PROJECT SPECIAL PROVISIONS

PART I – PROJECT NOTICE TO BIDDERS

1. NOTICE TO BIDDERS – CONTRACT COMPLETION DATE. This Contract shall be completed on or before October 13, 2023.

In accordance with this requirement, and with reference to Subsection 108.09(d), work will be allowed during the seasonal closure period from April 1st to April 15th, 2023.

2. NOTICE TO BIDDERS – VOLUNTARY PRE-BID MEETING. Prospective Contractors are hereby notified that there will be a pre-bid meeting for this project to be held at 2:00 PM, Monday, June 27th, virtually via Microsoft Teams. Please use the following link to join this meeting: https://teams.microsoft.com/l/meetup-join/19%3ameeting_ZGE4ZGMyY2UtNWE0ZS00ZTQyLTliNWUtMWEwNjdlMmIwOTli%40thread.v2/0?context=%7b%22Tid%22%3a%2220b4933b-baad-433c-9c02-70edcc7559c6%22%2c%22Oid%22%3a%22c47be1a6-8081-4ca5-9c65-d3ee66fcfdea%22%7d

Attendance by the Contractor at this pre-bid meeting is voluntary and not required in order to bid on this project. Subcontractors are also not required to attend but can if they wish.

Prospective Bidders/Contractors are encouraged to submit inquiries related to this project to the Agency's Office of Contract Administration AOT.ConstructionContractingInquiry@vermont.gov before 4:30 PM Eastern Time on Thursday, June ~~24th~~ 23rd , 2022. Inquiries submitted by this time will be kept anonymous as to the author of the inquiry. Other questions will be taken at the pre-bid meeting and following the pre-bid meeting until the deadline specified in Special Provision No. 13.

Prior to the bid opening date of July 15, 2022, the Agency's Office of Contract Administration will issue to Prospective Bidders/Contractors both a written summary of the pre-bid meeting and, if necessary, an addendum to the proposal documents.

3. NOTICE TO BIDDERS – PROHIBITION OF RUSSIAN GOODS. The Contractor is hereby notified that, pursuant to Vermont Executive Order No. 02-22, dated March 3rd, 2022, the purchase of Russian-sourced goods and goods produced by Russian entities (defined as institutions or companies that are headquartered in Russia or have their principal place of business in Russia) is prohibited. The awarded Contractor must fill out and sign the Executive Order 02-22 Vendor Certification as part of Contract awarding process.

4. NOTICE TO BIDDERS – MEASURES TO MITIGATE POTENTIAL IMPACTS DUE TO THE COVID-19 PANDEMIC. The Contractor is hereby notified that they should anticipate the possibility of future temporary Contract shutdowns, delays, or suspensions as a result of the COVID-19 pandemic. The Contractor shall consider risks associated with the COVID–19 pandemic as the Contractor develops project schedules and advances the work. The Contractor shall schedule work in a manner that in the event of a temporary shutdown, delay, or suspension, the impacts to mobility will be minimized. The sequence and progression of the work will be solely the Contractor's responsibility. The Contractor is expected to communicate with the Agency regularly to discuss the risks to the project and proposed mitigation measures. The Agency will collaborate with the contractor to mitigate the risks to the project and adjust the sequence of work as necessary to ensure that mobility is not impaired unnecessarily.

   If a shutdown, suspension, or delay occurs due to the COVID-19 pandemic, the Contractor shall ensure the site is in a stable, safe, and maintainable condition by implementing mitigation measures. Such mitigation measures may include, but are not limited to, limiting the area of milled surfaces exposed at once, or limiting the number of work operations in progress at any one time. The Contractor is solely responsible for any additional maintenance activities or delays related to the sequence and progression of operations. The Agency has established a contract duration which may be longer than expected for the specified work to account for inefficiencies related to the COVID-19 pandemic. The Contractor should anticipate mobility, labor, employee protection measures and material supply issues related to the COVID-19 pandemic. The Contractor is also expected to comply with any Executive Orders.

5. NOTICE TO BIDDERS – SITE CONDITION. Prior to any shutdown or suspension, the site condition shall be in a stable, safe, and maintainable condition for the travelling public. Stable, safe, and maintainable condition means that the Contractor shall establish necessary erosion and environmental controls; ensure that the full width of the roadway is fully paved with no milled sections; install all safety features including guardrail, traffic signs, and pavement markings as designed or restored to the existing condition to meet the existing geometry; and undertake any additional measures as needed based on site conditions. No lane reductions will be allowed through the winter months. Subsection 109.06 will not apply for work that is required to bring a project to a satisfactory shutdown condition. In the event of a project Suspension of Work Ordered by the Engineer, the Contractor will be reimbursed per Subsection 108.16.

6. NOTICE TO BIDDERS – SUBSECTION 108.16(b). Subsection 108.16(b) is hereby modified by adding the following language.

   (4) The ownership costs for equipment with a current *Blue Book* value in excess of $200,000.00 on site of an active project at the time of a suspension caused by the COVID-19 pandemic will be paid per Subsection 109.06(c)

7. NOTICE TO BIDDERS – SUBSECTION 631.02(a)(5). Subsection 631.02(a)(5) is hereby modified by adding the following as the second paragraph.

The heating and cooling systems shall be fitted with HEPA air filters meeting the requirements of the most current version of DOE-STD-3020. New HEPA filters shall be installed upon initial erection of the Field Office. All HEPA filters shall be replaced with new filters every 12 months, or when airflow through the filter becomes restricted, or as recommended by the manufacturer, whichever is more frequent.

8. NOTICE TO BIDDERS – SUBSECTION 631.02(a)(6). Subsection 631.02(a)(6) is hereby modified by being deleted in its entirety and replaced with the following.

(6) Sanitary Facilities and Cleaning Supplies. Sanitary facilities consisting of a flush toilet, chemical toilet, or other approved type, 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 be cleaned and disinfected regularly, per the CDC guidance at: https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fcommunity%2Freopen-guidance.html. The frequency of cleaning shall be as outlined in the CDC guidance, or as directed by the Engineer. The degree of cleanliness shall be approved by the Engineer. Sanitary facilities shall be provided with either hot, running, potable water and soap, or an alcohol-based hand sanitizer containing at least 70% alcohol by volume, for use in 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.

The Contractor shall supply the Field Office with hand sanitizer to be used for washing hands, and with a disinfectant for use in disinfecting surfaces. The hand sanitizer shall be alcohol based and shall contain at least 70% alcohol by volume. The disinfectant shall be one of the products identified on EPA List N: Disinfectants for Use Against SARS-CoV-2 (COVID-19), and shall have a contact time of 5 minutes or less, as specified on List N. If the disinfectant supplied is of the liquid or spray-on type, the Contractor shall also supply the Field Office with disposable paper towels for use in applying the disinfectant.

9. NOTICE TO BIDDERS – SUBSECTION 635.03(a). Subsection 635.03(a) is hereby modified by being deleted it in its entirety and replaced with the following:

The first payment of 50% of the lump sum price for Mobilization/Demobilization, or 10% of the adjusted Contract price, whichever is less, will be made within 30 days after execution of the Contract.

10. NOTICE TO BIDDERS – NIGHT WORK. The Contractor is hereby notified that all work within the roadway except for blasting activities**, associated clean-up and trench backfilling,** shall be performed between the hours of 7:00 p.m. and 6:00 a.m. of the next calendar day. The Engineer may abbreviate this time period as necessary. Night work is allowed for all construction activities except for blasting. All work performed at night shall be completed in accordance with Subsection 105.14.

For the purposes of this Contract, "night" shall mean the period from sunset until sunrise of the following day for the location of the Project. The time of sunrise and sunset for any day of the year and any location can be determined using the following link: https://www.esrl.noaa.gov/gmd/grad/solcalc/.

11. NOTICE TO BIDDERS – NIGHT WORK NOISE RESTRICTIONS. The Contractor shall take measures to control the noise caused by its night work (as defined above) construction operations, including but not limited to noise generated by equipment used for drilling, concrete cutting, pneumatic tools, generating power for lights, compaction, vibration, demolition, excavation, and hauling. The cost for meeting the specified noise level criteria will not be paid for separately but will be considered incidental to all other Contract items.

(a) Overview of Noise Measurement. The decibel (dB) is the universal unit of sound measurement and is measured with ammeter that registers sound pressure and displays these readings on a sound level scale. Decibels are a logarithmic unit, which means that a noise measuring 110 decibels is actually 10 times as intense as a noise registering at 100 decibels. Because in certain areas and at certain times of the day, the existing ambient noise level can be significant, the goals for limiting construction noise are relative to the existing ambient conditions.

(b) Recommended Mitigation Measures. Noise reduction mitigation measures as outlined in the FHWA Construction Noise Handbook http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook07.cfm may be utilized by the Contractor and include the following:

(1) Sequence work such that noisy activities occur concurrently, when possible.

(2) Shield or insulate stationary equipment such as air compressors and light towers.

(3) Properly maintain equipment with attention to lubrication, air intake, exhaust, and other aspects that impact noise.

(4) Employ systems to prevent slamming tailgates on dump trucks.

(5) Minimize idling of equipment.

(c) Required Mitigation Measures. The Contractor shall utilize broadband sound (i.e., "white-noise, whooshing sound") types of backup alarms, or adjustable backup alarms that can be adjusted down for the ambient noise level. Broadband sound is defined as sound where the acoustic energy is distributed over a very wide frequency range. The spectrum is largely smooth and continuous, except at the extremes.

12. NOTICE TO BIDDERS – ELECTRONIC DOCUMENT MANAGEMENT. The Contractor is hereby notified that the Contractor, their subcontractors, and suppliers shall create a Doc Express account and use the application for collection and management of electronic documents. Doc Express is a web-based document management application which accepts electronic documents and provides security as appropriate for each submittal. All Contract required documents, such as Working Drawings as defined in Subsection 105.03 of the 2018 Standard Specifications for Construction, Progress Schedules, Mix Designs, Weld Procedures, Requests for Information and Erosion Control Plans shall be submitted at the following link: https://docexpress.com. The entire submittal and review process shall occur within Doc Express.

All costs associated with the use of Doc Express will be considered incidental to Item 635.11, Mobilization/Demobilization. The State will manage the Doc Express application including Contract setup upon Contract execution.

To create an account and for more information regarding the use of Doc Express see the information at the following link:

https://outside.vermont.gov/agency/vtrans/external/docs/construction/Contracting/DocExpressOverviewforContractors.docx

13. NOTICE TO BIDDERS – CONTACT WITH THE AGENCY. From the time of advertising until the actual bid opening for this Contract, all prospective Contractors, subcontractors, and suppliers shall direct all inquiries related to this project solely to the Agency's Office of Contract Administration AOT.ConstructionContractingInquiry@vermont.gov.

The deadline for submitting inquiries related to this project to the Office of Contract Administration is 4:30 p.m. Eastern Time on July 6, 2022. No exceptions will be made to this requirement.

14. NOTICE TO BIDDERS – OTHER SPECIFICATIONS AND CONTRACT REQUIREMENTS.
404 Corps of Engineers Permit
Operational Stormwater Permit
Construction Stormwater Permit
Act 250 Land Use Permit
PIF – V-Bio Wrap
PIF – Viton Gaskets
PIF – Ductile Iron Pipe and Valve Procurement
Required Contract Provisions for Federal-Aid Construction
Certification for Federal-Aid Contracts
U.S. Department of Labor Davis-Bacon Wage Rates
Disadvantaged Business Enterprise (DBE) Policy Contract Requirements
Bulletin 3.5 Attachment C: Standard State Provisions for Contracts and Grants
USDOT Standard Title VI/Non-Discrimination Assurances, Appendices A and E
Standard Federal EEO Specifications
Contractor's EEO Certification Form
Vermont Certificate of Compliance
Vermont Minimum Labor and Truck Rates
Commodity Index Prices
Schedule of Pay Items

15. NOTICE TO BIDDERS – DAVIS-BACON. U.S. Department of Labor Davis-Bacon wage rates are applicable to this Contract. Copies of the applicable rates are included in this proposal.

In the included wage rates, the requirements of Executive Order 13658 do not apply to this Contract.

16. NOTICE TO BIDDERS – GENERAL SPECIAL PROVISIONS. The Contractor is hereby notified that the most recent General Special Provisions in effect on the date of advertisement shall apply to this Contract. The General Special Provisions may be found at the following address: https://vtrans.vermont.gov/highway/construct-material/construct-services/pre-contractspecifications/active

17. NOTICE TO BIDDERS – VTRANS COVID-19 PANDEMIC TEMPORARY GUIDELINES FOR THE QUALITY ASSURANCE PROGRAM. The Contractor is hereby notified that VTrans COVID-19 Pandemic Temporary Guidelines for the Quality Assurance Program (QAP) dated May 18, 2020, and its latest revisions are hereby in full effect and shall be adhered to. The QAP is located at the following link: https://vtrans.vermont.gov/highway/construct-material/test-cert

18. NOTICE TO BIDDERS – STANDARD DRAWINGS. The Vermont Agency of Transportation Standard Drawings listed on the Index of Sheets are not included in the plan set, but may be found at the following address: https://outside.vermont.gov/agency/vtrans/external/CADD/WebFiles/Downloads/Standards/VAOTconSTD_Owner.xml

19. NOTICE TO BIDDERS – INFORMATIONAL DOCUMENTS. The Contractor is hereby notified that the following informational documents for this Contract are available on iCXWeb and the VTrans Bid Opportunities website. These documents are being provided during the bid solicitation period for informational purposes only.

