.

(2) Stitch Requirements. Two rows of lock-type stitching shall be used to make the seam. The two rows of stitching shall be 1/2 inch apart with a tolerance of ± 1/4 inch and shall not cross, except for re-stitching.

(3) Minimum Seam Allowance. The minimum required seam allowances, i.e., the minimum distances from the geotextile edge to the stitch line nearest to that edge, are as specified in Table 649.04C.

TABLE 649.04C – MINIMUM GEOTEXTILE SEAM ALLOWANCES

Seam Type (See Plans)	Minimum Seam Allowance (inches)
Flat or prayer seam, Type SSa-1	1-1/2
J-Seam, Type SSa-1	1
Butterfly folded seam, Type SSd-1	1

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(4) Seam Type. The Contractor shall obtain the geotextile manufacturer's recommendations for the type of seam and stitch to be used. If the Contractor does not provide the foregoing technical information, then the Contractor shall use a J-seam with two passes of a lock-type stitch which places at least three stitches per 1 inch of sewn seam. This seam will be tested as required by these specifications. The prayer seam (flat) may be used for repair of damaged in-place geotextile.

649.05 METHOD OF MEASUREMENT. The quantity of Geotextile of the type specified to be measured for payment will be the number of square yards placed in the complete and accepted work. Slope measurements will be used in computing the area. Measurement will not be made for material used for repairs, seams, or overlaps. Measurement will not be made for material used to replace an installation of fabric that has become damaged, destroyed, lost, washed away, or otherwise ineffective unless authorized by the Engineer.

649.06 BASIS OF PAYMENT. The accepted quantity of Geotextile of the type specified will be paid for at the Contract unit price per square yard. Payment will be full compensation for furnishing, transporting, storing, handling, placing, repairing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Unless otherwise specified in the Contract, payment for the maintenance of Geotextile of the type specified will not be paid for directly, but will be considered incidental to the specific Contract item.

Payment will be made under:

Pay Item	Pay Unit
649.11 Geotextile For Roadbed Separator	Square Yard
649.21 Geotextile Under Railroad Ballast	Square Yard
649.31 Geotextile Under Stone Fill	Square Yard
649.41 Geotextile For Underdrain Trench Lining	Square Yard
649.61 Geotextile For Filter Curtain	Square Yard

SECTION 650 – THIS SECTION RESERVED

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SECTION 651 – TURF ESTABLISHMENT

651.01 DESCRIPTION. This work shall consist of the preparation of the area and the application of topsoil, grubbing material, sod, seed, soil amendments, and mulch.

651.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Topsoil 755.02
Sod 755.03
Seed.....755.04
Compost 755.05
Fertilizer.....755.06
Agricultural Limestone 755.08
Liquid Lime 755.09
Hay Mulch .....755.10(a)
Fiber Mulch.....755.10(d)
Hydraulic Matrix.....755.10(e)
Tackifier.....755.10(f)
Straw Mulch.....755.10(g)
Rolled Erosion Control Product, Type I .....755.11(a)
Rolled Erosion Control Product, Type II.....755.11(b)

Stakes for holding sod shall be rounded or square wooden stakes at least 8 inches long, having a cross-sectional area of approximately one square inch. Stakes of other materials or designs may be used when authorized by the Engineer.

Grubbing material for use on stone fill along streams shall consist of grubbed or stripped earth material containing roots of native stream bank vegetation. Material for use on rock fill slopes shall consist of grubbed or stripped earth material containing roots (not necessarily from native stream bank vegetation) which will promote the growth of vegetation.

Grubbing material, from outside of the project limits, shall not contain any invasive plant material found on the State or Federal noxious weed lists on file with the Vermont Agency of Agriculture, Food, and Markets.

651.03 GENERAL. Turf establishment shall occur from May 1st to September 15th, inclusive, unless otherwise authorized under applicable permits and as directed by the Engineer.

The Contractor shall place turf establishment items on all cuts and fills within 48 hours of obtaining final grade, unless otherwise directed by the Engineer.

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All seeded areas shall be inspected, by the Engineer, for turf establishment within 14 calendar days of application. Areas not showing signs of sufficient growth shall have seed, limestone, fertilizer, and mulch reapplied at the Contractor's expense.

651.04 PREPARATION OF AREA. Preparation of areas for turf establishment shall not take place when the area is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer. Areas receiving topsoil and/or sod shall have an allowance made for the depth of topsoil and/or thickness of sod if not accounted for on the Plans.

Surfaces shall be prepared smooth with all breaks in grade well-rounded, to the satisfaction of the Engineer. All stones, lumps, roots, or other objectionable materials shall be removed.

(a) Native Material. For areas where native material is to be used for turf establishment, existing soil shall be loosened to a depth of 4 inches. Native material shall meet the requirements of Subsection 755.02, native material shall also be soil tested in accordance with Subsection 755.02. Native material shall be reworked as necessary to meet the requirements of Subsection 755.02 and any amendments needed, as determined by soil testing, shall be added at the determined rates.

When native material is specified to be used for turf establishment and soil analysis identifies that soil amendments will not allow the soil to be suitable for vegetation, the native material shall either be removed and the area prepared in accordance with Subsection 651.04(b) or the area shall be prepared in accordance with Subsection 651.05(b), to the discretion of the Engineer and covered with 4 inches of Topsoil.

(b) Topsoil. For areas to receive topsoil, existing soil shall be loosened to a depth of 2 inches.

(c) Sod. For areas to receive sod, existing soil shall be loosened to a depth of 2 inches. Compost shall be uniformly incorporated into the loosened soil such it comprises a minimum of 25%, by volume, of the loosened soil. Fertilizer and limestone shall be applied to the entire area to receive sod in accordance with Subsection 651.08. Fertilizer and limestone shall be applied the same day the area is sodded.

651.05 GROWTH MEDIUM. The growth medium shall be uniformly spread at the locations shown on the Plans. Spreading of growth medium shall not be done when the existing ground or growth medium is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer.

All stockpiles of growth medium shall be properly drained and all excess or unsuitable material removed and disposed of. When growth medium is stockpiled for seven or more calendar days it shall be protected in accordance Subsection 651.07. When growth medium is stockpiled for 30 calendar days or more, it shall be seeded in accordance Subsection 651.06 and protected in accordance with Subsection 651.07. Stockpiling shall be done in accordance will all relevant permits.

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(a) Topsoil. Topsoil shall be spread to a depth of 4 inches, ± 1 inch, unless otherwise shown on the Plans. Topsoil shall be lightly compacted as heavy compaction will reduce the potential for seed-soil contact and germination success. Whenever topsoil is stockpiled for more than one year, the Contractor shall have the topsoil tested in accordance with Subsection 755.02 to determine which amendments are needed. The Contractor shall incorporate all amendments as determined necessary by soil testing.

(b) Grubbing Material. The grubbing material shall be spread to a depth of 12 inches, ± 1 inch, unless otherwise shown on the Plans.

651.06 SEED AND AMENDMENTS. Seed and amendments shall be spread uniformly at the locations shown on the Plans and shall not be applied when the existing ground or growth medium is frozen, excessively wet, or otherwise untillable, as determined by the Engineer. Seed and amendments may be applied by hand, mechanical, or hydro-seeding methods.

(a) Hand or Mechanical Seeding.

(1) Seed. Seed shall be spread at the rates shown on the Plans. Seed shall be incorporated into the top 1/4 inch of the growth medium.

(2) Fertilizer. Fertilizer shall be spread at a rate of 500 pounds per acre, unless otherwise specified in the Contract or determined by soil testing.

(3) Limestone. Limestone shall be spread at the rates specified in Table 651.06A, unless otherwise specified in the Contract or determined by soil testing, as applicable.

TABLE 651.06A – LIMESTONE SPREADING RATES FOR HAND OR MECHANICAL SEEDING

Limestone Type	Spreading Rate (tons per acre)
Agricultural	2
Pelletized	1

Agricultural Limestone shall be applied with mechanical methods. Hand application will not be allowed.

(b) Hydro-Seeding. Hydro-seeding shall consist of mixing and applying seed, fertilizer, limestone, hydraulic matrix, water, and other materials as required.

(1) Seed. Seed shall be spread at a rate of 2 times that shown on the Plans.

(2) Fertilizer. Fertilizer shall be spread at a rate of 500 pounds per acre, unless otherwise specified in the Contract or determined by soil testing.

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(3) Limestone. Limestone shall be spread at the rates specified in Table 651.06B, unless otherwise specified in the Contract or determined by soil testing, as applicable.

TABLE 651.06B – LIMESTONE SPREADING RATES FOR HYDRO-SEEDING

Limestone Type	Spreading Rate
Agricultural	2 tons per acre
Liquid	4.5 gallons per acre

Liquid Lime application rates may be adjusted to be in accordance with the manufacturer's recommendations.

(4) Hydraulic Matrix. Hydraulic matrix shall be composed of tackifier and fiber mulch.

a. Tackifier. Tackifier shall be applied in accordance with the manufacturer's recommendations.

b. Fiber Mulch. Fiber mulch shall be applied in in accordance with the manufacturer's recommendations.

(5) Water. Water shall be used in accordance with the recommendations of the hydraulic matrix manufacturer.

Hydro-seeding shall not be applied when precipitation is forecast within 12 hours after application or when temperatures are below 40°F.

651.07 PROTECTION. Areas where seed and amendments are applied shall be protected in accordance with Subsection 653.07(a) or Subsection 653.07(b)(1) for Mulch or Rolled Erosion Control Product, Type I, respectively. Protection, of the type shown on the Plans, shall be applied after, and the same day, seeding and amendments are applied and at the locations shown on the Plans. The Contractor shall maintain all protection measures through acceptance of the work. Rolled Erosion Control Product, Type I may be substituted for Mulch at the Contractor's discretion, with no additional compensation.

651.08 SODDING.

(a) Cutting and Transporting. Before cutting sod, the area from which it is to be removed shall be mowed to a height of approximately 2 inches and cleared of excess grass clippings and other foreign material.

The sod shall be cut into strips of uniform width having a minimum dimension of 12 inches in width and 18 inches in length and uniform thickness of approximately 2 inches, unless otherwise directed by the Engineer. The sod shall contain most of the feeding roots of the grasses.

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The sod shall be transported in an unbroken condition to the area to be sodded. Unless otherwise directed by the Engineer, the sod shall be placed in its final position within 48 hours after cutting. When conditions require the sod to be stored, it shall be placed in stacks or piles for not more than five calendar days and shall be protected against drying from sun and wind.

(b) Placing. The sod shall be moist when placed on the prepared surface with the edges in close contact and alternate courses staggered. Any gaps shall be filled with sod plugs or topsoil.

Sod shall be staked at 2 foot intervals on grades greater than 1:4 (V:H) and in drainage ditches, unless otherwise directed by the Engineer. In ditches, the sod shall be placed with the longer dimension perpendicular to the flow of water. On slopes, starting at the bottom of the slope, the sod shall be placed with the longer dimension approximately parallel to the bottom of the slope.

The stakes shall be driven center to center in each direction and driven through the sod perpendicular to the surface so that the tops of stakes are flush with the top of the sod.

After installation, sod shall be rolled in order to form tight contact between the sod and the soil grubbings. Sod shall be thoroughly watered within an hour of placing. If any sections of sod turn brown or curl up, these areas are to be carefully cut out and new sod applied and watered, to create a uniform mat and appearance.

651.09 CARE DURING CONSTRUCTION. The Contractor shall be responsible for protecting and caring for sodded, seeded, and mulched areas until acceptance of the work. The Contractor shall repair and replace all areas where seed has failed to germinate or sod has failed to grow and any areas damaged by pedestrian or vehicular traffic or other causes at no cost to the Agency, except for conditions covered in Subsection 107.18. The Contractor shall maintain seeded areas to a height of no more than 1 foot in rural areas and between 3 and 6 inches in urban areas through acceptance of the work. The Contractor shall be responsible for watering seeded and/or sodded areas sufficiently to promote continuous growth as needed for an acceptable stand of grass.

651.10 ACCEPTANCE. An acceptable stand of grass shall show a reasonably thick, uniform stand, free from sizable areas of thin or bare spots, with a uniform count of at least 100 plants of the specified grass type per square foot.

651.11 METHOD OF MEASUREMENT. The quantities of Seed, of the type specified, and Fertilizer to be measured for payment will be the number of pounds used in the complete and accepted work, as determined by application rates and area treated. With written permission of the Engineer, the weight of small quantities may be determined by alternate methods. The Engineer will verify and document such weight determination.

The quantity of Agricultural Limestone to be measured for payment will be the number of tons used in the complete and accepted work, as determined by application rates and area treated. When seeding is done by the hydraulic method, Liquid Lime will be measured for payment in equivalent units of Agricultural Limestone, with 2.25 gallons of Liquid Lime equivalent to 1 ton of Agricultural Limestone.

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The quantity of Sodding to be measured for payment will be the number of square yards of sod used in the complete and accepted work, as determined using slope measurements.

The quantity of Topsoil to be measured for payment will be the number of cubic yards including any compost added, used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Grubbing Material to be measured for payment will be the number of square yards of Grubbing Material used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

651.12 BASIS OF PAYMENT. The accepted quantities of Seed, of the type specified, and Fertilizer will be paid for at the Contract unit price per pound for the item specified.

The accepted quantity of Agricultural Limestone will be paid for at the Contract unit price per ton.

The accepted quantity of Sodding will be paid for at the Contract unit price per square yard. Incorporating compost and soil amendments will not be paid for separately but will be considered incidental to the Sodding item.

The accepted quantity of Topsoil will be paid for at the Contract unit price per cubic yard. Compost will not be paid for separately but will be considered incidental to the Topsoil item.

The accepted quantity of Grubbing Material will be paid for at the Contract unit price per square yard.

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing the material specified, including Tackifier when used, and for furnishing all labor, tools, equipment, maintenance, water necessary to promote growth, and incidentals necessary to complete the work. All work required for preparation of the area will not be paid for separately but will be considered incidental to other Contract items.

Payment will be made under:

Pay Item	Pay Unit
651.15 Seed	Pound
651.16 Wildflower Seed	Pound
651.17 Seed, Winter Rye	Pound
651.18 Fertilizer	Pound
651.20 Agricultural Limestone	Ton
651.30 Sodding	Square Yard
651.35 Topsoil	Cubic Yard
651.40 Grubbing Material	Square Yard

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SECTION 652 – THIS SECTION RESERVED

SECTION 653 – EROSION PREVENTION AND SEDIMENT CONTROL

653.01 DESCRIPTION. This work shall consist of the design and modification of the erosion prevention and sediment control plan (herein known as the EPSC plan) and/or furnishing, installing, monitoring, maintaining, removing, and disposing of erosion prevention and sediment control measures in accordance with these specifications.

653.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Coarse Aggregate for Concrete.....704.02
Dense Graded Crushed Stone for Subbase 704.06
Aggregate for Erosion Prevention and Sediment Control 704.17
Geotextile Under Stone Fill 720.04
Geotextile for Silt Fence 720.07
Barrier Fence.....727.03
Project Demarcation Fence 727.04
Hay Mulch .....755.10(a)
Wood Chip Mulch.....755.10(b)
Fiber Mulch.....755.10(d)
Hydraulic Matrix.....755.10(e)
Straw Mulch.....755.10(g)
Rolled Erosion Control Product, Type I .....755.11(a)
Rolled Erosion Control Product, Type II.....755.11(b)
Erosion Logs 755.17

This sentence deleted.

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Woven wire reinforcement shall be a minimum of 14-gauge mesh with a maximum mesh opening of 6 inches.

Posts for silt fence shall be wood, with minimum dimensions of 1 inch by 1 inch, or steel. Steel posts shall meet the requirements specified in *AASHTO M 281* or *AASHTO M 181*.

Filtering aggregate shall meet the requirements of Subsection 704.02 and Table 704.02B or Subsection 704.06.

653.03 EPSC PLAN. The Contractor shall be responsible for development of an EPSC plan and shall become a co-permittee with the Agency on projects with associated permits.

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(a) Development. The Contractor shall develop an EPSC plan. When an EPSC plan is included in the Contract, the Contractor may use the included EPSC plan as a basis for making modifications, meeting the requirements of the VTrans *Erosion Prevention and Sediment Control Plan Contractor Checklist (for Non-Jurisdictional and Low Risk)*.

When construction activities occur in phases requiring successive phases of the EPSC plan, those phases shall be included in the EPSC plan.

The preparer of the EPSC plan shall be a licensed professional engineer registered in the State of Vermont, a Certified Professional in Erosion and Sediment Control (CPESC) certified by EnviroCert or an equivalent as determined by the Engineer. The EPSC plan shall be stamped if prepared by a professional engineer and signed if prepared by a CPESC (or equivalent). This shall occur even if the EPSC plan included in the Contract is used unmodified.

The current EPSC plan and all manuals, checklists, forms and other supporting documentation necessary to maintain compliance with associated permits shall be available to the Engineer and maintained on site by the Contractor.

(b) Submittals. The Contractor shall submit the EPSC plan and an updated risk evaluation as required by the permit and preparer certification, if necessary, to the Engineer to determine conformance. The EPSC plan shall be submitted in accordance with Subsection 105.03(b)(3)b.

The Engineer will provide a conformance memo or comments to the Contractor within 10 working days of the receipt of the EPSC plan. The Contractor shall submit a revised EPSC Plan, addressing all comments, within 10 working days of receipt of comments. This cycle shall continue until a conformance memo has been issued for the EPSC plan. The submittal process will not be considered as an acceptable delay of the work under Subsection 108.11.

The EPSC plan, and each subsequent revision, which have demonstrated conformance, shall be forwarded to the ANR as appropriate.

Construction activities shall not commence prior to issuance of a conformance memo for the EPSC plan by the Engineer. For projects where ANR authorization is required, construction activities shall not commence until the conformance memo for the EPSC plan has been issued by the Engineer and authorized by the ANR.

653.04 MONITORING EROSION PREVENTION AND SEDIMENT CONTROL PLAN. The Contractor shall be responsible for monitoring all EPSC measures in accordance with the conforming EPSC plan and Contract from installation of the EPSC measures through removal of the EPSC measures or acceptance of the project, whichever applies.

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(a) On-Site Plan Coordinator. The Contractor shall designate an on-site plan coordinator (OSPC) that is responsible for monitoring the implementation of the EPSC plan on the project. The OSPC shall have demonstrated experience in construction practices as they relate to erosion prevention and sediment control as well as a general understanding of State and Federal environmental regulations and permits pertaining to the National Pollutant Discharge Elimination System Construction Program. The OSPC shall be proficient at reading and interpreting engineering and EPSC plans. The OSPC shall generally be on-site daily and shall have the authority to halt construction activities if necessary.

(b) Inspection. For Non-Jurisdictional and Low Risk Projects, inspections shall be conducted using the Agency's *EPSC Plan Inspection Report (Non-Jurisdictional and Low Risk Projects)*, available on the Agency's website. For all other projects, inspections shall be done in accordance with permit requirements.

(1) Active Construction. Inspection shall occur once every 7 calendar days and within 24 hours of the end of a storm event that results in a discharge of stormwater from the site. During the winter season (October 15th to April 15th, inclusive) inspections shall occur daily at all sites.

(2) Inactive Construction. Inspection shall occur at least once every 30 calendar days and within 24 hours of any storm or significant snow melt event that may cause stormwater runoff. The Contractor shall contact the Engineer prior to conducting any inspection. The Contractor shall provide, within 24 hours, the necessary personnel, equipment, and materials to repair or correct any deficiencies identified during inspection. All deficiencies and corrective measures taken shall be documented in the inspection reports.

653.05 MAINTENANCE OF EROSION PREVENTION AND SEDIMENT CONTROL PLAN. The Contractor shall provide all labor and equipment necessary for field maintenance of erosion prevention and sediment control items not included in the Contract, and providing materials and labor necessary for installing, monitoring, maintaining and, where necessary, removing additional measures needed to correct deficiencies that develop during construction that lessen the performance of the EPSC plan.

Erosion prevention and sediment control measures shall be maintained by the Contractor and removed when authorized by the Engineer. The Contractor shall establish vegetation in all areas disturbed during installation, maintenance and removal of the erosion prevention and sediment control measures.

Any maintenance required due to the failure of the Contractor to follow the conforming EPSC plan shall be performed at no additional cost to the Agency.

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653.06 DELINEATION MEASURES.

(a) Barrier Fence. Barrier fence shall be installed as a visible barrier beyond which there shall be no construction activity by the Contractor or project personnel. Barrier fence shall be installed at the locations shown on the Plans, in accordance with the Contract and as directed by the Engineer.

Barrier fence shall be installed on W-shape steel posts. The fence shall have a minimum height of 4 feet. The posts shall be embedded a minimum of 2 feet into the ground, extend above the fabric, and be installed at a 5-foot spacing.

The Contractor shall install, inspect, and maintain barrier fence in accordance with the Contract or as directed by the Engineer.

The Contractor shall remove barrier fence from the project when deemed no longer necessary by the Engineer, and the barrier fence shall remain the property of the Contractor.

(b) Project Demarcation Fence (PDF). PDF shall be installed as a visible barrier beyond which there shall be no construction activity by the Contractor or project personnel. PDF shall be installed at the locations shown on the Plans, as per the Contract and as directed by the Engineer.

PDF shall be installed on hardwood stakes and shall have a minimum width of 3 inches. The stakes shall be 1 inch × 1 inch × 4 feet, shall be embedded 1 foot into the ground, extend above the fabric, and be installed at a 10-foot spacing.

The Contractor shall install, inspect, and maintain PDF in accordance with the Contract or as directed by the Engineer.

The Contractor shall remove the PDF from the project when deemed no longer necessary by the Engineer, and the PDF shall remain the property of the Contractor.

653.07 STABILIZATION MEASURES. Stabilization measures shall be used to prevent erosion of disturbed soils in accordance with the Contract.

(a) Mulch. Mulch shall be applied uniformly, maintained and in accordance with the application rates as specified herein.

(1) Hay Mulch. Hay mulch shall be applied at a minimum rate of 2 tons per acre. Hay mulch shall only be used on slopes less than 1:3 (V:H).

(2) Hydraulic Mulch. Hydraulic mulch consists of applying a fiber mulch or hydraulic matrix with hydro-mulching equipment.

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Fiber mulch shall be mixed in a hydraulic application machine and applied as a liquid slurry in accordance with the manufacturer's specified procedures and rates. Fiber mulch shall be applied from multiple directions and angles to ensure complete and proper coverage and only when rainfall is not predicted for at least 12 hours. The resulting coverage must be at least 1/8 inch in thickness over the entire area.

Hydraulic matrix shall be hydraulically applied to the soil as a viscous mixture, creating a continuous three-dimensional blanket that adheres to the soil surface. Upon drying, the matrix shall form a high-strength, porous, and erosion-resistant mat that shall not inhibit the germination and growth of plants in and beneath the layer. The matrix shall retain its form despite re-wetting. Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied until vigorous vegetation is established.

(3) Straw Mulch. Straw mulch shall be applied at a minimum rate of 2 tons per acre. Straw mulch shall only be used on slopes less than 1:3 (V:H).

(4) Wood Chip Mulch. Wood chip mulch shall be applied to a depth of 1 inch.

(b) Rolled Erosion Control Product. Rolled erosion control products, of the type specified, shall be installed at the locations shown on the Plans or as directed by the Engineer.

The ground surface shall be shaped to the lines and grades shown on the Plans and be free of any depressions or objectionable material that would allow water to collect and flow beneath the matting or prevent the matting from maintaining contact with ground. Rolled erosion control products shall not be stretched or allowed to bridge over surface inconsistencies.

For areas where rolled erosion control products are to be installed and seed and amendments are also to be applied, all seed and amendments shall be applied prior to installation of the rolled erosion control products.

Rolled erosion control product and ground fasteners shall be installed in accordance with the Contract or the manufacturer's recommendations, whichever is more stringent.

(1) Rolled Erosion Control Product, Type I. Rolled Erosion Control Product, Type I shall be used to provide temporary erosion control while vegetation is established in those areas where vegetation will provide permanent erosion protection.

Rolled Erosion Control Product, Type I shall meet the requirements of Table 755.11A for the specific site properties as applicable.

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Rolled Erosion Control Product, Type I shall not be applied to grades steeper than 1:1 (V:H).

The Contractor shall maintain Rolled Erosion Control Product, Type I through turf establishment in accordance with Section 651.

(2) Rolled Erosion Control Product, Type II. Rolled Erosion Control Product, Type II shall be used to provide permanent erosion control where vegetation will not sustain expected flow conditions or provide sufficient long-term erosion protection.

Rolled Erosion Control Product, Type II shall meet the requirements of Table 755.11B for the specific site properties as applicable.

The Contractor shall maintain Rolled Erosion Control Product, Type II through acceptance of the project.

No vehicular traffic of any kind will be permitted over stabilization measures during or after placement. Damage or displacement of stabilization measures through the fault of the Contractor shall be replaced or repaired at the Contractor's expense.

653.08 RUNOFF CONTROL MEASURES. Runoff control measures shall be used to slow runoff in accordance with the Contract.

(a) Check Dams. Check dams shall be used for the primary purpose of reducing flow velocity and the secondary purpose of allowing sediment to settle. Check dams, of the type specified, shall be installed in the water flow path, as shown on the Plans, in accordance with the Contract and as directed by the Engineer.

(1) Check Dam, Type I. Check Dam, Type I shall be placed in channels and on Geotextile Under Stone Fill meeting the requirements of Subsection 720.04.

Check Dam, Type I shall be constructed of Aggregate for Erosion Prevention and Sediment Control meeting the requirements of Subsection 704.17.

(2) Check Dam, Type II. Check Dam, Type II shall be placed along curbs. Check Dam, Type II structures shall vary in height, width, and length depending on site-specific conditions. They shall have a minimum height of 4 inches, a minimum width of 6 inches, and shall extend 1 foot in a direction perpendicular to the curb and 2 feet up gradient of the curb at an angle ranging from 30° to 60° from the curb face.

For slopes of 3% or less, Check Dam, Type II shall be constructed of stone meeting the requirements of Subsection 704.02 and Table 704.02C.

For slopes greater than 3%, Check Dam, Type II shall be constructed of stone meeting the requirements of Subsection 704.17.

(3) Check Dam, Type III. Check Dam, Type III shall be installed in accordance with the Contract and the manufacturer's recommendations.

Check Dam, Type III shall be one of the Check Dam, Type III products on the Agency's *Approved Products List*.

The Contractor shall remove accumulated sediment when the depth of the sediment reaches half the height of the check dam, measured at the ditch flowline.

Check dams shall be removed from the project when deemed no longer necessary by the Engineer, and shall remain the property of the Contractor.

(b) Silt Fence. Silt fence shall be installed in accordance with the Contract, and shall be installed perpendicular to the water flow to intercept and collect sediment and associated pollutants by filtering and settling.

(1) Silt Fence, Type I. Silt Fence, Type I shall be constructed of posts and Geotextile for Silt Fence meeting the requirements of Subsection 720.07.

(2) Silt Fence, Type II. Silt Fence, Type II shall be constructed of posts, Geotextile for Silt Fence meeting the requirements of Subsection 720.07, and woven wire reinforcement.

The Contractor shall remove accumulated sediment when it reaches half the height of the silt fence above the existing ground.

The Contractor shall repair or replace damaged silt fence as ordered by the Engineer. Silt fence shall be removed from the project by the Contractor when deemed no longer necessary by the Engineer, and shall remain the property of the Contractor.

(c) Erosion Logs. Erosion logs shall be installed to intercept water flow and collect sediment and associated pollutants by settling and filtering. Erosion logs may be placed over bare or mulched soils or rolled erosion control products; around inlet and outlets; to slow runoff velocities in ditches, slope interrupters on steep slopes, and perimeter control; and along stream banks as a base for plantings. The type of erosion log selected shall be for the intended application.

Prior to placing erosion logs, the ground surface shall be properly graded and compacted and free of depressions or obstructions such as tree roots, protruding stones, or other foreign matter.

Erosion logs shall be installed in accordance with the manufacturer's installation guidelines, staking pattern guide, and details based upon the intended use on the construction site.

The Contractor shall remove accumulated sediment when it has reached one half of the effective height of the log, or as directed by the Engineer. Erosion logs shall be maintained until disturbed area above the device has been permanently stabilized and construction activities have ceased.

Erosion Logs shall be removed from the project and disposed of when deemed no longer necessary by the Engineer. When fill material and netting are 100% biodegradable, erosion logs may be cut open, spread or graded flat and left in place, in a manner to not cause concentration of surface runoff in the future.

653.09 TREATMENT MEASURES.

(a) Stabilized Construction Entrances. Stabilized construction entrances shall be constructed at each access point between the construction area and all public or private roads. The Contractor shall maintain any existing drainage and flow paths within the stabilized construction entrance.

Stabilized construction entrances shall be constructed of stone meeting the requirements of Subsection 704.17 and shall be placed on top of Geotextile Under Stone Fill meeting the requirements of Subsection 720.04.

Stabilized construction entrances shall be maintained such that aggregate does not become clogged, resulting in tracking of sediment onto public rights-of-way. Additional aggregate may be added on top of the existing aggregate only to a point which a smooth transition between the road surface and construction area is maintained. When a smooth transition can no longer be maintained when adding aggregate, the stabilized construction entrance shall be removed in its entirety and replaced.

Stabilized construction entrances shall be removed from the project and disposed of when deemed no longer necessary by the Engineer.

(b) Inlet Protection Devices. Inlet protection devices shall be used for treating stormwater prior to entering a drainage structure. Inlet protection devices shall be constructed and installed such that flow is directed through the device and into the inlet.

(1) Inlet Protection Device, Type I. Inlet Protection Device, Type I shall be for use at drop inlets located outside of roadway surface and shall be installed in accordance with the Contract.

Block and stone devices shall be constructed of Aggregate for Erosion Prevention and Sediment Control and concrete blocks approved by the Engineer.

Stake and fabric devices shall be constructed of Geotextile for Silt Fence meeting the requirements of Subsection 720.07 and stakes approved by the Engineer.

When deemed necessary by the Engineer, filtering aggregate shall be applied to the upstream surface of the Inlet Protection Device, Type I.

Inlet Protection Device, Type I shall be removed from the project and disposed of when deemed no longer necessary by the Engineer.

(2) Inlet Protection Device, Type II. Inlet Protection Device, Type II shall be for use at drop inlets located within the roadway surface and shall be installed in accordance with the Contract and the manufacturer's recommendations.

Inlet Protection Device, Type II shall be one of the Inlet Protection Devices, Type II on the Agency's *Approved Products List*.

Inlet Protection Device, Type II shall be removed from the project when deemed no longer necessary, by the Engineer, and shall remain the property of the Contractor.

(3) Inlet Protection Device, Type III. Inlet Protection Device, Type III shall be for use at culvert inlets and shall be installed in accordance with the Contract.

Inlet Protection Device, Type III shall be constructed of Aggregate for Erosion Prevention and Sediment Control and shall be placed on top of Geotextile Under Stone Fill meeting the requirements of Subsection 720.04.

When deemed necessary by the Engineer, filtering aggregate shall be applied to the upstream surface of the Inlet Protection Device, Type III.

Inlet Protection Device, Type III shall be removed from the project, and disposed of, when deemed no longer necessary, by the Engineer. Aggregate may be flattened along the channel upon approval of the Engineer. Geotextile shall be removed.

The Contractor shall remove accumulated sediment when it reaches half the height, at its lowest point, of Inlet Protection Devices.

(c) Filter Bag. A filter bag is a device that may be used during dewatering pumping operations. The filter bag shall retain silt, sand, and fines while allowing filtered water to pass through.

Where possible, a filter bag shall be placed a minimum of 50 feet from any waters of the State and on a gradual slope in order that incoming water flows downhill through the bag. To increase the efficiency of filtration the filter bag shall be placed on a coarse aggregate or hay bale bed, unless otherwise directed by the Engineer or specified in the Contract.

The neck of the filter bag shall be strapped tightly to the discharge hose. A filter bag is full when it no longer can efficiently filter sediment or allow water to pass at a reasonable rate. Use of excessive flow rate or overfilling a filter bag with sediment will cause rupture of the bag or failure of the hose attachments and shall not be permitted under any circumstances.

Filter bag shall be one of the filter bags on the Agency's *Approved Products List*.

Filter bags shall be disposed of at an approved location as directed by the Engineer.

653.10 THIS SUBSECTION RESERVED.

653.11 THIS SUBSECTION RESERVED.

653.12 THIS SUBSECTION RESERVED.

653.13 THIS SUBSECTION RESERVED.

653.14 THIS SUBSECTION RESERVED.

653.15 THIS SUBSECTION RESERVED.

653.16 METHOD OF MEASURMENT. The quantity of EPSC Plan to be measured for payment will be on a lump sum basis for design and modification of an EPSC Plan in the complete and accepted work.

The quantity of Monitoring EPSC Plan to be measured for payment will be the number of hours, authorized by the Engineer, actually spent monitoring the EPSC Plan. Hours will be rounded to the nearest quarter hour. Travel time and other time not spent at the construction site(s), or time not authorized by the Engineer, will not be measured for payment (e.g., travel expenses, clerical staff time, copying, miscellaneous expenses, overhead, etc.).

The quantity of Maintenance of EPSC Plan will be on a lump unit basis for installation and maintenance of EPSC measures not otherwise included in the Contract.

The quantity of Barrier Fence, Project Demarcation Fence, Erosion Log, Silt Fence, Type I and Silt Fence Type II to be measured for payment will be the number of linear feet used in the complete and accepted work.

The quantity of Hay Mulch and Straw Mulch to be measured for payment will be the number of tons used in the complete and accepted work.

The quantity of Hydraulic Mulch to be measured for payment will be the number of gallons used in the complete and accepted work.

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The quantity of Rolled Erosion Control Product, of the type specified, to be measured for payment will be the number of square yards used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Check Dam, Type I, Check Dam, Type II, Stabilized Construction Entrance, and Inlet Protection Device, Type III to be measured for payment will be the number of cubic yards, of the stone specified, used in the complete and accepted work.

The quantity of Check Dam, Type III, Inlet Protection Device, Type I, Inlet Protection Device, Type II and Filter Bag to be measured for payment will be for each used in the complete and accepted work.

Wood Chip Mulch will not be measured for payment separately but will be considered incidental to other Contract items.

653.17 BASIS OF PAYMENT. The accepted quantity of EPSC Plan will paid for at the Contract lump sum price. Payment will be full compensation for the initial preparation of an EPSC Plan, modifications, submittals, and all incidentals necessary to complete the work. Subsequent modifications to the EPSC Plan during construction will be considered incidental.

The accepted quantity of Monitoring EPSC Plan will be paid for at the Contract unit price per hour. Payment will be full compensation for monitoring, reviewing, and reporting on the construction site, including waste, borrow, and staging areas or other support activities, as it relates to the EPSC Plan. Payment will not be made unless a report for the monitoring is submitted to and accepted by the Engineer.

The accepted quantity of Maintenance of EPSC Plan will be paid for as specified for force account work in Subsection 109.06. Payment will be drawn against the Contract lump unit amount. To provide a common proposal for all bidders, the Agency has entered an amount in the proposal to become part of the Contractor's total bid. Maintenance related to material supply and disposal areas shall be performed in accordance with Subsection 105.29.

The accepted quantities of delineation measures, stabilization measures, run-off control measures, and treatment measures will be paid for at the Contract unit price specified for each item. Payment shall be full compensation for furnishing, transporting, handling, placing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Geotextile, culverts, excavation, or any other items necessary to complete the work shall be considered incidental to the appropriate Contract item.

Unless otherwise specified in the Contract, payment for the maintenance of erosion prevention and sediment control measures will be incidental to the specific Contract item.

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Payment will be made under:

Pay Item	Pay Unit
653.01 EPSC Plan	Lump Sum
653.02 Monitoring EPSC Plan	Hour
653.03 Maintenance of EPSC Plan (N.A.B.I.)	Lump Unit
653.10 Hay Mulch	Ton
653.11 Hydraulic Mulch	Gallon
653.12 Straw Mulch	Ton
653.20 Rolled Erosion Control Product, Type I	Square Yard
653.21 Rolled Erosion Control Product, Type II	Square Yard
653.25 Check Dam, Type I	Cubic Yard
653.26 Check Dam, Type II	Cubic Yard
653.30 Check Dam, Type III	Each
653.35 Stabilized Construction Entrance	Cubic Yard
653.40 Inlet Protection Device, Type I	Each
653.41 Inlet Protection Device, Type II	Each
653.42 Inlet Protection Device, Type III	Cubic Yard
653.45 Filter Bag	Each
653.475 Silt Fence, Type I	Linear Foot
653.476 Silt Fence, Type II	Linear Foot
653.50 Barrier Fence	Linear Foot
653.55 Project Demarcation Fence	Linear Foot
653.60 Erosion Log	Linear Foot

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SECTION 654 – THIS SECTION RESERVED

SECTION 656 – PLANTING TREES, SHRUBS, AND VINES

656.01 DESCRIPTION. This work shall consist of furnishing, transporting, planting, and transplanting various size trees, shrubs, vines, perennials, and ground cover plants.

656.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Barrier Fence.....727.03
Water.....745.01
Landscape Backfill.....755.01
Topsoil.....755.02
Compost.....755.05
Fertilizer.....755.06
Mycorrhizal Fungi Product.....755.07
Bark Mulch.....755.10(c)
Plant Materials.....755.12
Antidesiccant.....755.13
Tree Watering Bags.....755.16

656.03 PLANTING SEASON. Unless otherwise specified on the Plans, plantings shall take place between April 1st and October 31st, inclusive. No planting shall be done in frozen ground, when snow covers the ground, or when the soil or weather is determined by the Engineer to be unsatisfactory for planting.

656.04 INSPECTION AND DELIVERY. Plants transported in open vehicles shall be covered by tarpaulins or other suitable covers securely tied to the body of the vehicle. Closed vehicles shall be adequately ventilated to prevent overheating of the plants.

The Engineer will make a preliminary inspection of all plants at the time of delivery on the project. Trees with multiple leaders will be rejected unless otherwise specified in the Contract. Trees with damaged or crooked leaders, bark abrasions, sun scald, disfiguring knots, insect damage, or cuts of limbs over 3/4 inch in diameter that are not completely closed will be rejected. Container grown plants that have stem girdling roots will be rejected. Balled and burlapped trees and shrubs with excessive soil on top of the root flare and an otherwise minimal root ball will be rejected.

Substitutions of plant materials will not be permitted unless authorized in writing by the Engineer. Plant substitutions shall be either the nearest available size of that variety or a similar variety with comparable form and function.

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The Engineer shall perform an inspection at the time of planting. Plants rejected by the Engineer at this inspection shall not be planted.

656.05 PROTECTION AND TEMPORARY STORAGE. The Contractor shall keep all plant material moist and protected from drying out. Temporary storage shall be limited to 45 calendar days from the time of delivery. Plants shall be protected when in transit, in temporary storage, and on the project site awaiting planting.

The Contractor shall exercise the utmost care in loading, unloading, and handling of plants to prevent injuries to the branches or to the roots of the plants. The solidity of balled and burlapped plants shall be carefully preserved.

Plants which are not scheduled for planting within 48 hours shall be kept in a moist condition and protected adequately by covering the roots with topsoil, wood chips, or other suitable material until removed for planting.

Failure to manage the storage of plant material as specified herein may be cause for rejection.

656.06 LAYOUT. Plant material locations and bed outlines shall be staked by the Contractor and approved by the Engineer.

656.07 EXCAVATION. Prior to excavating for plant pits and beds, the area shall conform to the lines and grades shown on the Plans. All sod, weeds, roots, and other objectionable material unsuitable for backfill shall be removed from the site and disposed of by the Contractor in a manner satisfactory to the Engineer.

Bare root, non-containerized seedlings, or transplants may be planted in the existing soil. The size of planting pits shall be as shown in the Contract.

The Contractor shall restore all areas disturbed by the planting operations at no cost to the State.

656.08 SETTING PLANTS. Plants shall be set at the locations shown on the Plans and in accordance with the Contract.

All plants shall be moved with the root ball intact, using mechanical methods if needed. If the root ball has been badly cracked or broken, the plant shall be rejected for use.

(a) Watering. All plant material shall be watered thoroughly at planting. Unless otherwise specified, the minimum number of waterings during the establishment period shall be twice weekly. At each watering, the soil around the plant shall be thoroughly saturated. The time interval between waterings may be increased or decreased by the Engineer to maintain adequate moisture levels. Trees shall receive a minimum of 10 gallons at each watering, shrubs a minimum of 5 gallons and vines and plants a minimum of 3 gallons. Natural rainfall shall not be considered a watering unless otherwise approved by the Engineer.

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Tree watering bags may be utilized at the discretion of the Contractor. The installation and maintenance of the bags shall be in accordance with the manufacturer's recommendations. The bags shall be removed by the Contractor after final inspection. Replacement of watering bags during the establishment period shall be the responsibility of the Contractor.

The Contractor shall provide to the Engineer a weekly log to account for the frequency and amount of watering during the establishment period. When natural rainfall replaces a watering it shall be noted in the log as measured on site or noted by the U.S. Weather Service.

(b) Pruning. All broken, injured, or damaged branches shall be pruned before or immediately after planting in accordance with the current *VTrans Technical Landscape Manual*.

(c) Mulching. Bark mulch material shall be applied as detailed in the Contract. Wood chip mulch shall not be used. The same type of material shall be used in all areas to provide visual uniformity.

(d) Antidesiccant Spray. The use of antidesiccant spray shall be at the discretion of the Contractor. Antidesiccant spray shall be applied per the manufacturer's recommendations unless otherwise specified in the Contract.

(e) Fertilizer and Mycorrhizal Fungi. The use of fertilizer and mycorrhizal fungi shall be at the discretion of the Contractor. Fertilizer and mycorrhizal fungi shall be applied per the manufacturer's recommendations unless otherwise specified in the Contract.

(f) Rodent Guards. Rodent guards may be used at the Contractor's discretion. The Engineer shall approve the type of rodent guard. If used, rodent guards shall be removed prior to acceptance of the project.

656.09 ESTABLISHMENT AND MAINTENANCE. The Contractor shall actively maintain the plants after planting. All mulched areas shall be kept weeded, neat, and maintained to the original layout lines. Saucers shall be maintained in accordance with the Contract until acceptance.

If the Contractor feels that spraying of the plant materials and mulched areas is necessary to prevent damage from insects or plant diseases, the material, application rate, number of applications, and any other data pertinent to the spraying shall be submitted to the Engineer for approval. The submittal shall also include a letter from the Vermont Agency of Agriculture, Food, and Markets approving the spraying.

Approximately four to six months following planting, the Engineer and Contractor shall inspect the plantings. Any dead, dying, or damaged plantings shall be replaced by the Contractor. Any replacement plantings shall be completed within 30 calendar days after inspection or as directed by the Engineer. This cycle shall continue until a 90% survival rate has been achieved to the satisfaction of the Engineer.

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656.10 TRANSPLANTING. Transplanting shall be done in accordance with the requirements of Subsection 656.08 or as ordered by the Engineer.

Transplanted plant materials shall be maintained during establishment in accordance with the requirements of Subsection 656.09, except that on projects where only transplanting of existing plant materials is performed, the establishment period shall end on the Contract acceptance date.

656.11 TREE PROTECTION. The purpose of this item is to prevent damage to branches, stems, and root systems of existing individual trees to remain, and to ensure their survival. Provisions under this item include steps to minimize soil and root disturbance and to construct protection measures for trees close to construction areas. The Contractor shall install barrier fence to the drip line of existing trees or shrubs marked either "Save" or "Protect" or shown with a Tree Protection Zone (TPZ) on the Plans prior to any earth disturbance; barrier fence shall not be removed until the final project inspection.

There will be no activity within the TPZ or the drip line of the tree except watering or installation of erosion prevention or sediment control measures where required. Only hand digging shall be allowed within the TPZ when necessary. Avoid making root cuts during hot, dry weather. All tree protection shall be performed in accordance with the current version of the *VTrans Technical Landscape Manual*. The Engineer shall approve tree protection methods and schedule of work.

The following protection procedure shall apply when excavation is to be performed near trees or shrubs labeled "Save" or "Protect" or shown with a TPZ on the Plans:

(a) Care shall be taken to avoid breaking tree limbs and branches with construction equipment. Prior to construction, tree limbs of trees identified for protection and any other trees identified by the Engineer shall be pruned in accordance with the requirements of Subsection 656.08(b).

(b) Roots encountered during excavation work near a TPZ area shall be cleanly cut with no tearing of roots. Exposed tree roots shall be protected by a double layer of dampened burlap at all times until they can be covered with soil, at which time the dampened burlap shall be removed.

(c) Following excavation and during the construction season, water shall be provided to impacted trees at a minimum of 2-1/2 gallons per week per 1 inch caliper or as directed by the Engineer. The Contractor shall provide a log to document watering and natural rainfall to the Engineer.

If a tree is damaged due to the Contractor's negligence and determined to be non-repairable by the Engineer, the Contractor shall replace it at no additional cost to the Agency with a tree of equal value, or two or more trees with a total value equal to that of the damaged tree. The appraisal shall be performed by an Arborist who has been certified by the International Society of Arboriculture. Replacement plantings shall be installed as specified herein.

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656.12 METHOD OF MEASUREMENT. The quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, and Perennials to be measured for payment will be the number of each of the specified types and sizes furnished and planted or transplanted in the complete and accepted work, except for Transplanting Groundcover, which will be measured by the square yard. Only living plants in healthy condition at the completion of Establishment and Maintenance period, as defined in Subsection 656.09, will be accepted.

The quantity of Landscape Watering to be measured for payment will be the number of thousand gallons (MGAL) of water used in the complete and accepted work. The Contractor shall provide a written log meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Landscape Backfill, Truck Measurement to be measured for payment will be the number of cubic yards used in the complete and accepted work, as determined by vehicle loads using three-dimensional measurement. All loads designated shall be leveled at the point of delivery when directed by the Engineer. A load ticket shall be furnished to the Engineer with each load delivered to the job site.

The quantity of Tree Protection to be measured for payment will be on a lump sum basis in the complete and accepted work.

656.13 BASIS OF PAYMENT. The accepted quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, and Perennials will be paid for at the Contract unit price each for the specified types and sizes and kinds for planting or transplanting, except for Transplanting Groundcover, which will be paid for at the Contract unit price per square yard. All Seedlings, Trees, Shrubs, Ground Covers and Vines, and Perennials that have died, failed to grow, or otherwise have proven unsatisfactory to the Engineer during the establishment period shall be replaced with healthy stock of the same type or approved substitute at the Contractor's expense.

Payment will be made as follows:

(a) 80% of the Contract unit price shall be paid after the initial planting.

(b) The remaining 20% of the Contract unit price shall be paid upon completion of the Establishment and Maintenance period, as defined in Subsection 656.09.

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing plants, fertilizer, mycorrhizal fungi, mulch, and all incidental materials. Payment for these items will be full compensation for excavation, pruning, guying and staking, mulching, wire rodent guards, water basin formation, cleanup, restoration, and plant maintenance establishment work and care, including replacement.

Payment for these items will be full compensation for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Weed separator fabric, water bags, or any other item necessary to complete the work will be considered incidental to the appropriate Contract items.

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The accepted quantity of Landscape Watering will be paid for at the Contract unit price per thousand gallons (MGAL). When the Landscape Watering item is not specified as a separate pay item in the Contract, water applied during the plant establishment period will not be paid for directly, but will be considered incidental to the other Section 656 items in the Contract. Water bags, when specified in the Contract, will not be paid for directly but will be considered incidental to Landscape Watering.

The accepted quantity of Landscape Backfill, Truck Measurement will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for furnishing, mixing, testing, transporting, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Tree Protection will be paid for at the Contract lump sum price. Payment will be full compensation for all tree protection measures including barrier fence, branch and root pruning, watering, and all incidentals necessary to complete the work.

The project will not be accepted until the replacement of all dead, dying, or poorly-growing material has been completed to the satisfaction of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
656.15 Evergreen Seedlings	Each
656.16 Deciduous Seedlings	Each
656.20 Evergreen Trees	Each
656.25 Evergreen Shrubs	Each
656.30 Deciduous Trees	Each
656.35 Deciduous Shrubs	Each
656.40 Ground Covers and Vines	Each
656.41 Perennials	Each
656.45 Transplanting Trees	Each
656.50 Transplanting Shrubs	Each
656.55 Transplanting Groundcover	Square Yard
656.65 Landscape Watering	MGAL
656.80 Landscape Backfill, Truck Measurement	Cubic Yard
656.85 Tree Protection	Lump Sum

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SECTION 658 – THIS SECTION RESERVED

SECTION 660 – THIS SECTION RESERVED

SECTION 661 – THIS SECTION RESERVED

SECTION 664 – THIS SECTION RESERVED

SECTION 665 – THIS SECTION RESERVED

SECTION 674 – THIS SECTION RESERVED

SECTION 675 – TRAFFIC SIGNS

675.01 DESCRIPTION. This work shall consist of constructing, furnishing, and installing sign post foundations, sign posts, traffic signs, removing existing signs, setting salvaged sign posts, and erecting salvaged signs.

675.02 MATERIALS. Materials shall meet the requirements of the following subsections:

This material list item deleted.

Bar Reinforcement 713.01
Sign Posts 750.01
Extruded Aluminum Panels 750.02
Flat Sheet Aluminum 750.03
Retroreflective Sheeting 750.08
Demountable Characters 750.09
Plastic Lettering Film 750.10
Extruded Aluminum Molding 750.11
Assembly Hardware 750.12

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

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675.03 GENERAL. Foundation components, sign posts and traffic signs shall always be handled to prevent damage. Damaged foundations, sign posts, or traffic signs will be rejected. Signs shall be installed with adequate sight distance in accordance with the *MUTCD*.

675.04 FOUNDATIONS. Foundations, of the size and type specified, shall be constructed at the locations shown on the Plans. The Contractor shall excavate to depths and dimensions as required and shall construct the foundation in accordance with the Contract. Stub posts or steel pipe, whichever applies, shall be placed in position, plumbed, leveled, and braced prior to the construction of the foundation, and projection above final grade shall be as shown in the Contract. Care shall be taken during construction of foundations to ensure that minimum shimming between the post and foundation is required.

Forms and braces shall not be removed and posts shall not be mounted on foundations until the concrete has cured in accordance with the requirements of Section 541. It shall be the Contractor's responsibility to ensure that all foundations, stub posts, and steel pipes are oriented such that when posts are mounted to the foundation the applicable sign post faces will be in the same plane, as required by the Contract. Foundations shall be backfilled with material approved by the Engineer and compacted in layers of not more than 6 inches by use of a mechanical tamper.

675.05 SLIP BASES. Slip bases shall be installed on sign posts at the locations shown on the Plans. Slip bases shall be compatible with the type and size of sign post on which they are to be installed. Slip bases shall meet the requirements of *NCHRP Report 350*, *MASH 2009* or later. The Contractor shall provide the type of slip base and FHWA's corresponding eligibility letter to the Engineer for approval prior to installation.

675.06 SIGN POSTS. Sign posts, of the size and type specified, shall be installed at the locations shown on the Plans. Sign posts shall be installed on foundations, in anchors, or directly in the ground as specified in the Contract. Sign posts shall be erected plumb and level and shall remain plumb and level after the installation of the traffic sign, bracing or the sign itself will not be used to maintain sign posts plumb and level. When installed on foundations, minimum shimming will be allowed between a foundation and sign post at the discretion of the Engineer.

When two or more sign posts are required for a single-sign installation, they shall be oriented such that the sign post faces which the signs will be attached to, will be in the same plane, the plane shall be as required by the Contract. The tops of all posts in a single-sign installation shall be the same elevation and shall not extend above the sign.

For posts that do not require foundations and are set into a dug hole, holes shall be backfilled with material approved by the Engineer and compacted in layers of not more than 6 inches by use of a mechanical tamper.

Unless otherwise specified in the Contract all required modifications to posts shall be incidental to other Traffic Sign items.

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675.07 TRAFFIC SIGNS. Traffic signs, of the design specified, shall be installed at the locations and on the post type(s) as shown on the Plans.

(a) General. All traffic signs shall conform to the requirements of the Contract and the current *MUTCD* and its latest revisions.

The traffic sign type will be determined by measurement of the area of the sign face. Type A signs will be classified as measuring 20 square feet and less, regardless of whether extruded aluminum panels are required due to attachment to a Type B sign installation. Type B signs will be classified as measuring greater than 20 square feet.

All new signs installed, excluding double-sided signs, shall include a decal on the back of the sign with the following information, in 1-inch numbers and text, and as shown in this example:

Ownership: (Town or VTrans)

Date Fabricated: (MM/YY)

Route: (US ##, VT ## or TH ##)

Decals shall remain intact and legible during the life of the sign, at least 15 years.

"Ownership" shall refer to the entity owning the sign. Generally, signs on state highways and U.S. routes, as well as stop signs and legal load signs on town highways at the intersection with a state or US route, belong to VTrans. All other signs on Class 1, 2 and 3 town highways belong to the town.

"Date fabricated" shall be the month and year of sign fabrication in MM/YY date format.

"Route" shall be the designation of the route the sign is located on. Note that in the case of stop and legal load signs at the intersection of a town highway and a state highway, the owner will be VTrans and the route will be US ## or VT ##.

(b) Sign Substrate. Type A signs shall be flat sheet aluminum, except that Type A signs shall be extruded aluminum panels when attached to a Type B sign. Type B signs shall be extruded aluminum panels.

The surfaces of sign substrate shall be flat and free of buckles, warps, dents, burrs, open cracks, open splits, open joints, or other defects. All edges shall be true and smooth with no tears, cracks, burrs, or other defects.

(1) Extruded Aluminum Panels. Extruded aluminum panels shall be of the butting type, 12 inches wide and of the lengths shown on the Plans. The moment of inertia of a panel shall not be less than 0.765 inch^4, and the panel shall be designed to carry a wind load of 30 psf.

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All signs fabricated from extruded aluminum panels shall have extruded aluminum molding on the two vertical sides. The color shall be the same as the parent sign.

Fabrication, including punching or drilling holes and cutting to length, shall be completed prior to metal degreasing, treating, and application of the background material. Flame cutting will not be permitted. The panels shall be fabricated for horizontal mounting. Each panel shall extend the full width of a sign and shall be bolted at least every 24 inches to each adjacent panel.

(2) Flat Sheet Aluminum. Fabrication of the flat aluminum sheets, including cutting to size, shall be completed prior to degreasing, etching, or treating, and application of the retroreflective sheeting. Flat sheet aluminum may be sheared, blanked, sawed, or milled. No flame cutting will be permitted. Field drilling or punching of holes will be allowed as needed.

(c) Retroreflective Sheeting. Retroreflective sheeting shall be of the color and type shown in the Contract or in accordance with the *MUTCD*, whichever applies. The face of a sign shall be completely covered by the retroreflective sheeting when used as a background. All panels of a multi-panel sign shall be of uniform background color and brilliance both day and night.

All sheeting shall be retroreflective. Transparent sheeting will not be allowed.

Sign substrate shall be prepared and retroreflective sheeting applied in accordance with the retroreflective sheeting manufacturer's recommendations for the respective sign substrate.

(d) Mounting. Signs shall be mounted as tightly to the posts, frame, or the horizontal supporting members as shown on the Plans. For permanent installations of Type A signs to frames or posts, a nylon-insert locking nut and two washers shall be used. For all sign types, if bolts are used for mounting, the installed bolt shall be at least flush with the nut.

Horizontal and vertical supporting members required to hold together the separate extruded aluminum panels forming a multi-panel sign and to attach the sign to the posts, shall be either standard steel or aluminum structural shapes meeting the same requirements as for sign posts in accordance with the Plans. After a multi-panel sign is mounted, the individual panels shall be joined together as shown on the Plans to ensure a smooth, flat sign face, free of deflection.

675.08 REMOVING SIGNS. The Contractor shall remove signs as shown on the Plans. Unless otherwise shown on the Plans, removal shall include foundations to a minimum depth of 12 inches below finished grade, and anchors, sleeves, sign posts, traffic signs, frames, overhead supports, hardware, all other incidentals, as applicable, and filling holes and returning the area to a condition consistent with the adjacent areas.

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Foundations shall not be removed when signs are to be set or reset on them. Except for where signs that are to be removed are also to be salvaged or reset, sign faces shall be defaced, including decal, so as not to be reused. Defacing shall be done using paint or to the satisfaction of the Engineer. Unless otherwise shown on the Plans, all material removed shall become the property of the Contractor.

Signs shown on the Plans that are to be removed and salvaged, including anchors, sleeves, sign posts, frames, traffic signs, and hardware, as applicable, shall be removed as specified herein and delivered to the locations identified in the Contract. Mounting hardware shall be in a sealed container and clearly marked with its contents. Components damaged during removal or salvaging, through the fault of the Contractor as determined by the Engineer, shall be replaced at no cost to the Agency.

Signs shown on the Plans that are to be removed and reset, including anchors, sleeves, sign posts, frames, traffic signs, and hardware, as applicable, shall be removed as specified herein and stored as necessary until they are to be reset. Components damaged during removal or storage, through the fault of the Contractor as determined by the Engineer, shall be replaced at no cost to the Agency.

675.09 RESETTING SIGNS. Signs that are to be reset, including anchors, sleeves, sign posts, sign frames and mounting hardware, as applicable, shall be reset to the location shown on the Plans.

The Contractor shall be responsible for transporting and stockpiling all anchors, sleeves, sign posts, sign frames and mounting hardware, as applicable, to and from the stockpiling location. The Contractor shall supply new mounting hardware, as required, to reset signs.

Anchors, sleeves, sign posts, frames, and traffic signs damaged through the fault of the Contractor, as determined by the Engineer, shall be replaced at no additional cost to the Agency.

675.10 METHOD OF MEASUREMENT. The quantity of Traffic Sign to be measured for payment will be the number of square feet of the type specified, installed in the complete and accepted work. The measured quantities of traffic signs for signs with retroreflective sheeting on both sides shall be multiplied by a factor of 1.5.

The quantity of Square Tube Sign Post and Anchor to be measured for payment will be linear feet measured from the top of the post to the bottom of the anchor, installed in the complete and accepted work. No additional measurement will be made for required sleeves, anchors and/or overlap of posts.

The quantity of W-Shape Steel Sign Post, Tubular Aluminum Sign Post, and Tubular Steel Sign Post to be measured for payment will be the number of pounds of each type of post installed in the complete and accepted work, as determined by the lengths and the standard weight per linear foot of the specified material. No additional measurement will be made for required anchors, slip bases or breakaway features.

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The quantity of Foundation for W-Shape Steel Post, Foundation for Tubular Steel Post, Soil Bearing Slip Base, Erecting Salvaged Signs, and Setting Salvaged Posts to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity for Removing Signs and Resetting Signs to be measured for payment will be the number of each sign removed or reset in the complete and accepted work.

675.11 BASIS OF PAYMENT. The accepted quantities for Traffic Signs, of the type specified, will be paid for at the Contract unit price per square foot. Payment will include frames, supports, tee bars, and mounting hardware as required.

The accepted quantities for Square Tube Sign Post and Anchor will be paid for at the Contract unit price per linear foot. Anchors, sleeves, and other required hardware will not be paid for directly but will be considered incidental to the respective sign post item.

The accepted quantities for W-Shaped Steel Sign Post, Tubular Aluminum Sign Post, and Tubular Steel Sign Post will be paid for at the Contract unit price per pound. Payment will include anchors, slip bases, breakaway features, and other hardware as required.

Foundation for W-Shaped Steel Post, (24-inch) Diameter, Foundation for W-Shaped Steel Post, (30-inch) Diameter, and Foundation for Tubular Steel Post will be paid for at the Contract unit price per each. Payment will include concrete, reinforcing steel, anchor bolts, stub posts, steel pipe, breakaway features, and other hardware as required.

Soil Bearing Slip Base, Setting Salvaged Posts, Removing Signs and Resetting Signs will be paid for at the Contract unit price per each.

Removal of sign posts and foundations will be considered incidental to the Contract item Removing Signs, as applicable.

The cost of attachment hardware, including vandal-proof hardware when required, will be considered incidental to the Contract item for the particular sign being used.

Payment will be full compensation for furnishing and erecting, fabricating, transporting, handling, applying, and installing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation and backfill will not be paid for separately, but will be considered incidental to the Contract unit prices for other items in the Contract.

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Payment will be made under:

Pay Item		Pay Unit
675.20	Traffic Sign, Type A	Square Foot
675.21	Traffic Sign, Type B	Square Foot
675.31	W-Shape Steel Sign Post	Pound
675.32	Tubular Aluminum Sign Post	Pound
675.33	Tubular Steel Sign Post	Pound
675.341	Square Tube Sign Post and Anchor	Linear Foot
675.35	Soil Bearing Slip Base	Each
675.41	Foundation for W-Shape Steel Post, 24 Inch Diameter	Each
675.42	Foundation for W-Shape Steel Post, 30 Inch Diameter	Each
675.43	Foundation for Tubular Steel Post	Each
675.50	Removing Signs	Each
675.60	Resetting Signs	Each
675.61	Setting Salvaged Posts	Each

SECTION 676 – DELINEATORS

676.01 DESCRIPTION. This work shall consist of removing or furnishing and installing reflector units or delineators consisting of new or salvaged posts, reflectors, and plaques.

676.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Flat Sheet Aluminum	750.03
Retroreflective Sheeting	750.08
Delineator Posts	751.01
Assembly Hardware	751.06

676.03 INSTALLATION. Delineator posts shall be set to the heights and at the locations shown on the Plans. They shall be set vertically facing the direction shown on the Plans or as directed by the Engineer.

Posts set in the ground shall be driven either by hand or by mechanical devices using a suitable driving cap and shall be set in the ground to the satisfaction of the Engineer. Hand tamping will be permitted. Posts set on the roadway surface shall have the base securely fastened to the surface. Delineators to be attached to bridge rail shall be consistent with the design shown on the Plans and securely fastened to the railing as shown on the Plans or as directed by the Engineer. Delineator assemblies and plaques, when required, shall be attached after the posts are set.

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Delineators shall consist of flat sheet aluminum substrate and completely covered by retroreflective sheeting of the color and type shown in the Contract.

The replacement of delineators on existing posts that are to remain shall be as shown on the Plans or as directed by the Engineer.

676.04 METHOD OF MEASUREMENT. The quantity of Delineators with Steel Post, Removal of Existing Delineator and Post, Remove and Replace Delineator, and Delineator with Flexible Post to be measured for payment will be the number removed, installed, or replaced in the complete and accepted work.

676.05 BASIS OF PAYMENT. The accepted quantity of Delineators with Steel Post, Removal of Existing Delineator and Post, Remove and Replace Delineator, and Delineator with Flexible Post will be paid for at the Contract unit price for each. Payment will be full compensation for removing or furnishing, fabricating, transporting, handling, and installing the materials specified, including plaques when required, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
676.10 Delineator with Steel Post	Each
676.12 Removal of Existing Delineator and Post	Each
676.15 Remove and Replace Delineator	Each
676.20 Delineator with Flexible Post	Each

SECTION 677 – OVERHEAD TRAFFIC SIGN SUPPORTS

677.01 DESCRIPTION. This work shall consist of furnishing and installing overhead traffic sign supports and removing and disposing of existing overhead traffic sign supports, including the concrete footings.

677.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV	707.03
Aluminum-Impregnated Caulking Compound	707.13
Bar Reinforcement	713.01
Carbon Steel Bolts, Nuts, and Washers	714.04
High-Strength Bolts, Nuts, and Washers	714.05
Anchor Bolts, Traffic Signals, Lighting, and Overhead Sign Structures	714.09
Steel Tubing	714.11
Preformed Fabric Bearing Pads	731.01
Grounding Electrodes	752.15

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The sign support shall be of the materials shown on the Plans.

The sign support design may be a cantilever structure or a multi-support structure (tubular beam, tri-chord, or box truss).

All design details, quality of work, procedure, materials, etc., shall be in accordance with the latest edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All welding shall be performed in accordance with the provisions of Section 506.

677.03 GENERAL. The overhead traffic sign supports shall be constructed in accordance with the details shown on the Plans.

The design of mast arm and overhead sign support foundations shall be performed in accordance with VTrans *Materials & Research Engineering Instructions MREI 10-01*.

Prior to installation, the Contractor shall submit fabrication drawings in accordance with Section 105, which shall include a complete list of materials.

High-Strength Bolts, Nuts, and Washers shall be tensioned in accordance with Subsection 506.19. Field verification testing for Direct Tension Indicators is not required.

Anchor bolts shall be pre-tensioned in accordance with the following procedure:

(a) Verify that the nuts can be turned onto the bolts past the elevation corresponding to the bottom of each in-place leveling nut and be backed off by the effort of one person on a 12-inch long wrench or equivalent (i.e., without employing a pipe extension on the wrench handle).

(b) Clean and lubricate the exposed threads of all anchor bolts. Clean and lubricate the threads and bearing surfaces of all leveling nuts. Re-lubricate the exposed threads of the anchor bolts and the threads of the leveling nuts if more than 24 hours has elapsed since earlier lubrication, or if the anchor bolts and leveling nuts have become wet since they were first lubricated.

(c) Turn the leveling nuts onto the anchor bolts and align the nuts to the same elevation.

(d) Place structural washers on top of the leveling nuts, with one washer corresponding to each anchor bolt. Install the base plate atop the leveling nuts and place structural washers on top of the base plate with one washer corresponding to each anchor bolt. Turn the top nuts onto the anchor bolts.

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(e) Tighten the top nuts to a snug-tight condition in a star pattern. Snug-tight is defined as the maximum nut rotation resulting from the full effort of one person on a 12-inch long wrench or equivalent. A star tightening pattern is one in which the nuts on opposite or near-opposite sides of the bolt circle are successively tightened in a pattern resembling a star. For example, for an 8-bolt circle with bolts sequentially numbered 1 to 8, tighten the nuts in the following bolt order: 1, 5, 7, 3, 8, 4, 6, 2.

(f) Tighten leveling nuts to a snug-tight condition in a star pattern.

(g) Before final tightening of the top nuts, mark the reference position of each top nut in a snug-tight condition with suitable marking on one flat with a corresponding reference mark on the base plate at each bolt. Then incrementally turn the top nuts using a star pattern until achieving the required nut rotation specified below. Turn the nuts in at least two full tightening cycles (passes). After tightening, verify the nut rotation.

(h) Top nuts for *ASTM F 1554,* Grade 55, Anchor Bolts shall be tightened to 1/3 turn beyond snug-tight condition for bolts less than or equal to 1-1/2 inch diameter and 1/6 turn beyond snug-tight condition for bolts greater than 1-1/2 inch diameter. The tolerance for nut rotation is + 20°. Use a beveled washer if the nut is not in firm contact with the base plate or the outer face of the base plate is sloped more than 1:40 (V:H).

Tightening requirements for all other bolted connections shall be specified on the fabrication drawings.

Concrete footings shall be backfilled by placing and compacting uniform layers of approved material not exceeding 6 inches in depth.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 1/8 inch in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

The space between the top of the concrete footing and metal base of the support shall be sealed with a stainless steel wire cloth. The wire cloth shall be stainless steel standard grade, with a 1/4 inch maximum opening and a minimum wire diameter of AWG number 16 with a 2-inch lap. It shall be secured with 3/4 inch stainless steel banding after anchor bolts are fully tightened.

Where existing overhead traffic sign supports are to be removed, the Contractor shall remove and dispose of the entire sign assembly, including concrete footings, to a depth of 18 inches below existing grade. Areas of ground disturbance shall be restored to the satisfaction of the Engineer.

677.04 GROUNDING. All posts used in overhead sign supports shall be grounded in accordance with Section 678.

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677.05 METHOD OF MEASUREMENT. The quantity of Overhead Traffic Sign Support, of the type specified, to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity of Remove and Reset Overhead Traffic Sign Support to be measured for payment will be the number of each removed and reset in the complete and accepted work.

The quantity of Remove Existing Overhead Sign Assembly of the type specified to be measured for payment will be the number of each assembly removed in the complete and accepted work.

677.06 BASIS OF PAYMENT. The accepted quantity of Overhead Traffic Sign Support, of the type specified, will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and installing the materials specified, including the concrete footings, excavation, and backfilling and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Remove and Reset Overhead Traffic Sign Support will be paid for at the Contract unit price for each. Payment will be full compensation for removing the existing sign support, including all excavation, removal of the existing base as required, furnishing, placing, and compacting all necessary backfill, all necessary disconnections and modifications to existing wiring, construction of a new base as required, grading all areas disturbed by the work, turf establishment in those areas if turf establishment is not otherwise included in the Contract and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Remove Existing Overhead Sign Assembly of the type specified will be paid for at the Contract unit price per each. Payment will be full compensation for removing and disposing of assembly components, including concrete footings; for performing any excavation necessary; for restoring areas of ground disturbance; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Costs associated with providing traffic control and/or Flaggers for performing the work will be paid under the appropriate Contract item(s).

Payment will be made under:

Pay Item	Pay Unit
677.12 Overhead Traffic Sign Support, Cantilever	Each
677.13 Overhead Traffic Sign Support, Multi-Support	Each
677.22 Overhead Traffic Sign Support, Cantilever with Lighting	Each
677.23 Overhead Traffic Sign Support, Multi-Support with Lighting	Each
677.25 Remove and Reset Overhead Traffic Sign Support	Each
677.30 Remove Existing Overhead Sign Assembly, Cantilever	Each
677.35 Remove Existing Overhead Sign Assembly, Multi-Support	Each

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SECTION 678 – TRAFFIC CONTROL SIGNALS

678.01 DESCRIPTION. This work shall consist of furnishing and installing a traffic control system, and removing existing traffic control systems.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever position is applicable. As a minimum, all work must meet the requirements of the *National Electrical Code*.

678.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Mortar, Type IV 707.03
Paint for Traffic Control Signals 708.07
Polyvinyl Chloride (PVC) Plastic Pipe 710.06
Anchor Bolts, Traffic Signals, Lighting, and Overhead Sign Structures 714.09
Preformed Fabric Bearing Pads 731.01
Pedestal Posts and Bases 752.01
Strain Poles 752.02
Traffic Signal Poles with Mast Arms or Bracket Arms 752.03
Span Wire 752.04
Traffic Signal Heads 752.05
Traffic Signal Controllers and Cabinets 752.06
Flashing Beacons 752.07
Electrical Conduit 752.08
Traffic Signal Conductor Cable 752.09
Detectors 752.10
Vehicle Detector Slot Sealant 752.11
Pull Boxes ..... 752.12(a)
Junction Boxes ..... 752.12(b)
Accessible Pedestrian Signals 752.13
Pedestrian Pushbutton Assemblies 752.14
Grounding Electrodes 752.15

678.03 GENERAL. Prior to beginning any work, the Contractor and the Engineer will perform a joint inspection of the condition of existing equipment and components. Any equipment that is found to be defective or damaged prior to beginning work shall be maintained in at least as good condition until replaced under the Contract.

Prior to ordering any traffic control components of the signal system, the Contractor shall submit fabrication drawings in accordance with Section 105. One advance copy of equipment manuals furnished by the manufacturer shall be submitted to the Engineer. The submittal shall contain, as a minimum, the following information:

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(a) Traffic Signal Controller. Type of controller, manufacturer, model, number of phases and functions, and assurance of conformance to NEMA standards. Bench testing (a minimum of 7 calendar days) will be required. Copies of the test results shall be submitted as discussed in Subsection 752.06. The test results shall contain the begin and end time and date of the test, all controller and time-based coordinator settings used, equipment serial numbers, signature of the person performing the test, and signature of a witness who shall be either a registered electrical engineer or a licensed master electrician. The bench test report shall be approved by the Agency prior to the shipping of the controller(s).

(b) Traffic Signal and Pedestrian Heads. Size, manufacturer, model, lamp wattage, wiring, housing (material and color), visors, and back plates, if required. The signal heads shall conform to the requirements of *ITE Standards*.

(c) Controller Cabinet. Size, manufacturer, model, accessories, materials, and finish.

(d) Auxiliary Equipment. Flashers, vehicle detectors, conflict monitors or malfunction management units, pedestrian audio units, accessible pedestrian signals, manufacturer, model, functions, and assurance of conformance to NEMA standards, where applicable.

(e) Strain Poles, Cantilevers, and Pedestal Posts.

(1) Dimensions for pole/post height, span wire attachment height, pole/post diameter (top and bottom), pole gauge, handhole (size and location), baseplate, bolt circle, and anchor bolt size

(2) Material specifications for each component

(3) Welding information for all welded connections

(4) Special features as shown on the Plans, such as finish or color

(5) Pole/baseplate stamping detail

In the above, all information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalog sheets are acceptable if all the appropriate information is included.

Submitted fabrication drawings shall indicate by either text in the transmittal letter or by text and signature on the fabrication drawings, that the Contractor has reviewed the fabrication drawings and that the fabrication drawings are in conformance with the Contractor's proposed installation procedures.

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Strain pole styles other than that shown on the Plans will be permitted. The poles must be able to carry the design loads with a maximum dead load (span wire and signal head) deflection of 6 inches. Bending stress (f_b) is limited to 66% of the minimum yield stress (f_y). All design details, quality of work, procedures, materials, etc., shall be in accordance with the latest edition of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.*

Schedule 80 conduit shall be used for all applications.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Steel bar reinforcement shall conform to the requirements of Section 507.

Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with *AASHTO M 111M/M 111*. Pull boxes shall be designed and constructed to support at least an AASHTO HS-20 loading.

678.04 VEHICLE DETECTION SYSTEM. The Contractor shall be responsible for furnishing all training, labor, materials, cables, connectors, tools, equipment, shipping, and incidental items necessary to complete the installation and make the Vehicle Detection System fully operational. The vehicle detection system shall be as specified in the Plans. All work associated with the Vehicle Detection System shall be completed prior to testing and turn on of the traffic signal system.

All equipment shall be installed and wired in a neat and orderly manner in conformance with the manufacturer's instructions. All Vehicle Detection System components shall be current production equipment produced by the same manufacturer for system operation compatibility purposes unless otherwise specified.

The Contractor shall install the detector to achieve the desired fields of detection as shown on the Plans or as directed by the Engineer.

Routing of the detector cable shall provide a drip loop for protection of the detector and connector. The detector cable shall be installed as a continuous run with no splices from the detector to the processor in the traffic control cabinet unless specified otherwise by the manufacturer.

Removal and disposal of existing detection systems will be considered incidental to other Contract items.

678.05 EMERGENCY VEHICLE PREEMPTION SYSTEM.

(a) System Requirements. The Emergency Vehicle Preemption System shall include type of phase selector, size of chassis, manufacturer, model, number of phases and functions, detectors, strobe, and detection cables.

The Emergency Vehicle Preemption System shall be installed in the same cabinets as the controllers.

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The emergency vehicle preemption system shall consist of a data-encoded phase selector to be installed within the traffic control cabinets. Those units will serve to validate, identify, classify, and record the signal from the optical detectors located on support structures at the intersections. Upon receiving a valid signal from the detectors, the phase selectors shall generate a preempt call to the controllers initiating preemption operations as shown on the Plans.

The preemption detectors shall be single input, single output units used to control one approach. All traffic signal installations shall be supplied with a single optical detector for each approach to the intersection unless otherwise noted in the major list of equipment or as shown on the Plans.

The phase selectors shall have full ID and logging capabilities and be a rack-mounted plug-in four-channel or two-channel, dual priority devices. The phase selectors shall plug into shelf-mounted single card slot chasses. Programming the phase selectors shall be via a PC-based computer utilizing unit-specific software.

One copy of software shall be supplied and licensed to the towns listed in the Plans. A hard copy of final programming data shall be left in the control cabinet. The Contractor shall supply a complete set of interface cables for phase selector to laptop connection in each controller cabinet. The Contractor shall also supply any required cables.

(b) Construction Requirements. The Contractor shall be responsible for furnishing all training, labor, materials, cables, connectors, tools, equipment, shipping, and incidental items necessary to complete the installation and make the Emergency Vehicle Preemption System fully operational.

The optical preemption detectors for each intersection shall be mounted facing the mainline approaches or as shown in the Plans. Final equipment locations and positioning of the preemption detectors shall be installed in accordance with the manufacturer's instructions to provide the optimal field of detection.

The Contractor shall install the quantity of confirmation strobes at each traffic signal location as shown in the Plans or as directed by the Engineer. The confirmation strobe shall serve to validate to the driver of the emergency vehicle that the traffic signal has recognized the preemption call and will initiate the proper preemption sequence. The confirmation strobes shall be illuminated whenever any emergency vehicle preemption green is on. The confirmation strobes shall have a red lens.

The Contractor shall be responsible for the proper programming of the phase selector, orientation of the optical detectors, and all other work necessary to provide a complete and operating emergency vehicle preemption system. The Contractor may be required to field adjust the location of the optical detectors in the presence of the Engineer and the emergency services, if necessary, listed in the Plans to properly detect preemption calls from approaching vehicles.

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678.06 GLOBAL POSITIONING SYSTEM (GPS) CLOCK ASSEMBLY.

(a) System Requirements. The GPS clock assembly shall consist of a programmable GPS interface device, GPS receiver, receiver-to-interface device harness, and power-output harness. The assembly shall be designed to reset the clock time for the controller using a time reference signal from GPS at least once a day. The interval for the controller clock resetting shall be programmable. The assembly shall automatically adjust for Daylight Saving Time.

The GPS clock assembly shall come with a fully enclosed case and be suitable for wall mounting or setting on a shelf inside the cabinet. The device shall have a removable front/back cover, a liquid-crystal display (LCD), programming-status switches, power-output port, and antenna input port.

The receiver shall be a fully enclosed rain-tight GPS antenna unit that shall be suitable for mounting on the exterior of a traffic signal cabinet. The GPS antenna case shall be made of a long life exterior-grade UV-resistant plastic.

The GPS clock assembly shall include a direct serial interface (*National Marine Electronic Association Standard 0183*) that can accommodate either a 9-pin or 25-pin serial cable as specified in the Plans. The GPS Clock must have flexible input voltage levels of 8-40 volts DC. The required temperature range is -35°F to 165°F.

The GPS clock assembly shall be as specified in the Plans.

(b) Construction Requirements. The Contractor shall be responsible for furnishing all training, labor, materials, cables, connectors, tools, equipment, shipping, and incidental items necessary to complete the installation and make the GPS clock assembly fully operational.

The Contractor shall install the quantity of GPS clock assembly at each location as shown in the Plans or as directed by the Engineer.

678.07 PAINTING TRAFFIC SIGNAL STRUCTURES.

(a) General Requirements. All signal structures specified to be painted flat black shall be galvanized and powder-coated with at least two coats of exterior grade powder coat paint suitable for a low speed traffic environment subject to high levels of salt.

All steel components, except for stainless steel and anchor plates, shall be galvanized, pre-treated, and shop painted except as noted. Hardware need not be painted after galvanizing except for the portions exposed to view after installation, such as bolt heads, ends, nuts, and washers, which may be field painted. Touch-up and repairs shall be made using paint from the same batch run as used for the shop-applied coats and supplied by the shop applicator.

(b) Fabrication Drawings and Samples. The following provisions shall be made for hot-dip galvanizing and shop-applied paint for traffic signal hardware as shown on the Plans or as directed.

The requirements for the surface preparation shall conform to Subsection 506.14, except as required herein, or approved otherwise.

The fabricator shall send the fabrication drawings to the galvanizer for review to note considerations particular to the galvanizing process and to coordinate any proposed modifications to the fabricated materials, prior to submission of fabrication drawings to the Engineer for approval.

One sample of material to be used in the work, each approximately 3 inches × 6 inches, shall be galvanized and painted as specified herein and submitted to the Engineer for approval of surface texture and color prior to full production galvanizing and painting. The fabricator of the material shall provide the galvanizer with samples taken from the same material to be used in the work.

To determine its suitability for processing, the fabricator shall notify the galvanizer if the chemical composition of the steel to be galvanized exceeds the following limits: 0.26% carbon, 0.24% silicon, 0.05% phosphorous, and 1.35% manganese.

(c) Coating System Process and Material. The galvanizing-paint duplex coating system shall consist of the following generic type at the minimum coating thickness specified in Table 678.07A.

TABLE 678.07A – MINIMUM COATING THICKNESS

Coating	Description	Thickness
Galvanized	Hot-dipped galvanizing	Per Subsection 726.08
Pre-Treatment	SP1 solvent cleaning	--
Pre-Treatment	SP7 brush-off blast cleaning	--
Pre-Treatment	Phosphate cleaning [1]	--
Intermediate (force-cured)	High build epoxy polyamide	3 mils DFT [2]
Finish (force-cured)	Aliphatic polyurethane	3 mils DFT [2]

[1] Required when painting occurs more than 12 hours after galvanizing

[2] Dry film thickness

(d) Galvanizing. Surfaces to be galvanized shall be zinc coated in conformance with *AASHTO M 111M/M 111* or *AASHTO M 232M/M 232* utilizing the dry kettle process in a bath of molten zinc containing nickel (0.05% to 0.09% by weight). Hardware may be mechanically galvanized in conformance with *ASTM B 695,* Class 50.

The galvanized steel product shall be pre-treated and painted by one of the following methods:

(1) Method 1 (Under 12 Hours). The galvanized steel shall be pre-treated. The first coat of paint shall be applied within 12 hours of galvanizing and within 8 hours of blast cleaning or surface abrasion by approved mechanical means.

(2) Method 2 (Over 12 Hours). When the galvanized steel is to be painted more than 12 hours after galvanizing, the steel shall be pre-treated followed by a treatment of zinc phosphate applied within 8 hours of blast cleaning or surface abrasion by approved mechanical means. The first coat of paint shall be applied within 12 hours of phosphating.

(e) Pre-Treatment. Prior to painting, the galvanized surface shall receive pre-treatment consisting of *SSPC-SP 1* and *SSPC-SP 7*, or abraded by approved mechanical means to remove detrimental contaminants and to thoroughly roughen the entire surface and produce a uniform anchor profile of 1 to 2 mils. The required thickness of the zinc coating shall be maintained and checked prior to painting. The pre-treatment shall meet the paint manufacturer's requirements.

An additional pre-treatment or tie coat may be considered if required by the paint manufacturer and approved by the Engineer.

Blast cleaning shall be performed prior to the formation of wet storage stain (also known as "white rust") on the galvanized surface. Wet storage stain shall be defined in the *Inspection of Products Hot Dip Galvanized After Fabrication,* by the American Galvanizers Association. If any white rust is detected by visual means, the galvanizing shall be stripped off and the steel re-galvanized in conformance with these provisions.

Paint coating shall be shop applied to the galvanized product within 15 calendar days of galvanizing. Painting shall be performed inside a controlled environment meeting applicable atmospheric requirements as recommended by the coating manufacturer. Prior to pre-treatment, rough areas of galvanizing shall be ground smooth to achieve a uniform galvanized surface to accept paint.

Phosphating, when required as described herein, shall conform to zinc phosphate coating (light) of galvanized steel, *DOD Specification TT-C-490E*, or approved equal, and shall be applied in accordance with the manufacturer's recommendations.

When phosphating is required, the phosphate applicator shall document in writing that the phosphating procedure is acceptable to the galvanizer and coating manufacturer prior to performing the work.

(f) Painting. Each coat of paint shall be separately colored to contrast with other coats and to ensure complete coverage. The previous coat shall be hidden by a single application of each coat. The final color of the painted product shall be flat black, Chip #27038 per *SAE AMS-STD-595B*.

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Intermediate and finish coats shall be shop-applied only when the air and steel temperatures are a minimum of 50°F above the dew point. The finish coat shall be spray applied.

The intermediate and finish paint coats shall each be force-cured in a heated booth maintained at a minimum temperature of 150°F for 2 to 4 hours.

The finished shop-coated material shall be handled with care using nylon slings, padded cables, etc. as required to protect the finished coating. The paint applicator shall be responsible for the condition of the finished coating until the material arrives at the job site.

(g) Field Touch-up and Repairs. Damaged galvanized surfaces shall be repaired by applying an organic zinc repair paint conforming to *ASTM A 780 M/A 780* and recommended by the galvanizer. Galvanizing repair paint shall be 65% zinc by weight, minimum, and shall be brush applied. The thickness of repair shall not be less than the coating thickness required by *AASHTO M 111M/M 111* or *M 232M/M 232* but not less than 3 mils DFT. Repair touch up shall not be permitted using aerosol spray, silver paint, bright paint, Brite paint, or aluminum paints.

Damaged shop-applied paint shall be repaired in conformance with the solvent cleaning and abrasion pre-treatment requirements specified above or the paint manufacturer's recommendations, to a minimum thickness of the original system. Touch-ups shall be such that the repair is not noticeable to the Engineer from 6 feet away.

678.08 EXCAVATION AND BACKFILL.

(a) General. Unless otherwise shown in the Contract, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work in accordance with the Contract or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 2 inches along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by construction operations shall be restored to their original condition at the Contractor's expense upon completion of the work.

(b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.

(c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 6 inches. The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 6 inches of the bottom of conduit.

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678.09 ERECTION OF POSTS AND POLES. All posts and poles shall be erected on concrete bases at the locations shown on the Plans.

In the erection of posts and poles, leveling nuts shall be provided for installation between the bases and the concrete foundation to aid in plumbing.

The space between the top of the concrete footing and metal base of the support shall be sealed with stainless wire cloth.

The wire cloth shall be stainless steel standard grade, with a 1/4 inch maximum opening with a minimum wire diameter of AWG number 16 with a 2-inch lap. It shall be secured with 3/4 inch stainless steel banding after anchor bolts are fully tightened.

High-strength bolts, nuts and washers shall be tensioned in accordance with Subsection 506.19. Field verification testing for Direct Tension Indicators is not required.

Anchor bolts shall be tightened in accordance with Subsection 677.03.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 1/8 inch in thickness or cleaned and thoroughly coated with an aluminum-impregnated caulking compound.

678.10 PLACING OF CONDUIT, PULL BOXES, AND JUNCTION BOXES. Unless otherwise specified, the conduit for the cable shall be placed not less than 24 inches below the top of curb in the sidewalk areas and not less than 36 inches below the finished grade of pavement when passing under roadways. Conduit shall be pitched or graded at not less than 1:400 (V:H) and provision shall be made for draining moisture away from pull boxes as directed by the Engineer.

Red plastic marking tape 6 inches wide shall be placed in the excavated trench 6 to 12 inches below the finished grade for all conduit and sleeve runs except those jacked under the roadway.

High density polyethylene (HDPE) plastic pipe conduit shall be used only for underground installations.

A minimum of 24 inches of cover shall be required over conduit at all times during construction.

Unless otherwise specified, the conduit shall be laid in a straight line with no bends except pre-formed bends and at the entrance to a pull box or a concrete base.

All joints for PVC or HDPE conduit shall be made with a tapering tool and not an edging tool.

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For metal conduit, all couplings shall be tightened until the ends of the conduit are together and provide a good electrical connection. Any cutting of the conduit shall be made squarely so that the resulting ends will butt together over their full area. The ends of conduits shall be reamed and have threaded connections. Slip joints or running threads shall not be used for couplings. The exposed ends for all types of conduits shall be capped with standard conduit caps until wiring starts, at which time they shall be replaced with approved bushings.

Where factory conduit bends are not being used, the conduit shall be bent using the longest radius possible but not less than six times the inside diameter of the conduit and in a manner that will not crimp or flatten the conduit.

No more than three 90° bends or equivalent (270° total) shall be used on a continuous conduit line. If more than 270° in total bends are necessary, then a pull box or junction box shall be installed. Either elbows or sweeps may be used for entering concrete bases, but elbows shall be used at the base of a service pole on the street quarter of the pole

One approved expansion fitting shall be used for each conduit run on a bridge structure at every expansion joint of the bridge. Expansion couplings shall also be used on the power service pole and all conduits entering or leaving the meter or disconnects on a power drop stanchion.

After the conduit lines are completed, the Contractor shall, in the presence of the Engineer, check the installation by pushing a one diameter long mandrel, having a diameter of 1/4 inch less than the diameter of the conduit, through the length of conduit. Any obstructions, including stone and dirt, shall be removed. Damaged conduit shall be removed and replaced at the Contractor's expense. When conductor cable is not being placed in conduit under the Contract, a pull cord with a 5 kips minimum pull strength shall be installed in all conduits. The pull cord shall terminate beyond the end of the conduit in each pull box or just under the cap at concrete bases for poles.

Pull boxes and junction boxes shall be placed at locations shown on the Plans or as directed by the Engineer.

678.11 INSTALLATION OF ELECTRICAL CONDUIT SLEEVES. Electrical conduit sleeves shall be installed at the locations shown on the Plans or as directed by the Engineer.

Unless otherwise specified, electrical conduit sleeves placed under roadways or drives shall have a minimum cover depth of 3 feet measured from the finished roadway surface. Sleeves shall be pitched or graded at not less than 1:400 (V:H) and provision shall be made for draining moisture away from the sleeve location or as directed by the Engineer.

Unless otherwise specified, the Contractor shall install electrical conduit sleeves in a straight line with no bends. The installed sleeve shall terminate a minimum of 4 feet outside the face of curb or edge of shoulder of the roadway or drive that the sleeve crosses. Electrical conduit sleeves may be placed by an open cut or may be directionally bored under roadways or drives.

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When conduit is not being placed in a sleeve, prior to backfilling around the sleeve, the Contractor shall install a suitable pull cord with a 5 kips minimum pull strength in the sleeve and seal the ends prior to backfilling the sleeve.

678.12 DETECTORS AND CONTROLLERS. Detectors and controllers shall be installed at the locations shown on the Plans and in accordance with directions furnished by the manufacturer. The type of mounting of the controller cabinet shall be as shown on the Plans. Controller cabinets shall be provided with locks as shown on the Plans. Two keys shall be furnished with each lock.

All pedestrian activated push buttons shall have an advisory sign attached as shown on the Plans. At locations where Accessible Pedestrian Signals (APS) are installed, the push buttons shall include audible locator tones, raised arrows, and vibro-tactile features that comply with the latest editions of the *MUTCD* and *ADA* standards as specified in Subsection 752.14.

When applying vehicle detector slot sealant to the slot, it shall be by a pressurized system such as a manual or mechanical caulking gun or in a manner approved by the manufacturer. The loop wires shall be held in place during sealing by nonmetallic strips or tabs approximately 2 inches long located about every 24 inches along the slot.

678.13 ELECTRIC POWER SERVICE. Prior to submitting a proposal, the Contractor shall obtain from the utility company the location of the power source, the amount of power to be supplied, an understanding of the termination of the power company's services and the requirements of the power company for connection of the electrical facilities to be constructed under the Contract.

The Contractor shall furnish and install a service riser at the power control center, a fully enclosed and watertight cabinet with a meter socket, appropriate sized and number of disconnect equipment, and circuit breakers to meet load and/or equipment manufacturer's requirements. The Contractor shall adhere to all State and local codes.

Luminaires installed on strain poles shall utilize the same power source as the traffic signal but with a separate disconnect breaker and meter.

678.14 WIRING. All wiring shall be performed in accordance with the *National Electrical Code*. Splices shall be made only at pull boxes, junction boxes, or pole bases. All splices shall be electrically and mechanically secure and shall be insulated for 600 V. The completed splice shall be watertight and shall test electrically equal to or greater than the cable. All splices shall be soldered, using rosin core solder, and then be fully sealed by the application of dual wall heat-shrinkable tubing.

Unless otherwise shown on the Plans, each cable shall have a minimum of 3 feet of slack in each box or base.

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Where shown on the Plans, wired conduit may be either pre-wired before the conduit is installed or the wire may be installed after the conduit is installed. The item Wired Conduit includes both the conduit and the wires contained within the conduit; however, the wires and the conduit shall not be attached to each other and the wires shall be readily pulled from the conduit for replacement without excessive effort.

Except when otherwise shown on the Plans, the minimum size for installed conduit shall be 2-inch nominal inside diameter conduit or it shall match the size of the existing conduit to which it is to be attached. In either case, the installed conduit shall be of sufficient inside diameter to contain wiring of a size such that the voltage drop in the secondary circuits will not exceed 3%.

Wiring conduits shall have a sufficient inside diameter such that the combined cross-sectional area of the wiring does not exceed the percentage of conduit fill specified in the *National Electrical Code*. Conduits shall, in accordance with the other requirements of this subsection, contain all the wiring necessary to make the completed system or subsystem function.

Where electrical wiring is shown on the Plans, the Contractor shall remove the existing wiring, if such exists, from the existing conduit, strain pole, streetlight pole, or bracket arm and shall install new wiring meeting all code and specification requirements. The wiring shall be of a size such that the voltage drop in the secondary circuits will not exceed 3% and the wiring will contain only the number of conductors necessary to make the completed system or subsystem function.

The minimum wire sizes for circuits shall conform to the requirements specified in Table 678.14A.

TABLE 678.14A – MINIMUM WIRE SIZES

Service	AWG
From supply to disconnect	No. 6
Ground	No. 6
Disconnect to controller or flasher	No. 6
Controller to signals or beacons	No. 12
Controller to pavement units	No. 14
Controller to push buttons	No. 14
Interconnect figure “8” – One-half mile or less	No. 14 (Solid)
Interconnect figure “8” – One-half to one mile	No. 12 (Solid)

There shall be a neutral wire for every eight or fewer ungrounded conductors.

Plastic cable rings shall not be permitted for supporting electrical cable from a span wire.

Stranded wire shall be used for all unsupported and span wire supported wiring.

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The Contractor shall furnish and install sufficient cable and wire to operate the system properly as shown on the Plans and as specified and shall provide at least two spare conductors in all signal and interconnect cable runs, including fire and railroad preemption cables.

The Contractor shall wire the system in accordance with the following color-coding system where practicable as specified in Table 678.14B.

TABLE 678.14B – WIRE COLOR-CODING

Wire Color	Application
Red	Red light, main street
Orange	Yellow light, main street
Green [1]	Green light, main Street
Red with tracer	Red light, side street
Orange with tracer	Yellow light, side street
Green with tracer [1]	Green light, side street
White	Common ground for all signals and exposed metal parts
Blue	All steady burning arrows
Blue with tracer	Intermittent arrows
Remaining	Pavement units, push buttons, and spare

[1] Green wires shall be tagged "NOT GROUNDED WIRES"

678.15 GROUNDING AND TESTING. Each metal pedestal post, strain pole and signal pole, and the common grounding electrode connector of the signal system shall be grounded to the power source and shall be effectively grounded by connection to a grounding electrode driven at each post or pole location. The grounding shall be accomplished by means of a soft-drawn bare copper wire with a cross-sectional area of No. 6 AWG run between the post or pole base and the grounding electrode or electrodes. The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process.

The "white wire" shall be used for the neutral ground connections and shall be continuously connected to ground.

All exposed metal parts, including service pipe and control box housing shall be connected to ground. On all controllers employing the solid common ground, there shall be installed a visible jumper between the service neutral and the signal common ground. The signal common ground bar shall be jumpered to the bonded grounding electrode.

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Upon completion of each signal or beacon system, the Contractor shall demonstrate by tests that all circuits are continuous and free from short circuits and all circuits are free from unspecified grounds. The Contractor shall demonstrate by tests that the resistance to ground of non-grounded conductors is at least 100 MΩ for new construction or 5 MΩ for existing wiring at 60°F when the test is conducted using 500 V DC. The resistances in the entire specified grounding systems shall not be more than 25 Ω.

If luminaires are to be installed on strain poles, the lighting work shall be performed in accordance with the applicable requirements of Section 679.

All new traffic and pedestrian signal heads that have been installed but not placed in either flashing or full operation shall be covered. Existing signal heads which are placed out of service to perform work on the signal system shall also be covered, except when such work can be completed in a relatively short time (several hours) and with provisions for traffic control.

The signal covers shall consist of a one-piece plastic bag having a minimum thickness of 4 mils. The bag shall be black or dark brown in color and shall be opaque. The cover shall slip over the entire signal head and shall be securely tied at the opening to secure the cover. An intermediate tie of the same material shall be drawn around the center of the cover to prevent excess flapping in the wind.

A drain hole shall be made at the bottom of the bag to allow the escape of moisture. No tape or adhesive will be allowed to be attached to any surface of the signal housing or lenses. All covers shall be placed in a neat professional manner. Any cover that is torn or missing shall be immediately replaced. Payment for the covers, their placement and removal, and all incidentals for completion of the work will be considered incidental to the installation of the traffic signal.

678.16 TURN ON AND TESTING. Prior to turn on and testing, all construction of the signal system shall be complete.

(a) Turn On. The traffic control signal systems shall not operate without the pavement markings and signal related signing in place. Full operation for a new installation or switch over for replacement signals shall not be initiated except in the presence of the Roadway, Traffic, and Safety Engineer or a designated representative. A Uniform Traffic Officer shall be required at every turn on.

(1) Existing Signals. Any locations that require a switch over from one traffic signal system to another do not require a flash period.

(2) New Signals. Traffic signals installed at locations that were previously un-signalized shall be operated in the flash mode for a minimum of 48 hours prior to being put into full operation.

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(b) Testing. Once all equipment is installed and the traffic control signal system has been turned on, an inspection to start the 30-day test period shall be scheduled. Each traffic control signal system shall successfully complete a minimum 30-day test period. The required 30-day test period for the signal installation shall not begin until all construction of the signal installation is complete and the Engineer has received notice from the responsible Agency parties that all paperwork, including fabrication drawings, materials certifications, bench test reports, etc., related to the signal equipment and installation have been completed to the satisfaction of the Agency.

(1) The Engineer will notify the Highway, Safety, and Design Program Manager to request to begin the 30-day test period.

(2) An in-depth inspection will be conducted to start the 30-day test period. A written Punch List of items will be provided to the Contractor to correct by the end of the 30-day test period.

a. The test period for the traffic signal shall be at least 30 calendar days of continuous, satisfactory operation.

b. If a component or system fails or shows unsatisfactory performance, the condition must be corrected and the test restarted until 30 calendar days of continuous satisfactory operation is obtained.

(3) The traffic control signal system shall not be accepted until successful completion of the test period.

Once the 30-day test period has been successfully completed, the Engineer will notify the Highway, Safety, and Design Program Manager, the Traffic Signal Operations Engineer, and the appropriate Agency party stating that the above criteria have been met and that the Agency is now responsible for the maintenance of the traffic control signal system. The name of the power company and the account number on the power bill shall be included for the District Transportation Administrator's records.

678.17 INSTALLATION AND COMPLETION. The signals and equipment shall be properly installed, and operating sequences set as shown on the Plans by a competent factory-trained representative of the manufacturer or by workers under the manufacturer's supervision.

All span wire mounted signals shall have disconnect hangers. All fixed mounted signals shall have terminal components.

The traffic signals shall not operate without the pavement markings and signal related signing in place.

All work shall conform to the requirements of the *National Electrical Code*.

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After the signal or beacon system has been completely installed, any fixtures with damaged factory applied paint shall be corrected by applying one coat of enamel meeting the requirements of VT 6.01 (Flat Black Enamel) or VT 6.02 (Yellow Enamel) applied to the complete sectional area that is damaged after being lightly sanded to remove gloss. The visors (hoods) and the entire surface of louvers, fins, and the front surface of back plates shall have a dull black finish.

The Contractor shall submit in duplicate to the Engineer the wiring diagrams, signal sequence chart, signal terminal connection diagram, service manual, programming manual (if applicable), and parts list for each signal controller. The foregoing and manufacturer's warranties and guarantees furnished for materials used in the work shall be delivered to the Engineer prior to acceptance of the work. The warranties shall be the manufacturer's customary trade warranties.

The Contractor shall make every reasonable effort to have the installation complete and operating, including the test control period, prior to the date specified in the Contract. However, if all other work under the Contract has been completed, any portion of the test control period which extends beyond the completion date may not be considered time charged for liquidated damages.

For new traffic signals or flashing beacons, the Contractor shall be responsible for all utility costs until acceptance of the signal or beacon system. For upgrading of existing signals or beacons, the State or municipality, whichever is applicable, shall continue to pay for normal monthly power usage while the Contractor shall be responsible for all other utility costs.

When the installation of a telephone line in a traffic signal controller cabinet is included in the Contract, the Contractor shall initiate the installation by the telephone company by contacting the Business Manager for the Agency's Maintenance and Operations Bureau. The billing for the telephone service will be set up in the name of the Agency's Maintenance District within which the traffic signal controller is located. The Contractor shall reimburse the District for all costs incurred for the installation and for the monthly fees until acceptance of the traffic signal installation. The Contractor shall reimburse the District within 14 calendar days of receiving a copy of the bill. The final estimate will not be paid until the Agency's District Transportation Administrator certifies that all reimbursements have been received.

For projects where several signal systems are coordinated, all the individual signal systems must have successfully completed the 30-day test control period before the signal systems can be accepted.

The Contractor shall notify the Engineer and/or the town or city engineer at least 48 hours prior to turning off existing traffic control signals at any location, or when the Contractor is ready to install the traffic control signal system. Notice is required so that a representative may be provided to observe the installation of the equipment in preparation for maintenance and repair of the system and to have a Uniformed Traffic Officer present to maintain traffic.

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Removal of existing or reuse of salvaged traffic control equipment shall be conducted as follows:

(a) Unwanted equipment must be disposed of by the Contractor. Removal of equipment shall include removal of concrete bases and backfill of the holes, where applicable. Any equipment that is damaged or lost by the Contractor during removal shall be repaired or replaced to the satisfaction of the Engineer, at the Contractor's expense.

The Contractor shall remove any equipment to be salvaged or reused in such a manner that the equipment is not damaged.

(b) All salvaged and reused equipment shall be thoroughly cleaned and painted as required, before reuse.

(c) All reused traffic signal, flashing beacon, or street lighting lenses and reflectors shall be cleaned and all lamps shall be replaced using lamps conforming to the applicable requirements of Subsection 752.05.

678.18 TEMPORARY TRAFFIC CONTROL SIGNALS AND FLASHING BEACONS.

(a) General. Temporary traffic control signals and temporary flashing beacons shall be installed by the Contractor at the locations shown on the Plans or directed by the Engineer.

The temporary traffic control signal system or temporary flashing beacon system installed at the designated location shall include all necessary existing or Contractor provided materials and equipment shown on the Plans, including, but not limited to, controllers, flashers, wiring, conduit, strain poles, associated signs, sign posts, pavement markings, electrical service, vehicle detectors, span wires, interconnect cables, signal heads, warning beacons, and lights. In the case of temporary signals at a temporary bridge location, the signal system shall include all the signals and associated signage to be installed at all approaches to the temporary bridge.

(b) Materials. The traffic signal, flashing beacon, and lighting equipment provided shall conform to the requirements of the latest edition of the *MUTCD* and *NEMA*, but are not required to be new. fabrication drawings and certification will not be required for the temporary signal, flashing beacon, and lighting materials and equipment.

Materials shall conform to the applicable requirements of Section 678 and Section 679.

All associated signing shall conform to the *MUTCD* and Section 675, except that the materials are not required to be new.

Pavement marking shall conform to the *MUTCD* and Section 646.

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(c) Installation. The components of the temporary traffic signal and flashing beacon systems shall be installed in accordance with the applicable requirements of Section 646, Section 675, Section 677, Section 678, and Section 679, with the following modifications:

(1) Concrete bases will not be required for temporary traffic signal installations.

(2) The Contractor shall correct all deficiencies found in the traffic control signal system and shall repair or replace defective equipment at no cost to the State.

(3) During installation of the temporary traffic signal system or flashing beacons for advanced warning signs, no conduit shall be placed under the existing roadway.