    (a) Traffic Management Plan (TMP) Checklist

    (b) Transportation Management Report (TMR)

    (c) Geotechnical Report with Addendum

    (d) Record Plans

20. NOTICE TO BIDDERS – STAGING AND WASTE SITES. The Contractor is hereby notified that the Vermont Natural Resources Board has requested that the Agency's contractors planning to use staging and waste sites governed by preexisting Act 250 permits notify District Coordinators prior to using these sites. Complying with preexisting Act 250 permits at these sites is the sole responsibility of the landowner and the Contractor, not the State.

21. NOTICE TO BIDDERS – ACT 250. The Contractor is hereby notified in addition to the Act 250 permit there is a Memorandum of Understanding (MOU) to establish and coordinate procedures for regulating certain transportation-related projects, dated April 7, 2009. As described in the MOU, if the Contractor elects to open any new waste or borrow sites, they shall be responsible for coordinating with the DEC District Coordinator prior to the commencement of construction.

22. NOTICE TO BIDDERS – ENVIRONMENTAL COMMITMENTS.

    (a) Threatened, Endangered, and Rare Species.

        (1) This project shall be subject to Avoidance and Minimization Measures to protect the habitat and hibernacula of the northern long-eared bat. Measures applicable to this project include, Time-of-Year (TOY) restrictions for any potential impacts to suitable bat habitat, which include, but are not limited to trees ≥ 3" and/or habitat features on bridge structures.

It is anticipated that the Contractor will be required to cut trees ≥3" in diameter within the identified project limits as part of the work. An assessment of the project limits resulted in a finding of no suitable habitat. Therefore, tree cutting activities, within the project limits may occur without any TOY restrictions.

The Contractor is hereby made aware of the potential for TOY restrictions related to proposed Waste, Borrow and Staging areas. Cutting trees ≥ 3" in diameter outside of the contract project limits shall require review under Section 105.25 Control of Waste, Borrow, and Staging Areas.

(b) Emerald Ash Borer.

(1) As of 2018, emerald ash borer (EAB), Agrilus planipennis, has been confirmed within Vermont's borders. To provide an assurance of compliance with state and federal EAB laws the contractor shall adhere to the following:

Known EAB infestation areas are changing rapidly. Therefore, the Contractor shall consult the online version of the EAB Infested Area Map (Located here: www.vtinvasives.org/land/emerald-ash-borer-vermont) on the same day cutting is to occur. If the project is located with an EAB infested area, ALL tree material, regardless of species, within the project area shall be handled in accordance with a document developed by the Vermont Department of Forests, Parks and Recreation and the Vermont Agency of Agriculture titled "Recommendations to SLOW THE SPREAD of Emerald Ash Borer When Moving Ash from the Infested Area", https://vtinvasives.org/sites/default/files/images/SLS/SlowSpreadWoodVT%20FINAL.pdf. Tree material shall not be moved out of state.

Alternatively, the Contractor may choose to hire a qualified professional (Arborist certified by the International Society of Arboriculture or Licensed Forester), at their own expense, to identify the presence of ash trees. Those identified ash trees would be subject to the above referenced recommendations, however other tree species would not.

The Contractor is also hereby made aware of the same potential restrictions as they relate to proposed Waste, Borrow and Staging areas under Section 105.25 Control of Waste, Borrow, and Staging Areas.

23. NOTICE TO BIDDERS – UTILITIES. Existing aerial facilities owned by Green Mountain Power, Consolidated Communications, FirstLight Fiber, and Comcast Communications will not require adjustment. The Contractor is cautioned to protect these facilities from damage.

Existing underground facilities owned by Consolidated Communications, FirstLight Fiber, and Vermont Gas will not require adjustment. The Contractor is cautioned to protect these facilities from damage.

The Contractor is advised that existing aerial electric and communication lines as well as buried electrical and communication services will be active during the construction of this project. The supporting of buried facilities may be required. The Contractor is advised to use caution while working around all active facilities and to protect them from damage.

Construction of the underground duct system and associated appurtenances shall be performed by the Contractor, at the locations identified in the *Utility Plan* sheets, in accordance with the details and specifications incorporated in the project plans and corresponding Special Provisions. The Contractor is to coordinate all work with utility company representatives a minimum of 2 weeks in advance of anticipated work so as to allow sufficient time for utility companies to schedule on-site inspection.

Existing underground water facilities owned by Champlain Water District will be adjusted, to include the construction of new water main, and all associated appurtenances, by the Contractor, in accordance with the details and pay items included in the project plans and all pertinent project specifications. The Contractor must coordinate inspection and testing, as needed, with Champlain Water District or their representative.

Existing water valves owned by the Champlain Water District, may require adjustments to match the new finished pavement elevation. Necessary elevation adjustments to municipally owned water valves will be performed by the Contractor in accordance with Item 629.42, Transfer to New System, Water System.

Utility Contact Information:

Green Mountain Power	Scott Fraser	(802) 355-1970
Comcast Communications	Conrad Ritchie	(802) 735-4860
FirstLight Fiber	Bill Gray	(802) 373-4319
Consolidated Communications	John Stempek	(802) 793-0723
Vermont Gas Systems	Matt Anderson	(802) 951-0327
Champlain Water District	Andrew Legg	(802) 777-7523
Town of Colchester	Brian Osborne	(802) 264-5625

The Contractor is advised that one or more of the parties to the Agreements for the construction of the various utility facilities included in this contract have the option of withdrawing the work from the contract. If any of the options are exercised, the contract utility work, in whole or in part, shall be deleted from the contract by the Engineer. The deletion of all or part of these utility items from the contract will not constitute any portion of an increase or decrease of 25% of the total original contract amount or of the original length shown in the contract as set forth in subsection 109.05, Compensation for Altered Plans or Quantities, and will not be subject to the provisions of 109.04, Significant Changes in the Character of the Work.

The Contractor is advised that exploratory excavation to locate existing underground facilities may be necessary to protect these facilities from damage. Where approved by the Engineer, these utilities shall be located and/or exposed by methods such as air/vacuum excavation and/or hand digging to determine their exact location. This exploratory work shall be in accordance with Item 204.22, Trench Excavation of Earth, Exploratory (N.A.B.I).

The Contractor is advised that many towns are not members of Dig Safe. It is the Contractor's responsibility to check with the towns prior to excavation and it shall protect and restore any utilities damaged within the project limits as set forth in Subsection 107.13 PROTECTION AND RESTORATION OF UTILITIES AND SERVICES.

Employees or agents of the above listed companies are to be allowed free and full access within the project limits with the tools, materials, and equipment necessary to install, operate, maintain, place, replace, relocate, and remove their facilities.

There will be no extra compensation paid to the Contractor for any inconvenience caused by working around and with the companies, or their facilities.

Vermont Statutes Annotated, Title 30, Chapter 86 ("Dig Safe") requires notice to Dig Safe before starting excavation activities. The Contractor must telephone Dig Safe at 811 at least 48 hours (excluding Saturdays, Sundays, and legal holidays) before, but not more than 30 days before, starting excavation activities at any location.

Should the Contractor desire additional adjustments of the utility facilities for his/her convenience, proper arrangements shall be made in conformance with Subsection 105.07 of the Standard Specifications for Construction.

All Contractors, subcontractors or material suppliers involved in any project-related activity shall comply with all applicable codes and regulations related to working around live electrical lines; including, but not limited to maintaining the required minimum clear distance from an electrical utility facility. The Contractor's Competent Safety Officer shall be well versed in OSHA and VOSHA regulations and shall be capable of implementing a plan to conform to these regulations during prosecution of work.

24. NOTICE TO BIDDERS – CONCURRENT CONSTRUCTION. The Contractor is made aware of the following Agency construction project(s) which are expected to be in progress within the area of this project during its construction.

TABLE 1 – CONCURRENT CONSTRUCTION PROJECTS

Project	Contractor	Anticipated Contract Completion Date
Winooski US-7 NH PC22(2)	TBD	Fall 2022
Winooski Centerpoint TAP TA17(2)	TBD	Summer 2023
Colchester-Essex NH 030-1(34)	TBD	Fall 2022
Winooski Main Street/Mansion Street Development	TBD	2024
385 Main Street	TBD	2022
Winooski School District Campus Renovation	DEW	2022
Water Tower Hill Hotel	TBD	2022
Colchester Fire District #3 Rathe Road to US 2/7 Waterline Replacement	TBD	TBD
Mountain View Drive Sidewalk Construction	TBD	TBD
Colchester STP 5600(20)	TBD	2023
Colchester STP 5600(21)	TBD	2023

This list is not all-inclusive, and it is possible there may be other Agency, municipal, or private construction projects within the area of this project during its construction.

The Contractor shall coordinate construction schedules and traffic control with the work required for these projects.

There will be no extra compensation paid to the Contractor for any inconvenience caused by working around these or other projects.

25. NOTICE TO BIDDERS – SPECIAL CONSTRUCTION REQUIREMENTS.

(a) The Contractor shall maintain a safe access to all ramps and U-turns at all times during the construction of this project.

(b) The Contractor shall position Portable Changeable Message Signs at locations determined by the Engineer properly warning motorists of the roadway conditions ahead. As directed by the Engineer, these locations may change during construction as needs arise based on daily work activities. The message to be displayed shall be submitted to the Engineer in advance for approval. The displayed message should accurately reflect what motorists can expect to encounter through the project area. The cost of providing the Portable Changeable Message Signs shall be paid for under Contract item 641.15 or 641.17. The Contractor shall also install and maintain appropriate construction signing warning the traveling public of the expected roadway surface conditions.

(c) Prior to final acceptance of the project, all drop inlets within the project limits shall be cleaned and all material within the drop inlets and bridge joints shall be removed. All paved areas adjacent to curbs shall be swept and cleaned of all extraneous material. Costs for this work will not be paid for directly but will be considered incidental to all Contract items.

(d) There are special events throughout the year that may require close communication and coordination between the Contractor and the municipality to reduce conflicts. The municipality will advise the Engineer and Contractor of the specifics of each event and the Engineer will direct the Contractor as to what actions, if any, will be necessary on the Contractor's part to minimize impacts to the event. Special events that may conflict with Contractor operations are not limited to those which may be listed in this Notice to Bidders. There will be no extra compensation paid to the Contractor for any inconvenience caused by working around any listed or unlisted special events.

For more information about area special events, contact the following:

Colchester:
Kathi Walker O'Reilly
Director of Economic Development
Town of Colchester
781 Blakely Road
802-264-5508

Winooski:
Paul Sarne
Communications Coordinator
City of Winooski
27 West Allen Street
802-655-6410 x12

TABLE 1 – SCHEDULE OF KNOWN EVENTS

Event	Date
Champlain Valley Fair	August 26 – September 4, 2022

26. NOTICE TO BIDDERS – AFAD. The Contractor is hereby notified that Automated Flagger Assistance Devices (AFADs) are remotely operated devices that enable a certified flagger to be positioned out of the lane of traffic and are used to control motorists through work zones.

AFADs shall only be used in situations where there is no more than one lane of approaching traffic that needs to be controlled. Additionally, since AFADs are not traffic control signals, they shall not be used to replace traffic signals or other continuously operating traffic control devices.

These devices may be used as a safety enhancement to flaggers on an hour-for-hour basis. AFADs shall meet the following requirements:

(a) All AFAD applications shall meet the requirements of the applicable sections of the current edition of the *Manual on Uniform Traffic Control Devices* (*MUTCD*).

(b) All AFAD applications shall be in accordance with *NCHRP Report 350* or the *MASH* for the applicable test level and device weight. Documentation of the crashworthiness of the device shall be submitted to the Engineer for approval prior to use on the project.

(c) AFAD applications shall always be controlled by a flagger who has been trained in the operation of the AFAD and who meets the requirements of Section 630. The flagger shall not flag traffic and operate an AFAD at the same time.

(d) Should an AFAD malfunction or otherwise not function as intended they shall be replaced by another AFAD or flagger(s) or work shall cease and the roadway shall be opened to unrestricted traffic flow immediately.

(e) Each AFAD will be considered equivalent to one flagger and will be measured and paid for on an hourly basis under Item 630.15 Flaggers. One hour of AFAD use shall be paid for as one hour of flagging.

(f) Flaggers will only be measured for payment when actually performing flagging duties. Flaggers controlling AFADs but not actually flagging will not be measured for payment but will be considered incidental to the Contract lump sum price for Item 641.10 Traffic Control, or Item 641.11 Traffic Control, All-Inclusive, as applicable.

(g) The use of AFADs may be suspended at the discretion of the Engineer.

27. NOTICE TO BIDDERS – PUBLIC INFORMATION CONSULTANT AND PROJECT STATUS. Construction of this project will have a significant impact on the Winooski and Colchester communities, along with the northern Chittenden County region. To this end, the Agency has hired a public information consultant (PIC) to inform the public daily about anticipated construction activities. The Agency's PIC is:

Annabelle Dally
Communications & Public Involvement Specialist
WSP USA, Inc.
(802) 595-4399
annabelle.dally@wsp.com

The Contractor will be required to coordinate construction activities with the PIC. In addition, the Contractor shall anticipate attending public meetings before project construction begins and actively participating in weekly project status meetings with City of Winooski and Town of Colchester representatives, PIC, Engineer, and others as required by the Engineer. Additional meetings may be required at the request of the Engineer. All costs associated with PIC coordination and project status meeting participation shall be considered incidental to Contract Item 641.11 Traffic Control, All-Inclusive.

28. NOTICE TO BIDDERS – PUBLIC MEETING. There will be a public information meeting held prior to the start of construction activity. The Contractor's Superintendent or Project Manager must be available to attend. The Contractor's representative shall be prepared to discuss the Contractor's approach to construction and answer questions regarding the construction schedule and phasing, in addition to work zone conditions and traffic management with the public. The Agency's Project Manager, Engineer, and Public Information Consultant will be responsible for leading this meeting, setting this meeting up, and making appropriate contacts.

29. NOTICE TO BIDDERS – POSSIBLE HAZARDOUS MATERIAL. There is a possibility that the Contractor may encounter petroleum contaminated soils in excavations at, near or south of the intersection of US Route 7 and I-89 Exit 16 Southbound Ramps.

In the event petroleum contaminated soils, as defined in "Management and Disposal of Contaminated Soil" in Section 900, are encountered during excavation, the Contractor shall immediately notify the Engineer and coordinate further activities with the DEC Hazardous Site Manager and the AOT Hazardous Materials Coordinator(s). All necessary coordination, excavation and material management shall be paid for under the appropriate contract pay item, unless otherwise specified.

30. NOTICE TO BIDDERS – URBAN SOILS BACKGROUND AREA. This project is located within an Urban Soils Background Area, as shown on the Vermont ANR Natural Resources Atlas. These areas have higher background levels of certain constituents, and the Agency has therefore determined that material generated from these areas should be disposed of within an Urban Soil Background Area. These soils shall be reused on-site to the maximum extent possible, as shown on the plans or indicated by these Special Provisions; however, excess Urban Area soils shall be disposed of off-site by the Contractor within a designated Urban Soils Background Area. The process for submittal and review of proposed disposal locations shall be in accordance with Standard Specifications 105.25-105.28.

    If the Contractor elects to use an alternate location outside of an Urban Soil Background Area, then soils must be disposed of in accordance with the Investigation and Remediation of Contaminated Properties Rule (IRule), FINAL ADOPTED RULE, July 8, 2019, at no additional expense to the project. The alternate location must be reviewed and approved by the Agency in accordance with Sections 105.25-105.28 of the Specifications, and the Contractor must secure all necessary permits and approvals from the Vermont Agency of Natural Resources for the alternate disposal site.

31. NOTICE TO BIDDERS – PERFORMANCE GRADED ASPHALT BINDER. All permanent pavement on both main line and side streets is required to use the PG binder grade specified elsewhere in the Plans and Specifications. All pavement used for driveways or surface preparation, regardless of the method of placement, will be allowed to use either the binder grade specified elsewhere, or PG 58-28 binder. There will be no additional compensation allowed for using either binder grade.

32. NOTICE TO BIDDERS – CWD STANDARD DRAWINGS. The Champlain Water District's Standard Drawings listed in the Waterline Relocation Plans are not included in the plan set, but may be found at the following address:
http://www.champlainwater.org/DocumentCenter/View/134/Specifications-and-Details-For-The-Installation-of-Water-Lines-and-Appurtenances-PDF

33. NOTICE TO BIDDERS – AGENCY-PROCURED MATERIALS. The Contractor is hereby notified that the following materials will be procured by the Agency and made available to the Contractor to install as shown on the Plans: Ductile Iron pipe, Gate Valves, and Butterfly Valves.

The Contractor shall be responsible for picking up and transporting these materials to the project site. At least 48 hours in advance of water line work, the Contractor shall contact the VTrans District 5 maintenance facility in Colchester at (802) 655-1580 to schedule and coordinate the pick-ups. The location of the material stockpile is at 189 Troy Avenue, Colchester, Vermont. The Contractor's responsibility for the materials' safety and integrity begins at the initial pick-up. Any damage to the material prior to the initial pick-up must be reported to the Engineer immediately and the Contractor shall not be allowed to transport the damaged material off-site unless approved by the Engineer.

Installation of ductile iron pipe shall begin in the 2023 construction season as defined by the 2018 Standard Specifications for Construction. The Agency will make the pipe available to the Contractor by April 15th, 2023. If the State-procured materials have not arrived at the Troy Avenue site prior April 15th, 2023, the days lost as a direct result of a delayed delivery by the manufacturer shall not count against the Contractor.

34. <u>NOTICE TO BIDDERS – ADDITIONAL TRAFFIC ACCOMODATIONS</u>. All existing traffic lanes shall be open to public traffic usage between the hours of 6:00 AM to 9:00 AM and 4:00 PM to 7:00 PM or as directed by the Engineer. Between the hours of 9:00 AM and 4:00 PM, two lanes in each direction of US Route 7 must remain open to traffic or as directed by the Engineer.

PART II – SECTION 900 SPECIAL PROVISION ITEMS

DRILLING AND BLASTING

1. DESCRIPTION. This work shall consist of performing controlled blasting techniques and close-in rock excavation, as covered herein, for forming highway rock cut slopes and trenches in rock as detailed in the Project Plans or as directed by the Engineer.

2. DEFINITIONS.

(a) Rock is defined as an aggregate of one of more minerals, i.e., any solid formations of igneous, sedimentary, or metamorphic material within the design lines of the excavation which cannot be loosened or broken up by means of mechanical ripping. Frozen materials are not classified as rock.

(b) Blasting is defined as the use of explosive materials with procedures and techniques to limit ground vibration velocities, flyrock, permanent ground displacement, air concussion, and overbreak, so as to prevent damage to existing structures, services, and utilities.

(c) Controlled Blasting is required for all blasting operations and consists of the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce a smooth, free surface, or shear plane in the rock that makes up the sides of the trench. Acceptable controlled blasting techniques include presplitting, cushion blasting, line drilling, and smooth wall blasting. Controlled blasting is used to protect adjacent structures/utilities, minimize damage to the trench excavation, and provide long term stability of the trench excavation.

(d) Close-in Blasting consists of controlled blasting for the rock removal near sensitive structures identified by the Plans and/or by the Engineer and shall include more stringent perimeter control measures including but not limited to line drilling along the excavation neat line and/or predrilling/perforation of rock.

(e) Blasting Operation: All activities related to Blasting including collaring and drilling of holes; preparing, fixing, and firing of explosive charges; handling of misfires; and the removal and disposal of blasted material.

(f) Flyrock: The throw of fragmented material in response to the firing of explosive charges.

(g) Air Concussion/Airblast Overpressure: The propagation of pressure waves through the atmosphere imparted by firing explosive charges.

(h) Overbreak: The fragmentation or removal of material beyond the design limits of the blasting excavation as shown on the Drawings. Overbreak is considered a non-paid excavation.

(i) Peak Particle Velocity (PPV) shall mean the greatest of three peak velocity components (inches per second units) measured at any point, with the three components being measured in the vertical and mutually perpendicular horizontal directions.

(j) Dynamic Displacement – is the displacement that occurs to an adjacent structure during a blast and is calculated as PPV/2(π)f, where f=frequency in cycles per second (Hertz), assuming a sinusoidal wave form.

Controlled blasting techniques covered by this specification include presplitting, cushion (trim) blasting, and close-in blasting. When presplitting, the detonation of the presplit line shall be before the detonation of any production holes. Cushion blasting is similar to presplitting, except that the detonation along the cut face shall be performed after the detonation of the production holes.

Production blasting, as covered herein, refers to the rock fragmentation blasts resulting from more widely spaced production holes drilled throughout the main excavation area adjacent to the controlled blast line. Production holes shall be detonated in a controlled delay sequence.

The purpose of controlled blasting is to minimize damage to the rock backslope to help insure long-term stability. The Engineer may require the contractor to use controlled blasting to form the faces of slopes, even if the main excavation can be ripped. Note that production blasting and presplitting language is to be used for re-cutting existing rock cuts, while close-in blasting is to be used for trench excavation.

3. USE OF EXPLOSIVES. All blasting operations, including the storage and handling of explosives and blasting agents, shall be performed in accordance with the applicable provisions of the Standard Specifications and all other pertinent Federal, State, and local regulations. Whenever explosives are used, they shall be of such character and in such amount as is permitted by the State and local laws and ordinances and all respective agencies having jurisdiction over them.

All blasting will be limited between 9:00 a.m. and **4 3**:00 p.m. Monday through Friday, except for holidays, or as determined by the Engineer. Traffic stoppages on US Route 7 (Roosevelt Highway) and Interstate 89 are anticipated to accommodate blasting.

4. PRODUCT SPECIFICATIONS. The delay elements in blasting caps are known to deteriorate with age. For this reason, it is required that all blasting caps used on the project be 1 year or less of age. To ensure the accuracy of firing times of blasting caps, it is required that each cap period come from one lot number. Mixing of lot numbers for any one cap period is prohibited.

Explosives are also known to age and deliver much less than the rated energy. For this reason, it is required that all explosives used on the project be 1 year or less of age.

Product that does not meet manufacturer's specifications shall not be used on the project.
When, in the opinion of the Engineer (based on date codes on product boxes or cartridge labels), any blasting product is either of excessive age or in what appears to be a deteriorated condition, all work will cease until the products age or quality can be determined.

No blasting product will be brought to the job site if the date codes are missing.

5. SCALING AND STABILIZATION. All rock on the cut face that is loose, hanging, or which creates a potentially dangerous situation shall be removed or stabilized to the Engineer's satisfaction during or upon completion of the excavation in each lift. Drilling of the next lift will not be allowed until this work has been completed.

The slopes shall be scaled throughout the span of the contract and at such frequency as required to remove all hazardous loose rock or overhangs. The slopes shall be hand scaled using a suitable standard steel mine scaling rod. Subject to the Engineer's approval, other methods such as machine scaling or hydraulic splitters, may be used in lieu of or to supplement hand scaling.

6. SITE PREPARATION. With the exception of trench blasting, the area for each shot shall be cleared of overburden prior to drilling and blasting operations. Any boulders encountered in the overburden shall be cleared. The use of standard explosive charges is not permitted to blast boulders. Acceptable methods for breaking boulders include the following:

(a) Hydraulic Splitter

(b) Air cushion blasting

(c) Expansive concrete such as Bristar or S-mite

(d) Hydraulic Hammer

If air cushion blasting is the selected method, blastholes must be 2 inches or less in diameter.

7. BLASTING PLAN SUBMITTAL. Not less than 2 weeks prior to commencing drilling and blasting operations, or at any time the Contractor proposes to change the drilling and blasting methods, the Contractor shall submit a "Blasting Plan" to the Engineer for review. The blasting plan shall contain the full details of the drilling and blasting patterns and controls the Contractor proposes to use for both the controlled, production and close-in blasting. Blasthole drilling operations cannot begin until the blast plan is approved.

   If conditions change (other than the number of blastholes), the Contractor is required to submit a new blasting plan. A generic blasting plan will not be sufficient.

   The blasting plan shall contain the following minimum information:

   (a) Station limits of each proposed shot.

   (b) Proposed drilling equipment.

   (c) Proposed rope access/fall protection systems or devices for the drillers, blaster, and helpers.

   (d) Proof of Vermont blasting licenses (use and transport of explosives), and local blasting permits if required.

   (e) Plan and section views of proposed drill pattern including free face, burden, blasthole spacing, blasthole diameters, blasthole angles, lift height, and sub-drill depth for each proposed shot. This includes close-in blasting for utility trenches.

   (f) Specific explosive types, including dimensions, unit weights densities, energies, relative strengths, velocities, detonation pressures and other characteristics. Only include the explosives specifically anticipated to be used.

   (g) Proposed delivery method and times of explosives to the project site.

   (h) Loading diagram showing type and amounts of explosives, primers, initiators and location and depth of stemming. This includes close-in blasting for utility trenches.

   (i) Best management practices and safeguards to limit nitrate and other blasting compound exposures to the environment.

   (j) Methods proposed to reduce the potential for flyrock formation.

   (k) Layout diagram showing the initiation sequence of blast holes, including delay times and delay systems.

(l) Manufacturer's safety and product information data sheets for all explosives, primers, and initiators to be employed.

(m) Manufacturer's product information sheet for the lighting detection system.

(n) Ground vibration and air blast monitoring methods and equipment and scaled distance estimates of vibration and air blast effects.

(o) Blast warning system and procedures.

(p) Provisions for detection of approaching lightning/thunderstorms and procedures for securing the blasting site from risk of premature detonation from lightning/thunderstorms.

(q) Examples of proposed blasthole drilling logs, blasting logs and vibration/air blast monitoring logs.

(r) Aerial photograph/image of site showing the blast radius containing the structures and facilities to be included in pre-blast surveys, and to be monitored for ground vibration and air blast during blasting operations.

The blasting plan submittal is for quality control and record keeping purposes. Review of the blasting plan by the Engineer shall not relieve the Contractor of his responsibility for the accuracy and adequacy of the plan when implemented in the field.

When the contract requires the Contractor to retain a blasting consultant to assist with the blast design, all blasting plan submittals must be approved by the blasting consultant.