(4) The entire signal system including signs, warning beacons, poles, lights, detectors, and other required materials shall be in place and operating correctly prior to the start of the part of the project requiring its operation. Removal of the temporary signal system in its entirety and restoration of the disturbed areas shall constitute completion of the Contract item.

(5) The Contractor shall be responsible for all permits and costs associated with providing electrical power for the traffic signal and warning beacon operation.

(6) The Contractor shall notify the Engineer and/or the town or city officials at least 48 hours prior to turning off the existing traffic control signals, and/or installing temporary signals.

(7) Pavement marking shall meet the requirements for temporary pavement markings, unless otherwise shown on the Plans.

(d) Detectors. Unless shown on the Plans, detectors for temporary traffic signal activation may be of the type and manufacture chosen by the Contractor. However, the furnished detector must function properly and provide the actuation required for the specific installed site. If, in the opinion of the Engineer, the furnished detector either does not function properly or does not perform the required actuation, the Contractor shall replace the detector within 24 hours of receiving notice to do so from the Engineer. The costs of replacement shall be solely at the Contractor's expense.

Unless otherwise shown on the Plans, detectors designed to be installed in the roadway shall be cut and sealed in the pavement in the same manner as permanently installed detectors.

If temporary loop detectors are installed in a gravel roadway, they shall be placed in schedule 80 PVC or HDPE conduit and buried at least 4 inches below the travel surface. Other detectors installed in gravel roadways shall be installed in accordance with the manufacturer's recommendations.

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678.19 METHOD OF MEASUREMENT. The quantity of Traffic Control Signal System, Intersection to be measured for payment will be the number of each signal system installed in the complete and accepted work.

The quantity of Flashing Beacon, Ground Mounted or Flashing Beacon, Aerial Mounted to be measured for payment will be the number of each beacon system installed in the complete and accepted work.

The quantity of Interconnecting Cable to be measured for payment will be the number of linear feet of the interconnected system installed in the complete and accepted work, as measured between controller units along the alignment shown on the Plans. No allowance will be made for sag between poles or for loops created in making connections.

The quantity of Electrical Conduit and Wired Conduit to be measured for payment will be the number of linear feet of the specified conduit installed as required by the system being constructed in the complete and accepted work. The measurement will include sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Vehicle Loop Detector to be measured for payment will be the number of linear feet of pavement cut and sealed, measured from the curb, containing the loop and lead-in wires, in the complete and accepted work.

The quantity of Electrical Wiring to be measured for payment will be the number of linear feet of specified wiring installed in the complete and accepted work, as measured between connection points along the installed alignment. No allowance will be made for sags or loops for making connections, but including the wiring installed in sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Pull Box, of the type specified, and Junction Box to be measured for payment will be the number of each box installed in the complete and accepted work.

The quantity of Electrical Conduit Sleeve to be measured for payment will be the number of linear feet of the specified sleeve installed in the complete and accepted work.

The quantity of Temporary Traffic Signal System, Temporary Flashing Beacon, or Temporary Detector to be measured for payment will be the number of each system installed in the complete and accepted work, maintained during construction, and then removed from the project when the Engineer determined it was no longer required.

The quantity of Removal of Existing Traffic Control Signal System to be measured for payment will be for each traffic control signal system removed in the complete and accepted work.

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678.20 BASIS OF PAYMENT. The accepted quantity of Traffic Control Signal System, Intersection will be paid for at the Contract unit price per each at each designated intersection. Payment will include strain poles, foundations, signal heads, controller and cabinet, detection and preemption equipment, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, all removal, disposal, and salvage and/or reuse of existing system equipment and components, and all other materials necessary for a fully operational Traffic Control Signal System not otherwise paid for under other Contract items in this section.

The Contractor shall be responsible for all maintenance costs for new or existing signal(s) and beacons until project acceptance. This period shall include any winter shut downs during the Contract period. Replacement of poles and cabinet/controllers will not be considered maintenance costs unless the loss is due to the Contractor's negligence.

At the discretion of the Engineer, the Contractor may be required to replace poles and cabinet/controllers that are lost or damaged due to an accident, or to perform routine repairs to existing signals that are not necessitated by the Contractor's operations. If required, such work will be considered extra work under Subsection 109.06 and additional payment will be allowed. Any equipment that is defective or damaged prior to the beginning of the Contract shall be maintained in at least as good condition, until it is replaced as part of the Contract.

The accepted quantity of Flashing Beacon, Ground Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include beacon head(s), flasher and cabinet, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, power source, and all other materials necessary for a fully operational Flashing Beacon not otherwise paid for under other Contract items in this section. Sign post(s) and panel(s) will be paid for under their own Contract items.

The accepted quantity of Flashing Beacon, Aerial Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include strain poles, span wire, attachment hardware, beacon heads, and all other materials necessary for a fully operational flashing beacon system not otherwise paid for under other Contract items in this section. Sign post(s) and panel(s) will be paid for under their own Contract items.

(a) Payment for Traffic Control Signal System, Intersection; Flashing Beacon, Ground Mounted; and Flashing Beacon, Aerial Mounted will be made as follows:

(1) When applicable, 10% of the Contract unit price will be paid for the installation of strain poles.

(2) Upon installation of a functioning system as indicated by a successful continuous 24-hour operation test period, an additional 10% of the Contract unit price will be paid. When the installation does not include strain poles, 20% of the Contract unit price will be paid upon successful completion of a continuous 24-hour operation test.

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(3) Thirty percent of the Contract unit price will be paid upon receipt by the Engineer of notice from all responsible Agency parties that all paperwork related to the signal or beacon installation has been completed to the satisfaction of the Agency.

(4) The remainder, less 20% of the Contract unit price, will be paid after successful completion of the 30-day test control period.

(5) The final 20% of the Contract unit price will be paid upon acceptance of the work under this section.

(6) The Contractor will not be paid more than 50% of the Contract unit price for the traffic signal or flashing beacon installation, whether directly or through stockpile or any other means until the Engineer has been notified that all signal related paperwork has been completed to the satisfaction of the Agency.

The accepted quantities of Interconnecting Cable, Electrical Conduit, and Vehicle Loop Detector will be paid for at the Contract unit price per linear foot. Payment for Electrical Conduit will include installed electrical conduit only.

The accepted quantity of Wired Conduit will be paid for at the Contract unit price per linear foot. Payment will include both the installed conduit and the wiring inside the conduit.

The accepted quantity of Electrical Wiring will be paid for at the Contract unit price per linear foot. Payment will include removing any existing wiring in an existing conduit, strain pole, streetlight pole, or bracket arm; installing new updated wiring including necessary connections; fusing in that existing enclosed location, and providing all the required number of conductors (including grounds, neutrals, and the designated number of spares). No adjustment of the Contract price will be made if a lesser or greater number of conductors becomes necessary to complete the work.

Unless otherwise shown on the Plans, Wired Conduit and Electrical Wiring will not occur in the same location as Electrical Conduit. Furthermore, Electrical Wiring will only occur inside existing and previously installed conduits, strain poles, streetlight poles, or bracket arms.

The accepted quantities of Pull Box, of the type specified, and Junction Box will be paid for at the Contract unit price per each.

The accepted quantity of Electrical Conduit Sleeve will be paid for at the Contract unit price per linear foot. The cost of excavation and backfill will not be included in the costs of the sleeve. When the sleeve is installed for use with one or more conduits, the costs of excavation and backfill will be considered included in the Contract unit price for the conduit(s) installed within the sleeve. When the sleeve is installed without conduit, the pay limits and the excavation and backfill will be paid in the same manner as specified for culverts in Subsection 601.10.

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Payment for the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, concrete, hanger hardware for pole mounting of cable, pole identification, cutting and resealing the pavement, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Disconnecting existing loop or other detectors will be considered incidental to other Contract items.

The accepted quantity of Temporary Traffic Signal System will be paid for at the Contract unit price per each. Payment will include the installation and removal of strain poles, signal heads, controller and cabinet, luminaires, signs, sign posts, flashing beacons, pavement markings, wiring, conduit, and all other materials necessary for a fully operational Temporary Traffic Signal System complete in place.

When a Temporary Flashing Beacon system is installed on a project that also requires the installation of a temporary traffic signal, the Temporary Flashing Beacon will not be paid for directly, but will be considered incidental to the Contract item Temporary Traffic Signal System.

The accepted quantity of Temporary Flashing Beacon will be paid for at the Contract unit price per each. Payment will include the installation and removal of poles, span wires, signs, sign posts, beacon heads, flasher units and cabinets, conduit, wiring, attachment hardware, and all other materials necessary for a fully operational Temporary Flashing Beacon system complete in place.

The accepted quantity of Temporary Detector will be paid for at the Contract unit price per each. Payment will include the detector and all necessary installation hardware and materials. A detector consists of the "black box" container or the loop and leads within the paved area of the roadway (on unpaved highways, the graveled surface). Wiring from the controller to the detector, including connection to the detector, is included in the Contract item Temporary Traffic Signal System.

Payment of the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, hanger hardware for cable and signals, span wires, poles, cutting and resealing pavement, providing electrical service and power, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, to maintain the system while it is required, and then to completely remove it from the project and properly dispose of it when so directed by the Engineer.

All components, materials, and equipment furnished by the Contractor shall remain the property of the Contractor and shall be properly removed from the project and disposed of by the Contractor when the temporary system is removed. Existing components and materials that were utilized for the temporary system shall be disposed of as shown in the Contract.

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(b) Payment for Temporary Traffic Signal System and Temporary Flashing Beacon will be made as follows:

(1) When the entire system has been installed at a site (including signing and pavement markings) and working for 24 hours to the satisfaction of the Engineer, 50% of the Contract unit price for each will be paid.

(2) When 60% of the work days between the date of installation and the original completion date have elapsed, an additional 30% of the Contract unit price for each will be paid.

(3) Upon complete removal of the system from the site and restoration of disturbed areas, the remaining 20% of the Contract unit price will be paid.

The accepted quantity of Removal of Existing Traffic Control Signal System will be paid for at the Contract unit price per each. Payment will be full compensation for removing and handling the existing traffic control signal system components as specified in the Contract and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
678.15 Traffic Control Signal System, Intersection	Each
678.16 Flashing Beacon, Ground Mounted	Each
678.17 Flashing Beacon, Aerial Mounted	Each
678.20 Interconnecting Cable	Linear Foot
678.21 Electrical Conduit	Linear Foot
678.22 Vehicle Loop Detector	Linear Foot
678.23 Wired Conduit	Linear Foot
678.24 Electrical Wiring	Linear Foot
678.25 Pull Box, Standard	Each
678.26 Junction Box	Each
678.27 Pull Box, Double	Each
678.30 Electrical Conduit Sleeve	Linear Foot
678.40 Temporary Traffic Signal System	Each
678.41 Temporary Flashing Beacon	Each
678.42 Temporary Detector	Each
678.45 Removal of Existing Traffic Control Signal System	Each

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SECTION 679 – STREET LIGHTING

679.01 DESCRIPTION. This work shall consist of removing, furnishing, and installing the street lighting components necessary to provide a complete and operational system.

Street light assemblies shall consist of Light Pole Foundations, Transformer Bases, Light Poles, Bracket Arms and Luminaires.

679.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Grounding Electrodes 752.15
Light Pole Foundations 753.01
Transformer Bases 753.02
Light Poles 753.03
Bracket Arms, Aluminum .....753.04(a)
Bracket Arms, Steel .....753.04(b)
Luminaires 753.05
Highway Illumination Conductor Cable 753.06
Finish of Highway Illumination Components 753.07

679.03 GENERAL. Street lights shall be installed as specified in the Contract.

Street lights shall be designed to withstand an equivalent wind load of 100 mph velocity with an allowable angular deflection of 70 arc minutes or less.

All wiring shall meet the current *National Electrical Code*.

Street lighting design shall conform to the current edition of the *AASHTO Standard Specifications for the Structural Supports for Highway Signs, Luminaires and Traffic Signals* and its latest revisions.

679.04 SUBMITTALS. The Contractor shall submit fabrication drawings in accordance with Subsection 105.03. The submittal shall contain the following information, at a minimum:

(a) Wiring. Conductor material, insulation type, voltage rating and temperature rating.

(b) Light Pole Foundations.

(1) Dimensions and material specifications for all hardware used to mount the transformer base to the Light Pole Foundation

(2) For pre-cast Light Pole Foundations, complete design details and material specifications shall be supplied

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(b) Transformer Bases.

(1) Dimensions for bottom and top of transformer base, height of transformer base, transformer base door dimensions, bolt pattern for mounting the transformer base to the light pole foundation and type of transformer base. Include documentation indicating the transformer base meets the AASHTO standards.

(2) Dimensions and material specifications for all hardware used to mount the light pole to the transformer base

(c) Light Poles.

(1) Dimensions for pole height, mounting height, pole diameter (top and bottom), handhole (size and location), anchor base, bolt circle, and mounting bolt size

(2) Dimensions for the bolt pattern for mounting the light pole to the transformer base

(3) Material specifications for all components of the light pole

(4) Welding information in accordance with Subsection 506.10

(5) The welding process and procedures and the materials used to make the two continuous circumferential welds, one attaching the top of the anchor base to the pole shaft and the other attaching the bottom of the pole shaft to the inside of the shoe base

(6) Special features as shown on the Plans, such as finish or color

(d) Bracket Arms.

(1) Dimensions for bracket arm length and diameter

(2) Details for connection of bracket arm to light pole. The details shall be specific to the pole material on which the arm is to be mounted.

(3) Welding information in accordance with Subsection 506.10

(4) Material specifications for bracket arm and mounting hardware

(e) Luminaires.

(1) Luminaire Data

a. Manufacturer

b. Model number

c. Wattage

d. Lamp type, with number of LEDs

e. Any other features, such as finish, special wire access, etc.

f. BUG rating

g. Operating amperage

h. Street Lighting Control Device

(2) Photometric data shall be supplied when a street lighting design is not included in the Plans or when changes to the Plans are proposed

a. IES Distribution type

b. Utilization curve

c. Iso-lux curves

d. Mounting height factor

e. Maintenance factor

679.05 BRACKET ARM. Bracket arms shall be free of defects and burrs. Bracket arms shall be able to withstand a vertical load of 100 pounds and a horizontal load of 50 pounds without fracture or permanent deformation and shall be installed as shown in the Contract.

Bracket arms installed on aluminum posts shall be in accordance with Subsection 753.04(a). Bracket arms installed on steel or wood posts shall be in accordance with Subsection 753.04(b).

The length and mounting height of bracket arms shall be as shown on the approved drawings. The bracket arm shall be mounted perpendicular to the centerline of roadway, unless otherwise specified. The bracket arm shall be provided with a 2-inch slip-fit mounting of sufficient length to accommodate the luminaire.

All welds shall conform to the requirements of Subsection 506.10. No field welds shall be allowed.

679.06 LUMINAIRE. Luminaires shall meet the requirements of the current *Vermont Agency of Transportation Lighting Design Guide* unless otherwise specified in the Plans.

679.07 STREET LIGHT ASSEMBLY. Street light assemblies shall be installed as shown in the Contract and shall include the following:

(a) Light Pole Foundation. Light pole foundations shall be installed as shown in the Contract. Excavation and backfill shall be in accordance with Section 203.

(b) Transformer Bases. Transformer bases shall be installed on light pole foundations as shown in the Contract.

The bottom plate of the transformer base shall have a grounding bolt and nut, easily accessible from the transformer base door. Transformer bases, and all wiring contained in the transformer bases, shall meet the requirements of the current *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* for breakaway features.

(c) Light Poles. Light poles shall be mounted on transformer bases as shown in the Contract.

The anchor base shall be attached to the pole shaft by two continuous welds, one inside the base at the end of the shaft and the other on the outside at the top of the anchor base. All welds shall conform to the requirements of Subsection 506.10. No field welding shall be allowed.

Light poles shall be plumb and level. A 4 inch × 6 inch handhole, complete with cover and hardware shall be located approximately 18 inches above the top of the transformer base directly above the transformer base door. A lip shall be provided around the handhole opening to prevent the cover from tipping and falling inside the hole. A grounding bolt and nut, easily accessible from the handhole, shall be located inside the pole shaft.

The pole cap shall be securely held in place.

(d) Bracket Arms. Bracket arms shall be as specified herein.

(e) Luminaires. Luminaires shall be as specified herein.

679.08 REMOVE STREET LIGHT ASSEMBLY. The Contactor shall remove the entire street light assembly as identified in the Plans, including the light pole foundation, transformer base, light pole, bracket arm, luminaire, wiring and all other incidentals.

The street light assembly shall become property of the Contractor. All components of the street light assembly shall be removed from the project and properly disposed of by the Contractor.

All voids resulting from this work shall be backfilled in accordance with Section 203.

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679.09 REMOVE AND RESET LIGHT POLE. The Contractor shall remove, store and reset the transformer base, light pole, bracket arm, luminaire, wiring and other incidentals as shown in the Plans. All light poles shall be carefully separated from the light pole foundation on which they are mounted.

Light poles shall be completely removed from the light pole foundation, transported and stored at locations specified in the Contract or as ordered by the Engineer and reset on the light pole foundation at the original location.

679.10 STREET LIGHTING CONTROL DEVICES. An astronomical clock shall be provided for each wired group of street lights and installed at the power drop stanchion for each group, unless otherwise noted in the Plans.

Astronomical clocks shall have two-circuit scheduling, at least 20 set points for individual programs for each day of the week, be capable of Daylight Saving Time adjustments, have a manual override, and a power outage backup system with permanent schedule retention and memory module.

All astronomical clocks shall be placed in an enclosure meeting *NEMA 3R* standards and all shall be the same for the project. A mix of clocks will not be allowed for new installations.

679.11 POWER DROP STANCHION, STREET LIGHTING. Power drop stanchion, street lighting shall conform to the requirements of Subsection 678.08.

679.12 ELECTRIC WIRING. All wiring shall be in accordance with the *NEC* and Section 678.

All current carrying conductors shall have a fusible disconnect in the base of each light pole accessible from the hand hole or breakaway base.

Conductors shall not have any unnecessary kinks or bends. End caps, when necessary, of the appropriate size for the service conductors shall be installed at all termination points in pull boxes, junction boxes, and pole bases.

679.13 FINISH. All transformer bases, light poles, bracket arms, and luminaires shall have either a powder coating or anodized aluminum finish. All finishes shall be factory-applied finishes.

Anodized aluminum coatings shall have a minimum coating thickness of 1.0 mil.

Powder coatings shall be a thermosetting material, with a minimum film thickness of 4.0 mils. The powder coating process shall have pre-treatment steps that ensure complete cleaning and adherence of the coating materials, including at least the following steps: hot alkaline wash, rinse, hot phosphoric acid etching, and final rinse. It shall be free of blisters, cracks, stains and similar defects.

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679.14 ACCEPTANCE. Acceptance of street lighting systems shall be based on the following conditions:

(a) Prior to acceptance of the street lighting system the system shall successfully complete a test period. The street lighting systems shall be completely operable and energized for 30 consecutive calendar days without any defects in the system for successful completion of the test period. All required adjustments to the street lighting control device, if required, shall be completed to the satisfaction of the Engineer prior to acceptance.

(b) The Contractor shall be responsible for all power costs through project acceptance.

679.15 METHOD OF MEASUREMENT. The quantity of Bracket Arm to be measured for payment will be the number of each bracket arm installed in the complete and accepted work.

The quantity of Luminaire to be measured for payment will be the number of each Luminaire installed in the complete and accepted work.

The quantity of Street Light Assembly to be measured for payment will be the number of each Street Light Assembly installed in the complete and accepted work.

The quantity of Remove Street Light Assembly to be measured for payment will be the number of each Street Light Assembly removed in the complete and accepted work.

The quantity of Remove and Reset Light Pole to be measured for payment will be the number of each Salvaged Light Pole removed, stored, and erected in the complete and accepted work.

The quantity for Street Lighting Control Device to be measured for payment will be the number of each Street Lighting Control Device installed in the complete and accepted work.

The accepted quantity of Power Drop Stanchion, Street Lighting to be measured for payment will be the number of each stanchion installed in the complete and accepted work.

679.16 BASIS OF PAYMENT. Street lighting item prices shall be full compensation for furnishing, transporting, handling, and placing the materials specified. When a Power Drop Stanchion, Street Lighting is not a Contract item, connections to the power source, circuit testing, and the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work will be incidental to other items.

The accepted quantity of Bracket Arm shall be full compensation for the bracket arm, wiring within the bracket arm, hardware required to mount the bracket are to light pole and other incidentals as necessary to complete the work. Bracket arm shall be paid for at the Contract unit price for each.

The accepted quantity of Luminaire shall be full compensation for the luminaire housing, ballasts, lamps, photoelectric control device and other incidentals as necessary to complete the work. Luminaire shall be paid for at the Contract unit price for each.

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The accepted quantity of Street Light Assembly shall be full compensation for the light pole foundation, transformer base, light pole, bracket arm luminaire, wiring within the Street Light Assembly and other incidentals as necessary to complete the work. Street Light Assembly shall be paid for at the Contract unit price for each.

The accepted quantity of Remove Street Light Assembly shall be full compensation for removing and disposing a street light assembly, including light pole foundation, transformer base, light pole, bracket arm, luminaire, wiring and other incidentals. Remove Street Light Assembly shall be paid for at the Contract unit price for each.

The accepted quantity of Remove and Reset Light Pole shall be full compensation for removing, storing and installing a salvaged light pole, including transformer base, light pole, bracket arm, luminaire wiring and other incidentals as necessary to complete the work. Remove and Reset Salvaged Light Pole shall be paid for at the Contract unit price for each.

The accepted quantity of Street Lighting Control Device shall be full compensation for installing a fully functional Street Lighting Control Device at the Contract unit price for each.

The accepted quantity of Power Drop Stanchion, Street Lighting shall be full compensation for all work, materials and incidentals necessary to complete the work. Power Drop Stanchion, Street Lighting shall be paid for at the Contract unit price for each.

Circuit testing and connections to power sources will not be paid for separately but will be considered incidental to the Contract items that include the costs of wiring.

The cost of furnishing and installing electrical conduit, wired conduit, electrical wiring, electrical conduit sleeve, pull boxes, and junction boxes, when not covered under the Section 678, shall be considered incidental to items in this section.

Payment will be made under:

Pay Item	Pay Unit
679.24 Remove Street Light Assembly	Each
679.25 Remove and Reset Light Pole	Each
679.46 Street Light Assembly	Each
679.47 Bracket Arm	Each
679.50 Luminaire	Each
679.54 Street Lighting Control Device	Each
679.55 Power Drop Stanchion, Street Lighting	Each

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SECTION 680 – TRAVEL INFORMATION SIGNS

680.01 DESCRIPTION. This work shall consist of furnishing, erecting, and maintaining travel information signs and information plazas.

680.02 MATERIALS. Materials shall meet the requirements of the following subsections:

Aggregate for Bituminous Surface Treatment.....704.11
This material list item deleted.
Structural Timber and Lumber.....709.01
Nonstructural Lumber.....709.02
Timber Preservative.....726.01
Sign Posts.....750.01
Retroreflective Sheeting.....750.08
Plastic Lettering Film.....750.10
Assembly Hardware.....750.12

All materials shall be in conformance with the requirements of the State of Vermont Travel Information Council.

The colors used for specific signs, symbols, and plaques shall be as shown on the Plans and shall provide an acceptable match to the appropriate color chip in *SAE AMS-STD-595B* as specified in Table 680.02A.

TABLE 680.02A – SIGN COLORS

Color	Black	White	Magenta	Brown	Orange	Gray
Chip No.	17038	17875	11158	10100	12501	16373

The color of retroreflective material shall be Silver-White #2.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

680.03 PLANS. Plans for travel information signs, associated components, and work required will consist of assembly drawings of information plazas, Standard Drawings, location and site plan, and order forms detailing the work to be performed at each specified location.

680.04 SIGN POSTS. The installation of steel and aluminum sign posts shall conform to the requirements of Section 675. Posts shall be set to the depth shown on the Plans.

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680.05 SIGNS. Travel and business information signs shall be prepared and installed according to the requirements of Section 675, except as modified by this subsection.

All lettering, mileage numerals, and directional arrows shall be formed from retroreflective sheeting. Basic travel information symbols for use on sign boards carrying only travel information symbols shall be reflectorized either by silk-screening the background color on retroreflective sheeting or by applying reflective symbols on acrylic material of the appropriate color. All other travel information symbols and background material shall be non-reflectorized and shall be of the colors shown on the Plans.

Commercial logos, furnished by others, will be applied to certain signs as shown on the Plans.

680.06 INFORMATION PLAZAS. Information plazas shall be constructed at locations shown on the Plans or directed by the Engineer. The information plaza shall be constructed from materials shown on the Plans and shall be erected as shown on the Plans. The plazas shall also be erected in conformance with the *Application for Official Business Directional Signs (OBDS)* found on the Agency's website.

The area in which the information plaza is erected shall be reasonably level and unobstructed to provide for easy circulation by pedestrians. In areas subject to vehicular traffic, an 8-foot length of curbing shall be installed parallel to the axis of the structure for the separation of vehicular and pedestrian traffic. Pedestrian traffic areas shall be excavated and surfaced with 12 inches of peastone.

The relocation of an existing information plaza shall consist of removing the information plaza from its present location and reinstalling it on new posts or concrete bases at the location specified. The reinstallation shall be made as shown on the Plans and shall include the necessary electrical connections, grading, and curb installation if necessary. Removal and disposal of the original mounting posts and curb, if any, and any necessary cleanup of the original site shall also be included in the relocation item.

An information plaza that is damaged during its removal and resetting due to negligence on the part of the Contractor shall be repaired or components replaced by the Contractor at no additional cost to the Agency.

If lighting is called for, the plazas shall be lighted during the hours of darkness under the control of a suitably designed photoelectric device. Information plaza lighting and electrical circuitry shall be as shown on the Plans. All electrical materials and installation methods shall conform to the provisions of the *National Electrical Code* and all electrical work shall be in accordance with State and local regulations.

680.07 MAGNETIC PLAZA INFORMATION PLAQUES. When indicated in the Contract, the Contractor shall furnish magnetic plaques of the sizes and types indicated on the order form, complete with the legend provided on the order form.

Plaques shall have space reserved for the application of a commercial logo to be furnished by others. The plaques shall be installed by others.

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The graphics shall be white on a square panel of magnetic vinyl in the color specified. Graphics shall be on plaques 6 inches square, with 48-point lettering for headings, 18-point lettering for text, and logos 1-1/2 inches square.

680.08 SYMBOLS. When called for in the Contract, the Contractor shall furnish travel information symbols as ordered by the Engineer. The symbols shall consist of a self-adhesive acrylic background with the appropriate symbol superimposed, all of the size and color specified. The symbols shall be installed by others.

680.09 METHOD OF MEASUREMENT. The quantity of Travel Information Sign and Business Directional Sign to be measured for payment will be the number of square feet of sign(s) installed in the complete and accepted work.

The quantity of Travel Information Plaza or Relocate Information Plaza to be measured for payment will be the number of each plaza installed or relocated in the complete and accepted work.

The quantity of Magnetic Information Plaque, of the type specified, Travel Information Symbol, or Overlay for Travel Information Signs will be measured for payment as the number of plaques, symbols, and overlays furnished in the complete and accepted work.

680.10 BASIS OF PAYMENT. The accepted quantity of Travel Information Sign and Business Directional Sign will be paid for at the Contract unit price per square foot. Payment will include furnishing the sign complete with letter and symbol text and installing the sign as part of a unit at the location specified.

Sign posts for Travel Information Signs will be paid for at the Contract unit price for the appropriate Contract item for sign posts under Section 675.

The accepted quantity of Travel Information Plaza will be paid for at the Contract unit price per each. Payment will include excavation, preparation, and grading of the area; furnishing and placing backfill material; furnishing and placing protective curb where required; and the information plaza complete with electrical service.

The accepted quantity of Relocate Information Plaza will be paid for at the Contract unit price per each. Payment will include disassembly of the plaza, disposal of the original posts, cleanup of the original area, and reinstallation of the plaza on new posts or base at the location specified, complete with prepared, graded, and curbed area and electrical service.

The accepted quantity of 6 Inch Magnetic Information Plaque and Travel Information Symbol will be paid for at the Contract unit price per each. Payment will be full compensation for furnishing the materials specified with the required text or symbols superimposed.

The accepted quantity of Overlay for Travel Information Sign will be paid for at the Contract unit price per each. Payment will include furnishing the acrylic background of the color specified, placing the required text on the background, and installation of the overlay on the sign panel at the location specified.

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Payment for the above Contract unit prices will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
680.20 Travel Information Sign	Square Foot
680.25 Business Directional Sign	Square Foot
680.30 Travel Information Plaza	Each
680.40 Relocate Information Plaza	Each
680.65 6 Inch Magnetic Information Plaque	Each
680.70 Travel Information Symbol	Each
680.72 Overlay for Travel Information Sign	Each

SECTION 681 – THIS SECTION RESERVED

SECTION 686 – THIS SECTION RESERVED

SECTION 690 – THIS SECTION RESERVED

SECTION 696 – THIS SECTION RESERVED

SECTION 697 – THIS SECTION RESERVED

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DIVISION 700

MATERIALS

SECTION 700 – GENERAL

700.01 GENERAL STATEMENT. Where the Contract requires that materials conform to the requirements of AASHTO, ASTM, or other specifications, the latest publications and all modifications thereto in effect on the date of the Invitation for Bids shall apply.

Materials shall be accepted in accordance with the Agency's Quality Assurance Program and the *Materials Sampling Manual*.

Whenever there is a subsection entitled "General Requirements" within any Division 700 section, the requirements of that subsection are applicable to all other subsections in that section.

700.02 THIS SUBSECTION RESERVED.

700.03 APPROVED PRODUCTS. The *Approved Products List* (*APL*) is a listing of products and materials that have been tested and/or evaluated by the Agency and have been deemed satisfactory for use on Agency projects. Materials required to be on the *APL* do not have certification requirements, therefore material substitutions are not allowed.

The Agency reserves the right to remove any product from the *APL* at any time.

700.04 DEFINITION OF TERMS.

ADVANCED DECAY - In the case of wood, the older stage of decay in which the disintegration is readily recognized because the wood has become punky, soft, and spongy.

BEDROCK (LEDGE) - Rock of relatively great thickness and extent in its native location; any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

BITUMINOUS MATERIAL - A substance which is characterized by the presence of bitumen, or one from which bitumen can be derived.

BOULDER - A rock fragment, usually rounded by weathering or abrasion, with an average dimension of 12 inches or more.

CAPILLARY ACTION (CAPILLARITY) - The rise or movement of water in the interstices of a soil due to capillary forces.

CHECK - In the case of wood, a separation of the wood grain due to internal stresses caused by severe moisture cycling.

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CLAY (CLAY SOIL) - Fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dried.

COBBLE (COBBLESTONE) - A rock fragment, usually rounded or semi-rounded, with an average dimension between 3 and 12 inches.

COHESIONLESS SOIL - A soil that when unconfined has little or no strength when air-dried and that has little or no cohesion when submerged.

COHESIVE SOIL - A soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

COMPACTION - Densification by means of mechanical manipulation.

COMPACTION CURVE (PROCTOR CURVE, MOISTURE-DENSITY CURVE) - The curve on a graph that shows the relationship between the dry density and the water content of a soil for a given compactive effort.

COMPACTION TEST (MOISTURE-DENSITY TEST) - A laboratory procedure whereby a soil at a known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit mass (weight) determined.

COMPRESSIVE STRENGTH - The maximum compressive stress that a material is capable of sustaining.

CONSOLIDATION - Gradual reduction in volume of a soil mass.

CRUSHED GRAVEL - The product resulting from the mechanical crushing of gravel and cobblestones.

CRUSHED STONE - The product resulting from the mechanical crushing of blasted ledge, rocks, boulders, or cobblestones.

DENSITY - The density of a soil is measured in terms of the ratio of its mass (weight) per unit volume and usually expressed as pounds of wet soil or dry soil per cubic foot (kilograms per cubic meter). These ratios are designated as wet density and dry density respectively.

DRYING TIME - Drying times are based on the following criteria:

(a) Set to Touch. Film is “set to touch” when it still exhibits a tacky condition, but none of it adheres to the finger.

(b) Dry to Recoat. Film is “dry to recoat” when the top coat can be applied without the development of film irregularities, such as lifting or loss of adhesion of the undercoat.

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(c) Dry Through (Dry to Handle). Film is "dry through" when there is no loosening, detachment wrinkling, or other distortion of film under condition of test. Test conditions require full thumb pressure with twisting action.

ELONGATED PIECE - One in which the ratio of the length to width of its circumscribing rectangular prism is greater than five.

ELONGATION - The increase in gauge length of a tension test specimen, usually expressed as a percentage of the original gauge length.

FAMILY OF CURVES - A group of similar moisture-density curves assuming a characteristic shape.

FILTER (PROTECTIVE FILTER) - A layer or combination of layers of pervious materials designed and installed in such a manner as to provide drainage, yet prevent the movement of soil particles due to flowing water.

FINENESS MODULUS - An empirical factor obtained by adding the total percentages of a sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100.

FINES - Portion of a material finer than a No. 200 (0.075 mm) sieve.

FLY ASH - Finely divided residue that results from the combustion of ground or powdered coal.

FRACTURED FACES - Faces on aggregate pieces with sharp and well-defined edges.

FREEZING DEGREE-DAYS - The difference between the average temperature each day and 32°F. Freezing degree-days are positive for daily average temperatures above 32°F and negative for those below.

FREEZING INDEX - The number of freezing degree-days between the highest and lowest points on the cumulative freezing degree-days/time curve for one freezing season.

GAUGE LENGTH - The original length of that portion of the specimen over which strain or change of length is determined.

GLACIAL TILL (TILL) - Material deposited by glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

GRADATION (GRAIN-SIZE DISTRIBUTION, SOIL TEXTURE) - Proportion of material of each grain size present in a given material.

GRAIN-SIZE ANALYSIS (MECHANICAL ANALYSIS) - The process of determining gradation.

GRAVEL (AASHTO) - Rounded or semi-rounded particles of rock that will pass a 3 inch (75.0 mm) sieve and be retained on a No. 10 (2.00 mm) sieve.

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HARDNESS - The resistance of a material to deformation, particularly permanent deformation, indentation, or scratching.

HARDPAN - Extremely dense, cemented soil, which does not soften when wet.

HEAVE - Upward movement of soil caused by expansion or displacement resulting from phenomena such as moisture absorption, removal of overburden, driving of piles, and frost action.

INCIPIENT DECAY - The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of wood.

LIQUID LIMIT - The water content corresponding to the arbitrary limit between the liquid and plastic states of soil.

LOAM - A mixture of sand, silt, or clay, or a combination of any of these, with organic matter. It is sometimes called topsoil in contrast to the subsoils that contain little or no organic matter.

MANUFACTURED SAND - The product resulting from the mechanical processing and crushing of gravel or cobbles in which at least 50% of the material passing the No. 8 (2.36 mm) sieve has two fractured faces as determined by *ASTM C 295/C 295 M*, as modified by the Agency's Materials Section.

MODULUS OF RUPTURE IN BENDING - The value of maximum tensile or compressive stress (whichever causes failure) in the extreme fiber of a beam loaded to failure in bending.

MOISTURE CONTENT (WATER CONTENT) - The ratio, expressed as a percentage, of the mass (weight) of water in a given material to the mass (weight) of solid particles.

MUCK - A soil of very soft consistency containing greater than 10% organic matter.

MUD - A mixture of soil and water in a fluid or weakly solid state.

NATURAL SAND - Any sand that is found to exist in a natural deposit.

OPTIMUM MOISTURE CONTENT (OPTIMUM WATER CONTENT) - The water content at which a soil can be compacted to the maximum dry density by a given compactive effort.

PEAT - A fibrous mass of organic matter in various stages of decomposition, generally dark brown to black in color and of spongy consistency.

PERCENT COMPACTION - The ratio, expressed as a percentage, of dry density of a soil to maximum density obtained in a laboratory compaction test.

PERMEABILITY - The property of a soil allowing it to transmit water; largely dependent upon the size and number of continuous soil pores.

pH - An index of the acidity or alkalinity of a soil where seven is neutral, below seven is acidic and above seven is alkaline.

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PLASTICITY INDEX - Numerical difference between the liquid limit and the plastic limit.

PLASTIC LIMIT - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of soil.

POZZOLANS - Siliceous or siliceous and aluminous materials, which in themselves possess little or no cementitious value, but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

PVC - Polyvinyl chloride, a plastic polymer.

SAMPLING - The process of selecting a fraction of a total material that is similar in all respects to the total material.

SACK - A standard unit of dry powder cement with a mass (weight) of 94 pounds.

SAND (AASHTO) - Particles of rock that will pass the No. 10 (2.00 mm) sieve and be retained on the No. 200 (0.075 mm) sieve.

SCREENED SAND - The product resulting from the mechanical screening of natural sands or gravels.

SDS - Safety data sheet as required by OSHA. (Note: SDS Replaced MSDS in 2015.)

SILICA FUME - An extremely fine product of high amorphous silica content resulting from the condensation of rising vapor given off in the manufacture of ferrosilicon and metallic silicon in high temperature electric arc furnaces. This material is also referred to as microsilica.

SILT - Material passing the No. 200 (0.075 mm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air-dry.

STONE SCREENINGS - The product resulting exclusively from the mechanical crushing of quarried bedrock.

TENSILE STRENGTH - The maximum tensile stress that a material is capable of sustaining.

THIN PIECE - One for which the ratio of the width to thickness of its circumscribing rectangular prism is greater than five to one.

THIN AND ELONGATED PIECES - One in which the ratio of the length to the thickness of its circumscribed rectangular prism is greater than five to one.

WANE - Bark or lack of wood on the surface or edges of lumber.

YIELD STRENGTH - The stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain.

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SECTION 701 – HYDRAULIC CEMENT

701.01 GENERAL REQUIREMENTS. Hydraulic cement shall meet the following general requirements.

The Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which, for any reason, has become partially set or which contains lumps or is caked shall be rejected.

The mixing of different brands or types of Portland cement, and the mixing of Portland cement of the same brand or types from different mills, will not be permitted except by written permission of the Engineer.

Cement used in Subsection 701.05, Subsection 701.06, Subsection 701.07, and Subsection 701.08 shall conform to the requirements of Subsection 701.02 or Subsection 701.04.

701.02 PORTLAND CEMENT. Portland cement shall conform to the requirements of *AASHTO M 85*, Type II and *ASTM C 150/C 150 M,* Type II, unless otherwise shown on the Plans or directed by the Engineer.

701.04 HIGH EARLY-STRENGTH PORTLAND CEMENT. High early-strength Portland cement shall conform to the requirements of *AASHTO M 85,* Type III and *ASTM C 150/C 150 M,* Type III.

701.05 PORTLAND-POZZOLAN CEMENT. Portland-pozzolan cement, Type IP, shall conform to the requirements of *AASHTO M 240 M/M 240* and *ASTM C 595/C 595 M* except that the pozzolan constituent shall not be less than 20% of the total mass (weight) of the Portland-pozzolan cement.

701.06 THIS SUBSECTION RESERVED.

701.07 PORTLAND BLAST-FURNACE SLAG CEMENT. Portland blast-furnace slag cement, Type IS, shall conform to the requirements of *AASHTO M 240 M/M 240* and *ASTM C 595/C 595 M*, except that for concrete mixes complying with Table 541.03A, the slag constituent shall not be less than 25% of the total mass (weight) of the Portland blast-furnace slag cement.

701.08 TERNARY BLENDED CEMENT. Ternary blended cement, Type IT, shall conform to the requirements of *AASHTO M 240 M/M 240* and *ASTM C 595/C 595 M*.

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SECTION 702 – BITUMINOUS MATERIALS

702.01 GENERAL REQUIREMENTS. Bituminous materials shall meet the following general requirements.

(a) Sampling. Bituminous materials shall be sampled at the delivery point from vehicle tanks, above ground stationary tanks, or asphalt plant feed lines in a manner that the samples will show the true nature and condition of the materials.

(b) Sampling Valves. Sampling valves shall be installed in strategic locations, readily accessible so that representative samples of the required size can be obtained easily and quickly. The sampling valve shall be constructed of materials compatible with the product at the temperatures handled. The valve seat shall be either inside the tank or compartment or inside the insulating jacket. The flow shall be over a route that is as short and direct as practical. Pockets that will retain product will not be allowed. The outlet shall be a 3/4 inch pipe size. The outlet shall be provided with a chained cap or plug. The sampling valves shall conform to the requirements of *AASHTO R 66*.

(c) Location of Sampling Valves. The recommended location and number of sampling valves needed is as follows:

(1) Vehicle Tanks. Sampling valves on vehicle tanks shall be located below the horizontal mid line of the end head (rear preferred) at least 12 inches from the shell. The inlet to the sampling valve shall be at least 6 inches from walls or other internal surfaces, except that it shall be at least 12 inches from any heating surface.

(2) Horizontal Tanks. Sampling valves on horizontal tanks shall be located below the horizontal mid-line of an end bulkhead. The inlet of the sampling device shall be at least 3 feet from the bottom and 12 inches from the shell.

(3) Vertical Tanks. On vertical tanks where the contents can be agitated, one sampling device shall be required. It shall be located on the side, at least 42 inches from the bottom.

On vertical tanks in which the contents are not capable of being agitated, two sampling devices shall be required. They shall be located, with easy and safe access provided, on the side of the tank, with one no closer than 36 inches from the top, and the other no closer than 42 inches from the bottom.

(4) Asphalt Plant Feed Lines. Sampling valves for asphalt plant feed lines should be located downstream of all additive lines, preferably on a horizontal feed line, and be 24 inches to 36 inches above the surface.

Note: All sampling valves should be protected from inclement weather so as not to spray hot liquid or introduce moisture into tanks or lines.

(d) Defective Sampling Valves. When there is an apparent defect in the sampling valve and a sample cannot be obtained as indicated, the following procedure shall be used:

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(1) The sample shall be taken directly from the tank, through the inspection access port or an alternate valve.

(2) A defective equipment tag shall be filled out and attached to the valve and the plant manager or carrier shall be notified.

(3) A notation shall be made in the plant log or Engineer's daily report giving location of valve, date, storage tank, vehicle tank, or the asphalt plant number. The plant manager or carrier shall make the necessary repairs within 48 hours from the time notification is given.

(4) If, at the end of the repair period, the plant or tank valve is still found to be defective, the plant shall be shut down and not started again until repairs are made and inspected to the satisfaction of the Plant Engineer.

(5) Should the tanker return on a second trip and the defective tanker valve not be repaired, the load shall not be used but shall be returned to the sender.

702.02 PERFORMANCE-GRADED ASPHALT BINDER (PREPARED FROM PETROLEUM).

(a) Properties. Performance-graded asphalt binder (PGB) shall be homogenous, uniformly mixed, and blended liquid bituminous materials that are free of contaminants such as water, fuel oils, or other solvents, and shall not foam when heated to 350°F (175°C). PGB shall be asphalt prepared solely by the refining of crude petroleum and shall meet the requirements of *AASHTO M 320* from facilities compliant with the requirements of *AASHTO R 29* with the addition of SBS polymer modifiers.

The performance-graded asphalt binder manufacturer/supplier shall furnish to the Agency a Certificate of Analysis (COA) and bill of lading representing each delivery in accordance with the requirements of *AASHTO R 26*. The COA must also indicate the binder's specific gravity, rotational viscosity, and the mixing and compaction viscosity-temperature chart for each shipment. If additives are used for the modification of asphalt, preapproval is required. The addition of any material not normally obtained during the initial refining process shall constitute modified asphalt and shall be labeled appropriately.

The performance-graded asphalt binder shall be manufactured in accordance with the approved Quality Control Plan. The manufacturer shall remain in compliance with the plan, including all notifications, sampling, testing, and reporting requirements.

(b) Effect of Approval. VTrans reserves its right to remove its approval of any PGB lot if, in the sole discretion of the Agency, such approval was based on a material non-disclosure by the PGB supplier.

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(c) Pretest. Failure of performance-graded asphalt binder from any one source to meet the specifications may require placing this source on pretest status. This will require that samples from the source be tested in the Agency's Materials Section Central Laboratory and accepted prior to being used on a project.

The Pretest Status will remain in effect for three consecutive samples meeting the requirements of *AASHTO M 320* or until the Engineer is satisfied there is no longer any reason to continue the Pretest Status.

702.04 EMULSIFIED ASPHALT. Emulsified asphalt and polymer-modified emulsified asphalt shall meet the following requirements.

(a) General. Emulsified asphalt or polymer-modified emulsified asphalt shall be homogeneous. It shall show no separation of asphalt at the time of use and shall be used within 30 calendar days after delivery from the manufacturer/supplier. Emulsified asphalt or polymer-modified emulsified asphalt shall not be allowed to freeze.

(b) Emulsified Asphalt. Emulsified asphalt shall conform to the requirements of *AASHTO M 140* or *AASHTO M 208,* as appropriate.

(c) Polymer-Modified Emulsified Asphalt. Polymer-modified emulsified asphalt shall meet the requirements of *AASHTO M 316*. The polymer modification of the emulsified asphalt shall be performed when it is manufactured.

702.05 THIS SUBSECTION RESERVED.

702.06 APPLICATION TEMPERATURE RANGES. Bituminous materials for the applications specified in the specifications shall be applied within the temperature ranges designated in Table 702.06A.

TABLE 702.06A – EMULSIFIED ASPHALT APPLICATION TEMPERATURE RANGES

Emulsified Asphalt Type	Temperature Range (°F)		Temperature Range (°C)	
	Spray	Mix	Spray	Mix
	Min. – Max.	Min. – Max.	Min. – Max.	Min. – Max.
RS-1	70 – 170	--	21 – 77	--
RS-2, CRS-1	120 – 160	--	49 – 71	--
CRS-2	140 – 175	--	60 – 79	--
RS-1h, CRS-1h	70 – 170	--	21 – 77	--
SS-1h, CSS-1h	75 – 130	50 – 130	24 – 54	10 – 54
MS-2h, CMS-2h	--	75 – 140	--	24 – 60

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702.07 ANTI-STRIP ADDITIVES. Anti-strip additives shall be capable of improving the bonding properties of the cutback asphalt or the performance-graded asphalt binder to the aggregates in the presence of moisture and shall also be capable of reducing film stripping.

(a) Performance-Graded Asphalt Binder. The additive used in performance-graded asphalt binder shall be heat stable for all temperature ranges prescribed for such performance-graded asphalt binder. The additive shall not alter the material properties nor change the grade of the performance-graded asphalt binder when added in the recommended proportions. The additive shall be capable of thorough dispersion in the performance-graded asphalt binder and capable of remaining in the performance-graded asphalt binder, in storage, and at temperatures specified for the mix without losing its effectiveness.

(b) Testing Procedures. Testing of anti-strip additives shall be in accordance with, and meet the requirements of, Vermont Agency of Transportation *Test Procedure MRD-1* and *Test Procedure MRD-10*.

The percentage of anti-strip additive shall be a minimum of 0.5% of the asphalt content and shall be adjusted, as required, above this amount to meet testing requirements. Prior to the use of any anti-strip additive, the Contractor shall submit for testing and approval samples of the specific aggregates, the specific asphalt and the specific anti-strip additive proposed for the mix design.

To identify any change in effectiveness, the asphalt and the anti-strip additive being used shall be tested daily to verify that they pass the requirements of *Test Procedure MRD-10*.

702.08 SILICONE ADDITIVES. Silicone additives shall be a silicone material of the dimethylpolysiloxane type with a viscosity grading of 1,000 centistokes, ± 200, at 77°F. It shall be added to the liquid performance-graded asphalt binder at hot mix plants in amounts not to exceed five parts per million. After addition of the silicone additive, the performance-graded asphalt binder shall be thoroughly mixed by mechanical means to ensure complete dispersal.

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SECTION 703 – SOILS AND BORROW MATERIALS

703.01 CLASSIFICATION OF SOILS. Based upon their field performance, soils shall be classified into seven groups that are designated as A-1, A-2, A-3, A-4, A-5, A-6, and A-7. This classification shall be based upon the results of tests made in accordance with the requirements of *AASHTO M 145*, as designated in Table 703.01A.

TABLE 703.01A – CLASSIFICATION OF SOILS

General Classification	Granular Materials			Silt-Clay Materials								
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5 [1]	A-7-6 [2]
Percentage by Mass (Weight) Passing Square Mesh Sieves												
No. 10 (2.00 mm)	50 -	--	--	--	--	--	--	--	--	--	--	--
No. 40 (0.425 mm)	30 -	50 -	51 +	--	--	--	--	--	--	--	--	--
No. 200 (0.075 mm)	15 -	25 -	10 -	35 -	35 -	35 -	35 -	36 +	36 +	36 +	36 +	36 +
Characteristics of the Fraction Passing the No. 40 (0.425 mm) Sieve												
Liquid Limit	--		--	40 -	41 +	40 -	41 +	40 -	41 +	40 -	41 +	
Plasticity Index	6 -		NP	10 -	10 -	11 +	11 +	10 -	10 -	11 +	11 + [1, 2]	
Usual Types of Soil	Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clay Soils		

- indicates maximum allowable value

+ indicates minimum allowable value

NP indicates non-plastic

[1] The plasticity index of the A-7-5 Subgroup is equal to or less than the liquid limit minus 30

[2] The plasticity index of the A-7-6 Subgroup is greater than the liquid limit minus 30

Begin the classification procedure by taking the required data and proceeding from left to right in Table 703.01A. The correct group will be found by the process of elimination. The first group from the left into which the test data will fit is the correct classification.

Where the Unified Soil Classification System (USCS) is referenced in the Contract, it shall be based on the Soil Classification Chart in *ASTM D 2487*.

703.02 EARTH BORROW. Earth borrow shall be material of a quality approved by the Agency as meeting the requirements for the particular embankment, backfill, or other use for which the material is intended, and shall show evidence of satisfactory compaction when placed in embankments.

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The natural moisture content shall be less than the laboratory optimum moisture content as determined in accordance with the requirements of *AASHTO T 99,* Method C.

703.03 SAND BORROW AND CUSHION. Sand borrow and sand cushion shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the requirements of Table 703.03A as determined in accordance with *AASHTO T 27*.

TABLE 703.03A – GRADATION OF SAND BORROW AND CUSHION

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
2 inch (50.0 mm)	100
1-1/2 inch (37.5 mm)	90 – 100
1/2 inch (12.5 mm)	70 – 100
No. 4 (4.75 mm)	60 – 100
No. 100 (0.150 mm)	0 – 20
No. 200 (0.075 mm)	0 – 8

703.04 GRANULAR BORROW. Granular borrow shall be obtained from approved sources, consisting of stone and sand reasonably free from loam, silt, clay, and organic material and shall meet the requirements of Table 703.04A as determined in accordance with the requirements of *AASHTO T 27*.

TABLE 703.04A – GRADATION OF GRANULAR BORROW

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
No. 4 (4.75 mm)	20 – 100
No. 200 (0.075 mm)	0 – 12

The maximum size of stone particles in the granular borrow shall not exceed 67% of the thickness of the layer being spread.

703.05 ROCK BORROW. Rock borrow shall consist of blasted rock broken into various sizes that will form a compact embankment with a minimum of voids. The maximum size shall be 36 inches in its widest dimension and that size which may be incorporated in a 24 inch layer of rock embankment.

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SECTION 704 – AGGREGATES

704.01 FINE AGGREGATE FOR CONCRETE. Fine aggregate for concrete shall consist of natural sand, manufactured sand, or stone screenings washed in an approved manner or a combination thereof.

Fine aggregate shall consist of clean, hard, durable grains, uniformly graded from coarse to fine, and shall be free from detrimental amounts of organic matter or other harmful substances.

(a) Grading. Fine aggregate for concrete shall meet the gradation requirements of Table 704.01A as determined in accordance with the requirements of *AASHTO T 27*, with the exception that when the material is being tested in a producer's laboratory, the *AASHTO T 27* requirement to perform testing conforming to the requirements of *AASHTO T 11* on the material passing the No. 200 (0.075 mm) sieve is waived, and the material reported as passing the No. 200 (0.075 mm) sieve is obtained by dry sieving methods only.