8. PRODUCTION HOLES. All production blasting, including that carried out in conjunction with the blasting test section requirements of BLASTING TEST SECTION(S) of this Special Provision, shall be performed in accordance with the following general requirements.

Production blast holes shall be drilled on the patterns submitted by the Contractor and approved by the Engineer. The production blastholes shall be drilled within 2 blasthole diameters of the staked collar location. If more than 5 percent of the holes are drilled outside of this tolerance, then at the option of the Engineer, the Contractor may be required to refill these holes with crushed stone and re-drill them at the proper location.

If the blastholes are plugged or unable to be fully loaded, then at the option of the Engineer, the Contractor may be required to deepen or clean out those holes. The blastholes should all be checked and measured before any explosives are loaded into any of the holes to eliminate any safety hazard resulting from drilling near loaded holes.

All blastholes should reach their desired depth and if more than 5 percent of the holes are short before loading, the Contractor may be required by the Engineer to re-drill the short holes to proper grade at the Contractor's expense.

In order to control blasting effects, the Contractor must maintain a burden distance that is not more than one half the bench height and between 25 to 35 times the diameter of the explosive charge in the blasthole.

Blastholes will be covered to keep overburden from falling into the holes after drilling.

The row of production blast holes immediately adjacent to the controlled blast line shall be drilled on a plane approximately parallel to the controlled blast line. Production blast holes shall not be drilled closer than 6 feet to the controlled blast line, unless approved by the Engineer. The bottom of the production holes shall not be lower than the bottom of the controlled blastholes.

Production holes shall not exceed 3.5 inches in diameter, unless approved by the Engineer. Detonation of production holes shall be on a delay sequence toward a free face. Stemming material used in production holes shall be sand or other dry angular granular material, all of which passes a 3/8-inch sieve. Drilling cuttings shall not be used as stemming material.

It is the Contractor's responsibility to take all necessary precautions in the production blasting to minimize blast damage to the rock backslope.

Payment for production blasting shall be incidental to the contract unit price for Solid Rock Excavation.

9. CLOSE-IN BLASTHOLE DRILLING. All close-in blasting for utility trenches, including that carried out in conjunction with the blasting test section requirements of BLASTING TEST SECTION(S) of this Special Provision, shall be performed in accordance with the following general requirements.

Close-in blasts for utility trenches will be limited to 100 ft long per individual blast to limit impacts to traffic.

Close-in blast holes shall be drilled on the patterns submitted by the Contractor and approved by the Engineer. The production close-in blastholes shall be drilled within 2 blasthole diameters of the staked collar location. If more than 5 percent of the holes are drilled outside of this tolerance, then at the option of the Engineer, the Contractor may be required to refill these holes with crushed stone and re-drill them at the proper location.

If the blastholes are plugged or unable to be fully loaded, then at the option of the Engineer, the Contractor may be required to deepen or clean out those holes. The blastholes should all be checked and measured before any explosives are loaded into any of the holes to eliminate any safety hazard resulting from drilling near loaded holes.

All blastholes should reach their desired depth and if more than 5 percent of the holes are short before loading, the Contractor may be required by the Engineer to re-drill the short holes to proper grade at the Contractor's expense.

In order to control blasting effects, the Contractor must maintain a burden distance that is not more than one half the bench height and between 25 to 35 times the diameter of the explosive charge in the blasthole.

Blastholes will be covered to keep overburden from falling into the holes after drilling. Overburden and pavement materials can be used to help control flyrock.

Close-in blastholes shall not exceed 2.75 inches in diameter, unless approved by the Engineer. Detonation of production holes shall be on a delay sequence toward a free face. Stemming material used in production holes shall be angular, dry, crushed stone which passes a 3/8-inch sieve. Drilling cuttings shall not be used as stemming material.

To meet vibration criteria near sensitive structures (see Section 15 below), charges will likely need to be decked in blastholes to be separated in time and space. Decking material between charges shall be the same material as used for stemming.

It is the Contractor's responsibility to take all necessary precautions in the close-in blasting to minimize blast damage to the rock backslope.

Payment for close-in blasting shall be incidental to the contract unit price for Solid Rock Excavation.

10. BLASTHOLE DRILLING. The drill hole size for controlled blasting and close-in blasting shall be as shown in the approved blasting plan. The drill hole size shall be a size appropriate to produce a blast that does not violate the vibration thresholds for this project as detailed in section15 of the special provisions. Presplit drill holes for re-cutting rock slopes shall be a minimum of 2.5 inches in diameter and a maximum of 3 inches in diameter. The drill hole size for trench blasting shall not exceed 2.75 inches in diameter.

Drilling logs shall be kept on each blasthole to show open bedding, jointing and open or mud filled seams, zones of soft or weathered rock, mud pockets, etc. These logs shall be provided to the Engineer before any blastholes are loaded. The logs shall be used to properly design and load blastholes and design stemming decks. Stemming decks shall be used in weak zones to protect residents from blowout, flyrock and unusual or hazardous blasting effects. The stemming decks shall be constructed using crushed stone, well graded between 1/8 and 3/8 inch in diameter. Drill cuttings shall not be used.

11. BLASTING TEST SECTION(S). Prior to commencing full-scale blasting operations, the Contractor shall demonstrate the adequacy of the proposed blast plan by drilling, blasting, and excavating short test sections, up to 30 feet in length, to determine which combination of method, hole spacing, and charge works best. When field conditions warrant, as determined by the Engineer, the Contractor may be ordered to use test section lengths less than 30 feet.

Unless otherwise allowed by the Engineer, the Contractor shall begin the controlled blasting tests with the controlled blastholes spaced 2-1/2 feet apart, and then adjust if needed, until the Engineer approves the spacing to be used for full-scale blasting operations.

Requirements for controlled production and close-in blasting operations covered elsewhere in this specification shall also apply to the blasting carried out in conjunction with the test shots.

The Contractor will not be allowed to drill ahead of the test shot area until the test section has been excavated and the results evaluated by the Engineer. If the results of the test shot(s) are unsatisfactory, then, notwithstanding the Engineer's prior review of such methods, the Contractor shall adopt such revised methods as are necessary to achieve the required results.

Unsatisfactory test shot results include an excessive amount of fragmentation beyond the indicated lines and grade, excessive flyrock, or violation of other requirements within these specifications. All costs incurred by the Contractor in adopting revised blasting methods necessary to produce an acceptable test shot shall be considered incidental to the contract unit prices for Solid Rock Excavation and controlled blasting.

If at any time during the progress of the work, the methods of drilling and blasting do not produce the desired result of a uniform slope and shear face, within the tolerances specified, the Contractor will be required to drill, blast, and excavate in short sections, not exceeding 30 feet in length, until a technique is arrived at that will produce the desired results. Extra cost resulting from this requirement shall be borne by the Contractor.

12. SAFETY.

(a) Warnings and Signals. The Contractor will establish a method of warning all employees on the job site of an impending blast. The signal should consist of a five, minute warning signal to notify all in the area that a blast will be fired within a five-minute period. A second warning signal will be sounded 1 minute before the blast. After the blast is over, there will be an all-clear signal sounded so all in the area understand that all blasting operations are finished.

Five minutes prior to the blast, five long signals on an air horn or siren will be sounded. One minute prior to the blast, five short signals on an air horn or siren will be sounded. The all clear will be one long signal of at least 30 seconds in duration to indicate that all blasting has ceased.

(b) Lightning Protection. The Contractor shall furnish, maintain, and operate lightning detection equipment during the entire period of blasting operations and/or during the periods that explosives are used at the site. When the lightning detection device indicates a blasting hazard potential, personnel shall be evacuated from all areas where explosives are present. When a lightning detector indicates a blasting hazard, the following shall be performed:

(1) Clear the blasting area of all personnel.

(2) Notify the project Engineer of the potential hazards and precautions to be taken.

(3) Terminate the loading of holes and return the unused explosives to the day storage area.

(4) If blastholes are loaded and would pose a hazard to traffic if detonated, roads will be closed until the lightning hazard has passed.

(5) When the hazard dissipates, inform the project Engineer that production blasting will continue.

(c) Check for Misfires. The Contractor shall observe the entire blast area for a minimum of five minutes following a blast. The five-minute delay between blasting and allowing anyone but the blaster to enter the area is needed to make sure that no misfires have occurred.

During the 5-minute delay, it is the blaster's responsibility to go into the shot area and check all holes to make sure that they have detonated. If any holes have not fired, these misfires will be handled by the blaster before others enter the work area.

The Engineer shall have the authority to prohibit or halt the Contractor's blasting operations if it is apparent that through the methods being employed, the blasted slopes are unstable, or the safety and convenience of the traveling public is being jeopardized.

(d) Misfire Handling Procedures. Should a visual inspection indicate that complete detonation of all charges did not take place; the following procedures will be followed:

(1) If the system was energized and no charges fired for electric systems, the lead wire will be tested for continuity prior to inspection of the remainder of the blast. For non-electric systems, the lead in or tube will be checked to make sure that detonation has entered the blast area.

(2) Should an inspection of the electrical trunkline or lead in tubing-line indicate that there is a break in the line or if the tubing did not fire, then the system will be repaired, and the blast refired. If the inspection indicates that the trunkline has fired, and misfired charges remain, the blaster will do the following:

a. The blaster will exclude all employees except those necessary from the blast area to rectify the problem.

b. Traffic will be closed if a premature explosion could be a hazard to traffic on nearby roads.

c. The blaster will correct the misfire in a safe manner. If the misfire poses a problem that cannot be safely corrected by the blaster, a consultant, or an explosive company representative skilled in the art of correcting misfires will be called to rectify the problem.

13. CONTROLLED BLASTING.

(a) Presplitting. All presplitting shall be performed in accordance with the following requirements.

The Contractor shall completely remove all overburden soil and loose or decomposed rock along the top of the excavation for a distance of at least 25 feet beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the presplitting holes.

Boulders located beyond the excavation limits that may be potentially unstable shall also be removed as ordered by the Engineer. Payment for removal of the material located beyond the excavation limits shall be by Item 203.16, Solid Rock Excavation.

The presplit drill holes shall not be less than 2.5 inches and not more than 3 inches in diameter.

The Contractor shall control drilling operations by the use of proper equipment and technique to ensure that no hole shall deviate from the plane of the planned slope by more than nine (9) inches either parallel or normal to the slope. Presplit holes exceeding these limits shall not be paid for unless, in the Engineer's opinion, satisfactory slopes are being obtained.
Presplit holes shall be drilled within 3 inches of the staked collar location. If more than five (5) percent of the presplit holes are outside of the 3-inch tolerance, they will be filled with crushed stone, stemmed, and predrilled.

All drilling equipment used to drill the presplit holes shall have electro-mechanical or electronic devices affixed to the equipment to accurately determine the angle at which the drill steel enters the rock. Presplit hole drilling will not be permitted if these devices are either missing or inoperative.

If drilling outside the tolerance persists, the Contractor will be required to use a unit affixed to a laser profiler to determine blasthole orientation before the holes are loaded. Blastholes exceeding the allowable tolerance will be refilled with crushed stone or concrete and re-drilled at the proper location and at the proper alignment.

Presplit holes shall extend a minimum of 30 feet beyond the limits of the production holes to be detonated, or to the end of the cut as applicable.

The length of presplit holes for any individual lift shall not exceed 30 feet unless the Contractor can demonstrate to the Engineer that he/she can stay within the above tolerances and produce a uniform slope. Upon satisfactory demonstration, the length of holes may be increased to a maximum of 60 feet upon written approval of the Engineer. If greater than 5 percent of the presplit holes are misaligned in any one lift, the Contractor shall reduce the height of the lifts until the nine (9) inch alignment tolerance is met.

When the height will require more than one lift, a maximum 2-foot offset between lifts shall be permitted to allow for drill equipment clearances. The Contractor shall begin the control blast hole drilling at a point that will allow for necessary offsets and shall adjust, at the start of lower lifts, to compensate for any drift that may have occurred in the upper lifts. Payment for the additional excavation volume resulting from the allowed 2-foot offsets shall be at the contract unit price for Solid Rock Excavation.

Drilling 2 feet below ditch bottom will be allowed to facilitate removal of the toe berm.

Before placing charges, the Contractor shall determine that the hole is free of obstructions for its entire depth. All necessary precautions shall be exercised so that the placing of the charges will not cause caving of material from the walls of the holes.

Drill hole conditions may vary from dry to filled with water. The Contractor will be required to use whatever type(s) of explosives and/or blasting accessories necessary to accomplish the specified results.
The maximum diameter of explosives used in presplit holes shall not be greater than 1/2 the diameter of the presplit hole.

Bulk ammonium nitrate and fuel oil (ANFO) shall not be used on this project. Only standard explosives manufactured especially for pre splitting shall be used in presplit holes, unless otherwise approved by the Engineer. Explosives containing chlorate and perchlorate are prohibited.

If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in such a manner that the cartridges will not slip down the detonating cord nor bridge across the hole. Spacing of fractional cartridges along the length of the detonating cord shall not exceed 30 inches center to center and shall be adjusted to give the desired results.