TABLE 704.01A – GRADATION OF FINE AGGREGATE FOR CONCRETE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
3/8 inch (9.50 mm)	100
No. 4 (4.75 mm)	95 – 100
No. 16 (1.18 mm)	50 – 80
No. 30 (0.600 mm)	25 – 60
No. 50 (0.300 mm)	10 – 30
No. 100 (0.150 mm)	2 – 10

The fineness modulus on that portion of material passing the 3/8 inch (9.50 mm) sieve shall be determined by laboratory sieve tests. This fineness modulus is defined as the summation of the percentages of sand retained on the following sieve sizes: No. 100 (0.150 mm), No. 50 (0.300 mm), No. 30 (0.600 mm), No. 16 (1.18 mm), No. 8 (2.36 mm), and No. 4 (4.75 mm), divided by 100.

The minimum and maximum fineness moduli shall be 2.30 and 3.10, respectively. Fine aggregate from any one source for any one designated mix having a variation in fineness modulus greater than ± 0.20 from the fineness modulus of a representative sample proposed for use may be rejected.

(b) Organic Impurities. Fine aggregate for concrete shall show a color of not greater than two as determined in accordance with the requirements of *AASHTO T 21 M/T 21*.

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(c) Compressive Strength of Mortar. When sand or a combination of stone screenings and sand is mixed with Portland cement in the proportion of one part of cement to three parts of sand (or of the combination of stone screenings and sand) by mass (weight), according to the standard method of making 2 inch (50 mm) cubes, the resulting mortar at the ages of 3 and 7 days shall have a compressive strength of at least 100% of that developed in the same time by mortar of the same proportions and flow, made of the same cement and graded Ottawa Sand, when tested in accordance with the requirements of *AASHTO T 106 M/T 106*.

(d) Soundness. When there is any question of either soft or laminated pieces being detrimental to any aggregate, a soundness test shall be performed on the aggregate in accordance with the requirements of *AASHTO T 104*. The weighted average percentage of loss shall be not more than 8% by mass (weight) when subjected to five cycles of the sodium sulfate soundness test.

(e) Alkali-Silica Reaction (ASR). Fine aggregate shall be tested for Alkali-Silica Reaction (ASR) in accordance with the requirements of *AASHTO T 303*.

704.02 COARSE AGGREGATE FOR CONCRETE. Coarse aggregate for concrete shall consist of clean, hard, crushed stone or washed crushed gravel, uniformly graded. The blending of crushed stone and crushed gravel in the stockpile shall not be permitted. It shall be free from deleterious material and pieces that are structurally weak, and when proportioned in concrete shall not adversely affect the structural integrity or durability of the concrete when subjected to freezing and thawing. It shall also meet the following requirements:

(a) Grading. Coarse aggregate for concrete shall meet the gradation requirements of Table 704.02A, Table 704.02B, or Table 704.02C as determined in accordance with the requirements of *AASHTO T 27*, with the exception that when the material is being tested in a producer's laboratory, the *AASHTO T 27* requirement to perform testing conforming to the requirements of *AASHTO T 11* on the material passing the No. 200 (0.075 mm) sieve is waived, and the material reported as passing the No. 200 (0.075 mm) sieve is obtained by dry sieving methods only.

TABLE 704.02A – GRADATION OF 3/8 INCH STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1/2 inch (12.5 mm)	100
3/8 inch (9.50 mm)	85 – 100
No. 4 (4.75 mm)	10 – 30
No. 8 (2.36 mm)	0 – 10
No. 16 (1.18 mm)	0 – 5

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TABLE 704.02B – GRADATION OF 3/4 INCH STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1 inch (25.0 mm)	100
3/4 inch (19.0 mm)	90 – 100
3/8 inch (9.50 mm)	20 – 55
No. 4 (4.75 mm)	0 – 10
No. 8 (2.36 mm)	0 – 5

TABLE 704.02C – GRADATION OF 1-1/2 INCH STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
2 inch (50.0 mm)	100
1-1/2 inch (37.5 mm)	95 – 100
3/4 inch (19.0 mm)	35 – 70
3/8 inch (9.50 mm)	10 – 30
No. 4 (4.75 mm)	0 – 5

(b) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35% when tested in accordance with the requirements of *AASHTO T 96*. When the coarse aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50% when tested in accordance with the requirements of *AASHTO T 96*.

(c) Fractured Faces. When crushed gravel is used as coarse aggregate, at least 50% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve from each stockpile shall have at least one fractured face in accordance with the requirements of *AASHTO T 335*.

(d) Thin and/or Elongated Pieces. Not more than 10% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve from each stockpile shall consist of thin and/or elongated pieces in accordance with the requirements of *ASTM D 4791*.

(e) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

(f) Aggregate Failure. Coarse aggregate that fractures when used in a test cylinder, at a compressive strength less than the minimum compressive strength of the class of concrete tested, may be subject to suspension of aggregate source approval.

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(g) Freeze-Thaw. Coarse aggregate shall be tested for freeze-thaw resistance in accordance with the requirements of *AASHTO T 161*, except as modified to use 3% sodium chloride solution and excess weight loss of more than 8% to constitute a failure.

(h) Alkali-Silica Reaction (ASR). Coarse aggregate shall be tested for Alkali-Silica Reaction (ASR) in accordance with the requirements of *AASHTO T 303*.

704.03 THIS SUBSECTION RESERVED.

704.04 GRAVEL FOR SUBBASE. Gravel for Subbase shall consist of material reasonably free from silt, loam, clay, and organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. Gravel for Subbase shall meet the gradation requirements of Table 704.04A as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

TABLE 704.04A – GRADATION OF GRAVEL FOR SUBBASE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
No. 4 (4.75 mm)	20 – 60
No. 100 (0.150 mm)	0 – 12
No. 200 (0.075 mm)	0 – 6

The gravel shall be uniformly graded from coarse to fine. The maximum size stone particles shall not exceed 67% of the thickness of the layer being placed.

(b) Percent of Wear. Percent of wear shall not be more than 50% when tested in accordance with the requirements of *AASHTO T 96*.

704.05 CRUSHED GRAVEL FOR SUBBASE. Crushed Gravel for Subbase shall be produced from natural gravels or crushed quarried rock and shall be a material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. Crushed Gravel for Subbase shall be uniformly graded from coarse to fine and shall meet the gradation requirements of Table 704.05A or Table 704.05B as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

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TABLE 704.05A – GRADATION OF SUBBASE OF CRUSHED GRAVEL, COARSE GRADED

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
4 inch (100 mm)	95 – 100
No. 4 (4.75 mm)	25 – 50
No. 100 (0.150 mm)	0 – 12
No. 200 (0.075 mm)	0 – 6

TABLE 704.05B – GRADATION OF SUBBASE OF CRUSHED GRAVEL, FINE GRADED

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
2 inch (50.0 mm)	100
1-1/2 inch (37.5 mm)	90 – 100
No. 4 (4.75 mm)	30 – 60
No. 100 (0.150 mm)	0 – 12
No. 200 (0.075 mm)	0 – 6

(b) Percent of Wear. Percent of wear shall not be more than 40% when tested in accordance with the requirements of *AASHTO T 96*.

(c) Fractured Faces. At least 50% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve shall have at least one fractured face in accordance with the requirements of *AASHTO T 335*.

704.06 DENSE GRADED CRUSHED STONE FOR SUBBASE. Dense graded Crushed Stone for Subbase shall consist of clean, hard, uniformly graded, crushed stone. It shall be sufficiently free from dirt, deleterious material, and pieces that are structurally weak and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources. The area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. Dense graded Crushed Stone for Subbase shall meet the gradation requirements of Table 704.06A as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

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TABLE 704.06A – GRADATION OF DENSE GRADED CRUSHED STONE FOR SUBBASE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
3-1/2 inch (87.5 mm)	100
3 inch (75.0 mm)	90 – 100
2 inch (50.0 mm)	75 – 100
1 inch (25.0 mm)	50 – 80
1/2 inch (12.5 mm)	30 – 60
No. 4 (4.75 mm)	15 – 40
No. 200 (0.075 mm)	0 – 6

(c) Percent of Wear. The percent of wear of the crushed stone shall be not more than 40% when tested in accordance with the requirements of *AASHTO T 96*. When the aggregate is composed of crushed igneous rock, the percent of wear of the crushed stone shall be not more than 50% when tested in accordance with the requirements of *AASHTO T 96*.

(d) Thin and/or Elongated Pieces. Not more than 30% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve shall consist of thin and/or elongated pieces in accordance with the requirements of *ASTM D 4791*.

(e) Filler. Filler shall be obtained from approved sources and shall consist of clean, hard, uniform graded, crushed stone and/or stone screenings produced by the crushing process. The material shall consist of hard, durable particles sufficiently free from dirt, organic material, structurally weak pieces, and other deleterious materials and shall comply with the requirements of Subsection 704.06(a), Subsection 704.06(c), and Subsection 704.06(d).

Filler material shall meet the gradation requirements of Table 704.06B as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

TABLE 704.06B – GRADATION OF FILLER MATERIAL

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
3/4 in (37.5 mm)	100
1/2 in (12.5 mm)	70 – 100
No. 4 (4.75 mm)	50 – 90
No. 100 (0.150 mm)	0 – 12
No. 200 (0.075 mm)	0 – 6

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704.07 GRAVEL FILTER FOR SLOPE STABILIZATION. Gravel filter for slope stabilization shall be obtained from approved sources, consisting of stone and sand reasonably free from loam, silt, clay, and organic material and shall meet the requirements of Table 704.07A as determined in accordance with the requirements of *AASHTO T 27*.

TABLE 704.07A – GRADATION OF GRAVEL FILTER FOR SLOPE STABILIZATION

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1/2 inch (12.5 mm)	100
No. 4 (4.75 mm)	20 – 80
No. 200 (0.075 mm)	0 – 12

704.08 GRANULAR BACKFILL FOR STRUCTURES. Granular backfill for structures shall be obtained from approved sources. It shall consist of satisfactorily graded, free-draining granular material reasonably free from loam, silt, clay, and organic material.

Granular backfill for structures shall meet the gradation requirements of Table 704.08A as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

TABLE 704.08A – GRADATION OF GRANULAR BACKFILL FOR STRUCTURES

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
3 inch (75.0 mm)	100
No. 4 (4.75 mm)	45 – 75
No. 100 (0.150 mm)	0 – 12
No. 200 (0.075 mm)	0 – 6

704.09 BACKFILL FOR MUCK EXCAVATION. Backfill for muck excavation shall consist of granular material or blasted rock broken into various sizes that will form a compact embankment with a minimum of voids.

When granular material is used, it shall meet the requirements of Subsection 703.04.

704.10 AGGREGATE FOR BITUMINOUS CONCRETE PAVEMENT. Aggregate for bituminous concrete pavement shall meet the following requirements:

(a) Bituminous Concrete Pavement Aggregates. Coarse aggregate for bituminous concrete pavement shall consist of clean, hard, crushed stone, crushed gravel, or crushed igneous rock, and be uniformly graded. The blending of crushed stone, crushed gravel, and/or crushed igneous rock may be permitted only in the binder course if, in the opinion of the Engineer, the materials to be blended are equal in quality and are compatible. All aggregate shall be free from dirt, deleterious material, and pieces which are structurally weak. Coarse aggregate shall mean that portion of material coarser than the No. 8 (2.36 mm) sieve.

Fine aggregate for bituminous concrete pavement shall consist of stone screenings or a combination of stone screenings, screened natural sand and/or manufactured sands, and other fine aggregates, such that at least 95% of any individual stockpile of the fine aggregate shall pass a 3/8 inch (9.50 mm) sieve. "Fine aggregate" shall mean that portion of material finer than the No. 8 (2.36 mm) sieve.

Fine aggregate associated with Marshall mix shall have a minimum percentage by weight of the blended material passing the No. 8 (2.36 mm) sieve that must be stone screenings as shown in Table 406.03B, unless otherwise authorized in writing by the Engineer. Manufactured sand may be substituted for stone screenings when 100% of the material passing the No. 8 (2.36 mm) sieve has two or more fractured faces as determined in accordance with the requirements of *AASHTO T 304*.

(1) Grading.

a. Coarse Aggregate. Coarse aggregate shall be furnished in at least three nominal sizes for Mix Types I and IS and in at least two nominal sizes for Mix Types II, IIS, III and IIIS.

The gradation of the coarse aggregate shall be such that when combined with the fine aggregate, the composite gradation shall meet the gradation requirements for bituminous concrete pavement specified in Table 406.03A or Table 406.03D. The process of blending coarse and fine aggregates shall be accomplished using separate bins. Blending in the stockpile shall not be permitted.

b. Fine Aggregate. The gradation of the fine aggregate shall be such that, when combined with a coarse aggregate, the composite aggregate meets the gradation requirements for bituminous concrete pavement specified in Table 406.03A or Table 406.03D. The process of blending fine and coarse aggregates shall be accomplished using separate bins. Blending in the stockpile shall not be permitted.

The percentage of fine aggregate passing the No. 8 (2.36 mm) sieve shall remain uniform within a tolerance of ± 15% for any one mix design. Material produced that does not meet this tolerance may be stockpiled separately and used after an appropriate change is made in the mix design.

c. Recycled Asphalt Materials for Bituminous Pavement (RAM). Recycled asphalt pavement (RAP) and recycled asphalt shingle (RAS) products may be used individually or in combination in the production of bituminous concrete. The allowed RAP percentage shall be reduced proportionally, based on asphalt cement content, if RAS products are also used. Any changes in the combination of recycled materials shall require a new mix design unless otherwise approved by the Materials Engineer. The maximum allowable total reused asphalt binder in bituminous concrete mixes from RAM shall be 1.2% of the total binder replacement.

The bitumen component of recycled asphalt materials shall be asphalt cement and shall be free of significant contents of solvents, tars, and other volatile organic compounds or foreign substances that will make the recycled asphalt materials unacceptable for recycling as determined by the Materials Engineer.

The gradation of recycled asphalt materials shall be such that, when combined with a coarse and fine aggregate, the composite aggregate shall meet the specified gradation requirements for Marshall bituminous concrete in Subsection 406.03A or Superpave bituminous concrete pavement specified in Subsection 406.03B.

1. Recycled Asphalt Pavement (RAP). When RAP is used to produce bituminous concrete pavement, the resulting mixture shall meet all Specification requirements for the type(s) of mix specified. The percentage of RAP, when stated as a percentage of the total mix, shall be limited to a maximum of 50.0% for both design and production purposes.

   The bitumen component of the RAP shall be free of significant contents of solvents, tars, or other contaminating substances that will make the RAP unacceptable for recycling as determined by the Engineer.

   Should the characteristics of any proposed material for recycling be such that an acceptable mixture cannot be produced and/or maintained, the recycled mix will not be allowed for use on the Project.

   The Contractor may blend, crush, or prepare the proposed RAP into one or more homogenous stockpiles.

   When a bituminous concrete pavement is proposed using RAP, the Contractor shall submit, with the mix design information, an analysis of the RAP material. The analysis of the RAP material shall include an extracted aggregate gradation, coarse aggregate specific gravity, fine aggregate specific gravity, asphalt content, and recovered binder values. The recovered binder values will be obtained by *AASHTO M 323* testing for the designated Project PG grade.

The recovered RAP binder material shall be graded according to *AASHTO R 29* for all samples. *AASHTO M 323* testing will consist of Dynamic Shear Rheometer (DSR) values tested under Original, Rolling Thin Film Oven (RTFO) residue and Pressure Aging Vessel (PAV) residue parameters, and Bending Beam Rheometer (BBR) values. The recovered asphalt will be aged with the RTFO and the PAV for this testing. A minimum of four samples shall be analyzed (or tested) to produce design data. The analysis shall be valid for a 12 month period.

The process of blending the RAP, fine aggregate, and coarse aggregate shall be accomplished through the use of separate bins. Blending of these materials in the stockpiles shall not be permitted.

2. Recycled Asphalt Shingle (RAS) Products. RAS products shall consist of processed asphalt shingle products that comply with the provisions of *AASHTO MP 23* and as approved by the Agency. The RAS products shall be tested every 500 tons for gradation and asphalt binder content as a stockpile is being built. These test results shall remain on file by the contactor until such time as the entire RAS product stockpile has been utilized. RAS product shall be covered and kept dry.

When a bituminous concrete pavement is proposed using RAS, the Contractor shall submit, with the mix design information, an analysis of the RAS material. The analysis of the RAS material shall include an extracted aggregate gradation, specific gravity, and asphalt content. A minimum of four samples shall be analyzed (or tested) to produce design data. The analysis shall be valid for a 12-month period.

The maximum amount of RAS in any mix design will be limited to a maximum of 3% of the total weight of the aggregate in the mix design and, additionally, all provisions of *AASHTO PP 78* shall apply. RAS may be used in shim, base and intermediate courses.

(2) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35% when tested in accordance with the requirements of *AASHTO T 96*. When the coarse aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50% when tested in accordance with the requirements of *AASHTO T 96*.

(3) Fractured Faces. When crushed gravel is used as coarse aggregate in Marshall bituminous concrete pavements, at least 75% shall have at least two fractured faces in accordance with the requirements of *AASHTO T 335*.

For Superpave bituminous concrete pavements the following design criteria must be met:

a. Coarse Aggregate Angularity. The coarse aggregate angularity criterion relates to a one or two fractured face count, as a percentage by mass (weight) of material coarser than the No. 4 (4.75 mm) sieve based on traffic (ESALs). A fractured face for this purpose is defined as an angular, rough, or broken surface of an aggregate created by any means. A face is considered a "fractured face" only if it has a projected area at least as large as 25% of the maximum projected area when viewed directly on and the face has sharp and well-defined edges.

Measurement is made using test method *AASHTO T 355*. Measurement is based on the blended aggregate and is used for design and field control to monitor aggregate production.

TABLE 704.10A – MINIMUM FRACTURED FACE COUNT, COARSE AGGREGATE

Traffic (ESALs)	CA1/CA2
< 30,000,000	95/90 [1]
≥ 30,000,000	100/100

[1] 95/90 denotes that 95% of the coarse aggregate has one fractured face and 90% has two or more fractured faces.

b. Fine Aggregate. The fine aggregate angularity criterion is defined as the percent of air voids in loosely compacted aggregate that passes the No. 8 (2.36 mm) sieve based on traffic (ESALs). Measurement is made using *AASHTO T 304,* Method A, and is based on the blended aggregate. Results are used for design purposes, not as a field control tool.

TABLE 704.10B – MINIMUM UNCOMPACTED VOID CONTENT, FINE AGGREGATE

Traffic (ESALs)	Uncompacted Void Content
All	45%

(4) Thin and Elongated Pieces. Not more than 10% by mass (weight) of the blended material coarser than the No. 4 (4.75 mm) sieve shall consist of aggregates which have a ratio of maximum to minimum dimensions greater than five. Measurement is made using test method *ASTM D 4791,* Section 8.4. This criterion is used for design and field control to monitor aggregate production.

(5) Mineral Filler. Mineral filler shall consist of approved limestone dust, talc dust, or other approved materials and shall be added to the aggregate if required.

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(6) Soundness. Soundness shall meet the requirements of Subsection 704.01(d), except the percentage of loss shall not be more than 12% by mass (weight) and shall apply to wearing course aggregates only.

(7) Control of Aggregate Stockpiles. Before the start of bituminous concrete paving operations and throughout the duration of the paving operation, the cold feed aggregate stockpiles shall each contain at least 1,000 tons of accepted aggregate, or the amount required for the job when less than 1,000 tons.

The addition of unacceptable material to an accepted stockpile shall result in the rejection of the entire stockpile.

The stockpiles shall be separated by partitions or otherwise separated to the satisfaction of the Engineer to prevent intermixing.

All stockpiles shall be maintained at the mixing plant site unless otherwise approved in writing by the Engineer.

The respective sources of all aggregates to be used in the wearing course shall remain the same for the entire project unless otherwise authorized in writing by the Engineer.

(8) Clay Content for Superpave Bituminous Concrete Pavements. The clay content criterion is a measure of the amount of clay material in the portion of blended aggregate finer than the No. 4 (4.75 mm) sieve based on traffic (ESALs). Measurement is made using *AASHTO T 176* and the results are used for design purposes.

TABLE 704.10C – CLAY CONTENT CRITERIA (MINIMUM), SAND EQUIVALENT

Traffic (ESALs)	Sand Equivalent
< 30,000,000	45
≥ 30,000,000	50

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(b) Aggregate for Ultra-Thin Bonded Wearing Course. Aggregate shall meet the requirements of Subsection 704.10(a), except as modified in Table 704.10D.

TABLE 704.10D – AGGREGATE PROPERTIES

Aggregate Property	Test Method	Test Requirement
One fractured face	*AASHTO T 335*	95% min.
Two fractured faces	*AASHTO T 335*	90% min.
Flat and elongated (1:3)	*ASTM D 4791*	25% max.
Percent of wear	*AASHTO T 96*	30% max.
Sand equivalent	*AASHTO T 176*	60% min.
Clay lumps and friable particles	*AASHTO T 112*	2% max.
Methylene blue	*AASHTO T 330*	10% max.

(c) Mineral Filler. Mineral filler may be used to aid in meeting the gradation requirements. Hydrated lime and Type I Portland cement are acceptable as mineral filler. Mineral filler shall meet the requirements of Table 704.10E.

TABLE 704.10E – GRADATION OF MINERAL FILLER

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
No. 30 (0.600 mm)	100
No. 200 (0.075 mm)	75 – 100

704.11 AGGREGATE FOR BITUMINOUS SURFACE TREATMENT. The peastone and stone grits shall consist of washed crushed gravel or crushed stone and shall be reasonably free from dirt, deleterious material, and pieces that are structurally weak.

The sand shall be washed, natural sand and shall consist of clean, hard, durable grains, reasonably free from dirt and deleterious material.

(a) Grading. The peastone, stone grits, and sand shall meet the gradation requirements of Table 704.11A as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

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TABLE 704.11A – GRADATION OF AGGREGATES FOR BITUMINOUS SURFACE TREATMENT

Aggregate Type	Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
Peastone	3/4 inch (19.0 mm)	100
	5/8 inch (16.0 mm)	90 – 100
	No. 4 (4.75 mm)	0 – 5
Stone Grits	1/2 inch (12.5 mm)	100
	3/8 inch (9.50 mm)	90 – 100
	No. 8 (2.36 mm)	0 – 10
	No. 200 (0.075 mm)	0 – 3
Sand	5/8 inch (16.0 mm)	100
	No. 4 (4.75 mm)	90 – 100
	No. 100 (0.150 mm)	0 – 8

(b) Percent of Wear.

(1) Crushed Gravel. When the aggregate is composed of crushed gravel, the percent of wear shall not be more than 35% when tested in accordance with the requirements of *AASHTO T 96*. No wear requirements shall apply when grits are used as a shoulder treatment.

(2) Crushed Stone. When the aggregate is composed of crushed stone, the percent of wear of the aggregate shall not be more than 35% when tested in accordance with the requirements of *AASHTO T 96*. No wear requirements shall apply when grits are used as a shoulder treatment.

(c) Fractured Faces. When crushed gravel is used, at least 50% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve from each stockpile shall have at least one fractured face when tested in accordance with the requirements of *AASHTO T 335*.

(d) Thin and/or Elongated Pieces. Not more than 15% by mass (weight) of the material coarser than the No. 4 (4.75 mm) shall consist of aggregates that have a ratio of maximum to minimum dimensions greater than five. Measurement is made using test method *ASTM D 4791,* Section 8.4. This criterion is used for design and field control to monitor aggregate production in accordance with the requirements of *ASTM D 4791*.

704.12 AGGREGATE FOR SURFACE COURSE AND SHOULDERS. Aggregate for Aggregate Surface Course and Aggregate Shoulders shall consist solely of crushed gravel or crushed stone. It shall be reasonably free from deleterious materials. All aggregates shall meet the following requirements:

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(a) Aggregate Surface Course.

(1) Grading. The entire gradation shall be uniformly graded and shall meet the gradation requirements of Table 704.12A as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

TABLE 704.12A – GRADATION OF AGGREGATE FOR SURFACE COURSE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1-1/2 inch (37.5 mm)	100
1 inch (25 mm)	95 – 100
No. 4 (4.75 mm)	45 – 65
No. 100 (0.150 mm)	10 – 15
No. 200 (0.075 mm)	8 – 12

(2) Percent of Wear. The percent of wear shall not be more than 40% for material used as Aggregate Surface Course. Percent wear shall be in accordance with the requirements of *AASHTO T 96*.

(3) Fractured Faces. When crushed gravel is used, at least 50% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve from each stockpile shall have at least two fractured faces. Fractured faces shall be in accordance with *AASHTO T 335*.

(4) Plasticity Index. The plasticity index (PI) shall be determined in accordance with the requirements of *ASTM D 4318*. The PI shall be between 4 and 8.

(b) Aggregate for Shoulders.

(1) Grading. The entire gradation shall be uniformly graded and shall meet the gradation requirements of Table 704.12B as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

TABLE 704.12B – GRADATION OF AGGREGATE FOR SHOULDERS

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1-1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	90 – 100
No. 4 (4.75 mm)	45 – 65
No. 100 (0.150 mm)	0 – 15
No. 200 (0.075 mm)	0 – 12

(2) Percent of Wear. The percent of wear shall not be more than 50% for material used as Aggregate Shoulders. Percent wear shall be in accordance with the requirements of *AASHTO T 96*.

(3) Fractured Faces. When crushed gravel is used, at least 50% by mass (weight) of the material coarser than the No. 4 (4.75 mm) sieve from each stockpile shall have at least two fractured faces. Fractured faces shall be in accordance with the requirements of *AASHTO T 335*.

(4) Aggregate Shoulders, RAP. RAP shall consist solely of Bituminous Concrete Pavement. RAP shall be such that 100% of the material passes the 1-1/2 inch (37.5 mm) sieve prior to placement.

(5) Aggregate Shoulders, RAS. RAS shall be produced at a properly permitted facility and meet the requirements of *AASHTO MP 23*.

704.13 SAND FOR CEMENT MORTAR. Sand for cement mortar shall consist of clean, hard, durable grains. It shall be uniformly graded from coarse to fine, and shall be free from detrimental amounts of organic matter or other harmful substances.

(a) Grading. Sand for cement mortar shall meet the gradation requirements of *AASHTO M 45* as determined in accordance with the requirements of *AASHTO T 27* and *AASHTO T 11*.

(b) Organic Impurities. The sand shall show a color of not greater than two when determined in accordance with the requirements of *AASHTO T 21 M/T 21*.

(c) Soundness. When there is any question of either soft or laminated pieces being detrimental to any aggregate, a soundness test shall be performed on the aggregate in accordance with the requirements of *AASHTO T 104*. The weighted average percentage of loss shall be not more than 8% by mass (weight) when subjected to five cycles of the sodium sulfate soundness test.

704.14 LIGHTWEIGHT COARSE AGGREGATE FOR STRUCTURAL CONCRETE. Lightweight coarse aggregate for structural concrete shall be clean, hard, and uniformly graded. It shall be reasonably free from dirt, deleterious material, and pieces that are structurally weak. It shall meet the requirements of *AASHTO M 195* and *ASTM C 330/C 330 M* in addition to the following requirements.

(a) General Characteristics. Two general types of lightweight aggregates may be used.

(1) Aggregates prepared by expanding, calcining, or sintering products such as blast furnace slag, clay, shale, or slate. Other raw materials may be used if the resulting prepared aggregates meet the requirements of these specifications.

(2) Aggregates prepared by crushing, screening, and cleaning natural lightweight materials such as pumice, scoria, or tuff.

(b) Grading. Grading shall meet the requirements specified in *AASHTO M 195*.

(c) Percent of Wear. Percent of wear shall not be more than 50% when tested in accordance with the requirements of *AASHTO T 96*.

(d) Thin and/or Elongated Pieces. The thin and/or elongated pieces shall conform to the requirements specified in Subsection 704.02(d).

(e) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

(f) Density. The maximum dry loose density of the lightweight coarse aggregate shall not exceed 55 pounds per cubic foot when tested in accordance with the requirements of *AASHTO T 19 M/T 19*. The density of lightweight aggregate shall not differ by more than 10% from the density submitted on the approved mix design.

704.15 QUARTZITE OR GRANITE AGGREGATE USED IN PAVEMENTS. The Agency has identified a potential stripping problem with some granite and quartzite aggregates used in the production of bituminous concrete pavement. Until additional research can determine a more finite evaluation of the problem or identify optional corrective alternatives, any material supplied under Section 406 that contains aggregates from monomineralic (a rock consisting essentially of one mineral) quartzite sources or granite sources will require the addition of a minimum of 0.5% (by percentage of asphalt weight) of an anti-strip additive.

Anti-strip additives shall comply with the requirements of Subsection 702.07. The Agency reserves the option to require the use of an anti-strip additive at any time that a potential stripping problem is observed.

704.16 DRAINAGE AGGREGATE. Rock for drainage applications shall be produced from natural gravels or crushed quarried rock and shall consist of clean, hard, sound, and durable material.

(a) Grading. Drainage aggregate shall be uniformly graded from coarse to fine and shall meet the gradation requirements of Table 704.16A as determined in accordance with the requirements of *AASHTO T 27*.

TABLE 704.16A – GRADATION OF DRAINAGE AGGREGATE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
1 inch (25 mm)	100
3/4 inch (19.0)	90 – 100
3/8 inch (9.5 mm)	20 – 55
No. 4 (4.75 mm)	0 – 10
No. 8 (2.36 mm)	0 – 5

(b) Percent of Wear. Percent of wear shall not be more than 40% when tested in accordance with the requirements of *AASHTO T 96*.

(c) Soundness. Soundness shall conform to the requirements of Subsection 704.01(d).

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704.17 AGGREGATE FOR EROSION PREVENTION AND SEDIMENT CONTROL. Aggregate for erosion prevention and sediment control (EPSC) shall consist of clean, hard, crushed stone or crushed gravel. It shall be reasonably free from dirt and deleterious material. It shall be uniformly graded and meet the gradation requirements of Table 704.17A as determined in accordance with *AASHTO T 27*.

TABLE 704.17A – GRADATION OF AGGREGATE FOR EPSC

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
6 inch (150 mm)	100
4 inch (100 mm)	80 – 100
3 inch (75.0 mm)	40 – 60
2 inch (50.0 mm)	0 – 20

704.18 SELECT BACKFILL FOR MECHANICALLY STABILIZED EARTH (MSE) STRUCTURES. Select backfill material used in mechanically stabilized Earth structures shall be substantially free from organic matter and otherwise deleterious materials. It shall be obtained from approved sources and meet the following requirements.

(a) Grading. Select backfill material used in MSE structures shall conform to the gradation limits in Table 704.18A as determined by *AASHTO T 27*.

TABLE 704.18A – GRADATION OF SELECT BACKFILL FOR MSE STRUCTURES

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
4 inch (100 mm)	100
3 inch (75.0 mm)	75 – 100
No. 40 (0.425 mm)	0 – 60
No. 200 (0.075 mm)	0 – 12

(b) Soundness. Select backfill material shall be substantially free of shale or other soft particles with poor durability characteristics. The material shall have a sodium sulfate soundness loss of less than 8% after five cycles, as determined by the requirements of *AASHTO T 104*.

(c) Plasticity Index. The plasticity index (PI), as determined by the requirements of *AASHTO T 90*, shall not exceed 6.

(d) Electrochemical Requirements.

(1) Select backfill material for metallically reinforced systems shall conform to the requirements in Table 704.18B.

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TABLE 704.18B – BACKFILL FOR METALLICALLY REINFORCED SYSTEMS

Backfill Property	Requirement	Test Method
Resistivity at 100% saturation	Minimum 3,000 ohm-cm	*AASHTO T 288*
pH	Acceptable Range: 5 - 10	*AASHTO T 289*
Sulfates	Maximum 200 ppm	*AASHTO T 290*
Chlorides	Maximum 100 ppm	*AASHTO T 291*
Organic content	< 1%	*AASHTO T 267*

(2) Select backfill material for geosynthetically reinforced systems shall conform to the requirements in Table 704.18C.

TABLE 704.18C – BACKFILL FOR GEOSYNTHETICALLY REINFORCED SYSTEMS

Base Polymer Type	Property	Requirement	Test Method
Polyester (PET)	pH	3 – 9	*AASHTO T 289*
Polyolefin (PP & HDPE)	pH	> 3	*AASHTO T 289*

(e) Uniformity Coefficient. Select backfill material shall have a minimum uniformity, C_U, of 4.

704.19 LIGHTWEIGHT FINE AGGREGATE FOR STRUCTURAL CONCRETE. Lightweight fine aggregate for structural concrete shall be clean, hard, and uniformly graded. It shall be reasonably free from dirt and deleterious material. It shall meet the requirements *AASHTO M 195* and *ASTM C 330/ C 330 M*.

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SECTION 705 – MASONRY UNITS

705.01 BRICK. Brick masonry units shall meet the following requirements:

(a) Clay or Shale Manhole Brick. Brick used for sewer manhole inverts shall conform to the requirements of *ASTM C 32,* Grade MS.

(b) Clay or Shale Building Brick. Building brick shall be used in masonry construction where a high degree of resistance to frost action is desired and the exposure is such that water permeating the brick may be frozen. It shall conform to the requirements of *ASTM C 62,* Grade SW.

(c) Clay or Shale Sewer Brick. Brick used for construction where resistance to the action of sewage is needed shall conform to the requirements of *ASTM C 32,* Grade SM.

705.02 CONCRETE MASONRY BLOCKS. Concrete masonry blocks intended for use in the construction of catch basins or manholes shall conform to the requirements of *ASTM C 139* for solid precast units, or *ASTM C 90* for hollow precast units.

705.03 THIS SUBSECTION RESERVED.

705.04 PRECAST DROP INLETS, CATCH BASINS, AND MANHOLES. Precast drop inlets, catch basins, and manholes shall conform to the requirements of *AASHTO M 199 M/M 199* except for Reinforced Concrete Pipe for drop inlets, which shall conform to the requirements of Subsection 710.01. Reinforced Concrete Pipe shall be of the tongue-and-groove type with positive connection between sections.

SECTION 706 – STONE FOR MASONRY, RIPRAP, AND OTHER PURPOSES

706.01 STONE FOR MASONRY. Stone for masonry shall be quarry stone, field stone, or rock fragments approximately rectangular in shape and of a hard, sound, and durable quality acceptable to the Engineer. The stone shall be free from structural defects or imperfections that would tend to compromise its resistance to the weather.

At least 80% of the individual stones in a unit shall have a thickness of not less than 8 inches and a width of not less than 150% of the thickness. The minimum size of the other stones in the unit shall have a thickness of not less than 4 inches and a width of not less than 150% of the thickness.

706.02 STONE FOR MASONRY FACING. Stone for masonry facing shall be irregularly shaped or roughly rectangular quarried granite, marble, or another approved quarried stone.

Stone for capping shall conform to the dimensions shown on the Plans unless changes are ordered in writing by the Engineer.

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The stone shall be of approved quality, tough, sound, and durable, resistant to weathering action, uniform in color, free from seams, cracks, laminations, pyrite inclusions, and minerals or other structural defects which, by weathering, would cause discoloration or deterioration and shall be thoroughly cleaned of any iron or rust particles. Stone shall be of such character that it can be wrought to such lines and surfaces, whether curved or plane, as required. Any stone having defects that have been repaired with cement or other materials shall be rejected.

The stone shall be kept free from dirt, oil, and any other detrimental material that may prevent the proper adhesion of the mortar or detract from the appearance of the exposed surfaces.

The front face of the facial stone, including capstones when required, shall be smooth, quarry-split, free from drill holes in the exposed face, with no projections or depressions greater than 1 inch measured from the vertical plane of the face of the stone.

The capstone shall have a top surface sawed to an approximately true plane. The front and back arris lines of the capstones shall be pitched straight and true.

706.03 STONE FOR RIPRAP. Stone for riprap shall be approved, rough, unhewn quarry stone, as nearly rectangular in section as practical. The stones shall be hard, sound, and resistant to the action of water and weathering. They shall be of a rock type other than serpentine rock containing the fibrous variety chrysotile (asbestos) and suitable in every respect for the purpose intended.

(a) Heavy Type. The individual stones shall have a depth equal to the thickness of the course of riprap. At least 75% of the volume of the riprap, complete in-place, shall consist of stones that have a minimum volume of 16 cubic feet.

(b) Light Type. The individual stones shall have a depth equal to the thickness of the course of riprap. The riprap, complete in-place, shall consist of stones that have a minimum volume of 1/2 cubic foot.

706.04 STONE FOR STONE FILL. Stone for stone fill shall be approved, hard, blasted, angular rock other than serpentine rock containing the fibrous variety chrysotile (asbestos). The least dimension of the stone shall be greater than 33% of the longest dimension. The stone fill shall be reasonably well graded from the smallest to the maximum size stone specified to form a compact mass when in-place.

(a) Type I. The longest dimension of the stone shall vary from 1 to 12 inches, and at least 50% of the volume of the stone in-place shall have a minimum dimension of 4 inches.

(b) Type II. The longest dimension of the stone shall vary from 2 to 36 inches, and at least 50% of the volume of the stone in-place shall have a minimum dimension of 12 inches.

(c) Type III. The longest dimension of the stone shall vary from 3 to 48 inches, and at least 50% of the volume of the stone in-place shall have a minimum dimension of 16 inches.

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(d) Type IV. The longest dimension of the stone shall vary from 3 to 60 inches, and at least 50% of the volume of the stone in-place shall have a minimum dimension of 20 inches.

706.05 THIS SUBSECTION RESERVED.

706.06 ROCK FILL FOR GABIONS. Rock fill for gabions shall be well-graded, hard, sound, durable, and free from cracks and other structural defects that may cause it to deteriorate. It shall not contain any material that easily disintegrates or can be easily cleaved into Thin, elongated pieces (such as phyllite, shale, or slate). In addition to the following requirements, the size shall be such that a minimum of two layers of rock can be achieved when filling any gabion.

(a) Grading. The rock size shall measure from a 4 inch minimum to an 8 inch maximum when measured in accordance with the requirements of *ASTM D 5519*. A tolerance of 5% undersize and 5% oversize rock by number of particles shall be allowed. In addition, the rock shall be large enough to prevent individual pieces from passing through the gabion mesh openings.

(b) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

706.07 ENVIRONMENTAL STONE (E-STONE). E-stone fill shall be hard, blasted, angular rock other than serpentine rock containing the fibrous variety chrysotile (asbestos). E-stone fill material of the type specified shall be defined as follows:

(a) E-Stone, Type I. The longest dimension of the stone shall be at least 18 inches, and at least 50% of the volume of the stone in place shall have a least dimension of 12 inches, and at least 25% of the particles shall have a maximum dimension of 2 inches and be well graded material.

(b) E-Stone, Type II. The longest dimension of the stone shall be at least 24 inches, and at least 50% of the volume of the stone in place shall have a least dimension of 18 inches, and at least 25% of the particles shall have a maximum dimension of 2 inches and be well graded material.

(c) E-Stone, Type III. The longest dimension of the stone shall be at least 36 inches, and at least 50% of the volume of the stone in place shall have a least dimension of 24 inches, and at least 25% of the particles shall have a maximum dimension of 2 inches and be well graded material.

(d) E-Stone, Type IV. The longest dimension of the stone shall be at least 48 inches, and at least 50% of the volume of the stone in place shall have a least dimension of 36 inches, and at least 25% of the particles shall have a maximum dimension of 2 inches and be well graded material.

706.08 THIS SUBSECTION RESERVED.

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SECTION 707 – JOINT MATERIALS

707.01 MORTAR, TYPE I. Type I mortar is generally used as a joint filler between curb stones, for stone slope edging. It shall be used in small quantities as needed and shall not be re-tempered or used after it has begun to set.

The mortar shall be composed of one part cement and one part sand, and shall be mixed with sufficient water to form a plastic composition. For grouting, sufficient water shall be added to provide the required consistency.

The cement, sand, and water shall meet the following requirements:

(a) Cement. Cement shall conform to the requirements of Subsection 701.02.

(b) Sand. Sand shall conform to the requirements of Subsection 704.13 or Subsection 704.01, as appropriate.

(c) Water. Water shall conform to the requirements of Subsection 745.01.

707.02 MORTAR, TYPE II. Type II mortar is generally used as a joint filler for concrete and clay pipes, stone and brick masonry, and for repointing. It shall be used in small quantities as needed and shall not be re-tempered or used after it has begun to set.

The mortar shall be composed of one part cement and two parts sand, and shall be mixed with sufficient water to form a plastic composition.

The cement, sand, and water shall meet the requirements of Subsection 707.01.

707.03 MORTAR, TYPE IV. Type IV mortar is used when a non-shrinking cement mortar is required. It shall not be re-tempered or used after it has begun to set.

(a) Performance Requirements.

(1) Compressive Strength. The neat material shall exhibit a minimum compressive strength at 3 days, 7 days, and 28 days that satisfy the requirements of *ASTM C 1107/C 1107 M*.

(2) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with the requirements of *AASHTO T 161,* Procedure A. The material shall exhibit no more than an 8% loss in mass (weight) after 300 cycles.

(3) Volume Stability. The material shall exhibit a maximum and minimum height change as specified in *ASTM C 1107/C 1107 M*.

(b) Other Types of Type IV Mortar. Instead of a commercially prepared product, the Contractor may produce a non-shrinking cement mortar that satisfies all the requirements of Subsection 707.03(a).

The cement, sand, and water shall meet the requirements of Subsection 707.01.

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707.04 JOINT SEALER, POURABLE. Pourable joint sealer shall meet the following requirements:

(a) Joint Sealer, Hot Poured. This material shall consist of a hot applied, single-component, low-modulus, elastic sealant meeting the requirements of *ASTM D 6690,* Type II or Type IV as specified in the Contract.

(b) Joint Sealer, Cold Poured. This material shall consist of a cold applied, two-component, low-modulus, elastic sealant capable of 200% elongation at -20°F when placed in a typical joint configuration.

(c) Backer Rod. Backer rod shall be 100% watertight, closed-cell, non-gassing, polyethylene, polyolefin, or other suitable material that does not react chemically with the sealant. It shall be compatible with the sealant applied at temperatures up to 410°F, shall remain stable down to a temperature of -20°F, and shall not cause bubbling of the sealant bead. The backer rod shall be approximately 1/8 inch larger in diameter than the width of the joint in which it is used.

707.05 JOINT SEALER, POLYURETHANE. Polyurethane joint sealer shall consist of a single or a two-component, cold-applied, polyurethane, elastomeric compound for use in expansion joints in widths up to 6 inches. The sealer shall be suitable for installation at temperatures above 45°F and below 80°F, self-leveling where used in horizontal joints, capable of filling the joint completely without the formation of air holes or other discontinuities, and non-sagging or not subject to flow when placed in vertical or inclined joints.

The sealer shall cure by chemical reaction between the two components or by reaction with moisture from the atmosphere.

(a) Primer. When recommended by the manufacturer, a primer system shall be used to ensure adhesion to steel, concrete, epoxy, epoxy mortar, or granite under all conditions. The primer system shall be furnished by the sealer manufacturer.

(b) Filler Material. A foam spacer (backing) or filler material shall be used where shown on the Plans. The foam spacer shall be a closed-cell polyethylene or PVC foam, recommended by the manufacturer of the joint sealer and acceptable to the Engineer.

(c) Bond Breaker. A suitable bond breaker shall be applied to those surfaces shown on the Plans. The bond breaker shall be polyethylene-coated tape or other substitute acceptable to the Engineer.

(d) Proportioning and Mixing. When required, proportioning and mixing shall be accomplished strictly according to the manufacturer's instructions.

(e) Packaging. The joint sealer materials shall be delivered to the project in suitable containers for handling and shall be sealed or otherwise protected from contamination.

The containers shall be clearly labeled with the following information:

(1) Name and address of the manufacturer

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(2) Name of the product or component identification

(3) Batch number

(4) Date of manufacture

The manufacturer shall furnish to the Engineer complete instructions for the storage, proportioning, mixing, handling, joint preparation, joint installation procedures, and complete SDS information for each shipment.

(f) Performance Requirements for Two-Component Materials. The joint sealer system, consisting of sealer and primer, shall meet the requirements of *ASTM C 920*.

(g) Performance Requirements for Single-Component Materials. The joint sealer system shall meet the requirements of *ASTM C 920*.

707.06 JOINT SEALER, PREFORMED NEOPRENE. Preformed neoprene joint sealer shall have the following properties:

Preformed neoprene joint sealer shall conform to the requirements of *ASTM D 2628*. The lubricant-adhesive shall be of the formulation recommended by the manufacturer for the kind of material adjacent to the joint sealer. The Contractor shall furnish representative samples of joint sealer, lubricant-adhesive, or other components at no additional cost to the Agency for laboratory testing, when requested by the Engineer.

Any material not conforming to this subsection at the time of application or which has been improperly stored or which has exceeded the stated shelf life will be rejected. Lubricant-adhesive shall not be used beyond one year following its date of manufacture or if the container has been previously opened.

707.07 PREFORMED FABRIC MATERIAL. Preformed fabric material shall be a multi-layered sheet composed of multiple plies of 15 ounces per square yard, ± 5%, polyester fabric laminated with butadiene acrylonitrile, and vulcanized to form an integral laminate.

Physical properties of the laminate shall meet the material requirements in Table 707.07A.

TABLE 707.07A – PREFORMED FABRIC PROPERTIES

Preformed Fabric Property	Number of Plies		
	2	3	5 – 8
Minimum mass (weight) per unit area of laminate (lbs/ft^2)	0.75	0.85	4.00
Minimum thickness (inches)	1/8	5/32	3/4
Minimum ultimate tensile strength of laminate (lbs/in. of width)	800	1,200	2,000
Maximum elongation at ultimate tensile	30%	30%	30%
Maximum elongation at 10% of ultimate tensile	3%	3%	3%

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707.08 PREFORMED JOINT FILLER, CORK, AND ASPHALT-TREATED FELT. Preformed joint filler, cork, and asphalt-treated felt shall have the following properties.

Preformed cork joint filler shall conform to the requirements of *AASHTO M 153,* Type II unless otherwise specified. Asphalt-treated felt shall conform to *AASHTO M 213* unless otherwise specified.

707.09 PREFORMED JOINT FILLER, CLOSED-CELL FOAM. Preformed joint filler shall be a closed-cell polyethylene, polypropylene, or PVC foam, pre-molded to a semi-rigid consistency and meeting the performance requirements of *ASTM D 7174,* Type I when tested in accordance with the requirements of *ASTM D 545*.

707.10 POLYVINYL CHLORIDE (PVC) WATERSTOP. PVC waterstop shall be manufactured from virgin PVC resin with the addition of only those plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, it will meet the requirements of this subsection. No reclaimed, scrap, or reprocessed PVC shall be used.

The finished waterstop shall conform to the requirements of Table 707.10A.

TABLE 707.10A – PVC WATERSTOP PROPERTIES

Waterstop Property	Test Method	Min.	Max.
Tensile strength (psi)	*ASTM D 638* (Type IV)	1,400	--
Ultimate elongation (%)	*ASTM D 638* (Type IV)	250	--
Low temperature brittleness	*ASTM D 746*	[Note 1]	--
Durometer hardness – Shore Type A	*ASTM D 2240*	60	80
Stiffness in flexure (psi)	*ASTM D 747*	400	--
Alkali resistance (10% NaOH) Mass (Weight) Change (%)	*ASTM D 543*	-0.10	+0.25
Durometer hardness change	--	-5	+5

[1] No cracking or chipping shall be permitted on three specimens at -20°F

707.11 RUBBER GASKETS. Rubber gaskets for culvert pipe joints shall conform to *ASTM C 990*.

707.12 JOINT SEALER, BUTYL RUBBER TAPE. Butyl rubber tape joint sealer shall be a flexible plastic gasket conforming to the requirements of *ASTM C 990*. The sealant shall be in roll form with release paper backing dimensioned to the width and thickness specified.

707.13 ALUMINUM-IMPREGNATED CAULKING COMPOUND. Aluminum-impregnated caulking compound is generally used to protect the surfaces of aluminum alloy in contact with other metals, wood, or Portland cement concrete. The compound shall be impregnated with aluminum flake or powder and shall be of such consistency and properties that it can be readily applied with a trowel, putty knife, or caulking gun without pulling or drawing. Aluminum-impregnated caulking compound shall meet the approval of the Engineer.

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707.14 PREFORMED JOINT FILLER. Preformed joint filler shall have the following properties:

(a) Bituminous Type. Bituminous type preformed joint filler shall conform to the requirements of *AASHTO M 33* or *AASHTO M 213*.

(b) Closed-Cell Polypropylene Type. Closed-cell polypropylene type preformed joint filler shall conform to the requirements of Table 707.14A.

TABLE 707.14A – CLOSED-CELL POLYPROPYLENE PREFORMED JOINT FILLER PROPERTIES

Preformed Joint Filler Property	Requirement	Test Method
Water absorption (volume)	< 1.0%	**This test method deleted.** *ASTM D 545*
Compression strength (to 50%)	35 – 50 psi	
Compression recovery (from 50%)	> 80%	
Extrusion (at 50%)	< 0.1 in.	
Density	> 3.5 lbs/ft^3	
Heat resistance at 392°F ± 5°F (shrinkage)	< 1%	*ASTM D 5249*
UV weathering (1,000 hrs, Cycle A - 340 nm)	No observable change or cracking	*ASTM D 4329*
Freeze-thaw resistance (300 cycles)	No visual change, < 10% tensile strength change	*ASTM C 666/ C 666 M*

707.15 ASPHALTIC PLUG JOINTS FOR BRIDGES. Asphaltic Plug Joints for Bridges shall be single and/or multiple layer systems consisting of asphaltic binder, aggregate, closed cell foam expansion joint filler, and steel bridging plate, as applicable. Asphaltic Plug Joints shall be in accordance with *ASTM D 6297* and shall be one of the products listed on the Agency's *Approved Products List*.

707.16 CONCRETE BONDING SYSTEMS. Concrete bonding systems shall conform to the requirements of *ASTM C 881/C 881 M*.

707.17 ASPHALTIC PLUG JOINT BINDER. Asphaltic Plug Joint Binder shall be a thermoplastic polymeric-modified asphalt in accordance with *ASTM D 6297* and shall be one of the products listed on the Agency's *Approved Products List*.

SECTION 708 – PAINTS, STAINS, AND TRAFFIC MARKING MATERIALS

708.01 GENERAL REQUIREMENTS.

(a) General. All paints shall be ready-mixed in accordance with the specific formulas from ingredients that meet the requirements described below. The paints shall be free of coarse particles, skins, and water, and other foreign and objectionable matter except where tolerances have been allowed. The paints shall not skin over, thicken, liver, settle out excessively, or cake in the container in storage and shall be readily broken up with a paddle into a smooth, uniform consistency.

No rosin or rosin derivatives shall be added to the paints, but beneficial agents such as antioxidants or wetting aids may be added.

Ready-mixed paints that have hardened on standing or otherwise deteriorated to any extent will not be acceptable.

All paints shall be suitable for use in airless spray equipment.

(b) Packaging. Ready-mixed paints shall be shipped in strong, new, airtight containers. All containers of paint shall be clearly labeled with the following information:

(1) Name and address of the manufacturer

(2) Manufacturer's batch number

(3) Date of manufacture

(4) Vermont Paint Number, name, and color

(5) Volume of contents

Containers shall be clearly marked to indicate any hazards connected with the use of the paint and the protective measures that should be provided to prevent injury to the health of workers.

(c) Sampling, Testing, and Certification. No paint or stain shall be used until it has been approved by the Agency's Materials Section.