Continuous column cartridge type of explosives used with detonating cord shall be assembled and affixed to the detonating cord in accordance with the explosive manufacturer's instructions, a copy of which shall be furnished to the Engineer.
The bottom charge of a presplit hole may be larger than the line charges but shall not be large enough to cause overbreak. The top charge of the presplitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving. The upper portion of all presplit holes, from the topmost charge to the hole collar, shall be stemmed. Stemming materials shall be sand or other dry angular granular material, all of which passes a 3/8-inch sieve. Drill cuttings shall not be used as stemming material.

As long as equally satisfactory presplit slopes are obtained, the Contractor, at his/her option, may either presplit the slope face before drilling for production blasting or may presplit the slope face and production blast at the same time, provided that the presplitting drill holes are fired first. If required to reduce ground vibrations or noise, presplit holes may be delayed, providing the hole-to-hole delay is no more than 25 milliseconds.

The presplit slope face shall not deviate more than 1 foot from a plane passing through adjacent drill holes, except where the character of the rock is such that, as determined by the Engineer, irregularities are unavoidable. The 1-foot tolerance shall be measured perpendicular to the plane of the slope. In no case shall any portion of the slope encroach on the roadbed.

14. BLASTING CONSULTANT. If the Contractor is unable to maintain a slope consistent with the expected results identified in the project plans and special provisions, the Engineer may require the Contractor to retain an experienced and recognized blasting consultant to assist in the blast design. The blasting consultant shall assist in the design of both the controlled and production blasting. Before blasting proceeds, a written report will be submitted to the Engineer for his approval.
The Contractor shall submit a resume of the credentials of the proposed blasting consultant. The resume shall include a list of at least five highway rock excavation projects on which the blasting consultant has worked. The list shall contain a description of the projects, details of the blast plans, and modifications made during the project. The list shall also contain the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. The Blasting Consultant shall not be an employee of the explosive's manufacturer, or explosives distributor. The Blasting Consultant must be approved by the Engineer prior to the beginning of any drilling and blasting work requiring the use of the Blasting Consultant.

The Blasting Consultant must approve the blasting plan for every blast, must be present to review the blasthole layout on the ground before drilling begins, be present at the time of blasthole loading and must also sign every blasting plan and each blast report. The Blasting Consultant must have full authority to stop or delay any blast considered unsafe.

The Blasting Consultant must submit and sign a written checklist that all necessary precautions were reviewed and followed by the drilling and blasting crew. The checklist will be defined under the section on blast reports. The signed checklist will be attached to each blasting report.

15. VIBRATION, NOISE, AND FLY-ROCK CONTROL. These specifications will apply to "close in" work where blasting will be carried out near existing buildings, structures, or utilities.

(a) Pre-Blast Condition Survey. The Contractor shall conduct a pre-blast survey of any buildings, structures, or utilities within a 500-foot radius of the blasting operations. This includes the bridge structures carrying I-89 over US Route 7. The survey method used shall be acceptable to the Contractor's insurance company, the Agency, and local authorities. The Contractor shall be responsible for any damage resulting from blasting. The pre-blast survey records shall be made available to the Engineer for review. Occupants of local buildings shall be notified by the Contractor prior to the commencement of blasting.

(b) Vibration Control and Monitoring. When blasting near buildings, structures, or utilities which may be subject to damage from blast induced ground vibrations, the ground vibrations shall be controlled by the use of properly designed delay sequences and allowable charge weights per delay. Allowable charge weights per delay shall be based on vibration levels that will not cause damage and shall not exceed Maximum Peak Particle Velocity (PPV) and Dynamic Ground Displacement values shown in Table 1 for on-site structures. For off-site structures, safe vibration limits will be considered those not exceeding the United States Bureau of Mines (USBM) RI 8507 criteria (Appendix B).

TABLE 1 – PPV AND DISPLACEMENT MAXIMUMS

Structure Type	Maximum Allowable Peak Particle Velocity (PPV) above 40 Hz (1)	Maximum Dynamic Ground Displacement (2)
Reinforced Concrete Structures	2.0 in/sec	0.012 in
Steel Structures	4.0 in/sec	0.012 in
Buried Utilities/Wells	2.0 in/sec	0.012 in
Green Concrete	See Table 2 below	Depends on strength of concrete and as approved by the Engineer

TABLE 2 – PPV MAXIMUMS

Age of Concrete	Maximum PPV
< 3 days	No Blasting
> 3 days	1.0 in/sec
> 5 days	1.8 in/sec
> 7 days	2.0 in/sec

Notes:

1. Maximum PPV shall be the maximum of three components measured in three mutually perpendicular directions (transverse, vertical, and longitudinal). Contractor shall monitor vibrations at the nearest structure for all blasts and other sensitive structures as designated by Engineer.

2. Dynamic ground displacement evaluated assuming sinusoidal wave pattern and using the following formula:

   $D = PPV/2\pi f$, where:

   D = displacement (mm)

   PPV = peak particle velocity (mm/second)

   F = frequency (Hz)

   The allowable charge weights per delay shall be established by carrying out trial blasts and measuring vibration levels. The trial blasts shall be carried out in conformance with the blasting test section requirements of Section 11, modified as required to limit ground vibrations to a level that will not cause damage.

   Whenever vibration damage to adjacent structures is possible, the Contractor shall monitor each blast with approved seismographs located between the blast area and the closest structures subject to blast damage. The placement of seismograph geophones shall be made with the concurrence of the Engineer. The seismographs used shall be capable of recording particle velocity for 3 mutually perpendicular components of vibration in the range generally found with controlled blasting.

   Peak particle velocity of each component shall not be allowed to exceed the safe limits of the nearest structure subject to vibration damage. The Contractor shall employ a qualified Vibration Specialist to establish the safe vibration limits. The Vibration Specialist shall also interpret the seismograph records to ensure that the seismograph data shall be effectively utilized in the control of the blasting operations with respect to the existing structures. The Vibration Specialist must have at minimum a two-year associate’s college degree in science or engineering and at least 10 years of experience in seismic monitoring.

   The Vibration Specialist shall also interpret the seismograph records to ensure that the seismograph data shall be effectively utilized in the control of the blasting operations with respect to the existing structures. The Vibration Specialist used shall be subject to the Engineer's approval. The Vibration Specialist shall supervise the placement and operation of the seismographs.

Data recorded for each shot shall be furnished to the Engineer prior to the next blast and shall include the following:

(1) Identification of instrument used.

(2) Name of qualified observer and interpreter.

(3) Location including distance and direction of recording station from blast area.

(4) Type of ground at recording station and material on which the instrument is sitting.

(5) Maximum particle velocity in each component.

(6) A dated and signed copy of records of all seismograph readings.

(c) Airblast and Noise Control. The Contractor shall conduct airblast monitoring. Airblast monitoring equipment shall be installed between the main blasting area and the nearest structures subject to blast damage or annoyance. The equipment used to make the airblast measurements shall be the type specifically manufactured for that purpose. The peak airblast overpressure at any inhabited building will not be allowed to exceed 131 decibels (linear; dBL) when measured by an instrument with a high pass system and a lower frequency limit of 2 Hz. The equivalent maximum allowable airblast overpressure is 0.01 pounds per square inch (psi). Appropriate blasthole patterns, detonation systems, and stemming shall be used to prevent venting of blasts and to minimize airblast and noise levels produced by the blasting operations. The overpressure limit shall be lowered if it proves too high based on damage or complaints. A permanent signed and dated record of the peak overpressure measurements shall be furnished by the Engineer immediately after each shot.

(d) Flyrock Control. Before the firing of any blast in areas where flying rock may result in personal injury or unacceptable damage to property or the work, the rock to be blasted shall be covered with approved blasting mats, soil, or other equally serviceable material, to prevent flyrock.

On projects where flyrock cannot be permitted because of close proximity to home or where flyrock could cause property damage or injury to the public the following shall apply:

Before the firing of any blast, the rock to be blasted shall be covered with approved blasting mats, soil, or other equally serviceable material, to prevent flyrock that may result in damage to life or property.

The homeowners/renters determined to be in the potential flyrock zone for a particular blast shall be notified by the Contractor 24 hours in advance of the pending blast and at least two (2) hours prior to the blast so they may temporarily relocate during the blast.

Methods of protecting existing structures and utilities from the effects of the blasting, blast induced flyrock, vibration, and airblast overpressure include, but are not limited to the following:

(1) New sisal rope blasting mats

(2) Wire rope or rubber tire blasting mats

(3) Backfilling

(4) Reduced explosive loads per delay
(5) Use of millisecond delays

(6) Relocation of any or all existing utility lines

(7) Existing overburden and pavement left in place

The Contractor shall protect all overhead and underground utilities prior to blasting and immediately repair or replace any damaged by the blasting operations. If the Contractor wishes to temporarily relocate any utility lines that lie near a blast zone, he shall have written approval from the governing utilities and pay all relocation costs.

The exposed face(s) of the blast will also be covered with blasting mats or other suitable materials to prevent any flyrock. The method of covering must be approved by the Engineer.

If flyrock travels more than one-half the distance between the blast and the project boundary, the Contractor must file a report explaining the cause of the flyrock and methods to be employed on the subsequent blasts to reduce the throw of flyrock. This report must be presented for the Engineers review before any blasts are detonated.

If flyrock leaves the construction right-of-way and lands on private property, all blasting operations will be halted and will not resume until the Engineer has evaluated and approved the Contractor’s plans to prevent future encroachments of private property.

16. PUBLIC MEETINGS. The Contractor shall make their qualified Vibration Specialist and Blasting Consultant available, if requested by the Engineer, to prepare for and participate in public meetings conducted by the Engineer to better inform the public about anticipated drilling and blasting operations. The specialists shall be prepared to answer any questions dealing with the magnitude of seismic motion, airblast overpressure and flyrock expected to impact on the public.

17. STORAGE OF EXPLOSIVES. The Contractor shall not store explosives overnight on the project site or on State owned property unless prior approval has been granted by the Agency.

    Should a loss or theft of explosives occur, all circumstances and details of the loss or theft will be immediately reported to the nearest office of Alcohol, Tobacco, Firearms & Explosives as well as to the local law enforcement authorities and Contractor's offices representative.

18. DAILY BLASTING LOGS. The Contractor shall provide the Engineer on a weekly basis a daily log of blasting operations. The log shall be updated at the close of each business day. The log shall include the number of blasts, times, and dates of blasts. The logs should include blasting locations and patterns and all information shown below:

    (a) Station limits of the shot.

    (b) Plan and section views of drill pattern including free face, burden, blasthole spacing, blasthole diameters, blasthole angles, lift height, and subdrill depth.

    (c) Loading diagram showing type and amount of explosive, primers, initiators and location and depth of stemming.

    (d) Initiator's sequence of blastholes including delay times and delay system in each blasthole.

    (e) Trade names and sizes of all explosives, primers, and initiators to be employed.

    (f) Signature of the blaster in charge.

    Typical log sheets are presented below:

BLASTING REPORT

Location:	Report No.:	Date:

Type of Shot: _____ Exact Time: _____
Station Number: _____
Type of Material: _____ Shot Grid: _____
Type of Blast: _____
(To nearest occupied building neither owned or leased)
#1 Seis. Locat.: _____ Dist to Seis.: _____ (ft) Grid: _____
#2 Seis. Locat.: _____ Dist to Seis.: _____ (ft) Grid: _____

Number of Holes: _____ Stemming (ft): _____
Diameter (mm): _____ Type of Stemming: _____
Hole Depth (ft): _____ Face Height (ft): _____
Delay Periods: _____
Spacing (ft): _____ Subdrilling (ft): _____
Burden (ft): _____ Number of Rows: _____
Method of Firing: _____
Type of Circuit: ☐ Series ☐ Parallel
Maximum Charge Weight / Delay: _____ Lbs / delay

Temperature: _____ °F
Weather: ☐ Clear ☐ Cloudy ☐ Rain ☐ Snow
Wind From: ☐ N ☐ NE ☐ E ☐ SE
☐ S ☐ SW ☐ W ☐ NW

Fragmentation: ☐ Excellent ☐ V. Good ☐ Good ☐ Fair ☐ Poor
Backbreak: ☐ 3m ☐ 6 ft ☐ 9 ft ☐ 12 ft ☐ 15 ft or more

Trade Name of Explosive	Amount (Lbs)
	Total:

Charge / Hole Number	Depth (ft)	Stemming (ft)	Total Charge Weight / Delay (Lbs)

Powder Factor: _____ Lbs/yd³

Remarks:

Total Weight (Lbs):
Material Produced (yd³):
Superintendent Sig.:
Blaster's Signature:
License or S.S. No.:

BLASTING REPORT (continued)

Charge / Hole Number	Depth (ft)	Stemming (ft)	Total Charge Weight / Delay (Lbs)	SHOW DIMENSIONS ON SECTIONS, INCLUDE DEPTH OF POWDER
				
				PRIMER(S) LOCATION
				SKETCH PATTERN, SHOW INITIATION HOOK-UP

BLASTHOLE LOADING INFORMATION

EXPLOSIVE					EXPLOSIVE				
LOADING DENSITY					LOADING DENSITY				
HOLE / CHARGE NUMBER	TO:	TO:	TO:	TO:	HOLE / CHARGE NUMBER	TO:	TO:	TO:	TO:
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

BLASTHOLE DRILL LOG

DATE: _____ JOB/SHOT: _____ STATION: _____

BURDEN: _____FT. SPACING: _____ FT. HOLE DIAMETER: _____ IN.

NOTE: ALWAYS NUMBER HOLES LEFT TO RIGHT ALONG ROW FROM BEHIND SHOT LOOKING TOWARD FACE.

HOLE NO.	ROW NO.	INDICATE SEAMS/MUD/SOFT LAYERS

Review of the blasting logs by the Engineer shall not relieve the Contractor of his/her responsibility for the accuracy and adequacy of the blasting logs.

The Contractor is required to submit the form (or similar type of form) with information about each shot.

19. DIGITAL VIDEO RECORDING OF BLASTS. Two (2) digital video tape recordings will be taken of each blast. The recordings will be indexed in a manner to properly identify each blast. Two copies of the videos for each blast will be furnished on a weekly basis to the Engineer.

20. BASIS OF PAYMENT. This item shall be considered incidental to Contract Item 900.670 Special Provision (Precast Concrete Gravity Retaining Wall), Contract Item 900.670 Special Provision (Cast-in-Place Concrete Retaining Wall), 204.21 Trench Excavation of Rock, 900.640 Special Provision (Precast Concrete Encased Duct Bank, 1-4 Ducts)(4”), and to Contract Item 203.16 Solid Rock Excavation for all other areas beyond the limits of work for the retaining walls, water line trench or duct bank.

PERFORMANCE-BASED STRUCTURAL CONCRETE

1. 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.

2. MATERIALS. Materials shall meet the requirements of the following subsections:

Portland Cement.....701.02
Portland-Pozzolan Cement.....701.05
Portland-Limestone Cement 701.06
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
Lightweight Fine Aggregate for Structural Concrete 704.19
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 Systems.....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)
Slag Cement.....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.

3. CLASSIFICATION AND PROPORTIONING. The following classes of concrete, shown in Table 1, are included in these specifications, and shall be used as shown on the Plans.

TABLE 1 – PERFORMANCE-BASED CONCRETE CLASSES AND PROPERTIES

Concrete Class [1]	Min. 56-Day Compressive Strength (psi) [2]	Max. W/CM Ratio [3]	VSI [4]	Slump/ Spread Limit	Freeze/Thaw Durability [5]		Air Content Limits [6]	Max. Free Shrinkage	Max. 56-Day Surface Resistivity [7]
					Min. Durability Factor	Max. Air Void Spacing Factor (in.)			
PCD	4,000	TBD	--	N/A [8]	80	0.008	TBD	0.032%	Low
PCS	3,500	TBD	--	N/A [8]	80	0.008	TBD	0.042%	Low
SCC	4,000	TBD	≤ 1	TBD [9]	80	0.008	TBD	TBD [10]	Low

[1] PCD = Performance Concrete, Deck

PCS = Performance Concrete, Substructure

SCC = Self Consolidating Concrete

[2] The concrete may be accepted if the design compressive strength from standard cured cylinders has been obtained at 28 calendar days. Any 56 calendar day acceptance cylinders shall be tested regardless of the results of earlier tests.

[3] The maximum W/CM ratio shall be determined by the Contractor as established by mix qualification testing. During production, the W/CM ratio shall be less than or equal to the W/CM ratio from the approved qualification mix. See Subsection 3(b)(1).

[4] Visual Stability Index (VSI) as determined in accordance with *ASTM C 1611*.

[5] The freeze/thaw durability of the proposed mix design may be established by providing mix qualification testing demonstrating conformance with either of the two requirements. Testing shall meet the requirements of either *AASHTO T 161*, Procedure A, or *ASTM C 457*, as applicable. See Subsection 3(b)(2).

[6] The minimum air content shall be determined by the Contractor as established by mix qualification testing. During production, the air content shall be greater than or equal to the air content from the approved qualification mix, see note 10. See Subsection 3(b)(2).

[7] The Contractor shall determine the surface resistivity in accordance with Subsection 3(b)(4).

[8] The mix shall not exhibit segregation. If the mix does exhibit segregation, the load shall be rejected. If the spread is equal to or exceeds 18 inches, the mix shall be classified as SCC.

[9] The Contractor shall determine the spread target and limits in accordance with Subsection 3(b)(5). 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.

[10] The Contractor shall determine the free shrinkage in accordance with Subsection 3(b)(1). SCC will be allowed for use in superstructure elements if the free shrinkage meets the requirements for Class PCD. SCC will be allowed for use in substructure elements if the free shrinkage meets the requirements for Class PCS.

If a nominal maximum aggregate size is not specified, the Contractor shall determine the nominal maximum aggregate size using guidance from *ACI 211.1*. In no case shall the maximum aggregate size exceed 1/5 of the narrowest dimension between sides of the forms, 1/3 the depth of slabs, or 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 that are better optimized 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 to replace up to 30% of the volume of 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 the moisture content is uniform 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 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 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.

Prior to placing concrete on the project (or prior to the trial pour or prior to the pre-placement meeting, whichever occurs first), the Contractor shall submit for approval the single mix design formulation that satisfies all mix design qualification requirements and testing 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. The Structural Concrete Engineer may require a minimum of 8 weeks for testing, review, and approval of new mix designs. No class of concrete shall be placed on a Project, including the trial pour, until the mix design is approved.

If the proposed Performance Concrete mix design fails to meet the qualification requirements, the Contractor shall submit a revised mix design formula in writing to address the mix qualification deficiencies of the original failed mix design.

Review of the revised mix design formula by the Structural Concrete Engineer will be completed within 14 calendar days. Upon approval of the revised mix design formula by the Structural Concrete Engineer, testing of the revised mix design may commence. Testing of the revised mix design formula shall be completed within 6 months of the revised mix design formula approval.

Until the testing of the revised mix design is completed and approved, the Structural Concrete Engineer will specify the use of an alternative, prescriptive mix design formula for the application in question, including appropriate acceptance requirements for the prescriptive alternative mix.

(a) The mix design must contain the following information:

(1) Class of concrete.

(2) Type of mix, conventional or self-consolidating concrete (SCC).

(3) Saturated surface dry or dry weights (specify which).

(4) Aggregate types, sources, specific gravities, and absorption values.

(5) 56 calendar day design compressive strength, psi.

(6) Cementitious content and the amount of each, pounds per cubic yard.

(7) Air content lower limit, percent.

(8) 56 calendar day surface resistivity value.

(9) Determined spread lower limit and upper limit for SCC.

(10) Maximum water/cementitious materials (W/CM) ratio.

(11) Volumetric quantities of each material in the mix design.

(12) Design unit weight of the mix.

(13) Chemical admixture 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 a laboratory that is accredited by AASHTO resource or the Concrete and Cement Reference Laboratory (CCRL) in the particular test method, or as allowed by the Engineer.

(b) The following mix qualification tests shall be performed. The minimum air content value and the maximum water/cementitious materials ratio of the material used to pass the mix qualification tests shall become the minimum air content value and the maximum water/cementitious materials ratio allowed during production.

(1) The Contractor shall provide test results that establish the shrinkage tendency of the concrete. 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 a laboratory accredited in the specific test method.

(2) The Contractor shall provide test results that establish the freeze-thaw durability of the concrete. At the contractor's choice, either *AASHTO T 161* or *ASTM C 457* may be used to demonstrate freeze/thaw durability meeting the specification requirements.

Sampling shall be performed in accordance with *AASHTO R 60* on a qualification batch of concrete that is a minimum of 3 cubic yards. This freeze/thaw durability test batch shall also be tested for air content (*AASHTO T 152*), concrete temperature (*ASTM C 1064/C 1064 M*), and unit weight *(AASHTO T 121).* SCC concrete shall also be tested for spread (*ASTM C 1611/C 1611 M*, Procedure B).

For those electing to test for air void spacing factor in accordance with *ASTM C 457*, the Contractor shall make a minimum of two concrete cylinders per *AASHTO T 23* and report the average air-void spacing factor obtained from testing these two specimen. 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 air content of the qualification batch that passes freeze-thaw durability testing shall become the minimum air content allowed in production. This shall also become the minimum air content allowed for all subsequent mix qualification testing.

(3) The compressive strength of the concrete shall be measured based on the requirements of *AASHTO T 22* for 7, 14, 28, and 56 calendar day standard cured cylinders.

(4) The surface resistivity of the test mix shall be measured at 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. The surface resistivity may be accepted prior to 56 calendar days if the results meet these requirements. 56 calendar day test results shall be completed and submitted regardless of the results of earlier tests.

(5) 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.

(c) 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 a laboratory accredited in the specific test method.

(d) After the mix design furnished by the Contractor has been reviewed and approved by the Structural Concrete Engineer, no changes to the mix design shall be allowed except as defined in Table 2. Following an approved change in accordance with Table 2, a contractor may still revert back to original approved mix design formulation. If a source change is requested due to a change in product or material name that does not include any significant change in product formulation or material characteristic, and this is substantiated by the product or material supplier in writing, re-testing is not required.

TABLE 2 – ALLOWABLE MIX DESIGN CHANGES FOR ALL MIX TYPES

Previously Approved Component or Property Being Changed	Mix Design Resubmittal Requirements [1]	No. of Changes Allowed
Cement source	If the alkali content (Na and K) of the new source is greater than that of the original source, and the original result from Subsection 3(c) was greater than 0.08% expansion, then updated ASR testing is required. Otherwise, no qualification testing is required.	Unlimited
Cement proportioning (+/- 5% by volume)	No qualification testing required	One
Aggregate proportioning (+/- 10% by volume)	No qualification testing required	One
Aggregate source	ASR testing and gradation check by original Contractor method	One
Slag source	If same grade is used, no qualification testing required	Unlimited
Silica fume source	No qualification testing required	Unlimited
Fly ash source	If either the calcium (CaO) or the alkali (Na and K) content of the new source is greater than that of the original source, and the original result from Subsection 3(c) was greater than 0.08% expansion, then updated ASR testing is required. Otherwise, no qualification testing is required.	Unlimited
Air-entraining admixture source – 725.02(b)	Resubmittal of freeze/thaw durability qualification testing	Unlimited
Shrinkage reducing admixture source – 725.02(k)	Resubmittal of shrinkage qualification testing	Unlimited
Corrosion inhibiting admixture source – 725.02(k)	Resubmittal of shrinkage qualification testing. If shrinkage qualification testing of the original mix design is greater than 70% of shrinkage limit, then updated shrinkage testing is required.	Unlimited
Latex admixture source – 725.02(d)	Resubmittal of surface resistivity testing	Unlimited
Accelerating admixture dosage increase – 725.02(i), 725.02(j)	Resubmittal of shrinkage qualification testing	Unlimited
Accelerating admixture source – 725.02(i), 725.02(j)	No qualification testing required	Unlimited
ASR mitigating admixture dosage decrease – 725.02(k)	Resubmittal of ASR qualification testing	Unlimited
ASR mitigating admixture source – 725.02(k)	Resubmittal of ASR qualification testing	Unlimited
All other admixture source and dosage changes – 725.02	No qualification testing required	Unlimited

[1] All changes will require administrative submittal to establish proposed changes. Where required, resubmittal testing shall be completed using the same material sources and proportions from the original approved mix design.

No new materials shall be incorporated without prior written approval of the Engineer. 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.

The approved mix design will be allowed consecutive 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 and absorption.

The mix design shall be accompanied by the previously completed and accepted mix qualification test data and any applicable updated test information. The submittal shall also include all applicable quality control test results and all requests for variance from the material requirements of these specifications.

4. 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 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 and report batch weights.

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's notice of intent to place concrete. 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) Batch Weight Tickets. Batch weight tickets shall include the following information.

(1) Approved State of Vermont mix identification number

(2) Weight of all aggregates

(3) Weight of cementitious material

(4) Quantity of admixtures by type

(5) Quantity of water batched

(6) Aggregate moistures

(7) Total water to cementitious ratio

Materials on the batch weight ticket shall be identified by type. All batch weight ticket information shall be provided in English units. All materials added to the concrete batch shall be added to the batch weight ticket prior to delivery.

(b) 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 4(e).

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.

(c) 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 of material production for Agency projects.

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.

(d) 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.

(e) 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 3.

TABLE 3 – CONCRETE PRODUCTION TOLERANCES FOR BATCHING

Material	Tolerance (%)
Cement	± 1
Water	± 1
Aggregates	± 2
Chemical admixtures	± 3
Mineral admixtures	+ 10, - 1

(f) 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 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 Slag. Fly Ash or Slag 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.

5. 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 no more than 1.5 hours after the cement has been added to the water.

Concrete shall not have water added once discharging has begun. Admixtures may be adjusted as required by QC.

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) Addition of water or admixtures at the project site must be communicated to field inspection personnel. If additional mixing water, admixtures, or other additions are required, a minimum of 30 revolutions of the mixer drum at mixing speed shall be required before discharge of any concrete. If water is added in excess of the specified maximum W/CM ratio, the concrete shall not be used.

(3) The Engineer may require the Contractor to perform uniformity tests on a transit mixer or agitator, in accordance with *AASHTO M 157* and reported except as modified. 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.

(4) Each load of concrete delivered at the job site shall be accompanied by a batch weight ticket meeting the requirements of Subsection 4.

(5) 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.

(6) 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.

(7) 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 5(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.

For the purpose of this specification, the term agitator shall be interpreted to mean a vehicle with a drum that is not used to do the initial mixing of the concrete but is used to transport the concrete and mix the concrete prior to discharge.

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.

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.

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.

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.

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.