(d) Identification. To provide a means of identification for paints, the applicable identification number and name taken from the following list shall be printed on all Test Reports and container labels:

(1) Coatings for Structural Steel and Other Metals. For structural steel coatings, the identification number and the name for the coating used shall be the manufacturer's name, the manufacturer's name for the coating, and the manufacturer's lot number.

VT 1.01 – Structural Steel Primer Coat
VT 2.01 – Structural Steel Intermediate Coat
VT 3.01 – Structural Steel Finish Coat

(2) Wood Coatings.

VT 4.01 – Dark Brown Oil Base Stain

(3) Traffic Sign Paint.

VT 5.01 – Black Enamel
VT 5.02 – Blue Enamel
VT 5.03 – Green Enamel

VT 5.04 – Red Enamel
VT 5.05 – White Enamel
VT 5.06 – Yellow Enamel
VT 5.07 – Brown Enamel
VT 5.08 – Orange Enamel

(4) Traffic Control Signal Paint.

VT 6.01 – Flat Black Enamel
VT 6.02 – Yellow Enamel

(5) Pavement Marking Paint.

VT 7.01 – White Traffic Paint
VT 7.02 – Yellow Traffic Paint
VT 7.05 – White Traffic Paint, Fast Dry
VT 7.06 – Yellow Traffic Paint, Fast Dry

708.03 STRUCTURAL STEEL COATING SYSTEMS. Acceptable structural steel coating systems shall be one of the systems listed on both the Agency's *Approved Products List* and on the *NEPCOAT Qualified Products List B*, and shall meet the following requirements:

(a) System. The structural steel coating system shall be a three-coat system with a prime, intermediate, and top coat. Components of different systems shall not be intermixed.

(b) Color. Individual coats shall have contrasting colors. The finish color of the top coat shall be green, black, or brown as specified in the Contract, and shall conform to *SAE AMS-STD 595* for the respective chip number as specified in Table 708.03A.

TABLE 708.03A – COLORS FOR STRUCTURAL COATING SYSTEMS

Color	Chip Number
Green	14062
Black	27038
Brown	20059

Damage to structural steel coating systems shall be repaired with a compatible structural steel coating system as specified herein.

708.04 GREASE RUSTPROOFING COMPOUND. Grease rustproofing compound shall be a soft film type material made from petroleum combined with special additives to enhance its moisture displacing capabilities.

Grease rustproofing compound shall contain effective rust inhibitors and have properties that conform to the requirements of Table 708.04A.

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TABLE 708.04A – GREASE RUSTPROOFING COMPOUND PROPERTIES

Grease Rustproofing Property	Requirement
Appearance (color)	Brown-green
Flash, COC, min.	150°F
Melting point, min., *ASTM D 127*	145°F
Thinner, max.	20% by mass (weight)
Density, min.	7.00 lbs/gal at 60°F
Approximate NLGI grease grade	No. 2 before solvent evaporation, No. 5 after solvent evaporation

708.05 COATINGS FOR WOOD.

(a) VT 4.01 Dark Brown Oil Base Stain. Dark Brown Oil Base Stain is used as a protective coating for wood surfaces. The stain shall conform to the requirements of Table 708.05A and the pigment shall consist of pure mineral pigments combined in proportions necessary to match the specified color.

TABLE 708.05A – DARK BROWN OIL BASE STAIN PROPERTIES

Stain Component	Component Property	Min.	Max.
Vehicle	Heavy bodied linseed oil (%)	15	--
	Mineral spirits (%)	--	85
Stain	Pigment (%)	15	--
	Vehicle (%)	--	85
	Density (lbs/gal)	7.5	--
	Drying time, dry to recoat (hrs)	--	24
	Fineness of grind (Hegman Scale)	4	--

(b) Insecticide/Fungicide. Insecticide/fungicide coatings for interior applications shall be water/ glycol-based solutions per the manufacturer's specifications. Acceptable coatings shall be those on the Agency's *Approved Products List*.

(c) Fire Retardant. Fire retardant coatings for interior and exterior applications shall be non-toxic, non-hazardous, and water-based solutions meeting the requirements of *ASTM E 84/NFPA 255/UL 723*. Acceptable coatings shall be those on the Agency's *Approved Products List*.

708.06 THIS SUBSECTION RESERVED.

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708.07 PAINT FOR TRAFFIC CONTROL SIGNALS. Paint for traffic control signals shall consist of ready-mixed enamels suitable for exterior use on primed metal surfaces. Paint colors used for traffic control signals shall conform to the requirements of *MPI #8, MPI #9,* or *MPI #94*. The *SAE AMS-STD-595* standard shall be used to determine the acceptable color match for black and yellow traffic control signal paints.

(a) VT 6.01 Flat Black Enamel. The color shall conform to the requirements of *MPI #8, MPI #9,* or *MPI #94*. The color shall be an acceptable match to Chip No. 37038 in *SAE AMS-STD-595*.

(b) VT 6.02 Yellow Enamel. The color shall conform to the requirements of *MPI #8, MPI #9,* or *MPI #94*. The color shall be an acceptable match to Chip No. 13538 in *SAE AMS-STD-595*.

708.08 PAINT FOR PAVEMENT MARKINGS. Ready-mixed traffic paint suitable for marking on either bituminous or Portland cement concrete pavements shall conform to the following requirements:

(a) Polyurea Pavement Markings. Approved polyurea marking materials shall be one of the markings listed on the Agency's *Approved Products List*.

(b) Epoxy Paint. Epoxy Paint shall be one of the Epoxy Paints on the *Approved Products List*.

(c) Waterborne Traffic Paint. Waterborne Traffic Paint shall consist of properly formulated pigment and vehicle to give the desired results. The paint shall show the proper capillary action at the bead surface to provide anchorage, refraction, and reflection when beads are applied at the standard rate of 8 pounds per gallon of paint

(1) Materials.

a. Pigments. The pigments used shall be those designated which shall conform to the stated requirements.

b. Titanium Dioxide. Titanium dioxide shall be of the rutile type and shall meet the requirements specified in *ASTM D 476,* Type II.

c. Vehicle. The vehicle will be water.

(2) Composition. The waterborne paint binder shall be a 100% acrylic binder, as determined by infrared analysis according to the requirements of *ASTM D 2621* or other standard ASTM methods designated herein. The composition of the paint shall comply with Table 708.08C.

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TABLE 708.08C – WATERBORNE TRAFFIC PAINT COMPOSITION

Performance Characteristic	Test Method	White	Yellow/Blue/Green
Pigment content (% by mass)	*ASTM D 3723*	58% min. / 62% max.	58% min. / 62% max.
Vehicle content (% by mass)	--	38% min. / 42% max.	38% min. / 42% max.
VOC content (lbs/gal)	*ASTM D 3960*	1.25 lbs/gal (150 g/L) max.	1.25 lbs/gal (150 g/L) max.
Lead content (%)	--	0.005% max.	0.005% max.
Yellow pigment	--	N/A	Yellow #65 or #75
Titanium dioxide, rutile Type II	*ASTM D 1394*	1.00 lbs/gal (120 g/L) max.	0.21 lbs/gal (25 g/L) max.
Total non-volatile content (% by mass)	*ASTM D 2369*	76.0% min.	76.0% min.
Total volatile content (% by mass)	*ASTM D 2369*	25% max.	25% max.
Total non-volatile content, by volume	*ASTM D 2697*	62.0% min.	62.0% min.
Density	*ASTM D 1475*	14.0 ± 0.33 lbs/gal (1.68 ± 0.04 kg/L)	13.6 ± 0.33 (1.63 ± 0.04 kg/L)
Paint pH	--	9.6 min.	9.6 min.
Close cup flash point	*ASTM D 3278*	140°F (60°C) min.	140°F (60°C) min.
Viscosity	*ASTM D 562*	78 Krebs min./ 95 Krebs max.	78 Krebs min./ 95 Krebs max.
Dry Time	*ASTM D 711*	10 minutes max	10 minutes max.

708.09 OPTICS.

(a) Glass Beads. Glass beads for pavement markings shall conform to the requirements of *AASHTO M 247,* Type 1, unless otherwise specified.

(b) Premium Optics. Approved premium optics shall be one of the premium optics listed on the Agency's *Approved Products List*.

(c) Wet Recoverable and Wet Reflective Optics. Approved wet recoverable and wet reflective optics shall be one of the wet recoverable and wet reflective optics listed on the Agency's *Approved Products List*.

708.10 THERMOPLASTIC PAVEMENT MARKINGS.

(a) Thermoplastic Pavement Markings, Type A. Type A Thermoplastic Pavement Markings shall be one of the Thermoplastic Pavement Markings on the Agency's *Approved Products List*. These markings shall be used in long line applications or as specified in the Contract. Thermoplastic pavement markings shall comply with the requirements of *AASHTO M 249*.

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Thermoplastic Pavement Markings shall have a lead content less than 0.005% by weight.

(b) Thermoplastic Pavement Markings, Type B. Type B Thermoplastic Pavement Markings shall be one of the Preformed Thermoplastic Pavement Markings on the Agency's *Approved Products List*. These markings shall be used in intersection applications for legends, stop bars, or symbols or as specified in the Contract.

708.11 THIS SUBSECTION RESERVED.

708.12 TEMPORARY DELINEATION SYSTEMS.

(a) Line Striping Targets. Acceptable Line Striping Targets shall be one of the Line Striping Targets on the Agency's *Approved Products List*.

(b) Pavement Marking Mask. Acceptable Pavement Marking Mask shall be one of the Masking Marking Tapes on the Agency's *Approved Products List*.

708.13 THIS SUBSECTION RESERVED.

708.14 THIS SUBSECTION RESERVED.

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SECTION 709 – LUMBER AND TIMBER

709.01 STRUCTURAL LUMBER AND TIMBER. Structural lumber and timber shall conform to the species and stress-grades specified in the Contract and shall be acceptable to the Engineer.

(a) Grading. Structural lumber and timber shall be graded in accordance with the requirements of *AASHTO M 168*. Lumber ordered in multiple lengths shall be graded after having been cut to length.

(b) Moisture Content.

(1) Untreated Lumber and Timber. The maximum moisture content of untreated lumber and timber material being incorporated into the work shall be 19%.

(2) Treated Lumber and Timber. The maximum moisture content of treated lumber and timber material prior to treatment shall be 19%. Material treated with water-borne preservatives in accordance with AWPA standards shall be dried after treatment to a moisture content not exceeding 19% and shall be maintained at a moisture content of 19% or less until it is incorporated into the work.

(c) Minimum Stress Requirements. Unless otherwise specified in the Contract, lumber and timber shall meet the allowable unit stress requirements for No. 1 Grade or better material as specified in the *AASHTO LRFD Bridge Design Specifications*.

(d) Lumber Dimensions.

(1) Full-Sawn Lumber. Minimum full-sawn lumber sizes are nominal dimension sawn sizes after seasoning. Pieces shall be sawn to obtain the full nominal dimensions specified with only occasional slight variation permitted. Thickness and width dimensions are somewhat variable depending upon the sawmill equipment used.

(2) Rough-Sawn Lumber. Rough dry-sized lumber is minimally 1/8 inch larger in each dimension than standard (seasoned) dressed-sized lumber. Thickness and width dimensions are somewhat variable depending upon the sawmill equipment used.

(3) Dressed Lumber. Dressed lumber sizes are the finished planed dimensions of material after seasoning. Minimum net finished dimensions for dressed lumber shall be 1/2 inch less than nominal dimension, except that the minimum net width of dressed lumber exceeding 6 inches shall be 3/4 inch less than nominal dimension.

(e) Lumber Finish. Lumber finishes shall be as specified per the requirements of *AASHTO M 168* for manufacturing classifications, e.g., Rough Lumber or Dressed (Surfaced) Lumber.

(f) Soundness. Lumber material shall be sound and free from any incipient or advanced form of decay.

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(g) Preservative Treatment. Preservative treatment of lumber and timber materials shall conform to the requirements of Subsection 726.01. Unless otherwise specified, the treatment for lumber and timber materials shall conform to the requirements of Type II preservative.

(h) Miscellaneous Hardware, Shapes, and Fabricated Materials.

(1) Structural steel shapes and metal fabricated materials shall conform to the requirements of the Contract and the specific material requirements as specified in Section 714 and Section 715.

(2) Unless otherwise specified, bolts, studs, threaded rods, nuts, and washers shall conform to the requirements of *ASTM A 307,* Grade A. Carbon steel nuts (unless otherwise specified) shall conform to the requirements of *ASTM A 563* and *ASTM A 563 M*.

(3) Nails and spikes shall conform to the requirements of *ASTM F 1667*.

(4) Lag screws shall be of low to medium carbon steel and shall be of good commercial quality.

(5) Unless otherwise specified, all steel hardware and fabricated materials shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111* or *AASHTO M 232 M/M 232*, whichever is applicable.

709.02 NONSTRUCTURAL LUMBER. Material furnished under this subsection shall be for non-load–carrying structural applications with a maximum nominal thickness of 2 inches (e.g., boarding, siding, trim, etc.). Lumber shall be seasoned or kiln dried Spruce, Eastern White Pine, Eastern Hemlock, Southern Pine, or Western Fir, unless otherwise specified in the Contract.

(a) Grade. The grade classification of Yard Lumber, whether Common or Select, shall be as specified in the Contract. Structural lumber meeting the requirements of Subsection 709.01 and nominal 2-inch thickness may be used for nonstructural lumber applications. Except with the written permission of the Engineer, lumber which has not been grade classified or stress-graded shall not be used for nonstructural lumber.

(b) Moisture Content. The moisture content of nonstructural lumber shall be as specified in Subsection 709.01(b).

(c) Dimensions.

(1) Full-Sawn. When required in the Contract, lumber shall be furnished to the minimum full-sawn (nominal) dimensions specified. See Subsection 709.01(d) for a full definition of full-sawn lumber dimensions.

(2) Dressed. Unless otherwise specified, all lumber shall be surfaced four sides (S4S). Refer to Subsection 709.01(d) for a full definition of dressed lumber dimensions.

(d) Finish. Rough Lumber or Dressed (Surfaced) Lumber shall be finished per the requirements of *AASHTO M 168* manufacturing classifications.

(e) Soundness. Nonstructural lumber shall be sound and free from any incipient or advance form of decay.

(f) Preservative Treatment. Preservative treatment of lumber shall conform to the requirements of Subsection 726.01. Unless otherwise specified, the treatment shall conform to the requirements of Type IV preservative.

(g) Hardware, Shapes, and Fabricated Materials. Hardware, shapes, and fabricated materials shall be as specified in Subsection 709.01(h).

709.03 STRUCTURAL GLUED LAMINATED TIMBER.

(a) Material. Unless otherwise specified, structural glued laminated (glulam) timber shall be fabricated from Southern Pine, Coastal Douglas Fir, Western Hemlock, or Western Larch and shall meet the requirements of *AASHTO LRFD Bridge Construction Specifications,* Section 16.

Adhesives used in the lamination process shall be for wet-use conforming to the requirements of *ASTM D 2559* and shall comply with all other requirements of *ANSI/AITC A190.1*.

Unless otherwise specified, the appearance grade of the finished glulam products shall be "Industrial."

(b) Seasoning. Unless otherwise specified, all material shall have a moisture content not exceeding 16% at the time of gluing laminations.

(c) Preservative Treatment. Unless otherwise specified, all glued laminated timber shall be treated with Type II pentachlorophenol preservative (heavy oil solvent) conforming to the requirements of Subsection 726.01. Also, unless otherwise specified, all material shall be shop-fabricated prior to treatment. Any field treatment required by the Engineer shall be performed in accordance with the requirements of *AWPA Standard M4*.

(d) Miscellaneous Hardware, Shapes, and Fabricated Materials.

(1) Structural steel shapes and metal fabricated materials shall conform to the requirements of the Contract and the specific material requirements as specified in Section 714 and Section 715.

(2) Unless otherwise specified, bolts, studs, threaded rods, nuts, and washers shall conform to the requirements of *ASTM A 307,* Grade A. Stainless steel fasteners shall conform to the requirements of *ASTM F 593,* Alloy Group 1, Condition AF, Alloy 304 and its supplementary requirements for S5, with nuts conforming to the requirements of *ASTM F 594*.

(3) All welding shall conform to the requirements of Subsection 506.10.

(4) Nails and spikes shall conform to the requirements of *ASTM F 1667*.

(5) Lag screws shall be of low to medium carbon steel and shall be of good commercial quality.

(6) Unless otherwise specified, all steel hardware and fabricated materials shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111* or *AASHTO M 232 M/M 232*, whichever is applicable.

(e) Dimensions. The designated dimensions for glued laminated timber shall be taken as the actual net dimensions.

(f) Handling. Glued laminated timber shall be carefully handled to avoid damaging the edges and surfaces. The handling, transit, and erection procedures shall meet the requirements of *AITC 111-2005*.

SECTION 710 – CULVERTS, STORM DRAINS, AND SEWER PIPES, NONMETAL

710.01 REINFORCED CONCRETE PIPE. Reinforced concrete pipe shall conform to the requirements of *AASHTO M 170 M* and *AASHTO M 170* with the following notes or exceptions:

(a) Design Requirements. The circumferential reinforcement specified in *AASHTO M 170 M* and *AASHTO M 170,* Table 3 for 24-inch, Class III, Wall B pipe shall be 0.1 square inch per foot of pipe wall. Elliptical reinforcement shall not be used in circular pipes.

All pipe 24 inches in diameter or smaller shall be of the bell-and-spigot type. Pipes larger than 24 inches in diameter may be either of the tongue-and-groove or bell-and-spigot types.

(b) Marking. The exterior and interior of each length of pipe shall be clearly marked with the following data: pipe class; day, month, and year of manufacture; and name or trademark of the manufacturer. The marking method shall be by either clear, legible impressions in the pipe, or by clear, legible data stenciled on the pipe with waterproof paint.

710.02 REINFORCED CONCRETE PIPE END SECTIONS. Reinforced concrete pipe end sections shall conform to the requirements of Subsection 710.01. Where two cages of reinforcement are required in accordance with the requirements of *AASHTO M 170 M* and *AASHTO M 170*, they shall be placed in the barrel of the end section only. Reinforcement of the apron section shall be equal in area to the inner cage of the barrel reinforcement.

710.03 CORRUGATED POLYETHYLENE PIPE. Corrugated polyethylene pipe and fittings shall conform to the latest revisions of *AASHTO M 294,* Type S or *AASHTO M 252,* Type SP as appropriate. Acceptable corrugated polyethylene pipe shall be one of the corrugated polyethylene pipe products on the Agency's *Approved Products List*.

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710.04 THIS SUBSECTION RESERVED.

710.05 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PLASTIC PIPE. ABS pipe shall conform to the requirements of Table 710.05A.

TABLE 710.05A – ABS PIPE MATERIAL REQUIREMENTS

Pipe Type	Standard
Storm or sanitary sewer pipe, composite wall	*ASTM D 2680*

710.06 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE. PVC pipe shall conform to the requirements of Table 710.06A.

TABLE 710.06A – PVC PIPE MATERIAL REQUIREMENTS

Pipe Type	Pipe Dimensions	Standard
Smooth wall, perforated or un-perforated	4 – 16 inches (100 – 375 mm)	*AASHTO M 278*
	18 – 28 inches (450 – 700 mm)	*ASTM F 679* [1]
Corrugated, with smooth interior	All sizes	*ASTM F 949, ASTM F 794*

[1] Pipe with other cell classifications that meet or exceed the performance requirements of *ASTM D 3034* will be permitted if the wall thickness is not less than 94% of that in *AASHTO M 278*.

710.07 CORRUGATED POLYPROPYLENE PIPE. Corrugated polypropylene pipe and fittings shall conform to the requirements of *AASHTO M 330,* Type S. Acceptable corrugated polypropylene pipe shall be one of the corrugated polypropylene pipe products on the Agency's *Approved Products List*.

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SECTION 711 – CULVERTS, STORM DRAINS, AND SEWER PIPES, METAL

711.01 CORRUGATED STEEL PIPE, PIPE ARCHES, AND UNDERDRAINS. Corrugated steel pipe, elbows, end sections, reducer units, pipe arches, underdrain, risers, flushing basins, and coupling bands shall conform to the requirements of *AASHTO M 36*. Material furnished under this subsection shall be formed from sheet material coated in accordance with the requirements of *AASHTO M 218, AASHTO M 274*, or *AASHTO M 289*.

(a) Coupling Bands. Coupling bands shall conform to the requirements of *AASHTO M 36*, with the following modifications:

(1) Coupling bands and their connections shall be of such dimensions as required to meet the "Erodible Special Joint" category criteria of *AASHTO Standard Specifications for Highway Bridges,* Section 26. Structural steel for band connections shall conform to the requirements of *ASTM A 36/A 36 M*.

a. The only approved method of connection and connection details at the ends of the bands shall be 2 inch × 2 inch × 3/16 inch galvanized steel angles extending the full width of the band as detailed in VTrans *Standard D-4*.

b. 12-gauge die-cast angles shall be used with a configuration that provides at least the same section modulus as the 2 inch × 2 inch × 3/16 inch angle, extending the full width of the band.

c. A minimum of two bolts shall be used for 7 inch wide coupling bands, three bolts shall be used for 12 inch wide coupling bands, and five bolts shall be used for 24 inch wide coupling bands. All bolts shall be uniformly spaced.

Bolts, nuts, and other threaded items used with coupling bands shall be coated by the electroplating process as specified in *ASTM B 633,* Class Fe/Zn 25, the zinc coating process as specified in *AASHTO M 232 M/M 232*, or the mechanical zinc coating process as specified in *ASTM B 695*, Class 25.

d. Angles will be connected to bands by one of the following methods:

1. Spot welds spread over full width of the band.

2. Stitch-welds over the full width of the band.

3. Attached by rivets.

(2) The minimum coupling band thickness shall be 1/16 inch, and bands shall be no more than two nominal sheet thicknesses thinner than the wall thickness of the culvert or unit being connected. Coupling bands and die-cast angles may be formed from any one of the three types of sheet material specified above.

(3) The use of projection pipe coupling (dimpled) bands or preformed channel bands is not allowed.

(4) The Contractor may submit alternate coupling bands for approval to the Agency and shall allow 30 days for evaluation. Coupling bands shall not be shipped to projects until the Contractor has been notified that the coupling proposed band has been approved by the Agency.

(5) For attaching metal end sections to corrugated steel pipe, the Contractor may supply 1 inch wide × 12-gauge galvanized straps connected by a 1/2 inch galvanized bolt and nut for 12 inch through 24 inch diameter round pipes, and for 28 inch × 20 inch pipe arches and smaller.

(b) End Sections. Materials used in the manufacture of end sections shall conform to the requirements of *AASHTO M 36*, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(c) Reducer Units. Materials used in the manufacture of concentric metal reducer units shall conform to the requirements of *AASHTO M 36,* except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Underdrain. Perforated underdrain including all lateral and special connections shall conform to the requirements of *AASHTO M 36*. The required minimum sheet metal thickness shall be 0.052 inch for 6-inch diameter underdrain and 0.064 inch for 8-inch diameter underdrain and larger.

(f) Underdrain Risers and Flushing Basins. Underdrain risers and flushing basins, including all connectors, fittings, and covers shall conform to the requirements of *AASHTO M 36*, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract. Underdrain risers and flushing basins shall not be perforated.

(g) Marking. All material furnished under this subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

711.02 CORRUGATED ALUMINUM ALLOY PIPE, PIPE ARCHES, AND UNDERDRAINS. Corrugated aluminum alloy pipe, elbows, end sections, reducer units, pipe arches, underdrain, risers, flushing basins, and coupling bands shall conform to the requirements of *AASHTO M 196*.

(a) Coupling Bands. Coupling bands shall conform to the requirements of *AASHTO M 196.*

(1) Coupling bands and their connections shall be of such dimensions as required to meet the "Erodible Special Joint" category criteria of the *AASHTO Standard Specifications for Highway Bridges*, Section 26.

(2) Coupling band connections shall meet the following parameters:

a. Coupling bands connections shall have either 2 inch × 2 inch × 1/4 inch aluminum angles that meet the requirements of *ASTM B 221* and *ASTM B 221 M,* Alloy 6063-T6 or 12-gauge minimum die-cast aluminum angles. Angles shall extend the full width of the band.

b. Coupling bands connections shall have a minimum shear strength capacity of 6.3 kips.

c. Connections shall be made with a minimum of two bolts for 7 inch wide coupling bands, three bolts for 12 inch wide coupling bands, and five bolts for 24 inch wide bands. Bolts shall be uniformly spaced across the width of the band. Bolts, nuts, and other threaded items shall be coated in accordance with the requirements of Subsection 711.01(a)(1)c.

d. Coupling bands connections shall have angles attached to the bands by stitch-welding over the full width of the band or by rivets uniformly spaced across the width of the band.

(3) The minimum coupling band thickness shall be 0.06 inch, and bands shall be no more than two nominal sheet thicknesses thinner than the wall thickness of the culvert being connected.

(4) Alternate coupling bands may be submitted for approval as specified in Subsection 711.01(a)(5).

(b) End Sections. Materials used in the manufacture of end sections shall conform to the requirements of *AASHTO M 196*, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(c) Reducer Units. Materials used in the manufacture of concentric reducer units shall conform to the requirements of *AASHTO M 196*, except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Underdrain Risers and Flushing Basins. Underdrain risers and flushing basins, including all connectors, fittings, and covers shall conform to the requirements of *AASHTO M 196*, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract. Underdrain risers and flushing basins shall not be perforated.

(e) Marking. All material furnished under this subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

711.03 POLYMERIC COATED CORRUGATED STEEL PIPE AND PIPE ARCHES. Polymeric-coated corrugated steel pipe, elbows, reducer units, and pipe arches shall conform to the requirements of *AASHTO M 245*. Polymeric coating shall conform to the requirements of *AASHTO M 246,* Grade 250/250.

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(a) Coupling Bands. Coupling bands shall conform to the requirements of Subsection 711.01(a) modified as follows:

(1) Coupling bands and die-cast angles shall be formed from sheet material coated in accordance with the requirements of *AASHTO M 218, M 245, M 274,* or *M 289*.

(2) Coupling bands formed from *AASHTO M 274* or *M 289* material shall be not more than one nominal sheet thickness thinner than the wall thickness of the culvert or unit being connected.

(3) Coupling bands formed from *AASHTO M 245* material shall be not more than two nominal sheet thicknesses thinner than the thickness of the culvert or unit being connected. Angles must be attached to the band by rivets.

(4) Coupling bands formed from *AASHTO M 218* material shall be the same nominal sheet thickness as the culvert or units being connected. Angles must be attached to the band with rivets or by stitch-welding over the full width of the band.

(b) End Sections. Materials used in the manufacture of end sections shall conform to the requirements of Subsection 711.01(b).

(c) Reducer Units. Materials used in the manufacture of concentric reducer units shall conform to the requirements of *AASHTO M 245*, except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Marking. All material furnished under this subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

711.04 THIS SUBSECTION RESERVED.

711.05 COAL-TAR BASED COATING. Coal-tar based coating used to repair damaged areas of polymeric coating shall meet the requirements of *AASHTO M 243*.

711.06 STRUCTURAL PLATES, BOLTS, AND NUTS. Structural steel plates, bolts, and nuts for pipe, pipe-arches, arches, and box culverts shall conform to the requirements of *AASHTO M 167 M/M 167*.

Structural aluminum alloy plate, bolts, and nuts for pipe, pipe-arches, arches, and box culverts shall conform to the requirements of *AASHTO M 219*.

(a) Dimensions. The thickness of the plates or sheets and the radius of curvature shall be as specified in the Contract. Each plate or sheet shall be curved to one or more circular arcs.

(b) Fabrication. Plates shall be formed to provide lap joints. The bolt holes shall be punched so that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as specified in the Contract.

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Bolt holes along those edges of the plates that form longitudinal seams in the finished structure shall be in two rows. Bolt holes along those edges of the plates that form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall not be less than 1.75 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.

Cut edges shall be free from oxide and burrs. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

Unless otherwise specified in the Contract, plate pipes shall be elongated so that the finished pipe is elliptical in shape with the vertical diameter approximately 5% greater than the nominal diameter of the pipe. Pipe arches shall not be elongated.

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SECTION 712 – CRIBBING MATERIALS

712.01 METAL BIN-TYPE RETAINING WALLS. Metal bin-type retaining walls shall have the following components and properties:

(a) Galvanized Metal Units. The various units of metal bin-type retaining wall shall conform to the requirements of *AASHTO M 218*. The metal sheets used to form the members of the metal wall shall be of the thickness indicated in the Contract.

(b) Bolts and Nuts. Bolts and nuts shall conform to the requirements of Subsection 714.08 and shall be galvanized in accordance with the requirements of *AASHTO M 232 M/M 232*.

(c) Fabrication. All units shall be fabricated so that units of the same nominal size shall be interchangeable. Drilling, punching, or drifting to correct defects in manufacture will not be permitted. Any units improperly manufactured shall be replaced at the Contractor's expense.

Whenever possible in the manufacture of the units, a minimum forming radius of 1 inch shall be maintained. All units that are formed with less than a 1 inch radius shall be hot-dip galvanized after forming.

712.02 CONCRETE BIN-TYPE RETAINING WALLS. The materials, design details, and dimensions shall be as shown on the Plans and approved working drawings.

712.03 TIMBER CRIBBING. Timber cribbing shall meet the following requirements:

(a) Material. Dimensional timber furnished for cribbing shall be seasoned Red (Norway) Pine, White Pine, Eastern Hemlock, or Southern Pine, straight, sound, and cut from live timber.

Red Pine, White Pine, and Eastern Hemlock shall meet "Number 1 Grade" requirements specified by the Northeastern Lumber Manufacturers Association (NELMA). Southern Pine shall meet "Number 2 Grade" requirements specified by the Southern Pine Inspection Bureau (SPIB).

Structural timber furnished for glue laminated cribbing shall be seasoned Southern Pine, Coastal Douglas Fir, or Hem-Fir meeting the requirements of the *AASHTO LRFD Bridge Construction Specifications*, Section 16, with a minimum fiber stress in bending, about either axis, of 1,200 psi.

Dimensional timber shall be full-sawn S2E, uniformly-surfaced two edges to the dimensions specified.

Surfaces to be exposed in the finished product shall have a uniformly rough finish, with a coarse texture. The maximum allowable unevenness in the surface shall be 1/4 inch with any finishing processes to be performed prior to preservative treatment.

Adhesive used in the lamination process shall be for wet-use conforming to the requirements of *ASTM D 2559* and shall comply with all other requirements of *ANSI/AITC A190.1*

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(b) Seasoning. All material shall have a moisture content not exceeding 19% prior to preservative treatment.

(c) Preservative Treatment. Timber cribbing shall be pressure-treated in accordance with the requirements of *AASHTO M 133* and AWPA standards using a preservative as specified in Subsection 726.01.

Treatment, inspection, and testing of the treated timber materials shall conform to the requirements of Subsection 728.01.

(d) Miscellaneous Hardware.

(1) Connection and washer plates shall be fabricated from material conforming to Subsection 714.02 and galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(2) Bolts, nuts, and washers shall conform to the requirements of Subsection 714.04 and shall be galvanized in accordance with the requirements of *AASHTO M 232 M/M 232*.

(3) Threaded rods with nuts shall be either material conforming to Subsection 714.04 and galvanized in accordance with the requirements of *AASHTO M 232 M/M 232* or stainless steel conforming to the requirements of *ASTM F 593,* Alloy Group 1, Condition AF, Alloy 304 and its supplementary requirements for *S5*, with nuts conforming to the requirements of *ASTM F 594*.

(4) Bolts and threaded rods shall have a minimum of 4 inches of thread. Threads shall be wrapped with a minimum of two layers of Teflon tape prior to installation. All threads shall be UNC 2 Coarse.

(5) Sleeve nuts may either conform to the requirements of Subsection 714.04 and be galvanized or fabricated from stainless steel rod meeting the requirements of *ASTM A 276/A 276 M,* Type 304.

(6) All nuts shall be heavy hex type.

712.04 GABION BASKETS. Gabion baskets shall be manufactured from woven wire mesh. All steel wire used in the manufacture of gabion baskets shall be galvanized and PVC-coated. Gabion baskets shall be Type 8 × 10 mesh, Style 3 Coating, and meet the requirements of *ASTM A 975*.

Gabion basket wire shall meet the requirements of *ASTM A 641/A 641 M*, Class 3, have a soft-temper coating, and be gray in color.

The steel wire shall have a minimum elongation of not less than 12% when tested in accordance with the requirements of *ASTM A 370*.

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SECTION 713 – REINFORCING STEEL, STRAND, AND WELDED WIRE REINFORCEMENT

713.01 BAR REINFORCEMENT. Bar reinforcement for concrete structures shall be Grade 60, unless otherwise specified in the Contract.

(a) Plain Reinforcing Steel. Plain reinforcing steel shall conform to the requirements of *AASHTO M 31 M/M 31*, Type S, including supplementary requirements.

(b) Low-Alloy Reinforcing Steel. Low-alloy reinforcing steel shall conform to the requirements of *AASHTO M 31 M/M 31*, Type W.

(c) Epoxy-Coated Reinforcing Steel. Epoxy-coated reinforcing steel shall have an electrostatically applied epoxy protective coating, which has been prequalified, fabricated, tested, and installed in accordance with the requirements of *ASTM A 775/A 775 M*.

(d) Stainless-Clad Reinforcing Steel. Stainless-clad reinforcing steel shall meet the requirements of *AASHTO M 329 M/M 329*.

(e) Dual-Coated Reinforcing Steel. Dual-coated reinforcing steel shall meet the requirements of *ASTM A 1055/A 1055 M*.

(f) Solid Stainless Reinforcing Steel. Solid stainless reinforcing steel shall meet the requirements of *ASTM A 955/A 955 M* with one of the following UNS designations: S24100, S30400, S31603, S31653, S32101, S32201, S32205, or S32304. Different designations shall not be mixed within the same project.

Elongation requirements for solid stainless reinforcing steel shall be the same as for the equivalent size and grade of *AASHTO M 31 M/M31,* Type S reinforcing steel.

(g) Continuous Galvanized Reinforcing. Continuous galvanized reinforcing steel shall meet the requirements of *ASTM A 1094/A 1094 M*.

Where no core steel requirements are stated in the above specifications, the steel core of the bar reinforcement shall meet the requirements of plain reinforcing steel.

713.02 MECHANICAL SPLICES FOR BAR REINFORCEMENT. Mechanical splices for bar reinforcement shall develop, in tension or compression, a minimum of 125% of the specified yield strength of the bar intended to be spliced. Mechanical splices shall be installed in accordance with the manufacturer's recommendations or as ordered by the Engineer.

713.03 WIRE ROPE OR CABLE. Wire rope or cable for guardrail shall conform to the requirements of *AASHTO M 30,* Type I, Class A Coating.

713.04 COLD DRAWN STEEL WIRE. Cold drawn steel wire shall conform to the requirements of *AASHTO M 336 M/M 336*.

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713.05 WELDED WIRE REINFORCEMENT. Welded steel wire reinforcement for concrete structures shall conform to the requirements of *AASHTO M 336 M/M 336*, including supplementary requirements.

713.06 PRESTRESSING STRAND. Prestressing elements shall be uncoated, high tensile strength, seven "low-relaxation" wire strands of the grade and diameter shown on the Plans and shall conform to the requirements of *AASHTO M 203 M/M 203*. Wire for post-tensioning shall conform to the requirements of *AASHTO M 203 M/M 203* or *AASHTO M 204 M/M 204*.

713.07 THIS SUBSECTION RESERVED.

SECTION 714 – STRUCTURAL STEEL

714.01 GENERAL REQUIREMENTS. Structural steel and other related materials shall conform to the requirements specified in this section. All main load carrying members and components of rolled or welded sections subject to tensile stress shall meet the longitudinal Charpy V-Notch impact requirements specified in *AASHTO M 270 M/M 270*, Supplementary Requirement tables for non-fracture critical steel and fracture critical steel, for Zone 2. Impact test sampling and testing procedures shall be in accordance with the requirements of *AASHTO T 243*.

Main members are tension members and members subject to reversals of stress, including stringers, girders, cover plates, rigid frames, floor beams, and curved girder cross frames. Other members may be indicated in the Contract as main load-carrying members.

All steel bolts, nuts, and washers furnished for Agency projects shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's markings on each piece.

Nuts for galvanized fasteners shall be over-tapped a minimum amount to ensure fastener assembly.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye that will provide visual verification of the lubricant during installation. Black bolts must be "oily" to the touch when installed. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation.

714.02 STRUCTURAL STEEL. Structural carbon steel shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 36.

714.03 HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL. High-strength low-alloy structural steel with a 50 ksi minimum yield point up to 4 inches in thickness shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 50 and/or Grade 50W as required.

714.04 CARBON STEEL BOLTS, NUTS, AND WASHERS. Carbon steel bolts shall conform to the requirements of *ASTM A 307,* Grade A. Carbon steel nuts shall conform to the requirements of *ASTM A 563* and *ASTM A 563 M*. Carbon steel washers shall conform to the requirements of *ASTM F 844*.

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714.05 HIGH-STRENGTH BOLTS, NUTS, AND WASHERS. High-strength bolts shall conform to the requirements of *ASTM F 3125/F 3125 M,* Grade A 325, including rotational capacity testing, for each lot of fasteners. High-strength nuts shall conform to the requirements of *ASTM A 563 DH*. High-strength washers shall conform to the requirements of *ASTM F 436/F 436 M*.

Bolts installed in painted structural components shall be Type 1 and shall be provided with appropriate nuts and washers, as required. The combination of bolt, nut, and washer shall be mechanically galvanized in accordance with the requirements of *ASTM B 695*, Class 55, Type 1.

Bolts installed in unpainted weathering steel structural components shall be Type 3 and shall be provided with appropriate nuts and washers, as required.

714.06 HEAT-TREATED STEEL STRUCTURAL BOLTS. Heat-treated steel structural bolts shall conform to the requirements of *ASTM F 3125/F 3125 M,* Grade A 490, including rotational capacity testing, for each lot of fasteners. Heat-treated steel nuts shall conform to the requirements of *ASTM A 563 DH*. Heat-treated steel washers shall conform to the requirements of *ASTM F 436/F 436 M*.

Bolts installed in painted structural components shall be Type 1 and shall be provided with appropriate nuts and washers, as required. The combination of bolt, nut, and washer shall be mechanically galvanized in accordance with the requirements of *ASTM F 1136/F 1136 M*.

Bolts, nuts, and washers shall be Type 3 for all unpainted applications.

714.07 ANCHOR BOLTS, BRIDGE RAILING. Bridge railing anchor bolts shall conform to the requirements of *ASTM A 449,* Type 1. Bridge railing nuts shall conform to the requirements of *ASTM A 563 DH*. Bridge railing washers shall conform to the requirements of *ASTM F 436/F 436 M*.

714.08 ANCHOR BOLTS, BEARING DEVICES. Anchor bolts for bridge bearings shall conform to the requirements of *ASTM F 1554,* Grade 36, unless otherwise specified. Nuts for bridge bearings shall be heavy hex type and conform to the requirements of *ASTM A 563* and *ASTM A 563 M*. Washers for bridge bearings shall conform to the requirements of *ASTM F 436/F 436 M* and shall be a minimum of 3/8 inch in thickness, unless otherwise noted in the Plans.

When the bolts furnished under this subsection are required to be galvanized, the bolts, nuts, and washers furnished shall meet the requirements of *ASTM B 695,* Class 55 for mechanically-galvanized fasteners or *ASTM F 2329/F 2329 M* for hot-dipped galvanized.

Anchor bolts shall be swedged or threaded and shall conform to the shape, length, and diameter specified in the Contract.

714.09 ANCHOR BOLTS, TRAFFIC SIGNALS, LIGHTING, AND OVERHEAD SIGN STRUCTURES. Anchor bolts for traffic signals, lighting, and overhead sign structures shall conform to the requirements of *ASTM F 1554,* Grade 55, unless otherwise specified. Nuts shall be heavy hex type and conform to the requirements of *ASTM A 563 DH*. Washers shall conform to the requirements of *ASTM F 436/F 436 M* and

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shall be a minimum of 3/8 inch thick unless otherwise indicated on the Plans. All components shall be galvanized in accordance with the requirements of *ASTM F 2329/F 2329 M*.

Anchor bolts shall be swedged or threaded unless otherwise specified on the Plans.

714.10 WELDED STUD SHEAR CONNECTORS. Welded stud shear connectors shall conform to the requirements of the *AASHTO LRFD Bridge Construction Specifications*, *ANSI/AWS D1.5*, and *ASTM A 29/A 29 M*.

714.11 STEEL TUBING. Steel tubing shall conform to the requirements of *ASTM A 500/A 500 M,* Grade B, unless otherwise specified.

714.12 DIRECT TENSION INDICATORS. Direct Tension Indicators (DTIs) shall be Compressible-Washer-Type Direct Tension Indicators conforming to the requirements of *ASTM F 959/F 959 M*. DTIs shall be of the type corresponding to the bolt specification with which it will be used.

714.13 TENSION CONTROL ASSEMBLIES. Tension Control Assemblies shall be "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies conforming to *ASTM F 3125/F 3125 M*.

SECTION 715 – MISCELLANEOUS METALS

715.01 IRON CASTINGS. Iron castings shall meet the following requirements:

(a) General Requirements. Castings shall conform to the requirements of *AASHTO M 306*. Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arises shall be sharp and perfect. The surfaces shall have a blemish-free finish.

All castings shall be blast-cleaned or otherwise effectively cleaned of scale and sand to present a smooth, clean, and uniform surface. The dimensions of the frames and covers shall substantially conform to the dimensions for cast iron covers and frames as shown in the Contract.

The covers shall be flush with the upper surface of the frame when seated. The seatings shall be machined or made quiet using a gasket cushioning insert or supported by a three-point triangular suspension. The minimum depth of insertion of the cover into the frame shall be no less than 2 inches.

As a minimum, the covers and frames shall meet the HS-20 loading requirements of AASHTO and the proof load requirements of *AASHTO M 306*.

Covers shall be identified by the words "STORM SEWER," "WATER," "SEWER," "ELECTRIC," or others as applicable, in raised cast letters as indicated in the Contract or as directed by the Engineer.

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(b) Gray Iron Castings. Gray iron castings shall conform to the requirements of *AASHTO M 105,* Class No. 35B, unless otherwise specified.

(c) Ductile Iron Castings. Ductile iron castings for frames and covers shall conform to the requirements of *ASTM A 536,* Grade 80-55-06.

715.03 CAST IRON PIPE. Cast iron pipe and fittings shall conform to either the requirements of *ASTM A 74* or the requirements of *ASTM A 377*, unless otherwise specified.

715.04 ALUMINUM ALLOY. Aluminum alloy material shall be fabricated from Alloy 6061-T6.

(a) Sheet and Plate. Aluminum alloy sheet and plate shall conform to the requirements of *ASTM B 209* and *ASTM B 209 M*.

(b) Drawn Seamless Tubes. Aluminum alloy drawn seamless tubes shall conform to the requirements of *ASTM B 210* and *ASTM B 210 M*.

(c) Bars, Rods, and Wire. Aluminum alloy bars, rods, and wire shall conform to the requirements of *ASTM B 211* and *ASTM B 211 M*.

(d) Extruded Bars, Rods, Shapes, and Tubes. Aluminum alloy extruded bars, rods, shapes, and tubes shall conform to the requirements of *ASTM B 221* and *ASTM B 221 M.*

(e) Seamless Pipe and Seamless Extruded Tube. Aluminum alloy seamless pipe and seamless extruded tube shall conform to the requirements of *ASTM B 241/B 241 M*.

(f) Welding Rods and Electrodes. Aluminum and aluminum alloy welding rods and bare electrodes shall conform to the requirements of AWS.

(g) Standard Structural Shapes. Aluminum alloy standard structural shapes, rolled or extruded, shall conform to the requirements of *ASTM B 308/B 308 M*.

(h) Extruded Structural Pipe and Tube. Aluminum alloy extruded structural pipe and tube shall conform to the requirements of *ASTM B 429/B 429 M*.

(i) Sand Castings. Aluminum alloy sand casting shall conform to the requirements of *ASTM B 26/B 26 M*.

(j) Permanent Mold Castings. Aluminum alloy permanent mold castings shall conform to the requirements of *ASTM B 108/B 108 M*.

(k) Rivets. Aluminum alloy rivets shall conform to the requirements of *ASTM B 316/B 316 M*.

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(l) Bolts, Nuts, and Screws. Aluminum alloy bolts, nuts, and screws shall be made from rod conforming to the requirements of *ASTM B 211* and *ASTM B 211 M*. Bolt heads shall conform to the requirements of American Standard heavy hexagon, *ANSI B18.2.1/ANSI B18.2.3.6 M*. Nuts shall conform to the requirements of *ANSI B18.2.4.6M* in accordance with the requirements of *ANSI B18.2.1* and *ANSI B18.2.2/ANSI B18.2 M*. Bolt threads shall conform to the requirements of *ANSI B1.1/ANSI B1.13 M*. Both bolts and nuts shall be given an anodic coating at least 0.2 mil in thickness with a dichromate or boiling water seal.

(m) Washers and Shims. Aluminum alloy washers shall be made from aluminum alloy sheet conforming to the requirements of *ASTM B 209* and *ASTM B 209 M*. Aluminum alloy shims shall be made from aluminum alloy sheet or plate conforming to the requirements of *ASTM B 209* and *ASTM B 209 M* or *ASTM B 221* and *ASTM B 221 M*.

715.05 STAY-IN-PLACE CORRUGATED METAL FORMS FOR SUPERSTRUCTURE SLABS. Stay-in-place corrugated metal forms (SIPCMF) and form supports shall be in conformance with the requirements of *ASTM A 653/A 653 M,* Coating Designation G165. Fabrication shall be in conformance with the requirements of *ASTM A 924/A 924 M*.

715.06 METAL ROOFING. Metal roofing shall meet the following requirements:

(a) Roofing. Metal roofing shall conform to the requirements of *ASTM E 1514* or *ASTM E 1637*. The Contractor shall provide manufacturer's color samples to the Engineer for approval. The Engineer, in consultation with the owner, will determine which, if any, of the samples are acceptable.

(b) Trim. Metal roofing trim shall be of the type and size recommended by the roofing manufacturer.

(c) Fasteners. Metal roofing fasteners shall be pancake-head screws, or other low-profile fasteners, with a minimum nominal penetration length of 1 inch into the roof boards. A minimum ultimate pullout strength shall be provided to meet uplift requirement.

SECTION 719 – EPOXY RESIN MATERIALS

719.02 EPOXY BONDING COMPOUND. Epoxy bonding compound shall meet the requirements of *AASHTO M 235 M/M 235* for the type, grade, and class corresponding to the application and temperature range for which it is to be used.

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SECTION 720 – GEOTEXTILES

720.01 GENERAL REQUIREMENTS. Geotextiles shall be evaluated in accordance with the NTPEP geotextiles work plan and in compliance with the NTPEP audit program for geotextiles. Geotextiles shall be one of the products listed on the Agency's *Approved Products List* for the respective material specification.

720.02 GEOTEXTILE FOR ROADBED SEPARATOR. Geotextile for Roadbed Separator shall conform to *AASHTO M 288*, Table 1, Class 1 for Geotextile Strength Property Requirements, and shall conform to *AASHTO M 288*, Table 3 for Separation Geotextile Property Requirements.

720.03 GEOTEXTILE UNDER RAILROAD BALLAST. Minimum Average Roll Values (MARV) for Geotextile Under Railroad Ballast shall be as required in Table 720.03A.

TABLE 720.03A – MARV FOR GEOTEXTILE UNDER RAILROAD BALLAST

Geotextile Property	Test Method	MARV
Elongation Criteria at Failure [1]	*ASTM D 4632/ D4632 M*	≥ 50%
Grab Strength (lbs)	*ASTM D 4632/ D4632 M*	225
Tear Strength (lbs)	*ASTM D 4533/ D 4533 M*	115
Puncture Strength (lbs)	*ASTM D 6241*	850
Permittivity (s^{-1})	*ASTM D 4491/ D 4491 M*	0.70
Apparent Opening Size (mm)	*ASTM D 4751*	0.212 max. (No. 70 Sieve)
UV Resistance (% Strength Retained)	*ASTM D 4355/ D 4355 M*	70% at 500 hours of exposure
Structure	--	Nonwoven only

[1] Elongation corresponds to Maximum Grab Tensile Strength as measured in accordance with the requirements of *ASTM D 4632/D 4632 M*.

720.04 GEOTEXTILE UNDER STONE FILL. Geotextile Under Stone Fill shall conform to *AASHTO M 288,* Table 1, Class 1 for Geotextile Strength Property Requirements, and shall conform to *AASHTO M 288,* Table 5 for Stabilization Geotextile Property Requirements. Geotextile structure shall not be slit film.

720.05 GEOTEXTILE FOR UNDERDRAIN TRENCH LINING. Geotextile for Underdrain Trench Lining shall conform to *AASHTO M 288*, Table 1, Class 3 for Geotextile Strength Property Requirements, with a minimum elongation of 20%. Geotextile for Underdrain Trench Lining shall conform to *AASHTO M 288*, Table 2 (>50% of in situ soil passing the No. 200 (0.075 mm) sieve) for Subsurface Drainage Geotextile Requirements. Geotextile structure shall be nonwoven and shall not be slit film.

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720.06 GEOTEXTILE FOR FILTER CURTAIN. Minimum Average Roll Values (MARV) for Geotextile for Filter Curtain shall be as required in Table 720.06A.

TABLE 720.06A – MARV FOR GEOTEXTILE FOR FILTER CURTAIN

Geotextile Property	Test Method	MARV
Elongation Criteria at Failure [1]	*ASTM D 4632/ D4632 M*	20% max.
Grab Strength (lbs)	*ASTM D 4632/ D4632 M*	200
Tear Strength (lbs)	*ASTM D 4533/ D 4533 M*	50
Puncture Strength (lbs)	*ASTM D 6241*	430
Permittivity (s^{-1})	*ASTM D 4491/ D 4491 M*	0.28
Apparent Opening Size (mm)	*ASTM D 4751*	0.212 max. (No. 70 Sieve)
UV Resistance (% Strength Retained)	*ASTM D 4355/ D 4355 M*	70% at 500 hours of exposure
Structure	--	Woven only

[1] Elongation corresponds to Maximum Grab Tensile Strength as measured in accordance with the requirements of *ASTM D 4632/D 4632 M*.

720.07 GEOTEXTILE FOR SILT FENCE. Geotextile for Silt Fence shall conform to *AASHTO M 288*, Table 8 for Temporary Silt Fence Property Requirements. Geotextile structure shall be woven.

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SECTION 725 – CONCRETE CURING MATERIALS AND ADMIXTURES

725.01 CONCRETE CURING MATERIALS. Concrete curing materials shall meet the following requirements:

(a) White Burlap-Polyethylene Sheet. White burlap-polyethylene sheet shall conform to the requirements of *ASTM C 171*.

(b) Burlap Cloth. Burlap cloth shall conform to the requirements of *AASHTO M 182*. Worn burlap cloth with holes, or burlap cloth reclaimed from uses other than that of curing concrete, will not be permitted. The burlap cloth shall be free of any ingredients that may damage or be detrimental to concrete.

(c) White Polyethylene Sheeting. White polyethylene sheeting (film) shall conform to the requirements of *ASTM C 171*.

(d) Liquid Membrane-Forming Compounds. Liquid membrane-forming compounds shall be one of the products listed on the Agency's *Approved Products List* and shall meet the following requirements:

(1) Liquid membrane-forming compounds shall be evaluated in accordance with the NTPEP concrete curing compounds work plan.

(2) Liquid membrane-forming compounds shall conform to the requirements of *ASTM C 309*, Type 1-D or Type 2, Class B.

(3) Liquid membrane-forming compounds shall not be allowed to freeze.