6. QUALITY CONTROL. 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. 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.

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 1, 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.

(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 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 for acceptance 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.

1. 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.

2. The maturity method may be used as an alternative for estimating the concrete strength. The procedures of *ASTM C 1074* shall be followed except as noted below:

   i. For Section 8.1 there shall be a minimum of 17 cylinders cast. Two of the 17 shall have temperature sensors embedded in them to be used for monitoring.

   ii. For Section 8.4 there shall be 3 cylinders tested for each test age.

   iii. For Section 8.4 for rapid set concrete mixes the test ages shall be 12 hours, 1 day, 2 days, 7 days, and 28 days.

   The contractor may adjust or add test ages if approved by the Engineer.

   All temperature measuring devices shall be verified/calibrated on a 12-month basis or sooner if there are questions about the accuracy. The device shall have an accuracy of +/- 2º F.

   At least two temperature sensors shall be embedded each day in each pour. One sensor shall be placed where maturity is expected to develop the slowest at, or near, an exposed outer edge, and a second sensor shall be placed in the concrete poured from the last load of the day. Sensors shall be placed at least 2 inches to 4 inches from any existing concrete or an exposed outer edge. The temperature sensing end of the monitor shall not be placed in direct contact with reinforcing materials or other elements that will protrude through the surface of the concrete. The contractor shall submit the proposed locations to the Engineer for review and approval.

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 4.

TABLE 4 – CONCRETE SPECIMEN CURING REQUIREMENTS

Testing Category	Number of Specimens	Curing Location
Acceptance	See MSM	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*.

7. 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 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 15. 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.

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 ambient temperature with a maximum gradation of 1°F. The Inspector will use the thermometer to take periodic temperature measurements of the enclosure at varying locations.

The Contractor shall provide a hand-held infrared thermometer capable of taking no-contact measurements that is accurate within plus or minus 2% of the reading. The thermometer's accuracy shall be certified once every 12 months, with the certificate provided with each thermometer.

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.

8. FORMS. The Contractor shall be responsible for, and shall make good, any injury arising from inadequate forms. The Engineer shall be provided the opportunity to inspect 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 as approved by the Engineer.

(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.

(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 on vertical and overhead surfaces shall be filled with a product that meets the requirements of Subsection 780.02. The manufacturer's directions shall be followed for surface preparation, mix, and application. Cavities on horizontal surfaces shall be filled in with a mortar mix using the same proportion of cementitious material and sand. The surfaces shall be saturated with water for a minimum of an hour, dried to SSD just prior to being filled, and cured by a method in Subsection 15 approved by the Engineer for a duration of 3 calendar days

(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 1, 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 1.

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 5.

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.

(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.

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.

(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.

9. 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

(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 5.

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 due 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.

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 24 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.

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.

10. 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 7(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.

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.

11. 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.

12. 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 epoxy bonding system 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.

(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.

13. 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.

14. 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.

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) Turf Drag. When specified on the plans, 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 15(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 14(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.

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 14(a)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area.

15. 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 5.

TABLE 5 – CURING TIMES FOR CONCRETE COMPONENTS

Type of Construction	Curing Methods (Subsection)	Effective Cure Time (Days)
Substructure	17(b)(1), (2), (3), (5), (7), (8)	7
Superstructure	17(b)(2), (8)	10 [1]
Retaining walls	17(b)(1), (2), (5), (6), (8)	7
Headwalls	17(b)(1), (2), (5), (6), (8)	7
Sidewalks, curbs, and gutters	17(b)(2), (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.

(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 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 15(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.

16. 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 5, and until the field cured test cylinders have attained 85% of the compressive strength specified in Table 1. 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 in Table 1 and provided curing of the supporting section is maintained in accordance with Table 5.

(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 5 is complete and the field-cured test cylinders for this concrete have attained 85% of the compressive strength specified in Table 1.

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 1, 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 1.

(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.

17. BASIS OF PAYMENT. This item shall be considered incidental to item 900.670 Special Provision (Cast-in-Place Concrete Retaining Wall)

WATER LINE VALVES

1. DESCRIPTION. This work shall consist of installing valves as part of the water line relocation. The work under this Section shall be performed in accordance with these provisions, Section 629 – Water Systems, the Drinking Water Groundwater Protection Division, Permit to Construct, and as directed by the Engineer.

2. MATERIALS. All materials shall meet the requirements of Section 629 of the Standard Specifications.

   All gate valves and butterfly valves will be procured by the State of Vermont and supplied to the Contractor. All other materials required to complete the water line installation shall be the responsibility of the Contractor.

4. METHOD OF MEASUREMENT. The quantity of Special Provision (Valve with Valve Box) to be measured for payment will be for each valve installed in the complete and accepted work.

5. BASIS OF PAYMENT. The accepted quantity of Special Provision (Valve with Valve Box) will be paid for at the Contract unit price per linear foot. Payment will be full compensation for furnishing all materials except for the butterfly valves and gate valves, labor, tools, equipment, and incidentals necessary to complete the work.

   Payment will be made under:

Pay Item	Pay Unit
900.620 Special Provision (Valve with Valve Box)	Each

CONTAMINATED SOILS AND GROUNDWATER MANAGEMENT

1. DESCRIPTION. This work shall consist of proper management of contaminated soils and groundwater encountered during construction in accordance with the State of Vermont Investigation and Remediation of Contaminated Properties Rule (IRULE), FINAL ADOPTED RULE, July 27, 2017.

   This work includes the Contractor engaging the services of a qualified Environmental Professional (EP) to ensure the Contractor and its subcontractors working within the project limits meets all requirements for the safe management and/or disposal of groundwater and soils as detailed in the IRULE.

   This work shall be performed in accordance with these provisions, the Plans, and Sections 203 and 204 of the Standard Specifications.

   The work will include all planning, active management, treatment, and disposal of contaminated soils and groundwater, if encountered.

   No testing or explorations for contamination were conducted prior to the development of these bid documents, as the Vermont Department of Environmental Conservation's Site Management Section (SMS) in March 2020 has determined that remediation was no longer required and only monitoring persists in the vicinity of the Champlain Farms fueling facility at 156 Roosevelt Highway (Shell). However, contamination may still be encountered, and the management of these materials will be covered by this work. Additional information about the site can be obtained by contacting the Site Manager at SMS:

   John Schmeltzer
   (802) 249-5620
   john.schmeltzer@vermont.gov

2. GENERAL REQUIREMENTS – MANAGEMENT. The Contractor shall hire a qualified EP who shall prepare and submit to the Agency a site-specific Health & Safety Plan meeting all OSHA requirements, prepare and submit to the Agency a Soil & Groundwater Management Plan (SMP), train site workers, monitor contamination levels of excavated soils, and ensure that the SMP is followed. The EP shall document all work in daily field reports and submit them to the Engineer on the following business day.

   (a) EP Qualifications. Per the IRULE, the qualified EP shall mean a person who possesses the following education, training, and experience:

(1) A current professional engineer's or professional geologist's license or registration from a state, tribe, or U.S. territory (or the Commonwealth of Puerto Rico) and the equivalent of three years of relevant fulltime experience.

(2) A license or certification by the federal government, a state, tribe, or U.S. territory (or the Commonwealth of Puerto Rico) to perform environmental site work equivalent to that required by this rule and have the equivalent of three years of relevant fulltime experience.

(3) A baccalaureate or higher degree from an accredited institution of higher education in a discipline of engineering, geology, hydrogeology, or an applicable science and the equivalent of five years of relevant fulltime experience.

In addition, the qualified EP shall have completed a minimum of three (3) construction projects with similar scope and requirements to this project.

(b) Management Submittals.

(1) Qualifications. The Contractor shall submit qualifications of the qualified EP consistent with the minimum qualifications stated in this specification and including relevant experience on a minimum of five (5) construction projects and a minimum of three (3) references. These qualifications shall be reviewed and approved by the Agency and, at the determination by the Engineer, the Vermont Department of Environmental Conservation (DEC). The Agency and Vermont DEC reserve the right to request and require a different EP than that proposed by the Contractor if it is determined that the EP is not qualified to carry out the work based on the qualifications and experience submitted.

(2) Soil & Groundwater Management Plan (SMP). The Contractor's EP shall develop and submit a plan to the Engineer describing how the Contractor plans to manage and dispose of soils and groundwater per the requirements detailed in the IRULE. The plan shall include but not be limited to the following:

a. Contractor's proposed sequence of work.
b. Contractor's Health and Safety Plan (HASP).
c. Methods for identifying possible contaminated soils on site.
d. Methods for managing soils and groundwater on and off-site during construction for each phase of the work including any temporary stockpiling locations if necessary.
e. Protocol for notifying the Agency and Vermont DEC if there are spills during project construction.

The plan shall be submitted to the Engineer as Construction Drawings in accordance with Section 105. Submittals shall be received at a minimum 30 calendar days prior to the anticipated begin construction date to allow time for the Agency, City, and Vermont Agency of Natural Resources review. An Acceptance Memo or comments will be provided to the Contractor within 21 calendar days of receiving the narrative and plan from the Contractor. The Contractor will respond to comments as soon as possible and shall not commence construction activities until receiving the Acceptance Memo. Modifications or additions as a result of comments received to the Contractor's narrative and plan will not be considered as an acceptable delay of the work under Subsection 108.11.

The plan shall be updated by the Contractor and submitted to the Engineer for review if the proposed sequence of construction changes.

The Contractor is responsible for obtaining and paying for any local, state, or federal permits required to excavate, handle, re-use, or dispose of soils. The Contractor is required to provide and pay for any testing required by the receiving facility prior to disposing of soils. The Contractor shall ensure soils slated for disposal are tested and categorized as the least hazardous as possible with the disposal facility to avoid excessive and unnecessary costs to the project.

(3) Soil & Groundwater Closeout Report (SCR). The EP shall prepare and submit a SCR within 30 days of the completion of all excavation, dewatering, and disposal activities according to the requirements of the SMP. The SMR shall include but not limited to the following:

a. A narrative summary containing the total number of cubic yards/truckloads of each of the classification of contaminated soils excavated and transported off site and an estimation of material re-used on site, including final resting locations for each.

b. A narrative summary of any contaminated groundwater treatment and/or mitigation carried out during the project.

c. All manifests and bills of laden associated with contamination excavation.

3. GENERAL REQUIREMENTS – CONTAMINATED SOILS. Contaminated soils shall be screened, sampled, tested, handled, segregated, loaded, transported, disposed of, and treated in accordance with the SMP. Petroleum contaminated soils will be classified in accordance with the latest edition of the IRULE. All efforts should be made to minimize the volume of contaminated soil excavated and destined for disposal. Agency of Natural Resources Guidelines can be found at the following website address: https://dec.vermont.gov/waste-management/contaminated-sites/guidance. The Contractor shall make all efforts to avoid unnecessarily excavating or otherwise disturbing potentially contaminated soils that are not vital to construction operations.

(a) Notification. The Contractor shall provide the Engineer with a minimum of 2-days' notice prior to sampling. The Contractor, nor the EP, shall not sample unless the Engineer's approval is received, and the Engineer and/or the Agency's EP is present to witness the collection of samples. The Engineer will notify the Project Manager that the Contractor is preparing to begin excavating contaminated soils.

(b) Soil Screening. Field screening of excavated soil shall be performed by the EP, after notification has been made to the Engineer and/or the Agency's EP. Soil will be assessed for indications of petroleum contamination based on odor, appearance, and the presence of volatile organic compounds (VOCs) using a properly calibrated photoionization detector (PID). The EP shall collect PID readings of excavated soil in all known and suspected areas of soil contamination, as well as in any other areas where visual or olfactory evidence of petroleum contamination is observed. PID readings of all excavated soil shall be collected using the bag headspace method and compared to the following thresholds:

(1) Non-Contaminated Soil: PID reading 0 to 1 parts per million by volume (ppmv). These soils are acceptable for use, backfilling if geotechnical satisfactorily, or disposal at a non-residential Agency approved location.

(2) Class 0 Soil: PID reading 1 to 10 ppmv: These soils are acceptable for re-use on-site. If not reused on-site, this material shall be stockpiled for confirmatory laboratory analysis and shall be managed and disposed of in a legal manner by the Contractor at a non-residential Agency-approved location. If laboratory analysis indicates any VOC concentrations exceed the Vermont non-residential screening values, the soil shall be disposed of as a Class 1 soil.

(3) Class 1 Soil: PID reading >10 ppmv: These soils are unacceptable for re-use and shall be transported to an approved off-site disposal or treatment facility for proper disposal according to the off-site disposal requirements of the SMP.

(c) Soil Segregation and Stockpiling. The Contractor shall segregate excavated soils into temporary stockpiles based on the EP's classification in the SMP. Construct stockpiles with polyethylene sheeting in accordance with the SMP. Secure polyethylene sheeting to prevent disturbance by rain or wind. Maintain the stockpile and replace if damaged.

All contaminated stockpiles shall be removed from the Site and transported to an approved disposal or treatment facility within 2 weeks after receipt of analytical results. The Contractor shall protect excavated soil to prevent infiltration of water into, and erosion of soil from the stockpiles.

(d) Soil Testing for Disposal. The EP shall collect all required samples of Class 1 Soil for all laboratory analyses necessary for acceptance at the proposed receiving facilities. The EP shall also complete all necessary waste profiles for receiving facilities.