725.02 CHEMICAL ADMIXTURES.

(a) General Requirements. Non-bulk quantities of chemical admixtures shall be delivered in the manufacturer's original containers marked with the manufacturer's name and product name. Bulk quantities shall be accompanied by a delivery slip indicating both the manufacturer's name and the product name. Chemical admixtures shall be one of the products listed on the Agency's *Approved Products List* for the respective material specification, shall be evaluated in accordance with the NTPEP concrete admixtures work plan, and shall meet the requirements of the respective material specification below.

(b) Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of *AASHTO M 154*.

(c) Retarding Admixtures. Retarding admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C494 M,* Type B.

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(d) Latex Admixtures. Latex admixtures shall conform to the requirements of *ASTM C 1438,* Type II. Latex admixture shall be stored in suitable enclosures which will protect it from dampness, freezing, and from prolonged exposure to temperatures higher than 86°F. If no shelf life is specified by the manufacturer, the admixture shall not be used after two years from the date of manufacture.

(e) Water-Reducing Admixtures. Water-reducing admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C494 M,* Type A.

(f) Water-Reducing and Retarding Admixtures. Water-reducing and retarding admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M,* Type D.

(g) Water-Reducing, High Range Admixtures. Water-reducing, high range admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M*, Type F.

(h) Water-Reducing, High Range, and Retarding Admixtures. Water-reducing, high range, and retarding admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M*, Type G.

(i) Accelerating Admixtures. Accelerating admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M*, Type C.

(j) Water-Reducing and Accelerating Admixtures. Water-reducing and accelerating admixtures shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M,* Type E.

(k) Specific Performance Admixtures. Specific performance admixtures that provide desired performance characteristics, including but not limited to shrinkage reduction, alkali-silica reaction mitigation, and viscosity, shall conform to the requirements of *AASHTO M 194 M/M 194* and *ASTM C 494/C 494 M,* Type S.

725.03 MINERAL ADMIXTURES.

(a) Pozzolans. Pozzolans and fly ash shall conform to the requirements of *AASHTO M 295,* Class F. The supplier shall provide the State with the test results of the ten consecutive samples preceding the one submitted for approval to demonstrate compliance with *AASHTO M 295,* Class F. In addition, no fly ash shall contain greater than 10% total calcium content, expressed as calcium oxide (CaO).

The Contractor shall provide suitable means for storing and protecting the pozzolans from contamination with foreign materials. Fly ash containing any oil shall be rejected. The mixing of the same type of fly ash from different sources will not be permitted.

(b) Silica Fume. Silica fume shall conform to the requirements of *AASHTO M 307* and *ASTM C 1240*. When silica fume is delivered in packages or drums, the name brand of the manufacturer and the mass (weight) of the silica fume, if dry, or the concentration, if a slurry, shall be clearly marked on the package or drum.

(c) Ground Granulated Blast-Furnace Slag (GGBFS). GGBFS shall conform to the requirements of *AASHTO M 302*. The Contractor shall provide suitable means for storing and protecting the GGBFS from contamination by any foreign materials and moisture

SECTION 726 – PROTECTIVE COATINGS AND WATERPROOFING MATERIALS

726.01 TIMBER PRESERVATIVE. Preservatives and pressure treatment processes for lumber and timber shall conform to the requirements of *AASHTO M 133*. Acceptable preservatives and *AWPA Preservative Standards* are as shown in Table 726.01A.

TABLE 726.01A – TIMBER PRESERVATIVE STANDARDS

Preservative Type	Preservative Name or Subtype	AWPA Standard
I. Creosote	Creosote	*P1*
	Creosote – Coal Tar Solution	*P2*
	Creosote – Petroleum Solution	*P3*
II. Pentachlorophenol	Pentachlorophenol	*P35*
	Solvent for Pentachlorophenol – Heavy Oil Hydrocarbon Solvent, Type A	*P9*
	Solvent – Light Oil Hydrocarbon Solvent, Type C	*P9*
III. Chromated Copper Arsenate	Chromated Copper Arsenate	*P27*
IV. Alkaline Copper Quaternary	Alkaline Copper Quaternary	*P5*
	Type B – Chromated Copper Arsenate	*P27*
	Type C	*P28*
	Type DV – Alkaline Copper Quaternary	*P29*
V. Copper Naphthenate	Copper Naphthenate	*P36*

For wood components, AWPA Product Use and Commodity Specifications shall be as listed in Table 726.01B.

TABLE 726.01B – AWPA PRODUCT USE AND COMMODITY SPECIFICATIONS

Component	AWPA Use Category	AWPA Commodity Specification
Sawn guardrail post	*UC4B*	*6A*
Sawn bollard, marker post, guide post, and fence post	*UC4A*	*6A*
Sawn sign post	*UC4A*	*6A*
Sawn structural lumber and timber	*UC4B*	*6A*
Sawn nonstructural lumber	*UC4A*	*6A*
Sawn timber cribbing	*UC4B*	*6A*
Structural glued laminated timber	*UC4B*	*6F*
Round fence post	*UC4A*	*6B*
Round timber pole	*UC4B*	*6D*

Any field treatment required by the Engineer shall be performed in accordance with the provisions of *AWPA Miscellaneous Standard M4*. Prior to the delivery of preservative material, a copy of the safety data sheet for the product shall be provided to the Engineer.

726.02 THIS SUBSECTION RESERVED.

726.03 MINERAL SPIRITS. Mineral spirits shall conform to the requirements of *ASTM D 235*.

726.04 THIS SUBSECTION RESERVED.

726.05 WATERPROOFING PITCH. Waterproofing pitch shall conform to the requirements of *ASTM D 450/D 450 M,* Type II.

726.06 WOVEN COTTON FABRIC. Bitumen-saturated woven cotton fabric shall conform to the requirements of *ASTM D 173/D 173 M*.

726.07 WOVEN GLASS FABRIC. Coated woven glass fabric shall conform to the requirements of *ASTM D 1668/D 1668 M*.

726.08 GALVANIZING. Surfaces to be galvanized shall be zinc-coated in conformance with *AASHTO M 111 M/M 111* or, when applicable, *AASHTO M 232 M/M 232*. Galvanizing that has been damaged shall be repaired in accordance with the requirements of *ASTM A 780/A 780 M,* Annex A2.

726.09 METALIZING. Surfaces to be metalized shall be prepared and coated in accordance with the requirements of *AASHTO/NSBA S8.2/SSPC-PA 18*, and the following:

(a) The coating shall be zinc with a minimum purity of 99.9%.

(b) All surfaces to be thermal sprayed shall be blast-cleaned to white metal immediately prior to metalizing. The final surface appearance shall be equivalent to Preparation Grade *SSPC-SP 5* supplemented by *SSPC VIS-1*. All surfaces shall also have a uniform surface profile of 3.5 to 5.5 mils. If the profile requirements of the coating manufacturer are more restrictive, the Fabricator shall advise the Structural Steel Fabrication Engineer and comply with the more restrictive requirements.

The surface profile produced by the Fabricator's surface preparation procedures shall be determined by replica tape and spring micrometer at the beginning of the work, and each day that the surface preparation is performed. The replica tape shall be attached to the daily inspection records. Areas having unacceptable measurements shall be further tested to determine the limits of the deficient area and subsequently corrected to meet specification requirements.

(c) Thermal Spray Coating (TSC) shall be applied within six hours of completing blast cleaning. If this time is exceeded, or rust appears on the surface, the steel surface shall be properly prepared again. TSC shall be applied in the thickness range of 8 to 12 mils to all exterior surfaces. Internal surface (e.g. pot bearings) shall have a coating with a minimum thickness of 2 mils.

(d) Exterior surfaces (except faying surfaces) shall be sealed with an approved sealant conforming to the sealant manufacturer's recommendations for the TSC applied. The sealant name, manufacturer, and product data sheets shall be included with the submittal for the metalizing procedure. Unless otherwise specified in the Contract, a top coat will not be applied over the seal coat, and therefore the seal coat shall be UV-resistant. The dry film thickness of the sealant shall be 1 to 2 mils. The sealant shall be applied within 8 hours of completing the TSC application.

(e) In addition to the requirements above, the following shall also apply:

(1) QA witnessing of Job Reference Standard(s) is required, when applicable

(2) Companion coupons shall be used in lieu of destructive testing on the work piece, except when a test failure occurs.

(3) Bend tests shall be performed. The tests shall meet the requirements of *AWS C2.23*.

(f) Metalizing that has been damaged shall be repaired in accordance with the requirements of Subsection 726.08.

726.10 CONCRETE STAINING AND SEALING SYSTEMS. Approved Concrete Staining and Sealing Systems shall be one of the Concrete Staining and Sealing Systems on the Agency's *Approved Products List*.

726.11 WATERPROOFING MEMBRANE SYSTEMS. Waterproofing Membrane Systems shall conform the requirements of *ASTM D 6153*, be one of the products listed on the Agency's *Approved Products List*, and meet the following requirements for the respective material specification.

(a) Waterproofing Membrane System, Type I. Waterproofing Membrane System, Type I shall be a Type I cold applied elastomeric system in accordance with *ASTM D 6153*.

(b) Waterproofing Membrane System, Type II. Waterproofing Membrane System, Type II shall be a Type II hot applied elastomeric system in accordance with *ASTM D 6153*.

(c) Waterproofing Membrane System, Type III. Waterproofing Membrane System, Type III shall be a Type III preformed sheet membrane system in accordance with *ASTM D 6153*.

SECTION 727 – FENCING MATERIALS

727.01 WOVEN WIRE FENCE. Woven wire fence shall meet the following requirements:

(a) Woven Wire Fabric for Fencing and Gates. Woven wire fabric shall be rectangular mesh and shall conform to the requirements of *AASHTO M 279,* Class 3 Coating, Design Number 939-6-11 or 939-6-12½. At the option of the Contractor, the woven wire fabric may be aluminum coated and shall conform to the requirements for *AASHTO M 279.*

(b) Barbed Wire. Barbed wire shall conform to the requirements of *AASHTO M 280,* Two-strand, Design Number 12-4-5-14R, Class 3 Coating. The Contractor may also elect to furnish aluminum-coated barbed wire, which shall conform to the requirements of *ASTM A 121,* Class 2 Aluminum Coating.

(c) Wood Posts and Braces. Round wood posts shall be seasoned Red (Norway) Pine or Southern Pine, straight, sound, and cut from live timber.

If round posts are used, they shall conform to the diameter and length shown on the Plans. In all cases, they shall be not less than 4-1/2 inches in diameter at the small end after removal of the bark. They shall be shaved to an even surface and be free from bark or skin.

If sawn posts are used, they shall be rough-sawn and conform to the requirements of Subsection 728.01. The nominal dimensions shall be at least 4 inches square and of the length shown on the Plans.

The types of wood to be used for bracing shall be similar to those required for the posts. The braces shall conform to the dimensions shown on the Plans.

All wood posts and braces shall be pressure treated with a preservative as specified in Subsection 726.01. Any cut portions shall receive a field application in accordance with the requirements of *AWPA M 4-13*.

(d) Steel Posts and Braces. Line posts shall be standard commercial T-Type steel posts conforming to the requirements of *AASHTO M 281*.

End posts, corner posts, pull posts, bracing, and anchor plates shall conform to the requirements of *AASHTO M 281*.

Intermediate posts or line posts shall be provided with an anchor plate having a length and/or width of 4 to 5 inches with a net area of not less than 20 square inches.

All posts, braces, anchors, plates, and other metal fittings shall be zinc coated on all inner and outer surfaces in accordance with the requirements of *AASHTO M 111 M/M 111* or *AASHTO M 232 M/M 232*, whichever is applicable.

(e) Gates. Frames, diagonal tie bars, braces, and hardware for gates shall be zinc-coated on all inner and outer surfaces in accordance with the requirements of *ASTM A 53/A 53 M, AASHTO M 111 M/M 111* or *AASHTO M 232 M/M 232*, whichever is applicable. Woven wire fabric used for gates shall be of the same material used in fences.

(f) Miscellaneous Hardware. Miscellaneous hardware such as, but not limited to, wire, clips, nails, bolts, nuts, washers, hinges, latches, and staples shall be of low to medium carbon steel, galvanized, and shall be of good commercial quality. Staples shall be 0.1483-inch diameter (9-gauge) galvanized wire at least 1-1/2 inches long.

Galvanizing shall be in accordance with the requirements of *AASHTO M 232 M/M 232*, where applicable. Galvanized wire and clips produced from galvanized wire shall have a Class 1 Coating in accordance with the requirements of *AASHTO M 279*.

727.02 CHAIN-LINK FENCE. Chain-link fence shall conform to the requirements of *AASHTO M 181*.

(a) Chain-Link Fabric. Chain-link fabric shall consist of 0.1483-inch diameter (9-gauge) wire woven into a 2-inch mesh. The bottom selvedge of all chain-link fabric shall be knuckled. When the height of the fabric is 4 feet or less, the top edge shall also be knuckled. Polyvinyl chloride-coated fabric shall be Type IV fabric, and when used, the wire shall be 0.1483-inch diameter (9-gauge) prior to coating with the polyvinyl chloride.

Galvanized chain-link fabric shall be Type I, Class D, as specified in *AASHTO M 181*. When the Contract specify a 0.1483-inch diameter (9-gauge) wire woven into a 1-inch mesh, an aluminum-coated steel conforming to the requirements of *AASHTO M 181,* Type II will be allowed.

(b) Posts, Gate Frames, Rails, Braces, and Miscellaneous Hardware. Posts, gate frames, rails, braces, and miscellaneous hardware furnished for use in conjunction with zinc or vinyl coated steel fabric shall be of zinc coated steel. Zinc coated steel shall conform to the requirements of *AASHTO M 181,* Grade 1 or Grade 2.

Posts, gate frames, rails, braces, and miscellaneous hardware shall conform to the requirements of Table 727.02A and Table 727.02B.

TABLE 727.02A – ZINC-COATED STEEL MATERIAL FOR GATE COMPONENTS

Use and Section		Outside Diameter or Dimensions (in.)	Weight Per Foot (lbs)
Gate Posts for Nominal Width of Gate, Single Gate, or One Leaf of Double Gate			
6 feet and less:	Round, Grade 1	2.875	5.80
	Round, Grade 2	2.875	4.64
	Square	2.50 × 2.50	5.70
	Roll Formed	3.50 × 3.50	5.14
Over 6 to 13 feet:	Round, Grade 1	4.00	9.12
	Round, Grade 2	3.50	5.71
	Square	3.00 × 3.00	9.10
Over 13 to 18 feet:	Round, Grade 1	6.625	18.99
Over 18 feet:	Round	8.625	28.58
Gate Frames for Fabric Heights			
Less than 6 feet:	Round, Grade 2	1.660	1.84
	Square	1.50 × 1.50	1.90
6 feet and greater:	Round, Grade 1	1.90	2.72
	Round, Grade 2	1.90	2.28
	Square	2.00 × 2.00	2.10
Over 13 to 18 feet:	Round	6.625	18.97
Other Gate Components			
Top Rails and Brace Rods:	Round, Grade 1	1.660	2.27
	Round, Grade 2	1.660	1.84
	Roll-Formed	1.625 × 1.25	1.34
Truss Rods:	Round with Turnbuckle	0.375	--
Tension Wire:	Wire	0.1483	--
Tension Bars:	Bar	1/4 × 3/4	--

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TABLE 727.02B – ZINC-COATED STEEL MATERIAL FOR POSTS

Use and Section		Outside Diameter or Dimensions (in.)	Weight Per Foot (lbs)
End, Corner, and Pull Post for Fabric Heights			
Less than 6 feet:	Round, Grade 1	2.375	3.65
	Round, Grade 2	2.375	3.12
	Square	2.00 × 2.00	3.60
	Roll Formed	3.50 × 3.50	5.14
6 feet and greater:	Round, Grade 1	2.875	5.80
	Round, Grade 2	2.875	4.64
	Square	2.50 × 2.50	5.70
	Roll Formed	3.50 × 3.50	5.14
Line Posts for Fabric Heights			
Less than 6 feet:	Round, Grade 1	1.90	2.72
	Round, Grade 2	1.90	2.28
	Roll Formed	1.875 × 1.625	5.14
	H-Section	1.875 × 1.625 × 0.113	2.70
6 feet and greater:	Round, Grade 1	2.875	5.80
	Round, Grade 2	2.375	3.12
	Roll Formed	1.875 × 1.625	5.14
	H-Section	2.25 × 1.95 × 0.143	4.10

727.03 BARRIER FENCE. Barrier fence shall be fluorescent yellow or orange, ultraviolet stabilized, high density polyethylene mesh or grid that will not sag, corrode, rot, or conduct electricity.

727.04 PROJECT DEMARCATION FENCE. Project demarcation fence shall be non-adhesive, ultraviolet stabilized, fluorescent yellow or orange vinyl-coated polyester mesh or polyethylene plastic tape that will not sag or tear over time due to natural weather conditions.

727.05 SNOW BARRIER FENCE. Snow barrier fence shall conform to the requirements of *AASHTO M 181* and to the design, dimensions, and details shown on the Plans.

(a) Snow Barrier Fabric. Snow barrier fabric shall consist of 0.1483-inch diameter (9-gauge) wire woven into a 1-inch mesh. The bottom selvedge of all Snow Barrier fabric shall be knuckled. When the height of the fabric is 4 feet or less, the top edge shall also be knuckled.

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When vinyl-coated fabric is used, the wire shall be 0.1483-inch diameter (9-gauge) prior to coating with vinyl. Galvanized Snow Barrier fabric shall be Type I, Class D, as specified in *AASHTO M 181*. When the Contract specifies a 0.1483-inch diameter (9-gauge) wire woven into a 1-inch mesh, an aluminum-coated steel conforming to the requirements of *AASHTO M 181,* Type II will be allowed.

(b) Posts, Gate Frames, Rails, Braces, and Miscellaneous Hardware. Posts, gate frames, rails, braces, and miscellaneous hardware furnished for use in conjunction with zinc- or vinyl-coated steel fabric shall be of zinc-coated steel. Zinc-coated steel shall conform to the requirements of *AASHTO M 181,* Grade 1 or Grade 2.

Posts, gate frames, rails, braces, and miscellaneous hardware shall conform to the requirements of Table 727.02A and Table 727.02B.

727.06 PLANK RAIL FENCE. The plank for rail fence shall be seasoned Red (Norway) Pine or Southern Pine, planed on four sides, and of the dimensions shown on the Plans. Wood shall be pressure treated in accordance with the requirements of Subsection 726.01, Type I, II, III, or IV.

Miscellaneous hardware for plank rail fence such as spikes, lag screws, bolts, nuts, and washers shall conform to the dimensions shown on the Plans. Hardware shall be of low- to medium-carbon steel, galvanized, and shall be of good commercial quality. The metal brackets shall be fabricated from 1/4 inch steel plate and shall be galvanized after fabrication.

SECTION 728 – GUARDRAIL, GUIDE POSTS, AND BARRIERS

728.01 POSTS AND POST ACCESSORIES.

(a) Wood Posts and Offset Blocks for Rail, Guardrail, Barriers, and Guide Posts. Wood posts and offset blocks shall be straight and sound seasoned Red (Norway) Pine or Southern Pine. Red Pine shall meet Number 1 Stress Grade requirements specified by the Northeastern Lumber Manufacturer's Association (NELMA). Southern Pine shall meet Number 2 Stress Grade requirements specified by the Southern Pine Inspection Bureau (SPIB). Preservatives and pressure treatment shall conform to the requirements of *AASHTO M 133* and *AWPA Standard U1*. Inspection and care of treated material shall, at a minimum, conform to the requirements of *AWPA Standard M2, AWPA Standard M3,* and *AWPA Standard M4*.

Material shall be fabricated prior to treatment in conformance with the dimensions and details shown on the Plans.

Material shall be treated with a Type IV preservative as specified in Subsection 726.01.

Field repairs shall be made in accordance with the requirements of *AWPA Standard M4*. Cuts, holes, and damaged areas shall be treated in accordance with the requirements of *AWPA M4*. Bored holes shall be plugged with treated tight-fitting wooden plugs.

Timber material shall be produced in accordance with the requirements of the American Softwood Lumber Standard (ASLS) developed by the American Lumber Standards Committee (ALSC). Acceptable material shall be grade stamped with an appropriate tag or mark identifying conformance with ASLS requirements.

All lumber and timber shall be treated in a plant participating in an independent inspection program designed to provide continuous supervision, testing, and inspection for establishing acceptable quality control. Inspection agencies shall be accredited and overviewed by ALSC and/or the International Accreditation Service (IAS). Material meeting compliance with applicable specifications shall bear the quality mark of the authorized inspection agency.

Tags and marks identifying compliance shall, at a minimum, be placed on each post in a location that will be visible after installation.

Every charge of treated material shall be inspected in accordance with the applicable requirements specified in AWPA Standards. The treater shall perform laboratory analysis for measured penetration and retention of each charge. A copy of each analysis report shall accompany the materials delivered.

It is the responsibility of the producer to arrange for an all-independent inspection process. All inspection costs shall be included in the unit price of the material.

(b) Steel Posts and Post Accessories. Steel posts, offset blocks, splice plates, brackets, channel anchors, and other post accessories shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 250 (Grade 36). They shall conform to the details shown on the Plans. After fabrication, all posts, post accessories, and channel anchors shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(c) Alternative Blockouts. As an alternative to wood or steel blockouts in Subsection 728.01(a) or Subsection 728.01(b), blockouts made of synthetic materials and appearing on the Agency's *Approved Products List* are allowed.

728.02 RAIL ELEMENTS.

(a) Cable Rail. Cable shall conform to the requirements of Subsection 713.03.

(b) Steel Beam and Thrie Beam Rail. Steel beam (W-beam) and Thrie beam rail elements shall conform to the requirements of *AASHTO M 180,* Class A, Type II, Zinc-Coated. When a heavy-duty steel beam is specified, the rail elements shall conform to the requirements of *AASHTO M 180,* Class B, Type II, Zinc-Coated.

(c) Box Beam Rail. Box beam rail shall conform to the requirements of Subsection 714.11. The rail shall conform to the details shown on the Plans as to size and shape and all holes and slots shall be punched, drilled, burned, or cut as indicated. After fabrication, the rail shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(d) Steel-Backed Timber Guardrail. Steel-backed timber for guardrail shall have a minimum allowable bending stress of 1,450 psi. Steel rails and splice plates shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 345 (Grade 50) Steel and shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

728.03 HARDWARE.

(a) Hardware for Cable, Steel Beam, and Thrie Beam Rail. Miscellaneous hardware and fittings such as bolts, nuts, and washers, cable splices, hook bolts, anchor rod assemblies, and cable end units shall conform to the dimensions shown on the Plans. All cable fittings and anchorages shall conform to the requirements of *AASHTO M 30*.

Bolts, nuts, and washers for cable, steel beam, and Thrie beam rail shall conform to the following requirements:

(1) Steel bolts shall conform to the requirements of *ASTM A 307,* Grade A. Steel nuts shall conform to the requirements of *ASTM A 563* and *ASTM A 563 M*. Steel washers shall conform to the requirements of *ASTM F 436/F 436 M* and *ASTM F 844*.

(2) Steel cast bolts, nuts, and washers shall conform to the requirements of *AASHTO M 103 M/M 103* and *ASTM A 27/A 27 M,* Grade 65-35 full-annealed.

All hardware shall be galvanized in accordance with the requirements of *AASHTO M 232 M/M 232*. All bolts, nuts, and washers shall be either hot-dip galvanized in accordance with the requirements of *AASHTO M 232 M/M 232* or mechanically galvanized using a mechanically-deposited process conforming to the requirements of *ASTM B 696,* Class 50.

(b) Hardware for Box Beam Rail. Bolts shall conform to the requirements of *ASTM A 307,* Grade A, nuts shall conform to the requirements of *ASTM A 563* and *ASTM A 563 M*, and washers shall conform to the requirements of *ASTM F 436/F 436 M* and *ASTM F 844*. Bolts, nuts, and washers for rail-splice connections shall conform to the requirements of *ASTM F 3125/F 3125 M,* Grade A 325. All bolts, nuts, and washers shall be either hot-dip galvanized in accordance with *AASHTO M 232 M/M 232* or mechanically galvanized using a mechanically-deposited process conforming to the requirements of *AASHTO M 298,* Class 50.

All bolts, nuts, and washers required to conform to the requirements of *ASTM F 3125/F 3125 M*, Grade A 325, shall meet all requirements of Subsection 714.05, except that the rotational capacity tests, the proof load tests, and the wedge tests will not be required.

(c) Hardware for Steel Backed Timber Guardrail. Bolts and lag screws shall conform to the requirements of *ASTM A 307,* Grade A. Nuts shall conform to the requirements of *ASTM A 563* and *ASTM A 563 M*. Washers shall conform to the requirements of *ASTM F 844*. All fastener hardware shall be galvanized in accordance with the requirements of *AASHTO M 232 M/M 232*.

728.04 THIS SUBSECTION RESERVED.

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728.05 CONCRETE ANCHORS. Precast or cast-in-place concrete anchors for guardrail shall conform to the details shown on the Plans as to the size, shape, and placement of the bar reinforcement.

(a) Concrete Strength. Concrete shall attain a minimum 28-day compressive strength of 4,000 psi when tested in accordance with the requirements of *AASHTO T 22*.

(b) Curing. Concrete anchors shall be subjected to any one of the curing methods specified in *AASHTO M 199 M/M 199*, for a sufficient length of time so that the concrete will develop the specified compressive strength within 28 days.

Bar Reinforcement. Bar reinforcement shall conform to the requirements of Subsection 713.01.

728.06 THIS SUBSECTION RESERVED.

728.07 THIS SUBSECTION RESERVED.

SECTION 729 – CURB MATERIALS

729.01 VERTICAL GRANITE CURB. Vertical granite curb shall consist of hard, durable, quarried granite. It shall be gray in color, free from seams, cracks, or other structural defects, and shall be of a smooth splitting character. The curb may contain natural color variations that are characteristic of the granite source. Granite curb shall meet the requirements of *ASTM C 615/C 615 M*.

(a) Source. The Contractor shall submit for approval the name of the quarry that is the proposed source of the granite for curb materials. Such submission shall be made sufficiently in advance of ordering so that the Engineer may have an opportunity to judge the stone, both as to quality and appearance. Samples of curbing shall be submitted for approval only when requested by the Engineer.

(b) Finish and Surface Dimensions. The individual curb stones shall be of the dimensions shown on the Plans and shall be of uniform thickness in any continuous run. The individual curb stones shall be furnished in minimum lengths of 6 feet.

The top surface of the curb stones shall be sawed to an approximately true plane and shall have no projection or depression greater than 1/8 inch. The bottom surface may be sawn or split.

The top front arris line shall be rounded to a 1/2 inch radius as shown in the Contract. The exposed arris lines shall be pitched straight and true, with no variations from a straight line greater than 1/8 inch.

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The front face shall be at right angles to the plane of the top and shall be smooth quarry split or sawn for the full depth. Drill holes in the exposed part of the face shall not be permitted. The front face shall have no projections greater than 1 inch or depressions greater than 1/2 inch, measured from the vertical plane of the face through the top arris line for 8 inches down from the top. For the remaining distance, there shall be no projections or depressions greater than 1 inch measured in the same manner.

The back surface of the curb stones shall have no projection for 3 inches down from the top which would fall outside of a plane having a batter of one horizontal to three vertical from the back arris line.

The ends of all curb stones shall be square with the planes of the top and front face, and so finished that when the stones are placed end to end as closely as possible, no space more than 1 inch shall show in the joint for the full width of the top or down on the face for 8 inches. The remainder of the end may break back a maximum of 6 inches from the plane of the joint.

Curbing stones to be set on a radius of 80 feet or less shall be cut to the curve required, and their ends shall be cut on radial lines.

729.02 THIS SUBSECTION RESERVED.

729.03 GRANITE SLOPE EDGING. Granite slope edging shall consist of hard, durable, quarried granite. It shall be gray in color, free from seams, cracks, or other structural defects, and shall be of smooth splitting character. The edging may contain natural color variations that are characteristic of the granite source. Granite slope edging shall meet the requirements of *ASTM C 615/C 615 M*.

(a) Source. The Contractor shall submit for approval the name of the quarry that is the proposed source of the granite for edging materials. Such submission shall be made sufficiently in advance of ordering so that the Engineer may have an opportunity to judge the stone, both as to quality and appearance. Samples of edging shall be submitted for approval only when requested by the Engineer.

(b) Finish and Surface Dimensions. The individual edging stones shall be of the dimensions shown on the Plans and shall be of uniform thickness in any continuous run. The individual edging stones shall be furnished in minimum lengths of 2 feet.

The tops and bottoms shall be not under the square more than 4 inches, or over the square at the back more than 1 inch, when so tested.

The exposed face shall be smooth quarry-split or sawed. Drill holes will be permitted on the exposed face, but only along the bottom edge and extending no more than 3 inches upward from the edge. The exposed face shall have no projections or depressions greater than 1 inch, measured from a 24-inch long straightedge placed as closely as possible on any part of the face.

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The ends of all edging stones shall be square with the plane of the exposed face and so finished that when the stones are placed end to end as closely as possible, no space more than 1 inch shall show in the joint for the full depth of the face. The arris lines at the ends shall be pitched with no variation from the plane of the face more than 1/4 inch.

729.04 PRECAST REINFORCED CONCRETE CURB. Precast reinforced concrete curb shall be solid, precast, reinforced units of uniform quality and appearance. All curb shall be cast in steel or concrete forms which will produce a satisfactory surface requiring no further finishing, rubbing, or patching after the forms are removed, except for the removal of flash or excess material along the edges.

Precast reinforced concrete curb shall conform to the following requirements:

(a) Dimensions. The individual precast curb units shall be of the dimensions shown on the Plans and shall be cast in lengths of not less than 3 feet or greater than 10 feet. Random lengths of curb of not less than 3 feet in length may be obtained by sawing regular precast curb, if the Engineer determines it is necessary to meet field conditions. All curbs to be set on a radius of 160 feet or less shall be precast to fit the curve as required.

(b) Marking. Each pour shall be identified with a six-digit registration number (indicating in order the year, month, and day of month) cast in the curb, as well as the name or trademark of the manufacturer and the date of manufacture. A pour shall be considered one day's production.

(c) Materials. The concrete shall conform to the requirements of Section 540, and when sampled and tested in accordance with the requirements of *AASHTO T 22*, shall have a minimum compressive strength of 5,000 psi. Bar reinforcement shall conform to the requirements of Subsection 713.01.

(d) Curing. The precast curb units shall be subjected to any one of the curing methods specified in *AASHTO M 199 M/M 199*, for a sufficient length of time so that the concrete will develop the specified compressive strength at 28 days or less.

729.05 BITUMINOUS CONCRETE CURB. Bituminous concrete curb shall consist of blended aggregate, polyester fibers, performance-graded asphalt binder, and mineral filler if required, combined in such proportions that the resulting mixture conforms to the requirements of Table 406.03A, Type IV, except that the percentage of performance-graded asphalt binder shall be 7% to 9%.

(a) Aggregate. Aggregate for bituminous concrete cub shall conform to the requirements of Subsection 704.10.

(b) Performance-Graded Asphalt Binder. The grade of performance-graded asphalt binder shall be as specified on the Plans or in the Contract and shall conform to the requirements of Section 702.

(c) Polyester Fiber. Polyester fiber shall meet the requirements specified in Table 729.05A.

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TABLE 729.05A – POLYESTER FIBER PROPERTIES

Fiber Property	Value
Denier, *ASTM D 1577*	4.5 ± 1.5
Length (in.)	0.25 ± 0.02
Minimum tensile strength (psi), *ASTM D 2256/ D 2256 M*	70,000
Specific gravity	1.36 ± 0.04
Minimum melting temperature (°F)	475

729.06 TREATED TIMBER CURB. Treated timber curb and stakes shall be either seasoned Red (Norway) Pine, Eastern (Northern) White Pine, or Southern Pine, straight, sound, and cut from live timber. Material shall be fabricated prior to treatment in conformance with the dimensions and details shown on the Plans. The sides of the planks may be either surfaced or rough-sawn. Treatment shall be performed, inspected, tested, and reported in accordance with the requirements of Subsection 728.01(a).

All spikes, fasteners, U-bolts, nuts, and washers for treated timber curb shall conform to the dimensions shown on the Plans. They shall be of low- to medium-carbon steel, either galvanized or corrosion-resistance treated, and shall be of good commercial quality.

SECTION 730 – PILING

730.01 STEEL PILING. Steel piling shall be rolled steel sections of the mass (weight) and shape shown on the Plans. Piles, splice plates, and point reinforcement shall be new material conforming to the requirements of *ASTM A 572/A 572 M,* Grade 345 (Grade 50). When cast steel shoes are used, they shall conform to the requirements of *AASHTO M 103 M/M 103,* Grade 485-275 (Grade 70-40) or *ASTM A 148/A 148 M,* Grade 550-275 (Grade 80-40).

730.02 STEEL SHEET PILING. Steel sheet piling shall be rolled steel sections of the type, shape, and mass (weight) shown on the Plans and shall be capable of being interlocked so that a continuous wall is formed when individual pieces are driven side by side. Permanent steel sheet piling shall be new material conforming to the requirements of *AASHTO M 202 M/M 202*.

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SECTION 731 – BEARING PADS FOR STRUCTURES

731.01 PREFORMED FABRIC BEARING PADS. Preformed fabric bearing pads shall be manufactured from all new materials comprised of multiple layers of prestressed duck impregnated and bound with high quality oil-resistant rubber vulcanized and cured under pressure to form a resilient pad of uniform thickness. The duck material shall have a mass (weight) of at least 8 ounces per square yard with a filling of 50, ± 1, warp threads per 1 inch and a filling of 40, ± 2, woof threads per 1 inch.

The finished product shall have 64 plies per 1 inch of thickness and withstand a compressive load perpendicular to the plane of the laminations of 10,000 pounds per square inch. Load deflection shall not exceed 10% at 1,000 pounds per square inch and the material shall perform effectively in the temperature range of -65°F to 200°F. The test sample for measuring load deflection shall be 2 inches × 2 inches.

Bearing pads over 1/2 inch in thickness may be manufactured by laminating vulcanized sheets together to obtain the designed pad thickness. The number of laminated joints shall not be greater than the values specified in Table 731.01A.

TABLE 731.01A – NUMBER OF LAMINATED JOINTS BY BEARING PAD THICKNESSES

Bearing Pad Thickness (in.)	Number of Laminated Joints Permitted
1/2 to 1	1
1-1/8 to 1-1/2	2
1-5/8 to 2	3
Over 2	4

731.02 BEARING PADS. Bearing pads shall be manufactured from all-new materials comprised of high-quality elastomer with a random distribution of synthetic fibers in proper proportion to maintain strength and stability. The finished product shall withstand a compressive load perpendicular to the plane of laminations of 7,000 psi. The surface shall have a hardness of 80 ± 10 using a Shore A Durometer, in accordance with the requirements of *ASTM D 2240*.

731.03 ELASTOMERIC MATERIAL. Elastomeric material shall conform to the requirements in the latest version of the *AASHTO LRFD Bridge Design Specifications,* Section 18 and *AASHTO M 251*. Unless otherwise shown on the Plans or specified in the Contract, the elastomeric compound shall be virgin crystallization-resistant polychloroprene (neoprene) or virgin natural polyisoprene (natural rubber) as the raw polymer. The raw polymer for a disc shall be based on polyether urethane, using only virgin materials. The resulting product shall be free of porous areas, weak sections, bubbles, foreign matter, or other defects affecting serviceability.

Unless noted otherwise, elastomer shall have a design hardness of 50 points and a design shear modulus of 110 psi.

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Testing of elastomeric material shall be waived for bearings that will be encased in concrete in the final work. All other bearings shall be tested in accordance with Table 731.03A.

TABLE 731.03A – ELASTOMERIC MATERIAL TEST PARAMETERS

Material Property	Test Method	Required Result
Hardness	*ASTM D 2240*	Design hardness, ± 5 points
Shear modulus	*ASTM D 412* with *AASHTO M 251,* Subsection 8.8.4	Design shear modulus, 15%
Low temperature brittleness	*ASTM D 746,* Procedure B	Pass grade 4 test
Shear bond strength	*AASHTO M 251,* Annex A2 or Appendix X2	Pass
Minimum tensile strength	*ASTM D 412*	2,250 psi
Minimum ultimate elongation	*ASTM D 412*	(650 - 5 × design hardness) %

731.05 STAINLESS STEEL. Stainless steel shall conform to the requirements in the latest versions of *AASHTO LRFD Bridge Design Specifications,* Section 14 and *AASHTO LRFD Bridge Construction Specifications,* Section 18.

Stainless steel used as a mating surface with polytetrafluoroethylene (PTFE) material and incorporated in bearing devices shall conform to the requirements of *ASTM A 240/A 240 M,* Type 304.

731.07 BRASS RINGS. Brass sealing rings shall conform to the requirements of *AASHTO LRFD Bridge Design Specifications,* Subsections 14.7.4.5.2 and 14.7.4.5.3 and *AASHTO LRFD Bridge Construction Specifications,* Section 18. Brass sealing rings shall conform the requirements of *ASTM B 36/B 36 M* (Half Hard) for rings with a rectangular cross-section and *ASTM B 121/B 121 M* for rings with a circular cross-section.

731.08 PTFE MATERIAL. Polytetrafluoroethylene (PTFE) material incorporated in bearing devices shall be all-new material with a minimum thickness of 1/8 inch and conforming to the requirements of *AASHTO LRFD Bridge Design Specifications*, Subsection 14.7.2 and *AASHTO LRFD Bridge Construction Specifications*, Section 18.

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SECTION 732 – RAILING MATERIALS

732.01 METAL HAND RAILING. Material for metal hand railing and sleeves shall conform to the requirements of *ASTM A 53/A 53 M*.

732.02 ALUMINUM BRIDGE RAILING.

(a) Aluminum Alloy. Aluminum alloy for aluminum bridge railing, including hand railing, shall conform to the requirements of Subsection 715.04.

(b) Stainless Steel Bolts, Nuts, Washers, and Set Screws. Bolts and washers for post, rail, and offset block connections shall conform to the requirements of *ASTM F 593,* Alloy Group 1, Condition AF, Alloy 304 and its supplementary requirements for *S5*.

Nuts shall conform to the requirements of *ASTM F 836 M,* Property Class A1-50, Condition AF, Alloy 304 and *ASTM F 594,* Alloy Group 1, Condition AF, Alloy 304.

Stainless steel set screws for use in aluminum bridge railing connections shall conform to the requirements of *ASTM F 880* and *ASTM F 880 M,* Property Class A1-70, Condition CW, Alloy 304 and *ASTM F 880* and *ASTM F 880 M,* Alloy Group 1, Condition CW, Alloy 304.

Stainless steel anchor bolts and washers shall conform to the requirements of *ASTM F 593,* Alloy Group 1, Condition CW, Alloy 304. Heavy hex stainless steel nuts for stainless steel anchor bolts shall conform to the requirements of *ASTM F 836 M,* Property Class A1-70, Condition CW, Alloy 304 and *ASTM F 594,* Alloy Group 1, Condition CW, Alloy 304.

(c) Structural Carbon Steel. Structural carbon steel for anchor channel bars, approach railing posts, offset brackets, and anchor bolt sleeve bases shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 250 (Grade 36) or *ASTM A 36/A 36 M.*

(d) Steel Pipe. Steel pipe for anchor bolt sleeves shall conform to the requirements of Subsection 740.05.

(e) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

(f) Fabric Pads. Fabric pads for aluminum posts shall conform to the requirements of Subsection 731.01 or Subsection 731.02.

(g) Aluminum Impregnated Caulking Compound. Aluminum impregnated caulking compound shall conform to the requirements of Subsection 707.13.

732.03 GALVANIZED BOX BEAM BRIDGE RAILING.

(a) Structural Steel Tubing. Tubing for posts and rails shall conform to the requirements of *ASTM A 500/A 500 M,* Grade B, except as modified below:

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(1) General Requirements for Rail and Post Sections.

a. The manufacturer shall test both welded and formed tubular material for the physical properties specified. Results of all tests shall be submitted with material certifications.

b. Welds shall be sound, free from defects, and have no repairs. Transverse mill welds will not be permitted.

c. Longitudinally-welded tubing shall have a tensile strength of 58,000 psi when tested in accordance with the requirements of *ASTM E 8/E 8 M*.

d. A traceable identification number shall be placed on each piece of material in a form that can be read after the galvanizing process.

(2) Post Sections.

a. Post and baseplate material shall meet the requirements of *ASTM A 572/A 572 M,* Grade 50 and shall be tested for impact properties in accordance with the requirements for Charpy Impact Testing in *ASTM A 370*, using a Type A specimen.

b. Sampling procedures shall be conducted in accordance with the requirements of *AASHTO T 243 M/T 243* using Frequency "H" testing.

c. Full size 3/8 inch × 3/8 inch specimens shall be used whenever thickness permits. Sub-size specimens may be used when material thickness is less than 3/8 inch.

d. To qualify, the average energy absorbed by a full-size specimen shall be not less than 25 foot-pound force at 40°F. The average energy absorbed by a sub-sized specimen shall be prorated for the actual thickness of the specimen.

(3) Rail Sections.

a. Rail section materials shall be tested in accordance with the requirements of *ASTM E 436*. Test samples shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111* prior to testing.

b. Sampling procedure shall be in accordance with the requirements of *AASHTO T 243 M/T 243* with one test (a set of three specimens) for each heat.

c. Tests shall be conducted at a temperature of 0°F, without removing the galvanizing.

d. Specimens shall be 2 inches × 9 inches supported at a span of 7 inches.

e. The percent shear area shall be determined from testing nine specimens, three from each of three sides not containing a weld.

f. The final percent shear area shall be an average of the two sides having the highest average shear value.

g. The minimum average shear area shall be 50%.

h. If any *ASTM E 436* test averages between 30% and 50% shear, the manufacturer will be permitted to retest the heat. For each original heat test, three sets of nine specimens shall be retested. For the heat to be accepted, each set must show a minimum average shear of 50% for the two best sides.

(b) Structural Carbon Steel. Structural carbon steel for anchor plates shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 250 (Grade 36) or *ASTM A 36/A 36 M*. Structural carbon steel for angles and splice plates shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 345 (Grade 50) or *ASTM A 572/A 572 M*.

(c) Bolts, Nuts, and Washers. Bolts, nuts, and washers for railing and rail-to-post connections shall conform to the requirements of Subsection 714.04. Lock washers shall be high-carbon heat-treated spring steel conforming to the requirements of *ASME D18.2*.

(d) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

732.04 STEEL BEAM BRIDGE RAILING.

(a) Beam Guardrail. Beam guardrail for bridge railing shall conform to the requirements of Subsection 728.02. The beam guardrail shall be Class B type.

(b) Steel Posts and Components. Posts, baseplates, offset blocks, brackets, washers, and other steel components shall be structural carbon steel conforming to the requirements of the following Standards: *AASHTO M 270 M/M 270,* Grade 345W (Grade 50W), *ASTM A 588/A 588 M, ASTM A 572/A 572 M,* Grade 345 (Grade 50), or *AASHTO M 270 M/M 270,* Grade 345 (Grade 50).

(c) Steel Pipe. Steel pipe for anchor bolt sleeves shall conform to the requirements of Subsection 740.05.

(d) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

SECTION 735 – INSULATING MATERIALS

735.01 POLYSTYRENE INSULATION BOARD. Polystyrene insulation board shall conform to the requirements of *AASHTO M 230*. It shall be furnished in nominal 2-foot x 8-foot boards and shall be of the thickness, compressive strength, and density as shown on the Plans.

735.02 BLANKET INSULATION MATERIAL. Blanket insulation material shall consist of mats of fiberglass, rock wool, balsam wool, or other approved insulating materials completely enclosed on all sides within weatherproof facings of reinforced, coated, Kraft paper or polyethylene sheeting.

The thermal conductivity of the blanket insulation material shall not exceed 0.27 BTU-inch per hour per square foot per degree Fahrenheit at a mean temperature of 75°F.

SECTION 740 – WATER LINES AND APPURTENANCES

740.01 PLASTIC PIPE, FLEXIBLE. Flexible plastic pipe shall be polyethylene plastic pipe suitable for the transportation of potable water and shall conform to the requirements of *AWWA C 901*. The material grade selected shall be capable of withstanding a minimum sustained water pressure of 160 psi at 73°F. The pipe shall be inside-diameter controlled. Fittings may be either nylon, copper, or bronze. Clamps shall be stainless steel.

740.02 PLASTIC PIPE, RIGID (PVC). Rigid PVC plastic pipe shall be suitable for the transportation of potable water and shall conform to the requirements of *ANSI/AWWA C 900*. The material grade selected shall be capable of withstanding a minimum sustained water pressure of 160 psi at 73°F. Fittings shall be PVC plastic conforming to the requirements of *AWWA C 907*.

740.04 COPPER TUBE, SEAMLESS. Seamless copper water tube shall conform to the requirements of *ASTM B 88* and *ASTM B 88 M,* Type K.

740.05 STEEL PIPE, GALVANIZED. Galvanized steel pipe shall be suitable for the transportation of potable water and shall be the standard weight class conforming to the requirements of *ASTM A 53/A 53 M*.

740.06 THIS SUBSECTION RESERVED.

740.07 DUCTILE IRON PIPE, CEMENT LINED. Ductile iron pipe shall be cement-lined and centrifugally cast in metal- or sand-lined molds. The pipe shall conform to the requirements of *ANSI/AWWA C 151/A 21.51* and the cement mortar lining shall conform to the requirements of *AWWA C 104/A21.4*. The class of pipe shall be as specified in the Contract.

740.08 PIPE INSULATION. Thermal insulation for pipes shall be preformed to fit standard pipe sizes and may be supplied as either hollow cylindrical shapes (split in half lengthwise) or as curved segments. Insulation shall include all accessories complete with proper jackets or facings as required by the conditions. Multilayer insulation is acceptable provided the inside and outside diameters of each layer will ensure proper nesting.

The thermal conductivity of the insulation material shall not exceed 0.27 BTU-inch per hour per square foot per degree Fahrenheit at a mean temperature of 75°F as determined in accordance with the requirements of *ASTM C 177* or *ASTM C 518*.

The thickness and jackets shall be as specified in the Contract.

Pipe insulation used as bond breakers for structures shall meet the requirements of *ASTM C 534/C 534 M*.

740.09 THIS SUBSECTION RESERVED.

740.10 THIS SUBSECTION RESERVED.

740.11 THIS SUBSECTION RESERVED.

740.12 THIS SUBSECTION RESERVED.

740.13 THIS SUBSECTION RESERVED.

740.14 THIS SUBSECTION RESERVED.

SECTION 741 – THIS SECTION RESERVED

SECTION 742 – DISINFECTANTS

742.01 CHLORINE SOLUTION. Chlorine solution used for disinfecting springs, wells, and other water systems shall consist of a solution of water and liquid chlorine, sodium hypochlorite, calcium hypochlorite, or chloride of lime.

Liquid forms of chlorine or sodium hypochlorite and powder forms of calcium hypochlorite or chloride of lime shall be used according to the instructions supplied by the manufacturer and as recommended by the Vermont Department of Health.

If sodium hypochlorite is already in solution as a laundry bleach containing 5.25% sodium hypochlorite, it shall be used at the rate of one part per 12,000 parts of water to be disinfected. The dosage should be sufficient to produce a chlorine taste in the water.

742.02 SPACE DEODORIZER. Space deodorizer shall consist of a commercial liquid concentrate that, when applied at the dilution ratio recommended by the manufacturer, will suppress the obnoxious odors produced by the material to which it is applied. The deodorizer shall be nontoxic and nonirritating. It shall be approved by the Engineer before use.

SECTION 745 – WATER

745.01 WATER. All water used shall be clear and free of harmful amounts of oil, salt, acids, alkalis, sugar, organic matter, or other substances injurious to the finished product, plant life, or the establishment of vegetation.

Where the source of water is relatively shallow, the intake shall be maintained at such a depth and so enclosed as to exclude silt, mud, grass, and other foreign materials.

No formal tests of water will be made unless the Engineer questions the quality of the water. Water known to be of potable quality may be used without tests.

Mixing water for concrete or mortar shall meet the requirements of *ASTM C 1602/C 1602 M*.

SECTION 746 – CALCIUM CHLORIDE

746.01 CALCIUM CHLORIDE. Calcium chloride shall conform to the requirements of *AASHTO M 144*. Calcium chloride Type S Grade 1, Type S Grade 3, or Type L brine, as defined in *ASTM D 98*, may be used.

SECTION 747 – THIS SECTION RESERVED

SECTION 750 – TRAFFIC SIGNS

750.01 SIGN POSTS.

(a) Steel Posts and Anchors. Steel posts and anchors shall conform to the following requirements:

(1) Structural steel tubing shall conform to the requirements of Subsection 714.11. Steel posts consisting of standard rolled steel structural shapes shall conform to the requirements of *AASHTO M 270 M/M 270,* Grade 250 (Grade 36). After fabrication, these posts shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(2) Steel posts consisting of flanged channels shall conform to the mechanical requirements of *ASTM A 499,* Grade 60 and the chemical requirements of *ASTM A 1,* 85 to 114 lbs/yard Rail Class. Steel posts shall conform to the details indicated on the plans as to size, shape, weight, hole punching, hole drilling, and other details. After fabrication, these posts shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(3) Steel posts and anchors consisting of welded mechanical square tubes formed from hot-rolled carbon steel sheet shall conform to the mechanical and chemical requirements of *ASTM A 1011/A 1011 M,* Grade 380 (Grade 55) or Grade 245 (Grade 40). They shall conform to the details indicated on the Plans as to size, shape, weight, hole punching, hole drilling, strength, and other details.

The posts shall be fabricated in accordance with the requirements of *ASTM A 787/A 787 M,* Type 2, and shall be galvanized with a G140 Coating in accordance with the requirements of *ASTM A 653/A 653 M*. Alternatively, the posts shall be fabricated in accordance with the requirements of *ASTM A 787/A 787 M,* Type 3, and shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

(b) Aluminum Posts. Aluminum posts shall conform to the requirements of *ASTM B 308/B 308 M,* Alloy 6061-T6 for structural shapes, rolled or extruded, and *ASTM B 221* and *ASTM B 211 M* for extruded tubes. They shall conform to the details shown on the Plans as to size, shape, and mass (weight), and they shall be punched or drilled as shown on the Plans.

(c) Wood Posts. Wood posts shall be seasoned, straight, and sound sawn timber comprised of either Oak, Cedar, Spruce, Western Fir, or other approved wood. The posts shall conform to the dimensions and grade shown on the Plans or requirements specified in the Contract.

All wood posts shall be pressure-treated with preservative as specified in Subsection 726.01. All cut ends or notches shall be field-treated in in accordance with the requirements of *AWPA M4*. Depending on size and location, wood posts may have to be drilled as shown on the Plans.

(d) Sleeves. Sleeves for sign posts consisting of structural tubing shall conform to the requirements of *ASTM A 501/A 501 M*. They shall conform to the details shown on the Plans as to size, shape, and mass (weight), and they shall be punched or drilled as shown on the Plans. After fabrication, all steel sleeves shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*.

750.02 EXTRUDED ALUMINUM PANELS. Extruded aluminum panels shall conform to the requirements of *ASTM B 221* and *ASTM B 221 M*. Alloy 6063-T6 shall be used when reflective sheeting is to be applied to the face of the sign.

750.03 FLAT SHEET ALUMINUM. Flat sheet aluminum shall conform to the requirements of *ASTM B 209/B 209 M* for either Alloy 6061-T6 or Alloy 5052-H38. Aluminum components shall not be in direct contact with treated wood posts.

750.04 GALVANIZED FLAT SHEET STEEL. Galvanized flat sheet steel shall conform to the requirements of *ASTM A 606/A 606 M*. Structural steel shapes and welded sections shall conform to the requirements of *ASTM A 242/A 242 M*. The steel shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111* and *ASTM A 123/A 123 M*. The galvanized steel shall be given a light and tight phosphate coating by continuous mill process having not less than 100 milligrams per square foot of area.

750.05 FORMED GALVANIZED STEEL PANELS. Formed galvanized steel panels shall conform to the requirements of *ASTM A 606/A 606 M* or *ASTM A 1008/A 1008 M* and *ASTM A 1011/A 1011 M,* Grade 310 (Grade 340). The panels shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*. The galvanized panels shall be given a light and tight phosphate coating by continuous mill process having not less than 100 milligrams per square foot of surface area.

750.06 THIS SUBSECTION RESERVED.

750.07 THIS SUBSECTION RESERVED.

750.08 RETROREFLECTIVE SHEETING. Retroreflective sheeting shall conform to the applicable requirements of *AASHTO M 268*, with the following exceptions:

(a) Packaging Requirements. Retroreflective sheeting shall be furnished in both rolls and sheets. The packaging in which the sheeting is shipped shall protect the sheeting from damage and/or distortion in accordance with commercially acceptable standards and shall be suitable for storing the sheeting until it is used.

When retroreflective sheeting is furnished in continuous rolls, the material shall have a maximum of three splices in any 50 yards of length. Splices shall be butted or overlapped and shall be suitable for continuous application.

When stored under normal conditions, the retroreflective sheeting shall be suitable for use for a period of at least one year after purchase.

(b) Classification. Retroreflective sheeting (white or colored) shall meet the requirements of *AASHTO M 268* and the *ASTM D 4956* classifications below.

(1) Type III. A high-intensity retroreflective sheeting typically referred to as "high intensity."

(2) Type IV. A high-intensity retroreflective sheeting typically referred to as "micro-prismatic retroreflective element material."

(3) Type V. A super-high-intensity retroreflective sheeting.

(4) Type VI. An elastomeric high-intensity retroreflective sheeting without adhesive. This is a vinyl material commonly used for traffic cone collars, post bands, etc.

(5) Type VII. A super-high-intensity retroreflective sheeting having the highest retroreflectivity characteristics at long and medium road distances. This sheeting is typically an unmetallized micro-prismatic retroreflective element material.

(6) Type VIII. A super-high-intensity retroreflective sheeting having the highest retroreflectivity characteristics at long and medium road distances.

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(7) Type IX. A very-high-intensity retroreflective sheeting having highest retroreflectivity characteristics at short road distances.

(c) Retroreflective Requirements. Retroreflective sheeting shall meet or exceed the minimum brightness and color requirements of *AASHTO M 268*.

(d) Color. Silver is an acceptable designation for white.

(e) Physical Requirements. Retroreflective sheeting shall meet the physical requirements of *AASHTO M 268*.

750.09 DEMOUNTABLE CHARACTERS. Individual letters, digits, symbols, and borders as shown on the Plans for the text of the sign shall be shaped from sheet aluminum with a thickness of 0.04 inch conforming to the requirements of *ASTM B 209* and *ASTM B 209 M,* Alloy 3003-H12.

All characters with a stroke width of 3/4 inch or less shall be supplied with sealed edges.

750.10 PLASTIC LETTERING FILM. Plastic lettering film and pre-coated adhesive shall be fabricated in accordance with the requirements of *AASHTO M 268*.

750.11 EXTRUDED ALUMINUM MOLDING. Extruded aluminum molding to be used with extruded aluminum panel signs shall conform to the requirements of *ASTM B 221* and *ASTM B 221 M,* Alloy 6063-T6. Moldings shall be finished with baked-on enamel or sheeting of the color shown on the Plans for the background of the sign. The molding shall be extruded in the standard commercial form to fit the type of extruded aluminum panel used.

750.12 ASSEMBLY HARDWARE. Unless otherwise shown on the Plans, the assembly hardware used to fasten and support traffic sign components shall conform to the designs and sizes used in standard commercial practices for the materials involved.

(a) Bolts, Nuts, and Washers. Bolts and washers shall be stainless steel conforming to the requirements of *ASTM F 593,* Alloy Group 1, Condition AF, Alloy 304, and its supplementary requirements for S5. Nuts shall be stainless steel conforming to the requirements of *ASTM F 594,* Alloy Group 1, Condition AF, Alloy 304, and its supplementary requirements for S5.

(b) Rivets. Rivets shall be of aluminum conforming to the requirements of *ASTM B 316/B 316 M,* Alloy 6053-T61.

(c) Clips. Clips used to fasten extruded aluminum panels to the supporting posts shall be of aluminum conforming to the requirements of *ASTM B 108/B 108 M*, Alloy 356-T6.

Clips used to fasten formed galvanized steel panels to the supporting posts shall be of aluminum conforming to the requirements of *ASTM B 221* and *ASTM B 221 M,* Alloy 6063-T6. Clips may also be fabricated from steel conforming to the requirements of *ASTM A 242*, and then galvanized in accordance with the requirements of *AASHTO M 232 M/M 232* and *ASTM A 153/A 153 M*.

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SECTION 751 – DELINEATORS

751.01 DELINEATOR POSTS.

(a) Steel Posts and Anchors. Steel posts, anchors, and sleeves shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111* after fabrication, and shall conform to the following additional requirements:

(1) Steel posts fabricated as flanged channels shall conform to the mechanical requirements of *ASTM A 499,* Grade 60 and the chemical requirements of *ASTM A 1,* 85 to 114 lbs/yard Rail Class.

(2) Steel posts and anchors fabricated as welded mechanical square tubes formed from hot-rolled carbon steel sheet shall conform to the mechanical and chemical requirements of *ASTM A 1011/A 1011 M,* Grade 380 (Grade 55) or Grade 245 (Grade 40). The posts may be fabricated in accordance with the requirements of *ASTM A 787/A 787 M,* Type 2, and galvanized with a G140 Coating in accordance with the requirements of *ASTM A 653/A 653 M.* Alternatively, the posts may be fabricated in accordance with the requirements of *ASTM A 787/A 787 M,* Type 3.

(b) Flexible Delineators. Flexible delineators shall be listed on the Agency's *Approved Products List* and conform to the types shown on the Plans.

(c) Sleeves. Sleeves for sign posts consisting of structural tubing shall conform to the requirements of *ASTM A 501/A 501 M.*

751.02 THIS SUBSECTION RESERVED.

751.03 THIS SUBSECTION RESERVED.

751.04 THIS SUBSECTION RESERVED.

751.05 THIS SUBSECTION RESERVED.

751.06 ASSEMBLY HARDWARE. Unless otherwise shown on the Plans, the assembly hardware used for connecting the components of the housing, and for fastening delineators and plaques to posts shall conform to the following requirements:

(a) Bolts and Nuts. Bolts and nuts shall be fabricated from aluminum conforming to the requirements of *ASTM B 211* and *ASTM B 211 M,* Alloy 2024-T4. Both bolts and nuts shall be given another coating at least 0.2 mil in thickness with dichromate or boiling water seal.

(b) Washers. Washers shall be fabricated from aluminum conforming to the requirements of *ASTM B 209* and *ASTM B 209 M,* Alloy 2024-T4.

751.07 THIS SUBSECTION RESERVED.

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751.08 DETECTABLE WARNING SURFACE. Acceptable detectable warning surfaces shall be those detectable warning surface products included on the Agency's *Approved Products List*.

SECTION 752 – TRAFFIC CONTROL SIGNALS

752.01 PEDESTAL POSTS AND BASES. Steel posts shall utilize cast iron bases; aluminum posts shall utilize cast aluminum bases.

(a) Pedestal Posts.

(1) Steel Posts. Steel posts shall consist of 4-1/2 inch outside diameter galvanized steel pipe conforming to the dimensional requirements of *ASTM A 501/A 501 M* or *ASTM A 53/A 53 M,* Type S, Grade B Standard Weight. Galvanizing shall be in accordance with the requirements of *AASHTO M 111 M/M 111 and ASTM A 123/A 123 M*. The post shall have no taper and shall be threaded at the lower end to fit the base.

(2) Aluminum Posts. Aluminum posts shall consist of 4-1/2 inch outside diameter aluminum structural pipe conforming to the requirements of *ASTM B 429/B 429 M,* Alloy 6063-T6. Posts shall have no taper and shall be threaded at the lower end to fit the base.

(b) Bases.

(1) Cast Iron Bases. Cast iron bases shall conform to the requirements of *AASHTO M 105,* Class 20 or higher. Galvanized cast iron bases shall conform to the requirements of *ASTM A 126,* Class A. Galvanizing shall be in accordance with the requirements of *AASHTO M 111 M/M 111 and ASTM A 123/A 123 M.* Bases shall be galvanized by the same procedure used for steel posts and may be galvanized with the posts.

(2) Cast Aluminum Bases. Cast aluminum bases shall conform to the requirements of *ASTM B 26/B 26 M* or *ASTM B 108/B 108 M,* Alloy SG70A-T6.

752.02 STRAIN POLES.

(a) Wood Poles. Wood poles for span wire-mounted signal heads shall be either Douglas Fir, Southern Pine, or Western Red Cedar. The poles to be used shall be Class 3 and shall be a minimum of 35 feet in length, unless otherwise specified. Wood poles shall meet the requirements of *ANSI 05.1, Wood Poles – Specifications and Dimensions.*

(1) Quality. Outer bark shall be completely removed from all poles. No patch or inner bark more than 1 inch wide and 6 inches long shall be left on the pole surface between the top and 24 inches below the ground-line.

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All poles shall be neatly sawed at the top and at the butt along a plane which shall not be out of square with the axis of the pole by more than one unit per six units of diameter of the sawed surface. Beveling of not more than 8.33% of the butt diameter in width is permitted at the edge of the sawed butt surface, or an equivalent area asymmetrically located.

Completely overgrown knots, rising more than 1 inch above the pole surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 1 inch high need not be trimmed. Trimming may be done by a shaving machine or by hand.

(2) Dimensions. The dimensions for the poles required shall be not more than 3 inches shorter or more than 6 inches longer than the nominal length. The lengths shall be measured between the extreme ends of the pole.

The minimum circumference at 6 feet from the butt shall be 36 inches for Western Red Cedar and 34 inches for Douglas Fir and Southern Pine. The minimum circumference at the top of the pole shall be 23 inches for both Western Red Cedar and Southern Pine. The circumference at 6 feet from the butt of the pole shall be not more than 7 inches larger than the specified minimum. The top circumference requirements shall remain 23 inches at a point corresponding to the minimum length permitted for the pole.

The true circumference class shall be determined as follows: Measure the circumference at 6 feet from the butt. This dimension will determine the true class, provided its top (measured at the minimum length point) is large enough. Otherwise, the circumference at the top will determine the true class, provided the circumference at 6 feet from the butt does not exceed the specified minimum by more than 7 inches.

(3) Preservative Treatment. All wood posts shall be treated over their full length in accordance with the requirements of Subsection 726.01, using Type I, II, III, or IV preservatives.

(b) Steel Poles and Baseplates. Steel poles shall consist of tapered tubular shafts or a series of two to three different diameter pipes welded together with baseplates. The shafts shall conform to the requirements of *ASTM A 500/A 500 M,* Grade B. The metal thickness shall be not less than 1/4 inch for tapered poles and not less than 0.30 inch for the bottom section of multiple pipes. The steel poles shall withstand the stringing tension of the span wire with its signal load without exceeding a deflection of 6 inches and a bending stress limit of 66% of yield strength.

The tapered shafts shall be formed, welded, and longitudinally cold-rolled under sufficient pressure to flatten the weld and form a smooth tapered tube. A reinforced hand hole at least 4 inches × 6 inches, complete with cover, shall be provided in the pole approximately 18 inches above the base and located at 90° to the span wire on the side away from approaching traffic. A lip shall be provided around the handhole opening to prevent the cover from tipping and falling inside the hole.

Stainless steel machine screws shall be provided for attaching the handhole cover. A steel cap shall be provided for the top of each pole with provision for an overhead wire entrance when needed. Stainless steel machine screws shall be provided for securely fastening the cap to the top of the pole.

A 2 inch blind half-coupling shall be welded through the side of the shaft 6 to 12 inches below the span wire attachment height.

A grounding nut shall be located inside the shaft easily accessible from the handhole. Each steel strain pole and the neutral or common grounding electrode conductor shall be bonded to a soft-drawn, bare copper wire with a cross-sectional area of No. 6 AWG. The No. 6 AWG soft-drawn, bare copper wire shall be connected to grounding electrodes which will be driven at each strain pole or steel pole with mast arms location.

The baseplate shall be of adequate shape and size to carry the full bending moment of the pole at its yield point and shall consist of a heat-treated cast steel conforming to the requirements of *AASHTO M 103 M/M 103* and *ASTM A 27/A 27 M* or steel plate conforming to the requirements of *ASTM A 36/A 36 M.*

The baseplate shall be attached to the shaft by two continuous electric welds, one inside the base at the end of the shaft and the other on the outside at the top of the base. The design shall be such that the welded connection shall develop the full strength of the adjacent shaft section.

After fabrication, the shaft and baseplates shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111 and ASTM A 123/A 123 M* and shall have a flat black powder coat finish in accordance with the requirements of Subsection 753.07 unless otherwise specified.

Pole diameter, height, yield strength, and wall thickness shall be stamped on a metal tag attached near the hand hole. If stepped poles are used, the stamping shall indicate the equivalent tapered pole.

752.03 TRAFFIC SIGNAL POLES WITH MAST ARMS OR BRACKET ARMS.

(a) Steel Poles and Baseplates. Steel poles shall be fabricated from tapered tubular shafts with baseplates and shall conform to the requirements of *ASTM A 595/A 595 M,* Grade A or *ASTM A 1011/A 1011 M,* Grade 50. The minimum wall thickness shall be not less than 0.179 inch (7-gauge).

(b) Cantilever Mast Arms. Material for the mast arms shall conform to the requirements of Subsection 752.02(b) fabricated either as a tapered tube or multi-diameter pipe with a minimum metal thickness of 0.179 inch (7-gauge). Both types shall have a flange plate welded on the large end for attaching to the vertical pole. A removable cap shall be attached to the far end. Wire outlets with rubber grommets shall be provided for each indicated signal or related equipment location.

(c) Aluminum Poles, Bases, and Mast Arms. Aluminum poles with anchor bases and mast arms shall conform to the requirements of Subsection 753.06.

(d) Luminaire Bracket Arms. Luminaire bracket arms shall be the same type of material as the upright support. Luminaire Bracket Arms shall conform to the requirements of Subsection 753.04. The bracket arms shall be either truss or tapered tubes as shown on the Plans. The main member of a truss-type arm shall be an oval shaped tapered tube securely joined by means of vertical struts to its companion member.

(e) Identification. Pole and mast arm diameter, height/length, yield strength, and wall thickness shall be stamped on a metal tag attached near the hand hole. Cantilever arm dimensions, length, and diameter/wall thickness shall also be included on the tag. If stepped poles are used, the stamping shall also indicate the equivalent tapered pole/arm.

752.04 SPAN WIRE. Span wire shall consist of 3/8-inch diameter galvanized steel cable conforming to the requirements of *ASTM A 475*, Class A Coating, seven wire strand, utilities grade. The signal cable shall be attached to the span wire with a stainless alloy 18-gauge lashing (spinning) wire.

752.05 TRAFFIC SIGNAL HEADS. Traffic signal heads shall be self-contained assemblies that are expandable and adjustable. The signal heads may contain one or more signal faces as shown on the Plans. All traffic signal lenses shall be 12 inches in diameter, unless otherwise shown on the Plans.

Each traffic signal face shall consist of a specific number of signal sections rigidly fastened together in such a manner as to be watertight and dustproof. It shall be possible to assemble one or more signal faces into a multidirectional traffic signal head.

The components of the signal head; consisting of housings, doors, visors, optical units (lenses, reflectors, lamp sockets, and lamps), wiring, trunnions and brackets, shall conform to the latest requirements of the *ITE Technical Report, Adjustable Face Traffic Control Signal Head Standards.* Standard 8,000-hour traffic signal lamps shall be used, unless otherwise specified. The Contractor shall use 116 W lamps in 12 inch units, unless otherwise specified. Lamp socket lead wires shall be stranded. The Contractor shall use 135 W lamps with internal reflector and 1,750 rated initial lumen output for those faces having arrow lenses.

The components of the signal head shall be rigidly constructed of a diecast aluminum alloy in accordance with the requirements of *ASTM B 85/B 85 M,* Alloys S-12A, S-12B, SC-84A, SC-84B, or SG-100B or polycarbonate with a smooth outer surface and shall be capable of holding the optical units securely in place.

(a) Polycarbonate Signal Heads. When a polycarbonate signal head is utilized, it shall conform to the following requirements:

(1) Housing. The housing of each section shall be a one-piece polycarbonate resin material with front, sides, top, and bottom integrally molded. Two sets of internal bosses shall be provided in each section for mounting of terminal strip facilities. The terminal bosses shall have threaded inserts sonically welded into each boss. Signal housings shall be flat black unless otherwise noted in the Plans. The housing door of each signal section shall be of the same material and color as the housing.

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(2) Housing Door. The housing door of each signal section shall be of the same material as the housing.

(b) Aluminum or Polycarbonate Traffic Signals. For either aluminum or polycarbonate traffic signals, all requirements of the *ITE Technical Report, Adjustable Face Vehicular Traffic Control Signal Head Standards* shall be met as well as the following additional requirements:

(1) Optical System. The optical system shall be an LED with a polycarbonate lens (red, yellow, or green) with a nominal size of 8 or 12 inches unless otherwise noted in the Plans. The optical system shall include dimming capabilities and shall comply with the current version of the applicable ITE or pedestrian LED Signal Supplement or Module.

The manufacturer's name, trademark, serial number, and other necessary identification shall be permanently marked on the back of the module. A label shall also be placed on the module certifying compliance with these specifications.

(2) Wiring. Terminal blocks shall be placed in the center of a three-section signal, unless otherwise specified, and shall be a five-position, ten-terminal, barrier-type strip with the following terminal designations clearly marked "R-A-G-RC-AC." The terminal blocks shall be secured on both ends.

(3) Visors. Each signal door shall be equipped with a tunnel or cutaway-type polycarbonate resin visor dura-locked at four points to the door. The type shall be as shown on the Plans. Visors shall be painted or colored flat black unless otherwise noted on the Plans.

(4) Traffic Signal Backplates. All backplates shall be louvered and painted or colored flat black.

752.06 TRAFFIC SIGNAL CONTROLLERS AND CABINETS.

(a) General. To prevent the State from becoming a testing ground for newly developed traffic signal equipment, it is required that the manufacturer provide certification that the particular type and model of traffic signal controller to be used shall have been in actual field operation at a minimum of five locations for no less than one year each prior to its introduction in Vermont. This requirement does not apply to minor software updates of an existing unit.

Each traffic signal controller shall be designated to operate on 115 V AC, 60 Hz, single-phase, and shall be delivered completely wired and enclosed in a weatherproof housing. Controllers shall be of the same type and manufacture conforming to the standard used by the town, city, or village when extensions or improvements of existing traffic control facilities are contracted.

Prior to bench testing, the Contractor shall provide the proposed traffic signal controller settings for approval. Each controller shall be bench-tested with a NEMA test board that simulates all possible sequencing of signal intervals, corresponding to those for which the controller is to be used, for at least seven continuous calendar days prior to installation.

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The manufacturer or distributor shall have such bench testing performed by an independent testing company which shall certify that such test has been made and that the traffic signal controller functions properly. Copies of all test results and descriptions of all changes and repairs shall be submitted with the certification. A copy of the controller settings used for the test shall be included in the bench test results. These settings shall be retained in the controller through shipment and installation. A representative of the manufacturer shall be on the project site for turn-on of the units.

The controller shall be bench tested after it has been completely installed in its cabinet and all wiring internal to the cabinet has been completed. The bench test results shall include actual test results for all functions that the Plans require the controller to be able to perform.

Failure to test any required function will result in rejection of the controller without exception. Rejected controllers will not be permitted to remain on the project, and rejected controllers shall not be reworked and subsequently reinstalled on the project.

The controller shall not be shipped until the manufacturer has received full written approval of all the bench tests results from the Agency. Shipment of the controller prior to receipt of full written approval for all bench test results will result in the suspension of all payments for the traffic control signal items in the Contract until a fully approved controller is completely installed in-place and is functioning properly.

Traffic signal equipment design and performance shall meet or exceed all requirements of the latest NEMA standards for traffic control systems. Performance of the equipment shall be consistent with the *MUTCD*. The controller along with all auxiliary equipment shall be capable of producing the timing plans and coordination shown on the Plans.

(b) Controller/Auxiliary Equipment. All traffic signal controllers shall be actuated, solid-state, menu-driven, and with keyboard entry. They shall have a minimum of sixteen phases with dual maximum capabilities, and an internal time-based coordinator capable of providing at least four cycle lengths with multiple programs per cycle. All controllers shall have all necessary hardware/software for Ethernet communications. Controllers on a coordinated system with hardwire, telemetry, or radio interconnect shall have remote communications capability, unless otherwise specified on the plans.

Each installation shall include the following:

(1) Malfunction Management Unit. Sixteen-channel malfunction management unit (MMU) with stop-timing function, liquid crystal display, and the recording storage capacity for at least nine "events." The MMU and the controller shall be wired to ensure that the "events" logged by MMU and the controller indications at the time of failure can be uploaded directly to a computer.

(2) Switches and Relays. Sufficient load switches and flash transfer relays for all sixteen phases.

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(3) Load Switches. LED-display load switches on the input side and labeled on the cabinet wall.

(4) Remote Flasher. Remote flasher.

(5) Vehicle Detector Amplifiers. Vehicle detector amplifiers, if applicable, shall be rack-mounted units.

(6) Cabinets. The controller and all auxiliary equipment shall be enclosed within a pre-wired, rainproof *NEMA 3R* controller cabinet with a police door. The cabinet shall have a finish as specified on the Plans. The cabinet shall be sized to provide ample space for housing all equipment necessary to provide the timings shown on the Plans.

The cabinet shall have a main door within which an auxiliary door shall be placed. The auxiliary door (police door) shall house a compartment with the following switches: "Flash-Automatic;" "Power, On-Off;" and "Signal, On-Off." A metal plaque listing ownership and emergency telephone numbers shall be attached to the outside of the cabinet. The design and configuration of the plaque shall be as shown in the Plans.

Each cabinet shall have a weatherproof plastic envelope of sufficient size, at least 18 inches × 24 inches, to store wiring diagrams, program manuals, etc. The cabinet shall contain a suitably designed vent fan and thermostat with a range of 120°F to 160°F. The thermostat shall be set initially to 120°F.

The controller cabinet shall contain a strong mounting table, sliding track, hinged adjustable fixed or a folding support of such construction that it will permit the controller or other equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connection or interrupting normal operation of the controller.

A flexible-arm LED lamp receptacle capable of illuminating all areas of the cabinet, two convenience outlets, ground fault interruption protection, and surge protection shall be provided. Four non-ground fault outlets for equipment power shall be provided on the left side of the cabinet to be fed from the load side of the main breaker.

A wiring panel shall be included in each cabinet mounted in such a way to provide visibility and accessibility. The lowest row of terminals shall be at least 3 inches from the bottom of the cabinet.

The main door lock of the cabinet shall be a #2 tumbler-type lock as recommended by the manufacturer of the equipment. A police-type lock shall be provided for the auxiliary door.

An intersection layout drawing at a scale of 1 inch equals 40 feet shall be taped to the inside of the door, in the proper orientation and covered with plastic. It shall indicate numbers for the vehicle heads, phases, load switches, detectors, loops, and any other pertinent information.

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The Contractor shall indicate on the inside of the door the date and time of signal turn-on for new installations or switch-over for replacement installations. The door marking shall be permanent.

(7) Spare Equipment. In addition to equipment furnished to provide a functional signal system, the Contractor shall supply one of each of the following spare parts in each cabinet:

a. Flasher unit (independent of the controller).

b. Transfer relay.

c. Flash drive, USB 2.0 or later.

d. Cabinet lamp LED.

e. Filter for ventilation system.

f. Flash transfer relay.

g. Bus interface unit (BIU) in a protected container.

This equipment may be used during the construction period to replace malfunctioning equipment but must be replaced and maintained in the cabinet prior to acceptance.

(8) Wiring. All panel wiring shall be neat and firm and UL-approved circuit breakers shall be provided.

All field terminals shall be suitably identified.

The electrical connections from the controller and other accessory equipment to the outgoing and incoming circuits shall be made either by standard multiple plugs or jacks.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power supply and the common return of the signal circuits shall be of the same polarity as the ground side of the power supply.

The ground side of the power supply shall be grounded to the controller cabinet in an approved manner.

All signals shall be wired such that no more than two through faces (north/south and/or east/west) are wired into one load switch even though the two approaches may time during the same phase.

(9) Contacts. All contacts used in connection with interval indications shall be of pure coin silver or its equivalent and shall be capable of breaking and carrying 10 A at 125 V AC. All contacts shall be readily accessible and capable of being replaced in the controller without the use of any tools other than pliers and screwdrivers. Mercury tube contacts will not be accepted for use.

(10) Relays. Relays shall not be used in connection with any automatic non-flashing red, yellow or green indications without the approval of the Engineer. All relays shall be jack-mounted.

(11) Motor and Lamp Leads. All motor and lamp leads shall be moisture- and heat-resistant type of flexible stranded copper 600 V wire meeting the requirements of the *National Electrical Code*.

(12) Snap Switch. Each controller shall be equipped with a snap switch that will disconnect the timing mechanism and signal lights from all outside sources of electrical power.

(13) Lightning Arrester. Each controller shall be equipped with a suitable effective lightning arrester that filters lightning or high voltages to ground protecting internal components of the controller.

(14) Radio and Television Interference. Electrical equipment shall be protected against interfering with radio and television reception.

(15) Wiring Diagram. Two internal connection wiring diagrams for all apparatus, as well as mounting and operating instructions, shall be furnished.

(16) Flasher. Each controller shall be equipped with a flashing mechanism capable of providing flashing operation at a rate of not less than 50 or more than 60 flashes per minute, part of which may be yellow and part red, or all red, as directed by the Engineer. The illuminated period of each flash shall be not less than 50% or more than 67% of the total cycle.

Such flashing mechanisms shall be in an encapsulated cube style configuration, shall be adequately housed and protected from the weather, and shall be of such design as to be accessible for inspection, cleaning, and adjustment without disconnecting any part. The flasher shall be capable of flashing two inductive or tungsten loads and shall operate within a line voltage range of 95 to 135 V AC.

Alternately, a NEMA flasher meeting the same operational requirements may be provided. A mercury tube contact will not be accepted for flashing indications. The flashing operation shall begin automatically if the controller malfunctions and when called for by the timing plan. In addition, flashing shall be capable of being manually controlled by a switch in the police door. The controller itself need not be present to operate the signals in flashing mode.

(17) Interconnection. All controllers, installed in areas where other signalized intersections are nearby and there is likelihood of future coordination, shall be capable of future interconnect either by cable connection, telemetry, spread spectrum radio, or the use of time-based coordination. Such modifications shall not require return of the controller to the manufacturer.

(18) Semi-actuated Controllers. For semi-actuated controllers, in the absence of actuation, the right-of-way shall return to and remain on the non-actuated approach, or as shown on the Plans.

(19) Fully-actuated Controllers For fully-actuated controllers, in the absence of actuation, the right-of-way shall remain on the last actuated phase, or as specified.

752.07 FLASHING BEACONS.

(a) General Requirements. The applicable portions of Subsection 752.06 shall apply in addition to the specific functional requirements described below.

(b) Flasher. The controller shall be equipped with a flashing mechanism capable of providing flashing operation at a rate of not less than 50 or more than 60 flashes per minute, part of which may be yellow and part red, or all red as directed by the Engineer. The illuminated period of each flash shall be not less than 50% and not more than 67% of the total cycle.

The flashing mechanism shall be adequately housed and protected from the weather and shall be designed to be accessible for inspection, cleaning, and adjustment without disconnecting any part. A mercury tube contact will not be accepted for flashing indications.

Time cycle variations shall not occur due to any change in outside temperature between the limits of -20°F and 120°F. A heater unit may be activated, if required, to keep the unit functioning at temperatures lower than -20°F.

Solid state flasher units shall meet or exceed all requirements of the latest NEMA standards.

The flashing mechanism shall be protected against interfering with radio and television reception using a radio and television interference filter.

(c) Cabinets. The complete flashing mechanism and related interference filters shall be enclosed within a rainproof, *NEMA 3R*, cast aluminum cabinet or a glass meter socket housing, whichever is shown on the Plans. The cabinet shall be sized to provide ample space for housing the flashing mechanism, filters, and fuse panel.

The cabinet shall have a main door and lock. The lock shall be a tumbler type lock as recommended by the manufacturer of the equipment. Two keys shall be furnished for the lock.

The cabinet shall contain a suitably designed vent.

The mounting of the cabinet shall be as shown on the Plans.

(d) Flashing Beacon Signal Heads. Flashing beacon signal heads shall be self-contained assemblies that are expandable, adjustable, and may contain one or more signal faces as shown on the Plans.

The components of the signal head consisting of housings, doors, visors, optical units (consisting of lenses, reflectors, lamp sockets, and lamps), wiring, trunnions and brackets shall conform to the latest requirements of the *ITE Technical Report, Adjustable Face Traffic Control Signal Head Standards*, and the applicable portions of Subsection 752.05, unless otherwise specified.

752.08 ELECTRICAL CONDUIT. Electrical conduit shall conform to the following requirements:

(a) Rigid Polyvinyl Chloride (PVC) Electrical Conduit. Rigid PVC electrical conduit shall be Schedule 80 and shall meet or exceed the specifications of *ASTM D 1784*.

(b) Polyethylene Plastic Pipe and Fittings (HDPE) Electrical Conduit. Polyethylene plastic pipe and fittings (HDPE) electrical conduit shall be Schedule 80 and shall meet or exceed the specifications of *ASTM D 3350*.

(c) Plastic-Coated, Galvanized Steel, Rigid Metallic Electrical Conduit. Plastic-coated, galvanized steel, rigid metallic electrical conduit shall be hot-dip galvanized and shall have a plastic coating of at least 20 mils in thickness intimately bonded to both inside and outside galvanized surfaces. The conduit shall meet the requirements of *ASTM A 53/A 53 M.*

752.09 TRAFFIC SIGNAL CONDUCTOR CABLE.

(a) Polyethylene-Insulated, Polyvinyl Chloride (PVC) Jacketed Signal Cable. Polyethylene-insulated, PVC-jacketed signal cable for use in underground conduits or as an aerial cable supported by a span wire shall conform to the latest requirements of International Municipal Signal Association, Inc., *IMSA Specification No. 19-1*.

(b) Polyethylene-Insulated, Polyethylene-Jacketed Communication Cable. Polyethylene-insulated, Polyethylene jacketed communication cable for use in underground conduits or as an aerial cable supported by a span wire shall conform to the latest requirements of *IMSA Specification No. 20-1*.

(c) Polyethylene-Insulated, Polyvinyl Chloride (PVC) Jacketed, Integral Messenger Signal Cable. Polyethylene-insulated, PVC jacketed signal cable with integral supporting span wire for aerial installation shall conform to the latest requirements of *IMSA Specification No. 19-3*.

(d) Polyethylene-Insulated, Polyethylene-Jacketed, Integral Messenger Communication Cable. Polyethylene-insulated, polyethylene-jacketed communication cable with integral supporting span wire for aerial installation shall conform to the requirements of the latest edition of *IMSA Specification No. 20-3*.

752.10 DETECTORS. Vehicle detectors used for actuating traffic signal controllers shall be of the inductive loop type or as shown on the Plans. Inductive loop detectors shall meet or exceed all requirements of the latest NEMA standards for traffic control systems. Each detector unit shall be capable of serving up to four loops.

The wire loops shall consist of No. 12 gauge AWG minimum size, Type TW stranded wire with 600 V insulation. Loop feeder wire shall be in accordance with the loop detector manufacturer's recommendations. Loop feeder length capability shall be at least 755 feet for one loop, or a combined total feeder length capability of at least 755 feet for multiple loops. A single conductor shall consist of seven-strand tinned copper.

The configurations and installation of the wire loops and loop feeder wires shall be in accordance with the loop detector manufacturer's recommendations and/or as shown on the Plans. The loops shall be located as shown on the Plans.

Vehicle detector feeder wire (lead-ins) shall be enclosed in a nonmetallic conduit for underground travel from the curb to the controller.

752.11 VEHICLE DETECTOR SLOT SEALANT. Vehicle detector slot sealant material shall be a standard of the trade for this purpose, and it shall have the approval of the Engineer prior to being used.

752.12 PULL BOXES AND JUNCTION BOXES.

(a) Pull Boxes. Pull boxes shall be constructed of Concrete, Class B. Pull box frames and covers shall be steel plate and conform to the requirements of *ASTM A 36/A 36 M*. Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with the requirements of *AASHTO M 111 M/M 111*. Pull boxes shall be designed and constructed to support at least an AASHTO HS-20 loading.

(b) Junction Boxes. Junction boxes shall be constructed of fiberglass, high density polyethylene (HDPE), or acrylonitrile-butadiene-styrene (ABS) and shall be high-impact-resistant at temperatures ranging from -30°F to 120°F, ultraviolet-stabilized, and fire-retardant. The side wall shall be ribbed for strength. The cover shall be non-skid and shall be held down with recessed hex-head bolts. The junction box shall be capable of withstanding a loading of 15 kips over any 10 inch × 10 inch area on the cover. The size of the box shall be as specified in the Contract.

752.13 ACCESSIBLE PEDESTRIAN SIGNALS. Accessible Pedestrian Signals (APS) shall meet the standards of the *American with Disabilities Act* (*ADA*) and the most current edition of the *MUTCD*.

(a) Wiring. The APS shall interface and be coordinated with the other features of a traffic control signal.

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(b) Audible Features. The APS shall include an audible indication of the Walk interval by either tone or voice and shall be audible from the near side of the associated crosswalk. If the tone for the Walk interval is the same as the locator tone of the pushbutton, it shall have a faster repetition rate than the associated locator tone.

The volume of the audible features shall have automatic volume adjustment based on the ambient noise levels. Audible features shall be no more than 5 dB louder than ambient sound up to a maximum volume of 89 dB measured at 36 inches from the device. When voice messages are used, they shall include a clear message that the walk interval is in effect and shall indicate to which crossing it applies. Audible features may be integral to the Pedestrian Pushbutton Assembly or through a separate speaker housing.

752.14 PEDESTRIAN PUSHBUTTON ASSEMBLIES. Pedestrian pushbutton assemblies shall meet all ADA requirements. The plunger head shall have a minimum diameter of 2 inches and the force required to operate the plunger shall not exceed 5 pounds. The pushbutton shall activate both the Walk interval and the APS, if one is provided.

(a) Color. The color of the pushbutton shall contrast visually with the housing or mounting.

(b) Audible Features. The pushbutton assembly shall include an integral locator tone. The locator tone shall have a duration of 0.15 seconds or less and shall repeat at 1 second intervals. The locator tone shall be 2 dB minimum and 5 dB maximum above ambient noise levels and shall be responsive to ambient noise levels.

(c) Tactile Features. The pushbutton assembly shall incorporate a raised arrow. The arrow shall be raised a minimum of 1/32 inch and shall have a minimum length of 1-1/2 inches. The arrow color shall contrast with the background. The pushbutton shall vibrate to indicate that the walk interval is in effect.

752.15 GROUNDING ELECTRODES. Grounding electrodes shall include grounding rods and grounding conductors.

(a) Grounding Rods. Grounding rods shall be copper-clad steel rods with a diameter of 5/8 inch and a minimum length of 8 feet, conforming to the requirements of *UL No. 467* and *ANSI C33.8*.

(b) Grounding Conductors. Grounding conductors shall be installed throughout the system back to the power source. The earth shall not be used as the sole equipment-grounding conductor. Grounding conductors shall be AWG No. 6 soft copper or stranded copper conductors.

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SECTION 753 – HIGHWAY ILLUMINATION

753.01 LIGHT POLE FOUNDATIONS.

(a) Concrete. Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

(b) Reinforcing Steel. Reinforcing steel for light pole bases shall conform to the requirements of Section 507 for Reinforcing Steel, Level I.

(c) Electrical Conduit. Electrical conduit for light pole bases shall conform to the requirements of Subsection 752.08(a).

(d) Anchor Bolts. Anchor bolts for light pole bases shall be per the transformer base manufacturer's recommendation and conform to the requirements of Subsection 714.09.

(e) Grounding Electrodes. Grounding electrodes for light pole bases shall conform to the requirements of Subsection 752.15.

753.02 TRANSFORMER BASES.

(a) Transformer Bases. Transformer bases and transformer base doors shall consist of a one-piece aluminum casting conforming to the requirements of *ASTM B 26/B 26 M* or *ASTM B 108/B 108 M,* Alloy SG70A-T6, 356-T6. Galvanized bolts, nuts, washers, and other hardware shall be provided to attach the transformer base to the anchor base of the light pole. Galvanizing for bolts, nuts, washers, and other hardware shall conform to the requirements of Subsection 726.08.

(b) Mounting Hardware. Hardware for mounting the transformer base door to the transformer base shall be stainless steel.

753.03 LIGHT POLES.

(a) Anchor Bases. Anchor bases shall consist of a one-piece aluminum casting conforming to the requirements of *ASTM B 26/B 26 M* or *ASTM B 108/B 108 M,* Alloy SG70A-T6, 356-T6.

(b) Pole Shafts. Pole shafts shall be fabricated from tapered one-piece seamless aluminum tubes conforming to the requirements of *ASTM B 221* and *ASTM B 221 M,* Alloy 6063-T6, 6061-T6, or 6005-T5. The minimum wall thickness shall be 0.125 inch for mounting heights of less than 20 feet and 0.188 inch for mounting heights of 20 feet or more.

(c) Pole Caps. Pole Caps shall consist of a one-piece aluminum casting conforming to the requirements of *ASTM B 26/B 26 M* or *ASTM B 108/B 108 M*, Alloy SG70A-T6, 356-T6.

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753.04 BRACKET ARMS.

(a) Bracket Arms, Aluminum. Single member bracket arms and the main member of truss-type arms shall be fabricated from seamless aluminum tube conforming to the requirements of *ASTM B 221/B 221 M,* Alloy 6063-T6 or Alloy 6061-T6. Other members of truss-type arms shall conform to the requirements of *ASTM B 221/B 221 M,* Alloy 6063-T6. All screws, nuts, bolts and other hardware for mounting bracket arms to the light pole shall be stainless steel, unless otherwise specified.

(b) Bracket Arms, Steel. Components of single member and truss-type bracket arms shall be fabricated from standard steel pipe meeting the requirements of *ASTM A 53/A 53 M* or *ASTM A 501/A 501 M*.

753.05 LUMINAIRES. All luminaires shall be 120 V unless otherwise specified in the Plans.

753.06 HIGHWAY ILLUMINATION CONDUCTOR CABLE. Highway illumination conductor cables shall be conductors of stranded, soft-drawn copper with a moisture and heat resistant thermoplastic insulation. Cables shall be rated for 600 V service at 167°F for either dry or wet locations.

The single conductors shall conform to the requirements of the *National Electrical Code* for the intended wire use and existing field conditions. Wire size shall be such that no more than a 3% voltage drop will occur anywhere in the secondary circuit. All wiring shall be color-coded.

All conductors within the streetlight pole and bracket arm shall be No. 10 AWG stranded copper wire. Street lighting conductors within strain poles or mast arm poles shall also be No. 10 AWG stranded copper wire. UF cable is allowed in the bottom of the pole below the handhole.

753.07 FINISH OF HIGHWAY ILLUMINATION COMPONENTS.

(a) Powder Coating. Powder coating shall be a polyester powder coat in the manufacturer's standard black finish. Powder coatings shall be salt spray-resistant in accordance with the requirements of *ASTM B 117*. Powder coating shall exhibit no discoloration, cracking, or other visible defects when tested for accelerated weathering as described in *ASTM D 4587,* Cycle No. 4, for 300 continuous hours.

The chemical composition of powder coatings shall provide a highly durable UV and salt spray resistant finish in accordance with the requirements of *ASTM B 117* and shall be humidity-proof in accordance with the requirements of *ASTM D 2247*.

(b) Anodized Aluminum. Anodized aluminum coatings shall be in accordance with the requirements of *ASTM B 137, ASTM B 244, ASTM B 580,* Type A or B, and *ASTM B 680*.

753.08 THIS SUBSECTION RESERVED.

753.09 THIS SUBSECTION RESERVED.

753.10 THIS SUBSECTION RESERVED.

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753.11 THIS SUBSECTION RESERVED.

753.12 THIS SUBSECTION RESERVED.

753.13 THIS SUBSECTION RESERVED.

SECTION 754 – PAVEMENT MARKING MATERIALS

754.01 THIS SUBSECTION RESERVED.

754.02 THIS SUBSECTION RESERVED.

754.03 PAVEMENT MARKING TAPE. Pavement marking tape is a white or yellow preformed retroreflective tape. Pavement marking tape shall be evaluated in accordance with the applicable NTPEP pavement marking materials work plan, with a minimum of one year of data for permanent tape and a full data set for temporary tape, listed on the Agency's *Approved Product List* for the respective material specification, and meet the following requirements.

(a) Pavement Marking Tape, Type A. Pavement Marking Tape, Type A shall be a high performance and extended service life pavement marking tape in accordance with *ASTM D 4505*. The tape shall have continuous wetting properties and meet the following requirements.

(1) Skid Resistance. Skid resistance shall be Skid Resistance Level A in accordance with *ASTM D 4505*.

(2) Adhesive. Adhesive shall be Class I, II, or III in accordance with *ASTM D 4505*.

(3) Durability. Initial durability shall be 10 and three-year durability shall be a minimum of 7 as determined in accordance with *ASTM D 913*.

(4) Retroreflectivity.

a. Dry. Initial dry retroreflectivity shall be Reflectivity Level I in accordance with *ASTM D4505*. Three-year retroreflectivity shall be a minimum of 150 mcd/m^2/lx for white and 100 mcd/m^2/lx for yellow as determined in accordance with *ASTM E 1710*.

b. Wet. Initial wet retroreflectivity shall be a minimum of 250 mcd/m^2/lx for white and 200 mcd/m^2/lx for yellow. Three-year wetness retroreflectivity shall be a minimum of 150 mcd/m^2/lx for white and 75 mcd/m^2/lx for yellow as determined in accordance with *ASTM E 2177*.

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c. Wet Continuous. Wet continuous retroreflectivity shall be a minimum of 150 mcd/m^2/lx for white and 100 mcd/m^2/lx for yellow in accordance with *ASTM E 2832*.

(b) Pavement Marking Tape, Type B. Pavement Marking Tape, Type B shall be a standard performance pavement marking tape in accordance with *ASTM D 4505*.

(1) Skid Resistance. Skid resistance shall be Skid Resistance Level A in accordance with *ASTM D4505*.

(2) Adhesive. Adhesive shall be Class I, II, or III in accordance with *ASTM D 4505*.

(3) Durability. Initial durability shall be 10 and three-year durability shall be a minimum of 7 as determined in accordance with *ASTM D 913*.

(4) Retroreflectivity. Initial dry retroreflectivity shall be Level II in accordance with *ASTM D 4505*.

(c) Pavement Marking Tape, Type C. Pavement Marking Tape, Type C shall be a temporary pavement marking tape in accordance with *ASTM D 4592* and the following requirements.

(1) Retroreflectivity. Initial wet retroreflectivity shall be a minimum of 250 mcd/m^2/lx for white and 200 mcd/m^2/lx for yellow.

SECTION 755 – LANDSCAPING MATERIALS

755.01 LANDSCAPE BACKFILL. The landscape backfill material shall be premixed, consisting of approximately 50% topsoil, 25% compost, and 25% native soil as approved by the Engineer. In cases where native soil meets the topsoil specification, the proportions of native soil may be adjusted to up to 75% as approved by the Engineer.

755.02 TOPSOIL. Topsoil shall be a natural, workable soil, free of refuse, roots, stones, brush, weeds, or other material that would be detrimental to the proper development of plant growth. Topsoil shall be screened, loose, and friable, free of subsoil, roots, noxious weeds, stones larger than 1 inch, and other debris.

Topsoil shall be reasonably free-draining, have a clay content of less than 27%, and have an organic matter content, including woody plant materials, of 5% to 10%, as determined by the requirements of *AASHTO T 267*. Topsoil for lawn areas shall have an organic matter content of at least 4%.

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Salinity electrical conductivity shall be less than 0.1 Siemens per meter, as determined by the requirements of *AASHTO T 288*. The acidity range of the topsoil shall be pH 5.5 to 7.0 when tested in accordance with the requirements of *AASHTO T 289*.

Topsoil shall be obtained from a source that has been approved by the Engineer and has demonstrated, by a healthy growth of grass, cultivated crops, or wild vegetation, that it is of good quality. At least 14 calendar days prior to delivery and use, the Contractor shall provide at least one soil analysis for every 100 cubic yards of topsoil used on the project to the Engineer. The analysis shall be performed by a laboratory accredited in the given test method by a nationally recognized accrediting body such as AASHTO.

Testing shall be on dry material that has passed the No. 10 (2.00 mm) sieve with the gradation specified in Table 755.02A.

TABLE 755.02A – GRADATION OF TOPSOIL

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
No. 10 (2.00 mm)	85 – 100
No. 40 (0.425 mm)	35 – 85
No. 200 (0.075 mm)	10 – 35
No. 400 (0.038 mm)	< 5

Soil analysis shall show recommendations for soil additives to correct soil deficiencies and for additives necessary to accomplish the particular planting objectives noted.

Soil amendments shall be incorporated thoroughly into the topsoil to meet the specified requirements for topsoil prior to delivering the material to the site.

755.03 SOD. Sod shall be live, fresh, and of suitable character for the soil in which it is placed. Sod shall be of a firm, even texture, show good root development, be reasonably free from noxious weeds, and shall have a compact growth of vigorous, dark green grass. The sod shall have a minimum content of 70% Kentucky Bluegrass (*Poa pratensis*), improved variety, and 10% Red Fescue (*Festuca rubra*), improved variety.

The sod shall be approved by the Engineer prior to being cut and again before it is laid.

755.04 SEED. Seed shall be furnished in new, clean, sealed, and properly labeled containers, either separately or mixed, as appropriate, and shall conform to the seed formula shown on the Plans. Seed that has become wet, moldy, or otherwise damaged shall not be accepted.

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(a) Testing. The seed shall conform to all State and Federal regulations.

(b) Labels. Labels shall conform to all State and Federal regulations and shall be clearly marked with the following information:

(1) Seed name

(2) Lot number

(3) Germination (%)

(4) Purity (%)

(5) Weed seed content (%)

755.05 COMPOST. Compost shall be free of weed seeds and comply with EPA requirements for compost. The compost shall have a loose and granular texture with the following characteristics or properties as specified in Table 755.05A.

TABLE 755.05A – EPA COMPOST MATERIAL REQUIREMENTS

Compost Physical Property	Material Requirements
Organic matter content	30% – 60%
Total Kjeldahl nitrogen content	0.5% – 2.0%
pH	6.5 – 7.5
Maximum particle size	< 1 inch
Soluble salt content	< 5 mmhos/cm
Human inerts, by dry mass	< 1.0%
Moisture content	35% – 55%

Compost shall generally comprise 25% of the backfill material unless otherwise specified. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The compost must meet *40 C.F.R. 503* (also known as *EPA Part 503*) exceptional quality concentration limits for trace elements and heavy metals.

At least 14 days prior to delivery and use, the Contractor shall provide a compost analysis to the Engineer. The analysis shall be performed by a facility employing the latest *Test Method for the Examination of Composting and Compost* (*TMECC*).

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755.06 FERTILIZER. Fertilizer, if specified, shall be a standard commercial grade dry fertilizer and shall conform to the requirements of all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. Fertilizer shall contain not less than the minimum percentage of nitrogen, phosphoric acid, and potash shown on the Plans.

If the Plans do not specify the composition of the fertilizer, it shall contain 10% available Nitrogen (N), 10% available Phosphoric Acid (P), and 10% available Potassium (K). Of the available Nitrogen, 50% shall be in a slow-release form, as is found in certain urea form products or natural organic forms, or a combination of both.

(a) Packaging. The fertilizer shall be furnished in new, clean, sealed, and properly labeled bags not weighing more than 100 pounds each. Caked or otherwise damaged fertilizer shall not be accepted.

Labels shall be clearly marked with the following information:

(1) Manufacturer's name

(2) Type

(3) Mass (weight)

(4) Guaranteed analysis

755.07 MYCORRHIZAL FUNGI PRODUCT. Mycorrhizal fungi product, if specified on the Plans and details, shall be of granular form and shall include mycorrhizae spores to enhance root growth, nutrient uptake, and reduce transplant shock. All mycorrhizal fungi products shall be administered per manufacturer's recommendations. Mycorrhizal fungi shall be one of the mycorrhizal fungi listed Agency's *Approved Products List*.

755.08 AGRICULTURAL LIMESTONE. Agricultural limestone shall be a calcitic or dolomitic ground limestone containing not less than 85% of total (calcium or magnesium) carbonates. The limestone shall conform to the requirements of all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists.

(a) Packaging. The limestone shall be furnished in new, clean, sealed, and properly labeled bags not weighing more than 100 pounds each. Caked or otherwise damaged limestone shall not be accepted.

Labels shall be clearly marked with the following information:

(1) Manufacturer's name

(2) Type

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(3) Mass (weight)

(4) Guaranteed analysis

(b) Sieve Analysis. Limestone shall meet the following sieve analysis: 100% shall pass the No. 10 (2.00 mm) sieve, with a minimum of 40% passing the No. 100 (0.150 mm) sieve.

755.09 LIQUID LIME. Liquid lime shall be a commercially formulated calcium carbonate lime mixture.

(a) Packaging. Labels shall be clearly marked with the following information:

(1) Manufacturer's name

(2) Type

(3) Mass (weight)

(4) Guaranteed analysis

755.10 MULCH MATERIALS. Mulch materials shall conform to the following requirements:

(a) Hay Mulch. Hay mulch shall consist of mowed and properly cured grass or legume mowings, reasonably free from swamp grass, weeds, twigs, debris, or other deleterious material and free from rot or mold. It shall be in an air-dry condition suitable for placing with mulch blower equipment and shall be acceptable to the Engineer.

(b) Wood Chip Mulch. Wood chip mulch shall consist of hardwood chips, 1/8 to 1/4 inch nominal thickness, with 50% having an area of not less than 1 square inch or more than 6 square inches.

All wood chip mulch shall be reasonably free from deleterious materials that are injurious to plant growth. Wood chip mulch may be used only for temporary applications for erosion prevention and tree protection during construction.

(c) Bark Mulch. Mulch material used for landscape plantings shall consist of well composted shredded Cedar, Pine, or Spruce bark, 1/8 to 1/4 inch nominal thickness, with 50% having an area of not less than 1 square inch or more than 6 square inches.

All bark mulch shall be reasonably free from leaves, twigs, shavings, insect pests, eggs, larvae, or other deleterious material that is injurious to plant growth, and approved by the Engineer. The same type of material shall be used in all areas to provide visual uniformity. Bark Mulch shall be applied as detailed in the Contract Plans and on the landscape detail sheets.

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(d) Fiber Mulch. Fiber mulch shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials or from newsprint, chipboard, corrugated cardboard, or a combination of these processed materials. Fiber mulch shall be free of synthetic or plastic materials, weed seed, and growth or germination inhibiting substances and shall be nontoxic to plant or animal life.

Fiber mulch shall have a water-holding capacity by mass of not less than 900% and shall be of such character that the fiber will disperse into a uniform slurry when mixed with water. Water content of the fiber before mixing into slurry shall not exceed 12%, ± 3%, of the dry mass of the fiber. The moisture content of the fiber shall be marked on the package.

Fiber mulch shall be colored to contrast with the area on which it is to be applied, and shall not stain concrete or painted surfaces.

Acceptable Fiber Mulch shall be one of the fiber mulch products listed the Agency's *Approved Products List*.

(e) Hydraulic Matrix. The hydraulic matrix shall consist of a mix of long strand, residual, wood fibers and a high-strength bonding agent. The matrix shall be 100% biodegradable over time, nontoxic to fish and wildlife, and it shall not contain any synthetic fibers. The hydraulic matrix shall be colored to contrast with the area on which it is to be applied, and shall not stain concrete or painted surfaces.

Acceptable Hydraulic Matrix shall be one of the Hydraulic Matrices listed on the Agency's *Approved Products List*.

(f) Tackifier. Tackifier for hay mulch may be guar based organic tackifier, starch based-agricultural tackifier or another type of mulch binder as approved by the Engineer. Tackifier for stabilization of bare soils, without mulch or other fiber incorporated, shall use materials and quantities specified by the manufacturer based on the results of soils, water, and site assessment. Tackifiers shall be nontoxic to plant or animal life and non-staining to concrete or painted surfaces. Tackifiers must be water soluble, "linear," and "non-cross-linked."

Tackifiers shall be non-combustible and shall not change soil pH.

Acceptable Tackifier shall be one of the tackifier products listed on the Agency's *Approved Products List*.

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(g) Straw Mulch. Straw mulch shall consist of threshed plant residue of oats, wheat, barley, rye, or rice from which the grain has been removed. The material shall be free of noxious weeds, undesirable grasses and plants, and rot or mold, and shall be approved by the Engineer prior to use.

755.11 ROLLED EROSION CONTROL PRODUCT.

(a) Rolled Erosion Control Product, Type I. Temporary erosion matting shall conform to one of the following specifications and corresponding properties found in Table 755.11A. Temporary erosion matting shall be used in applications where natural vegetation will provide permanent erosion protection.

(1) Mulch Control Netting. A temporary biodegradable rolled erosion control product (RECP) composed of planar woven natural fiber.

(2) Erosion Control Blanket. A temporary all-natural biodegradable rolled erosion control product composed of processed fibers mechanically bound together to form a continuous matrix.

For use where natural vegetation will provide permanent erosion protection, Rolled Erosion Control Product, Type I shall be specified as shown in Table 755.11A.

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TABLE 755.11A – ROLLED EROSION CONTROL PRODUCT, TYPE I SPECIFICATIONS

Product Description	Material Composition	Longevity (months)	Slope Applications [7]		Channel Applications [7]	Min. Tensile Strength (lbs/ft) [1]
			Max. Gradient (V:H)	C Factor [2, 5]	Max. Shear Stress, (lbs/ft^2) [3, 4, 6]	
Mulch Control Nets	All-natural biodegradable mesh or woven netting	3	1:5	≤ 0.10	0.25	5
		12	1:5	≤ 0.10	0.25	5
		24	1:5	≤ 0.10	0.25	25
Netless Rolled Erosion Control Blankets	All-natural biodegradable fibers mechanically interlocked together to form a continuous matrix	3	1:4	≤ 0.10	0.50	5
		12	1:4	≤ 0.10	0.50	5
Single-Net Erosion Control Blankets	All-natural processed, biodegradable fibers mechanically bound together by a single net of yarn or twine woven into a continuous matrix	3	1:3	≤ 0.15	1.5	50
		12	1:3	≤ 0.15	1.5	50
Double-Net Erosion Control Blankets	All-natural processed, biodegradable fibers mechanically bound together between two nets of yarn or twine woven into a continuous matrix	3	1:2	≤ 0.20	1.75	75
		12	1:2	≤ 0.20	1.75	75
		24	1:1.5	≤ 0.25	2.00	100
		36	1:1	≤ 0.25	2.25	125

[1] Minimum Average Roll Values, machine direction using Erosion Control Technology Council (ECTC) *Mod. ASTM D 5035*.

[2] The "C" Factor is calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, V:H) to the ratio of soil loss from the unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions using *ECTC Test Method* # 2.

[3] Required minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (> 0.5 in soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using *ECTC Test Method #3*.

[4] The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 – 0.05.

[5] Acceptable large-scale test methods may include *ASTM D 6459, ECTC Test Method # 2*, or other independent testing deemed acceptable by the Engineer.

[6] Per the Engineer's discretion. The recommended acceptable large-scale testing protocol may include *ASTM D 6460, ECTC Test Method #3* or other independent testing deemed acceptable by the Engineer.

[7] The "C" factor and shear stress for mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material.

(b) Rolled Erosion Control Product, Type II. Permanent erosion matting shall be a long-term non-degradable rolled erosion control product composed of ultraviolet stabilized, non-degradable, synthetic fibers, filaments, nettings, and/or wire mesh processed into three-dimensional reinforcement matrices conforming to one of the specifications and corresponding properties found in Table 755.11B. Permanent erosion matting shall be used in applications where vegetation alone will not provide sufficient long-term erosion protection.

All categories of Turf Reinforcement Mat (TRM) must have a minimum thickness of 0.25 inch and meet the requirements of *ASTM D 6525/D 6525 M*. TRM shall also have an ultraviolet stability of 80% per the requirements of *ASTM D 4355/D 4355 M* for 500 hours of exposure.

For use where vegetation alone will not provide sufficient long-term erosion protection, Rolled Erosion Control Product, Type II shall be specified as shown in Table 755.11B.

TABLE 755.11B – ROLLED EROSION CONTROL PRODUCT, TYPE II SPECIFICATIONS

Type	Product Description	Material Composition	Slope Applications	Channel Applications	Minimum Tensile Strength (lbs/ft) [2, 3]
			Max. Gradient (V:H)	Maximum Shear Stress (lbs/ft^2) [4, 5]	
A	TRM	Non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness [6]	1:0.5	6.0	125
B	TRM		1:0.5	8.0	150
C	TRM		1:0.5	10.0	175

[1] For Turf Reinforcement Mats (TRMs) containing degradable components, all property values must be obtained on the nondegradable portion of the matting alone.

[2] Minimum Average Roll Values, machine direction only for tensile strength determination using *ASTM D 6818* (Supersedes *Mod. ASTM D 5035* for RECPs).

[3] Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 3,000 lbs/ft or greater.

[4] Required minimum shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion (> 0.5 in. soil loss) during a 30-minute flow event in large scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using *ECTC Test Method #3*.

[5] Acceptable large-scale testing protocol may include *ASTM D 6460, ECTC Test Method #3*, or other independent testing deemed acceptable by the Engineer.

[6] TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high-flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

755.12 PLANT MATERIALS. Plant materials shall conform to the following requirements:

(a) Quality of Plant Material. All plants shall be first-class representatives of their normal species or varieties, unless otherwise specified as extra heavy or clump according to the particular exception.

All plant materials shall be nursery grown stock that have been transplanted or root-trimmed two or more times, according to the kind and size of plants. They shall have average or normal, well developed branches, together with vigorous root systems. Plant materials shall be free of insects, disease, sun scald, injuries, abrasions of the bark, knots, dead or dry wood, broken terminal growth, or other objectionable disfigurements. Thin, weak plants shall not be acceptable. Plant materials shall display the appearance of normal health and vigor in strict accordance with these specifications.

Each shipment shall be accompanied by a description of all the included plant materials or an itemized bill of lading.

All plant materials furnished by the Contractor shall be grown within hardiness Zones 1 through 4 as established by The Arnold Arboretum, Jamaica Plain, MA, and the plant suppliers shall certify that the stock has been grown under Zone 4 or hardier conditions. Plants that are not certified to have been grown under the designated hardiness zone conditions will not be accepted.

(b) Plant Names. All scientific and common plant names of the items specified shall conform to the latest edition of Standard Plant Names, as adopted by the American Joint Committee on Horticultural Nomenclature. All plant materials delivered shall be true to name and legibly tagged with the names and sizes of materials.

Should it be necessary to substitute a plant or plants of a different variety than the plant material specified, it will be necessary for the Contractor to secure written approval from the Engineer for the proposed substitution prior to digging the plants. An approved substitute plant shall be of a value at least equal to the specified plant for which the substitution is being made and then only when sufficient evidence is shown that the plant specified cannot be obtained.

(c) Grading Standards. Grading of plant materials shall be accomplished according to the requirements of *ANSI Z60.1*, as approved by ANSI and published by the American Association of Nurserymen, Inc.

All plant measurements shall be made in conformance with the standard measurement methods in *ANSI Z60.1*.

If balled and burlapped trees and shrubs are not available, container grown trees and shrubs may be supplied in accordance with the requirements and limitations of *ANSI Z60.1*; however, all plants supplied shall be of the minimum size listed on the quantity sheet.

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Unless designated multi-stemmed, the trunk of each tree shall be a single trunk growing from a single unmutilated crown of roots. The tree trunks shall be free from sunscald, frost cracks, or wounds resulting from abrasions, fire, or other causes. No pruning wounds shall be present having a diameter exceeding 2 inches and all allowable pruning wounds must show vigorous bark on all edges.

Trees shall not be pruned prior to delivery. No trees with double-leaders or twin-heads shall be acceptable without the written approval of the Engineer. The Contractor shall reject such plants at time of delivery by the nursery/supplier unless such plants were previously selected by the Engineer as marked by tags and seals.

The height and spread of each shrub shall correspond to the specifications for Type 0 through Type 3 as referenced in *ANSI Z60.1*. Single stemmed or thin plants will not be accepted. The side branches shall be generous, well-twigged, and the plant, as a whole, well-branched to the ground. The plants shall be in a moist vigorous condition, free from dead wood, bruises, or other root or branch injuries. Plants shall not be pruned prior to delivery.

Vines and ground cover plants shall be of the size, age, and condition listed in the quantity sheet. Plants shall be healthy and free of insects and diseases. Ground cover plants shall be potted or in soil.

Container grown stock shall have been grown in a container long enough for the root system to have developed sufficiently to hold its soil together, firm and whole. No plants shall be loose in the container. No plants shall be root-bound in the container. Such plants shall be rejected at delivery by the Contractor.

Plants delivered by truck and plants requiring storage on-site shall be properly wrapped and covered to prevent wind-drying and desiccation of branches, leaves, or buds. Plant balls shall be firmly bound, unbroken, and reasonably moist to indicate watering prior to delivery and during storage. Tree trunks shall be free from fresh scars and damage in handling. No plant material from cold storage will be accepted.

Evergreens shall be quality evergreens with a well-balanced form complying with the relationship requirements of *ANSI Z60.1*.

(d) Nursery Inspection and Plant Quarantine. All plant materials shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the State of origin and the State of Vermont, as well as with Federal regulations governing interstate movement of nursery stock. A certificate of inspection shall accompany each package, box, bale, or carload of plant materials delivered and shall be provided to the Engineer.

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(e) Balled and Burlapped Plants (B&B). Balled and burlapped plants shall be dug to retain as many fibrous roots as possible, and shall come from soil which will form a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, transported, and handled in such manner that the soil in the ball will not be so loosened that it would cause stripping of small and fine feeding roots, or cause the soil to drop away from such roots.

All plants shall be moved with the root systems as solid units with balls of earth firmly wrapped with untreated burlap, Class 2, 8 ounces per yard, firmly held in place by a stout cord or wire. The diameter and depth of the balls of earth shall be sufficient to encompass the fibrous and root feeding system necessary for the healthy development of the plant and in accordance with the requirements of *ANSI Z60.1*.

No plant shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken preparatory to the process of planting or after the burlap, staves, ropes, or platform required in connection with its transplanting have been removed. The plants and balls shall remain intact during all operations. All plants that cannot be planted at once shall be heeled in by setting in the ground and covering the balls with soil and then watering them.

Any B&B designated plant material arriving at the project with broken or loose balls or balls manufactured on the root will not be acceptable and shall be rejected at delivery by the Contractor.

(f) Plant Certification. The plants shall be certified to have been grown under Zone 4 or hardier conditions, unless otherwise specified. A copy of this certification shall accompany each shipment of plant material to the project. The certifications shall be identified in such a manner as to be directly traceable to the individual shipments.

755.13 ANTIDESICCANT. Antidesiccant shall be an approved emulsion that will provide a film over plant surfaces permeable enough to permit transpiration. An antidesiccant shall be used only after its use has been approved by the Engineer.

755.14 THIS SUBSECTION RESERVED.

755.15 THIS SUBSECTION RESERVED.

755.16 TREE WATERING BAGS. Tree watering bags are available in varying sizes and can be used together to accommodate tree trunk diameters. These waterproof bags are made of reinforced, UV treated polyethylene, reinforced with nylon webbing and are secured to the tree using heavy duty zippers located on each side of the bag. The adjustable drip holes at the base allow for water to flow at varying rates for specific needs.

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Approved tree watering bags shall be one of the tree watering bags are listed on the Agency's *Approved Products List*.

755.17 EROSION LOGS. Erosion logs are available in varying diameters. The Contractor shall follow the manufacturer's recommendations for the material type and size based on the intended use.

Erosion logs shall be composed of weed-seed-free coir, straw, excelsior, compost, or other biodegradable filtering medium encased in a biodegradable netting or mesh.

Netting shall have openings of 1/2 inch to 1 inch, except for compost filled logs which should be 1/8 inch to 3/8 inch or as recommended by the manufacturer and accepted by the Engineer.

Anchors for erosion logs shall be wooden stakes, U-shaped wire or earth anchors, or rebar stakes; the size and length shall be as recommended by the manufacturer.

Compost shall meet the requirements of Table 755.05A, with the exception that 99% of the particle size shall be 2 inches or less and a maximum of 30% shall be less than 3/8 inch.

755.18 THIS SUBSECTION RESERVED.

755.19 THIS SUBSECTION RESERVED.

755.20 THIS SUBSECTION RESERVED.

SECTION 780 – CONCRETE REPAIR MATERIALS

780.01 GENERAL REQUIREMENTS. Concrete repair materials shall be those found on the Agency's *Approved Products List*.

(a) Packaging. The manufacturer's product designation and recommendations for surface preparation, mixing, placing, finishing, and curing shall be clearly outlined on the product packaging. Handling precautions and toxicity warnings shall be printed on all containers. The expiration date and a lot number shall appear on each package of material delivered to the project site. Liquid components which have been frozen shall not be used.

780.02 OVERHEAD AND VERTICAL CONCRETE REPAIR MATERIAL. Overhead and vertical concrete repair material shall be a prepackaged material to be used for patching spalled areas of concrete that are either on vertical or overhead surfaces. Its use shall be limited to patches with layer thickness within the manufacturer's specified limits.

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Products listed on the Agency's *Approved Products List* shall meet the following requirements:

(a) Compressive Strength. The neat material shall exhibit a minimum 7-day compressive strength of 2,000 psi and a minimum 28-day strength of 4,000 psi when tested in accordance with the requirements of *AASHTO T 106 M/T 106* or *AASHTO T 22*.

(b) Direct Tension Pull-off. The material shall exhibit a minimum bond strength of 150 psi when tested in accordance with the requirements of *ASTM C 1583/C 1583 M*.

(c) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with the requirements of *AASHTO T 161,* Procedure A. The material shall exhibit a durability factor of at least 80 after 300 cycles.

(d) Volume Stability. The material shall meet the performance requirements of *ASTM C 928/C 928 M* when tested in accordance with the requirements of *AASHTO T 160*.

(e) Chloride Ion Penetrability. The material shall exhibit a chloride ion penetrability level of 'Low' when tested in accordance with the requirements of *AASHTO T 277*.

780.03 RAPID SETTING CONCRETE REPAIR MATERIAL. Rapid setting concrete material shall be a prepackaged material to be used for patching horizontal concrete surfaces where rapid return of the structure to service is necessitated.

Products listed on the *APL* shall meet the following requirements:

(a) Compressive Strength. The neat material shall exhibit a minimum 2-hour compressive strength of 1,200 psi and a 7-day compressive strength of 5,000 psi when tested in accordance with the requirements of *AASHTO T 106 M/T 106* or *AASHTO T 22*.

(b) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with the requirements of *AASHTO T 161*, Procedure A. The material shall exhibit a durability factor of at least 80 after 300 cycles.

(c) Volume Stability. The material shall meet the performance requirements of *ASTM C 928/C 928 M* when tested in accordance with the requirements of *AASHTO T 160*.

(d) Direct Tension Pull-off. The material shall exhibit a minimum bond strength of 150 psi when tested in accordance with the requirements of *ASTM C 1583/C 1583 M*.

(e) Chloride Ion Penetrability. The material shall exhibit a chloride ion penetrability level of "Low" when tested in accordance with the requirements of *AASHTO T 277*.

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780.04 RAPID SETTING CONCRETE REPAIR MATERIAL WITH COARSE AGGREGATE. Rapid setting concrete material to contain coarse aggregate shall be a prepackaged material to be used for patching horizontal concrete surfaces where rapid return of the structure to service is necessitated. This material shall be formulated for the optional addition of 3/8 inch coarse aggregate to produce a rapid setting concrete mixture.

In addition to the material requirements of Subsection 780.03, the product shall meet the following requirements:

(a) Compressive Strength. The neat material plus coarse aggregate shall exhibit a minimum 3-hour compressive strength of 2,000 psi, a 1-day compressive strength of 2,900 psi, and a 7-day compressive strength of 5,000 psi when tested in accordance with the requirements of *AASHTO T 22*.

780.05 POLYMER CONCRETE REPAIR MATERIAL. Products listed on the *APL* shall meet the following requirements:

(a) Compressive Strength. The neat material shall exhibit a minimum 2-hour compressive strength of 1,200 psi and a 7-day compressive strength of 5,000 psi when tested in accordance with the requirements of *ASTM C 579*.

(b) Volume Stability. The material shall not exceed 0.15% linear shrinkage when tested in accordance with the requirements of *ASTM C 531*.

(c) Direct Tension Pull-off. The material shall exhibit a minimum bond strength of 150 psi when tested in accordance with the requirements of *ASTM C 1583*.

(d) Chloride Ion Penetrability. The material shall exhibit a chloride ion penetrability level of "Low" when tested in accordance with the requirements of *AASHTO T 277*.

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INDEX OF PAY ITEMS

Item No.	Pay Item Name	Pay Unit
646.200 - 646.209	4 Inch White Line	Linear Foot
646.2100 - 646.2119	4 Inch Yellow Line	Linear Foot
680.65	6 Inch Magnetic Information Plaque	Each
646.2140 - 646.2149	6 Inch White Line	Linear Foot
646.2150 - 646.2159	6 Inch Yellow Line	Linear Foot
646.220 - 646.229	8 Inch White Line	Linear Foot
646.230 - 646.239	8 Inch Yellow Line	Linear Foot
646.240 - 646.249	12 Inch White Line	Linear Foot
646.250 - 646.259	12 Inch Yellow Line	Linear Foot
646.260 - 646.269	24 Inch Stop Bar	Linear Foot
629.20	Adjust Elevation of Valve Box	Each
621.79	Adjust Height of Guardrail	Linear Foot
402.12	Aggregate Shoulders	Ton
402.13	Aggregate Shoulders, RAP	Ton
403.12	Aggregate Shoulders, RAP with RAS	Ton
401.10	Aggregate Surface Course	Cubic Yard
651.20	Agricultural Limestone	Ton
406.28	Air Voids Pay Adjustment (N.A.B.I.)	Lump Unit
608.25	All Purpose Excavator Rental, Type I	Hour
608.26	All Purpose Excavator Rental, Type II	Hour

Item No.	Pay Item Name	Pay Unit
621.65	Anchor for Cable Rail	Each
621.60	Anchor for Steel Beam Rail	Each
621.61	Anchor for Steel to Box Beam Transition	Each
418.10	Asphaltic Approach Material	Square Foot
653.50	Barrier Fence	Linear Foot
531.18	Bearing Device Assembly, Elastomeric Pad w/External Load Plates	Each
531.15	Bearing Device Assembly, High Load Multi-Rotational	Each
531.16	Bearing Device Assembly, Plain Elastomeric Pad	Each
531.17	Bearing Device Assembly, Steel Reinforced Elastomeric Pad	Each
616.305	Bituminous Concrete Curb, Type A	Linear Foot
616.315	Bituminous Concrete Curb, Type B	Linear Foot
616.47	Bituminous Concrete Gutters and Traffic Islands	Ton
406.45	Bituminous Concrete Pavement Surface Preparation	Ton
618.15	Bituminous Concrete Sidewalk	Ton
417.10	Bituminous Crack Sealing	Pound
417.20	Bituminous Crack Sealing, "Blow and Go" Method	Pound
619.14	Bollards	Each
407.15	Bonded Wearing Course	Square Yard
619.10	Boundary Markers	Each
621.30	Box Beam Guardrail	Linear Foot
620.20	Bracing Assembly for Chain-Link Fence, 4 Feet	Each
620.21	Bracing Assembly for Chain-Link Fence, 6 Feet	Each
620.22	Bracing Assembly for Chain-Link Fence, 8 Feet	Each
679.47	Bracket Arm	Each
516.10	Bridge Expansion Joint, Asphaltic Plug	Linear Foot
516.12	Bridge Expansion Joint, Finger Plate	Linear Foot
516.11	Bridge Expansion Joint, Vermont	Linear Foot
525.50	Bridge Railing Repair, Type I	Linear Foot
525.55	Bridge Railing Repair, Type II	Linear Foot

Item No.	Pay Item Name	Pay Unit
525.60	Bridge Railing Repair, Type III	Linear Foot
525.70	Bridge Railing, Concrete F-Shape	Linear Foot
525.33	Bridge Railing, Galvanized 2 Rail Box Beam	Linear Foot
525.335	Bridge Railing, Galvanized 3 Rail Box Beam	Linear Foot
525.34	Bridge Railing, Galvanized 4 Rail Box Beam	Linear Foot
525.41	Bridge Railing, Galvanized HD Steel Beam/Fascia Mounted	Linear Foot
525.44	Bridge Railing, Galvanized HDSB/Fascia Mounted/Steel Tubing	Linear Foot
525.45	Bridge Railing, Galvanized Steel Tubing/Concrete Combination	Linear Foot
608.10	Bulldozer Rental, Type I	Hour
608.11	Bulldozer Rental, Type II	Hour
680.25	Business Directional Sign	Square Foot
601.0200 - 601.0399	CAAP	Linear Foot
601.5200 - 601.5399	CAAP Elbow	Each
601.2200 - 601.2399	CAAP(SL)	Linear Foot
601.3200 - 601.3399	CAAPA	Linear Foot
601.4200 - 601.4399	CAAPA(SL)	Linear Foot
601.8200 - 601.8399	CAAPAES	Each
601.6200 - 601.6399	CAAPES	Each
621.17	Cable Guardrail	Linear Foot
621.173	Cable Guardrail Hook Bolt, Galvanized	Each
621.174	Cable Guardrail Splice Unit	Each
604.60	Cap Drop Inlet	Each
604.55	Cast Iron Cover with Frame	Each

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Item No.	Pay Item Name	Pay Unit
604.56	Cast Iron Cover with Frame, Sewer	Each
604.45	Cast Iron Grate with Frame, Type A	Each
604.46	Cast Iron Grate with Frame, Type B	Each
604.47	Cast Iron Grate with Frame, Type D	Each
604.48	Cast Iron Grate with Frame, Type E	Each
604.49	Cast Iron Grate, Type C	Each
616.27	Cast-in-Place Concrete Curb, Type A	Linear Foot
616.28	Cast-in-Place Concrete Curb, Type B	Linear Foot
602.15	Cement Masonry	Cubic Yard
620.11	Chain-Link Fence, 4 Feet	Linear Foot
620.12	Chain-Link Fence, 6 Feet	Linear Foot
620.13	Chain-Link Fence, 8 Feet	Linear Foot
604.40	Changing Elevation of Drop Inlets, Catch Basins, or Manholes	Each
604.42	Changing Elevation of Sewer Manholes	Each
203.25	Channel Excavation of Earth	Cubic Yard
203.26	Channel Excavation of Rock	Cubic Yard
653.25	Check Dam, Type I	Cubic Yard
653.26	Check Dam, Type II	Cubic Yard
653.30	Check Dam, Type III	Each
601.995	Cleaning Culv. Pipe, In-Place [0 to 24 In., Incl.]	Linear Foot
601.996	Cleaning Culv. Pipe, In-Place [Greater than 24 In.]	Linear Foot
201.10	Clearing and Grubbing, Including Individual Trees and Stumps	Lump Sum
201.11	Clearing and Grubbing, Including Individual Trees and Stumps	Acre
210.10	Coarse-Milling, Bituminous Pavement	Square Yard
208.40	Cofferdam	Lump Sum
208.30	Cofferdam Excavation, Earth	Cubic Yard
208.35	Cofferdam Excavation, Rock	Cubic Yard
415.20	Cold Mixed Recycled Bituminous Pavement	Square Yard
203.15	Common Excavation	Cubic Yard

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Item No.	Pay Item Name	Pay Unit
604.10	Concrete Catch Basin with Cast Iron Grate	Each
604.11	Concrete Manhole with Cast Iron Cover	Each
541.22	Concrete, Class A	Cubic Yard
541.21	Concrete, Class AA	Cubic Yard
580.19	Concrete, Class AA Overlay	Square Yard
541.25	Concrete, Class B	Cubic Yard
541.30	Concrete, Class C	Cubic Yard
541.31	Concrete, Class D	Cubic Yard
541.40	Concrete, Class LW	Cubic Yard
543.10	Contractor-Fabricated Precast Concrete Structure	Lump Sum
541.45	Controlled Density (Flowable) Fill	Cubic Yard
629.39	Corporation Stop	Each
601.0900 - 601.0999	CPEP	Linear Foot
601.5800 - 601.5899	CPEP Elbow	Each
601.2600 - 601.2799	CPEP(SL)	Linear Foot
601.7000 - 601.7099	CPEPES	Each
633.10	CPM Schedule	Each
601.5900 - 601.5999	CPPP Elbow	Each
601.7100 - 601.7199	CPPPES	Each
601.2800 - 601.2999	CPPP(SL)	Linear Foot
646.310 - 646.319	Crosswalk Marking	Each
629.54	Crushed Stone Bedding	Ton

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Item No.	Pay Item Name	Pay Unit
601.0000 - 601.0199	CSP	Linear Foot
601.5000 - 601.5199	CSP Elbow	Each
601.2000 - 601.2199	CSP(SL)	Linear Foot
601.3000 - 601.3199	CSPA	Linear Foot
601.4000 - 601.4199	CSPA(SL)	Linear Foot
601.8000 - 601.8199	CSPAES	Each
601.6000 - 601.6199	CSPES	Each
656.16	Deciduous Seedlings	Each
656.35	Deciduous Shrubs	Each
656.30	Deciduous Trees	Each
604.65	Decommission Drop Inlet	Each
676.20	Delineator with Flexible Post	Each
676.10	Delineator with Steel Post	Each
202.10	Demolition and Disposal of Building	Each
618.30	Detectable Warning Surface	Square Foot
205.10	Drilling and Blasting of Solid Rock	Linear Foot
205.20	Drilling and Blasting of Solid Rock Subgrade	Square Yard
507.16	Drilling and Grouting Dowels	Linear Foot
620.30	Drive Gate for Woven Wire Fence	Each
602.20	Dry Masonry	Cubic Yard
628.28	Ductile Iron Sewer Pipe, Cement-Lined	Linear Foot
629.24	Ductile Iron Water Pipe, Cement-Lined	Linear Foot

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Item No.	Pay Item Name	Pay Unit
646.400 - 646.409	Durable 4 Inch White Line	Linear Foot
646.410 - 646.419	Durable 4 Inch Yellow Line	Linear Foot
646.420 - 646.429	Durable 6 Inch White Line	Linear Foot
646.430 - 646.439	Durable 6 Inch Yellow Line	Linear Foot
646.440 - 646.449	Durable 8 Inch White Line	Linear Foot
646.450 - 646.459	Durable 8 Inch Yellow Line	Linear Foot
646.460 - 646.469	Durable 12 Inch White Line	Linear Foot
646.470 - 646.479	Durable 12 Inch Yellow Line	Linear Foot
646.480 - 646.489	Durable 24 Inch Stop Bar	Linear Foot
646.500 - 646.509	Durable Crosswalk Marking	Linear Foot
646.490 - 646.499	Durable Letter or Symbol	Each
646.510 - 646.519	Durable Railroad Crossing Symbol	Each
609.15	Dust and Ice Control with Calcium Chloride	Ton
609.10	Dust Control with Water	MGAL
505.45	Dynamic Pile Loading Test	Each
203.30	Earth Borrow	Cubic Yard
678.21	Electrical Conduit	Linear Foot
678.30	Electrical Conduit Sleeve	Linear Foot
678.24	Electrical Wiring	Linear Foot

Item No.	Pay Item Name	Pay Unit
634.10	Employee Traineeship	Hour
404.65	Emulsified Asphalt	CWT
415.25	Emulsified Asphalt, Cold Mix	CWT
621.575	Energy Absorption Attenuator, Permanent	Each
621.56	Energy Absorption Attenuator, Temporary	Each
653.01	EPSC Plan	Lump Sum
653.60	Erosion Log	Linear Foot
656.15	Evergreen Seedlings	Each
656.25	Evergreen Shrubs	Each
656.20	Evergreen Trees	Each
203.28	Excavation of Surfaces and Pavements	Cubic Yard
629.40	Expansion Assembly	Each
629.25	Extension Service Box and Curb Stop	Each
651.18	Fertilizer	Pound
631.26	Field Office Communications (N.A.B.I.)	Dollar
631.10	Field Office, Engineers	Lump Sum
631.11	Field Office, Soils and Materials	Lump Sum
653.45	Filter Bag	Each
210.12	Fine-Milling, Bituminous Pavement	Square Yard
630.15	Flaggers	Hour
678.17	Flashing Beacon, Aerial Mounted	Each
678.16	Flashing Beacon, Ground Mounted	Each
675.43	Foundation for Tubular Steel Post	Each
675.41	Foundation for W-Shape Steel Post, 24 Inch Diameter	Each
675.42	Foundation for W-Shape Steel Post, 30 Inch Diameter	Each
310.20	Full Depth Reclamation (FDR)	Square Yard
504.10	Furnishing Equipment for Driving Piling	Lump Sum
620.15	Gate for Chain-Link Fence, 4 Feet	Linear Foot
620.16	Gate for Chain-Link Fence, 6 Feet	Linear Foot

Item No.	Pay Item Name	Pay Unit
620.17	Gate for Chain-Link Fence, 8 Feet	Linear Foot
629.26	Gate Valve	Each
629.27	Gate Valve with Valve Box	Each
649.61	Geotextile for Filter Curtain	Square Yard
649.11	Geotextile for Roadbed Separator	Square Yard
649.41	Geotextile for Underdrain Trench Lining	Square Yard
649.21	Geotextile Under Railroad Ballast	Square Yard
649.31	Geotextile Under Stone Fill	Square Yard
616.20	Granite Slope Edging	Linear Foot
204.30	Granular Backfill for Structures	Cubic Yard
203.32	Granular Borrow	Cubic Yard
203.35	Gravel Filter for Slope Stabilization	Cubic Yard
656.40	Ground Covers and Vines	Each
510.24	Grouting Shear Keys	Linear Foot
651.40	Grubbing Material	Square Yard
621.746	Guardrail Approach Section to Concrete Bridge Railing, TL-2	Each
621.747	Guardrail Approach Section to Concrete Bridge Railing, TL-3	Each
621.748	Guardrail Approach Section to Conc. Comb. Bridge Railing, TL-3	Each
621.72	Guardrail Approach Section, Galvanized 2 Rail Box Beam	Each
621.725	Guardrail Approach Section, Galvanized 3 Rail Box Beam	Each
621.73	Guardrail Approach Section, Galvanized 4 Rail Box Beam	Each
621.737	Guardrail Approach Section, Galvanized HD Steel Beam	Each
621.738	Guardrail Approach Section, Galv. HD Steel Beam w/8 Feet Posts	Each
621.70	Guardrail Approach Section, Galvanized, Type I	Each
621.71	Guardrail Approach Section, Galvanized, Type II	Each
621.85	Guide Posts	Each
406.38	Hand-Placed Bituminous Concrete Material, Drives	Square Yard
653.10	Hay Mulch	Ton
621.21	HD Steel Beam Guardrail, Galvanized	Linear Foot

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Item No.	Pay Item Name	Pay Unit
621.215	HD Steel Beam Guardrail, Galvanized w/8 Feet Posts	Linear Foot
621.216	HD Steel Beam Guardrail, Galvanized/Nested	Linear Foot
621.217	HD Steel Beam Guardrail, Galvanized/Nested w/8 Feet Posts	Linear Foot
501.37	High Performance Concrete, Class PCD	Cubic Yard
501.38	High Performance Concrete, Class PCS	Cubic Yard
501.39	High Performance Concrete, Class SCC	Cubic Yard
629.28	Hydrant	Each
653.11	Hydraulic Mulch	Gallon
653.40	Inlet Protection Device, Type I	Each
653.41	Inlet Protection Device, Type II	Each
653.42	Inlet Protection Device, Type III	Cubic Yard
622.10	Insulation Board	MFBM
678.20	Interconnecting Cable	Linear Foot
524.12	Joint Sealer, Cold Poured	Gallon
524.13	Joint Sealer, Cold Poured	Linear Foot
524.10	Joint Sealer, Hot Poured	Gallon
524.11	Joint Sealer, Hot Poured	Linear Foot
524.20	Joint Sealer, Polyurethane	Gallon
524.21	Joint Sealer, Polyurethane	Linear Foot
678.26	Junction Box	Each
656.80	Landscape Backfill, Truck Measurement	Cubic Yard
656.65	Landscape Watering	MGAL
646.300 - 646.309	Letter or Symbol	Each
646.76	Line Striping Targets	Each
608.40	Loader Rental, Type I	Hour
509.10	Longitudinal Deck Grooving	Square Yard
406.31	Longitudinal Joint Compaction Pay Adjustment (N.A.B.I.)	Lump Unit
679.50	Luminaire	Each

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Item No.	Pay Item Name	Pay Unit
653.03	Maintenance of EPSC Plan (N.A.B.I.)	Lump Unit
527.10	Maintenance of Structures and Approaches	Lump Sum
621.50	Manufactured Terminal Section, Flared	Each
621.51	Manufactured Terminal Section, Tangent	Each
406.25	Marshall Bituminous Concrete Pavement	Ton
406.29	Mat Density Pay Adjustment (N.A.B.I.)	Lump Unit
410.10	Material Transfer Vehicle	Ton
410.11	Material Transfer Vehicle, Cold Mix	Ton
507.19	Mechanical Bar Connector	Each
406.27	Medium Duty Marshall Bituminous Concrete Pavement	Ton
519.10	Membrane Waterproofing, Spray Applied	Square Yard
629.31	Meter Pit	Each
213.10	Milled Rumble Strips	Linear Foot
635.11	Mobilization/Demobilization	Lump Sum
653.02	Monitoring EPSC Plan	Hour
541.55	Mortar, Type I	Cubic Yard
541.58	Mortar, Type IV	Cubic Yard
203.20	Muck Excavation	Cubic Yard
522.35	Nonstructural Lumber, Treated	MFBM
522.30	Nonstructural Lumber, Untreated	MFBM
528.10	One-Way Temporary Bridge	Lump Sum
580.18	Overhead and Vertical Concrete Repair Material	Cubic Foot
677.12	Overhead Traffic Sign Support, Cantilever	Each
677.22	Overhead Traffic Sign Support, Cantilever with Lighting	Each
677.13	Overhead Traffic Sign Support, Multi-Support	Each
677.23	Overhead Traffic Sign Support, Multi-Support with Lighting	Each
680.72	Overlay for Travel Information Sign	Each
646.81	Painted Curb	Linear Foot
646.82	Painted Island	Square Foot

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Item No.	Pay Item Name	Pay Unit
516.20	Partial Removal and Modification of Bridge Joint	Linear Foot
529.20	Partial Removal of Structure	Each
646.86	Pavement Marking Mask	Square Foot
601.0400 - 601.0599	PCCSP	Linear Foot
601.5400 - 601.5599	PCCSP Elbow	Each
601.5600 - 601.5799	PCCSP Elbow (PI)	Each
601.0600 - 601.0799	PCCSP(PI)	Linear Foot
601.2400 - 601.2599	PCCSP(SL)	Linear Foot
601.3400 - 601.3599	PCCSPA	Linear Foot
601.3600 - 601.3799	PCCSPA(PI)	Linear Foot
601.4400 - 601.4599	PCCSPA(SL)	Linear Foot
656.41	Perennials	Each
505.35	Permanent Steel Sheet Piling	Square Foot
620.45	Plank Rail Fence	Linear Foot
629.32	Plastic Water Pipe, Flexible	Linear Foot
629.33	Plastic Water Pipe, Rigid	Linear Foot
580.21	Polymer Concrete Repair Material	Cubic Foot
407.16	Polymer-Modified Emulsified Asphalt	CWT
641.16	Portable Arrow Board	Each
641.18	Portable Arrow Board Rental	Day
641.15	Portable Changeable Message Sign	Each
641.17	Portable Changeable Message Sign Rental	Day

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Item No.	Pay Item Name	Pay Unit
618.10	Portland Cement Concrete Sidewalk, 5 Inch	Square Yard
618.11	Portland Cement Concrete Sidewalk, 8 Inch	Square Yard
608.30	Power Broom Rental, Type I	Hour
608.31	Power Broom Rental, Type II	Hour
608.32	Power Broom Rental, Type III	Hour
679.55	Power Drop Stanchion, Street Lighting	Each
608.15	Power Grader Rental	Hour
540.10	Precast Concrete Structure	Lump Sum
604.20	Precast Reinforced Concrete Catch Basin with Cast Iron Grate	Each
604.30	Precast Reinforced Concrete Curb DI with Cast Iron Grate	Each
616.25	Precast Reinforced Concrete Curb, Type A	Linear Foot
616.26	Precast Reinforced Concrete Curb, Type B	Linear Foot
604.18	Precast Reinforced Concrete Drop Inlet with Cast Iron Grate	Each
604.21	Precast Reinforced Concrete Manhole with Cast Iron Cover	Each
604.25	Precast Reinforced Concrete Pipe DI with Cast Iron Grate	Each
604.26	Precast Reinforced Concrete Pipe DI with Concrete Cover	Each
546.10	Pre-Excavation of Abutment Piles, Earth	Linear Foot
546.20	Pre-Excavation of Abutment Piles, Rock	Linear Foot
544.10	Prefabricated Bridge Unit Superstructure	Linear Foot
510.21	Prestressed Concrete Box Beams	Linear Foot
510.23	Prestressed Concrete Girders	Linear Foot
510.26	Prestressed Concrete NEXT D Beams	Linear Foot
510.25	Prestressed Concrete Solid Slabs	Linear Foot
510.22	Prestressed Concrete Voided Slabs	Linear Foot
406.50	Price Adjustment, Asphalt Cement (N.A.B.I.)	Lump Unit
653.55	Project Demarcation Fence	Linear Foot
678.27	Pull Box, Double	Each
678.25	Pull Box, Standard	Each
628.35	PVC Sewer Pipe	Linear Foot

Item No.	Pay Item Name	Pay Unit
646.320 - 646.329	Railroad Crossing Symbol	Each
632.10	Railroad Flaggers (N.A.B.I.)	Dollar
	This pay item deleted	
580.17	Rapid Setting Concrete Repair Material	Cubic Foot
580.20	Rapid Setting Concrete Repair Material with Coarse Aggregate	Cubic Foot
601.0800 - 601.0899	RCP	Linear Foot
601.6800 - 601.6899	RCPES	Each
602.35	Rebuilt Stone Masonry	Cubic Yard
604.412	Rehab. Drop Inlets, Catch Basins, or Manholes, Class I	Each
604.415	Rehab. Drop Inlets, Catch Basins, or Manholes, Class II	Each
604.418	Rehab. Drop Inlets, Catch Basins, or Manholes, Class III	Each
507.11	Reinforcing Steel, Level I	Pound
507.12	Reinforcing Steel, Level II	Pound
507.13	Reinforcing Steel, Level III	Pound
601.99	Re-Laying Pipe Culverts	Linear Foot
628.30	Re-Laying Sewer Pipe	Linear Foot
629.29	Relocate Hydrant	Each
680.40	Relocate Information Plaza	Each
621.80	Removal and Disposal of Guardrail	Linear Foot
621.81	Removal and Disposal of Guide Posts	Each
529.10	Removal of Bridge Pavement	Square Yard
529.25	Removal of Concrete or Masonry	Cubic Yard
529.26	Removal of Concrete or Masonry	Square Yard
525.10	Removal of Existing Bridge Railing	Linear Foot
616.41	Removal of Existing Curb	Linear Foot
676.12	Removal of Existing Delineator and Post	Each

Item No.	Pay Item Name	Pay Unit
620.55	Removal of Existing Fence	Linear Foot
646.85	Removal of Existing Pavement Markings	Square Foot
678.45	Removal of Existing Traffic Control Signal System	Each
529.15	Removal of Structure	Each
676.15	Remove and Replace Delineator	Each
531.19	Remove and Replace Existing Anchor Bolt	Each
617.17	Remove and Replace Mailbox, Multiple Support	Each
617.15	Remove and Replace Mailbox, Single Support	Each
621.75	Remove and Reset Guardrail	Linear Foot
679.25	Remove and Reset Light Pole	Each
617.12	Remove and Reset Mailbox, Multiple Support	Each
617.10	Remove and Reset Mailbox, Single Support	Each
677.25	Remove and Reset Overhead Traffic Sign Support	Each
621.95	Remove and Reset Temporary Traffic Barrier	Linear Foot
677.30	Remove Existing Overhead Sign Assembly, Cantilever	Each
677.35	Remove Existing Overhead Sign Assembly, Multi-Support	Each
629.30	Remove Hydrant	Each
679.24	Remove Street Light Assembly	Each
616.40	Removing and Resetting Curb	Linear Foot
620.50	Removing and Resetting Fence	Linear Foot
619.20	Removing and Resetting Property Markers	Each
201.21	Removing Large Stumps	Each
201.16	Removing Large Trees	Each
201.20	Removing Medium Stumps	Each
201.15	Removing Medium Trees	Each
675.50	Removing Signs	Each
580.13	Repair of Concrete Substructure Surface, Class I	Square Yard
580.14	Repair of Concrete Substructure Surface, Class II	Square Yard
580.15	Repair of Concrete Substructure Surface, Class III	Cubic Yard

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Item No.	Pay Item Name	Pay Unit
580.10	Repair of Concrete Superstructure Surface, Class I	Square Yard
580.11	Repair of Concrete Superstructure Surface, Class II	Square Yard
580.12	Repair of Concrete Superstructure Surface, Class III	Cubic Yard
602.40	Repairing Stone Masonry	Square Yard
621.77	Replace Guardrail Beam Unit	Each
621.76	Replace Guardrail Post Assembly	Each
621.175	Replacement of Guardrail Cable	Linear Foot
616.225	Repointing Granite Bridge Curb	Gallon
602.30	Repointing Masonry	Square Yard
525.11	Reset Existing Bridge Railing	Linear Foot
675.60	Resetting Signs	Each
613.15	Riprap, Heavy Type	Cubic Yard
613.16	Riprap, Light Type	Cubic Yard
607.10	Roadway Patrol Maintenance	Hour
203.33	Rock Borrow	Cubic Yard
653.20	Rolled Erosion Control Product, Type I	Square Yard
653.21	Rolled Erosion Control Product, Type II	Square Yard
203.31	Sand Borrow	Cubic Yard
604.22	Sanitary Sewer Manhole	Each
629.23	Seamless Copper Water Tube	Linear Foot
651.15	Seed	Pound
651.17	Seed, Winter Rye	Pound
675.61	Setting Salvaged Posts	Each
508.15	Shear Connectors	Lump Sum
519.20	Sheet Membrane Waterproofing, Torch Applied	Square Yard
502.10	Shoring Superstructure	Lump Sum
502.11	Shoring Superstructure Bearings	Each
203.40	Shoulder Berm Removal	Linear Foot
653.475	Silt Fence, Type I	Linear Foot

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Item No.	Pay Item Name	Pay Unit
653.476	Silt Fence, Type II	Linear Foot
625.10	Sleeves for Utilities	Linear Foot
620.75	Snow Barrier Fence	Linear Foot
651.30	Sodding	Square Yard
675.35	Soil Bearing Slip Base	Each
203.16	Solid Rock Excavation	Cubic Yard
675.341	Square Tube Sign Post and Anchor	Linear Foot
653.35	Stabilized Construction Entrance	Cubic Yard
621.18	Steel Backed Timber Guardrail	Linear Foot
621.219	Steel Beam Guardrail Offset Block	Each
621.20	Steel Beam Guardrail, Galvanized	Linear Foot
621.205	Steel Beam Guardrail, Galvanized w/8 Feet Posts	Linear Foot
621.206	Steel Beam Guardrail, Galvanized/Nested	Linear Foot
621.207	Steel Beam Guardrail, Galvanized/Nested w/8 Feet Posts	Linear Foot
620.40	Steel Brace for Woven Wire Fence	Each
505.10	Steel Piling, HP 10 × 42	Linear Foot
505.12	Steel Piling, HP 10 × 57	Linear Foot
505.15	Steel Piling, HP 12 × 53	Linear Foot
505.155	Steel Piling, HP 12 × 63	Linear Foot
505.16	Steel Piling, HP 12 × 74	Linear Foot
505.165	Steel Piling, HP 12 × 84	Linear Foot
505.17	Steel Piling, HP 14 × 73	Linear Foot
505.18	Steel Piling, HP 14 × 89	Linear Foot
505.19	Steel Piling, HP 14 × 102	Linear Foot
505.20	Steel Piling, HP 14 × 117	Linear Foot
613.05	Stone Fill, Culvert Lining	Cubic Yard
613.06	Stone Fill, Stream Bed Material	Cubic Yard
613.10	Stone Fill, Type I	Cubic Yard

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Item No.	Pay Item Name	Pay Unit
613.11	Stone Fill, Type II	Cubic Yard
613.12	Stone Fill, Type III	Cubic Yard
613.13	Stone Fill, Type IV	Cubic Yard
602.25	Stone Masonry Facing	Square Yard
653.12	Straw Mulch	Ton
679.46	Street Light Assembly	Each
679.54	Street Lighting Control Device	Each
522.40	Structural Glued Laminated Timber	Lump Sum
522.25	Structural Lumber and Timber, Treated	MFBM
522.20	Structural Lumber and Timber, Untreated	MFBM
506.60	Structural Steel	Pound
506.75	Structural Steel	Lump Sum
506.56	Structural Steel, Curved Plate Girder	Pound
506.55	Structural Steel, Plate Girder	Pound
506.50	Structural Steel, Rolled Beam	Pound
506.57	Structural Steel, Truss	Pound
204.25	Structure Excavation	Cubic Yard
301.25	Subbase of Crushed Gravel, Coarse Graded	Cubic Yard
301.26	Subbase of Crushed Gravel, Fine Graded	Cubic Yard
301.28	Subbase of Crushed Gravel, Fine Graded	Ton
301.35	Subbase of Dense Graded Crushed Stone	Cubic Yard
301.15	Subbase of Gravel	Cubic Yard
301.40	Subbase, RAP	Ton
406.35	Superpave Bituminous Concrete Pavement	Ton
406.36	Superpave Bituminous Concrete Pavement, Type IVB	Ton
580.16	Surface Preparation for Membrane	Square Foot
406.30	Surface Tolerance Pay Adjustment (N.A.B.I.)	Lump Unit
629.35	Tapping Sleeve and Valve with Valve Box	Each

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Item No.	Pay Item Name	Pay Unit
646.600 - 646.605	Temporary 4 Inch White Line	Linear Foot
646.610 - 646.615	Temporary 4 Inch Yellow Line	Linear Foot
646.620 - 646.625	Temporary 6 Inch White Line	Linear Foot
646.630 - 646.635	Temporary 6 Inch Yellow Line	Linear Foot
646.640 - 646.645	Temporary 8 Inch White Line	Linear Foot
646.650 - 646.655	Temporary 8 Inch Yellow Line	Linear Foot
646.660 - 646.665	Temporary 12 Inch White Line	Linear Foot
646.670 - 646.675	Temporary 12 Inch Yellow Line	Linear Foot
646.680 - 646.685	Temporary 24 Inch Stop Bar	Linear Foot
646.700 - 646.705	Temporary Crosswalk Marking	Linear Foot
678.42	Temporary Detector	Each
678.41	Temporary Flashing Beacon	Each
646.690 - 646.695	Temporary Letter or Symbol	Each
528.12	Temporary Pedestrian Bridge	Lump Sum
646.710 - 646.715	Temporary Railroad Crossing Symbol	Each
621.90	Temporary Traffic Barrier	Linear Foot
678.40	Temporary Traffic Signal System	Each
621.53	Terminal Connector for Steel Beam Guardrail	Each
203.45	Test Borings	Linear Foot

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Item No.	Pay Item Name	Pay Unit
631.17	Testing Equipment, Bituminous	Lump Sum
631.16	Testing Equipment, Concrete	Lump Sum
631.19	Testing Equipment, Grout	Lump Sum
631.18	Testing Equipment, Protective Coatings	Lump Sum
201.30	Thinning and Trimming	Acre
201.31	Thinning and Trimming for Signs	Each
621.25	Thrie Beam Guardrail	Linear Foot
651.35	Topsoil	Cubic Yard
621.218	Traffic Barrier Delineator	Each
641.10	Traffic Control	Lump Sum
678.15	Traffic Control Signal System, Intersection	Each
641.11	Traffic Control, All-Inclusive	Lump Sum
675.20	Traffic Sign, Type A	Square Foot
675.21	Traffic Sign, Type B	Square Foot
628.42	Transfer to New System, Sanitary Sewer	Lump Sum
629.42	Transfer to New System, Water System	Lump Sum
656.55	Transplanting Groundcover	Square Yard
656.50	Transplanting Shrubs	Each
656.45	Transplanting Trees	Each
680.30	Travel Information Plaza	Each
680.20	Travel Information Sign	Square Foot
680.70	Travel Information Symbol	Each
616.35	Treated Timber Curb	Linear Foot
656.85	Tree Protection	Lump Sum
204.20	Trench Excavation of Earth	Cubic Yard
204.22	Trench Excavation of Earth, Exploratory (N.A.B.I.)	Cubic Yard
204.21	Trench Excavation of Rock	Cubic Yard
608.45	Truck-Mounted Attenuator	Hour
608.50	Truck-Mounted Attenuator, AWV/PV	Hour

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Item No.	Pay Item Name	Pay Unit
608.37	Truck Rental	Hour
675.32	Tubular Aluminum Sign Post	Pound
675.33	Tubular Steel Sign Post	Pound
528.11	Two-Way Temporary Bridge	Lump Sum
203.27	Unclassified Channel Excavation	Cubic Yard
203.17	Unclassified Excavation	Cubic Yard
605.20	Underdrain Carrier Pipe, 6 Inches	Linear Foot
605.21	Underdrain Carrier Pipe, 8 Inches	Linear Foot
605.23	Underdrain Carrier Pipe, 12 Inches	Linear Foot
605.95	Underdrain Flushing Basin	Each
605.10	Underdrain Pipe, 6 Inches	Linear Foot
605.11	Underdrain Pipe, 8 Inches	Linear Foot
605.13	Underdrain Pipe, 12 Inches	Linear Foot
630.10	Uniformed Traffic Officers	Hour
678.22	Vehicle Loop Detector	Linear Foot
616.21	Vertical Granite Curb	Linear Foot
616.215	Vertical Granite Curb, Mountable	Linear Foot
514.10	Water Repellent, Silane	Gallon
651.16	Wildflower Seed	Pound
678.23	Wired Conduit	Linear Foot
620.41	Wood Brace for Woven Wire Fence	Each
619.15	Wood Marker Posts	Each
620.25	Woven Wire Fence with Steel Posts	Linear Foot
620.26	Woven Wire Fence with Wood Posts	Linear Foot
675.31	W-Shape Steel Sign Post	Pound
619.17	Yielding Marker Posts	Each

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