(e) Soil Testing – Excavation Limits. At the limits of the excavation, the EP shall collect bag headspace PID readings and samples for laboratory analysis according to the requirements of the SMP.

(f) Soil Loading. For soil being transported off-site, the Contractor shall load Class 0 and Class 1 soils into lined, covered trucks. Truck decontamination facilities shall be indicated in the SMP.

(g) Soil Transportation and Disposal. The Contractor shall make all efforts to minimize the volume of contaminated soil destined for disposal. For soil that must be disposed of, the Contractor shall dispose of contaminated soil at an approved off-site facility. The Contractor shall contract with the disposal facility. Soil shall be transported in accordance with Agency requirements. Manifests and bills of lading, as required by Vermont and Federal regulations, shall be maintained by the Contractor and copies shall be provided to the EP for inclusion into the SCR. At a minimum, additional information provided to the EP for inclusion in their report shall include:

(1) Name and address of all transporters.
(2) Transporter Identification Number (USEPA or Vermont Agency of Transportation) with expiration date.
(3) Proof of permit, license, or authorization to transport excavated material, when applicable, in all affected states.
(4) Dust control measures.

(h) Weight and Measurement. The Contractor shall provide certified tare and gross weight slips for each load received at the disposal facilities and these shall be attached to each returned shipping document (i.e material shipping record, Hazardous Waste Manifests, etc.) within 21 days of obtaining final signatures.

4. GENERAL REQUIREMENTS – CONTAMINATED GROUNDWATER. If contaminated groundwater is encountered and must be dewatered to complete construction of subsurface infrastructure, the Contractor shall follow the requirements of the SMP and the latest edition of the IRULE.

The Contractor may also choose to temporarily store contaminated groundwater in a fractionation tank and dispose of all petroleum contaminated groundwater generated during the work at a licensed disposal facility. The Contractor shall perform all necessary permitting, testing, and manifesting for proper disposal.

(a) Permit. Discharge of groundwater removed during construction activities on petroleum contaminated sites must be conducted under General Permit 3-9004 or 3-0916. The EP shall apply for and obtain the required permit. The permit application shall be reviewed and authorized by the Agency of Natural Resources and the Engineer prior to discharge.

(b) Treatment. For on-site discharge of contaminated groundwater, the Contractor shall provide a treatment system per the requirements outlined in the SMP. The Contractor and/or EP shall provide mobilization, installation, startup, operation, maintenance, monitoring, demobilization, decontamination, and proper disposal of all treatment media and residuals. Containers shall be of adequate volume to store all contaminated groundwater generated during dewatering efforts. Containers shall be constructed of material compatible with the contaminants encountered.

(c) Monitoring. The EP shall collect all permit-required samples from the treatment systems for laboratory analysis. The sampling and monitoring methodology will be dependent on the treatment method selected. Treatment methods include reinjection, carbon filtration, air stripping, fractionalization tank storage, and carbon filtration, or disposal at a wastewater treatment plant. The EP shall include documentation of dewatering and groundwater activities in each daily field report including the condition of the treatment system, volume of water treated, and any samples collected for laboratory analysis.

5. CONSTRUCTION REQUIREMENTS. Construction will be carried out in accordance with the requirements included in the IRULE and the information contained in the Contractor's SMP. Soils that cannot be reused on the project site must be disposed of at an approved receiving facility.

The Agency's Hazardous Materials and Waste Coordinator, or their representative, may also monitor the contamination levels of the excavated soils and groundwater for the Engineer and ensure that the SMP is fully followed.

No additional compensation or allowance for additional Contract time will be made for any delays incurred in executing the SMP.

(a) Dewatering. The Contractor will mitigate the potential for surface water, potentially resulting from a rain event, from entering any open excavation. Where petroleum contaminated soils have been identified as present in this area and therefore surface water entering these area will potentially create additional contaminated water to be managed. It is the Contractor's and EP's responsibility to mitigate this potential and where it cannot, the provisions in the SMP shall be followed and executed.

(b) Excavation and Disposal. If hazardous waste or contaminated soils not classified as VSS Non-Residential Soils, Development Soils, or Urban Background Soils are encountered within the project's construction limits, the Contractor shall properly characterize, excavate, and properly dispose of this waste or contaminated soil as necessary and be compensated under Special Provision (Off-Site Disposal of Petroleum Contaminated Soils). These soils cannot be removed or disposed of until they are properly characterized, the plan is updated and submitted for review and Vermont DEC approves the proposed management and disposal of this waste.

(c) Unexpected Conditions. If, during any excavation of petroleum contaminated soil, the Contractor encounters any condition or situation which is different from that expected, the Contractor shall immediately notify the Engineer. All excavation operations in the contaminated area shall cease until the condition or situation can be evaluated. The evaluation shall include but is not limited to the determination of health or other hazards to the Contractor's personnel and the immediate neighborhood, the possibility of explosion, requirements for protective clothing and other equipment, and special excavation or transportation requirements.

The Contractor must coordinate activities with the Engineer, the VTrans Hazardous Materials Coordinator(s), and Vermont DEC's designated representative.

6. EXTRA WORK. All changes to the remediation and/or disposal plan ordered in writing by the Engineer will be paid for as Extra Work.

7. METHOD OF MEASUREMENT. The quantity of Special Provision (Soil and Groundwater Management) will be on a lump sum basis in the complete and accepted work of the development and execution of the plan.

The quantity of Special Provision (Off-Site Disposal of VSS Non-Residential and Development Soils) to be measured for payment will be the dollar amount charged to dispose of the soils exceeding VSS for Non-Residential Properties and Development Soils disposed of at an approved facility and verified by the Engineer. Contractor shall provide the engineer with disposal slips for payment.

The quantity of Special Provision (Off-Site Disposal of Petroleum Contaminated Soils) to be measured for payment will be the dollar amount charged to dispose of the contaminated material at an approved facility and verified by the Engineer. Contractor shall provide the engineer with disposal slips for payment.

Excavation of all soils will be measured and paid for in accordance with the applicable Section 203 or Section 204 pay items. If the Contractor elects to re-use any soils on-site and gains the necessary permits and approvals to do so, this work will not be paid separately, but be considered incidental to the Section 203 and Section 204 pay items. Excavation requiring more than one handling prior to final placement or disposal will not be measured for payment for the additional handling.

8. BASIS OF PAYMENT. The accepted quantity of Special Provision (Soil and Groundwater Management) will be paid for at the Contract lump sum price. Payment will be full compensation for the initial preparation of the plan and narrative, submittals, and all incidentals necessary to complete the work and execute the plan including but not limited to labor and materials used by the EP, securing necessary permits and approvals, furnishing any necessary treatment for dewatering excavations, and securing and managing temporary stockpile areas including necessary controls. Subsequent modifications to the plan and narrative during construction will be considered incidental to Contract item Special Provision (Soil and Groundwater Management).

Partial payments will be made as follows:

(a) The first payment of 50 percent of the Lump Sum price for Special Provision (Soil and Groundwater Management) will be paid for upon acceptance of the narrative and plan.

(b) The second payment of 35 percent of the Lump Sum price for the Special Provision (Soil and Groundwater Management) will be made on the first estimate following the completion of 50 percent of the project.

(c) The third payment of 15 percent of the Lump Sum price for the Special Provision (Soil and Groundwater Management) will be made when the project is substantially complete.

The accepted quantity of Special Provision (Off-Site Disposal of VSS Non-Residential and Development Soils) shall be paid for at the dollar value on the disposal slips. Payment will be full compensation for performing the work specified including but not limited to the completion of necessary laboratory tests and payment of disposal fees required by the approved disposal facility, transporting soils to and disposing soils at the approved facility.

The accepted quantity of Special Provision (Off-Site Disposal of Petroleum Contaminated Soils) shall be paid for at the dollar value on the disposal slips. Payment will be full compensation for performing the work specified including but not limited to the completion of necessary laboratory tests and payment of disposal fees required by the approved disposal facility, transporting soils to and disposing soils at the approved facility.

Payment will be made under:

Pay Item		Pay Unit
900.615	Special Provision (Off-Site Disposal of VSS Non-Residential and Development Soils) (N.A.B.I.)	Dollar
900.615	Special Provision (Off-Site Disposal of Petroleum Contaminated Soils) (N.A.B.I.)	Dollar
900.645	Special Provision (Soil and Groundwater Management)	Lump Sum

ANTI-GRAFFITI COATING

1 DESCRIPTION. This work shall consist of applying an anti-graffiti coating system for the sealing and protection of concrete surfaces as indicated in the Plans and as directed by the Engineer.

2. MATERIALS. Materials and coating(s) systems furnished under this Section shall conform to the manufacturer's specifications.

Coatings must not react deleteriously with above grade concrete, concrete block, exposed aggregate concrete, brick, stonework, painted steel, or aluminum substrates. Coatings shall dry as a matte or satin finish and must cure to a clear/transparent.

The consistency must be such that the coating can be satisfactorily applied by roller, or brush at atmospheric and material temperature above 50°F without thinning. When properly applied to vertical surfaces, the coating must remain uniform during the required curing period and must not sag, disintegrate, check, peel, or crack.

The coating shall have the capability of having all types of paint and graffiti material removed without damaging the surfaces to which the coating is applied. Removal of graffiti shall not result in "shadowing" of the base surface upon removal of graffiti.

Coating must allow for removal of graffiti with a low-pressure water wash. Pressure wash requirements must not exceed 500 psi, and the cured coating must not be damaged by a 1,700-psi pressure wash. Must be washable with water an ambient temperature of 50°F or higher.

3. SUBMITTALS. Four weeks prior to beginning the work, the Contractor shall provide Product Data Sheets, along with Material Safety Data Sheets for the coating products including thinners and cleaning agents to the Engineer for approval in accordance with subsection 105.03.

4. APPLICATION. All surfaces that are to be treated shall be at least 30 days old and as required by the coating manufacturer. These surfaces shall also be cleaned as required by the manufacturer to remove any latency, dirt, grease, oil, efflorescence, paint, or other foreign materials and contaminants. Any solvent cleaning necessary shall meet the recommendations of the coating manufacturer.

Coatings shall be applied in accordance with the manufacturer's recommendations.

5. SURFACE PROTECTION. After application(s) of the sealer and/or stain, the concrete surfaces shall be protected as necessary in accordance with the manufacturer's recommendations.

6. ENVIRONMENTAL PROTECTION. During cleaning, surface preparation, and coating operations, the Contractor shall provide appropriate measures (such as suitable protective coverings) to protect the public, the bridge superstructure, work area, river, etc. from cleaning and coating contamination due to drippings, spatter, wind-blown particles, falling objects, etc. The Contractor shall be fully responsible for property damage or personal injury which may result from operations incidental to sealing and staining concrete surfaces.

7. METHOD OF MEASUREMENT. The quantity of Special Provision (Anti-Graffiti Coating) to be measured for payment will be the number of gallons of stain applied in the complete and accepted work, measured to the nearest gallon.

8. BASIS OF PAYMENT. The accepted quantity of Special Provision (Anti-Graffiti Coating) will be paid for at the Contract unit price per gallon. Payment will be full compensation for furnishing, transporting, handling, and placing the material(s) specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

   Any apparatus, material, and labor not specifically mentioned herein which may be found necessary to complete or perform any portion of the work in a satisfactory manner and in compliance with the requirements implied or intended in these specifications shall be furnished by the Contractor at no additional cost to the Agency.

   Payment will be made under:

Pay Item	Pay Unit
900.625 Special Provision (Anti-Graffiti Coating)	Gallon

DUCTILE IRON PIPE WITH VITON GASKETS

1. DESCRIPTION. This work shall consist of installing Ductile Iron pipe with Viton Gaskets. The work under this Section shall be performed in accordance with these provisions, Section 629 – Water Systems, the Drinking Water Groundwater Protection Division, Permit to Construct, and as directed by the Engineer. Viton Gaskets will not be required at every ductile iron connection. See water line plans for the locations where Viton Gaskets will be required.

2. MATERIALS. Viton gaskets shall be a molded synthetic rubber ring gasket, shaped to fit the configuration of the gasket socket and manufactured per all requirements of ANSI/AWWA C111/A21.11. Gasket shall be manufactured from Flouroelastomer Fluorel Viton (FKM). Gaskets to be installed in Ductile Iron pipe with lubrication and as per manufacturer's recommendations.

   All Ductile Iron pipe will be procured by the State of Vermont and supplied to the Contractor. All other materials, including Viton Gaskets, required to complete the water line installation shall be the responsibility of the Contractor.

3. SUBMITTALS. Product data for Viton Gaskets and any other material, shall be submitted to the Engineer for approval.

4. METHOD OF MEASUREMENT. The quantity of Special Provision (Ductile Iron Pipe with Viton Gaskets) to be measured for payment will be the number of linear feet installed in the complete and accepted work.

5. BASIS OF PAYMENT. The accepted quantity of Special Provision (Ductile Iron Pipe with Viton Gaskets) will be paid for at the Contract unit price per linear foot. Payment will be full compensation for furnishing all materials except for the Ductile Iron pipe, labor, tools, equipment, and incidentals necessary to complete the work.

   Payment will be made under:

Pay Item	Pay Unit
900.640 Special Provision (Ductile Iron Pipe with Viton Gaskets)	Linear Foot

V-BIO ENHANCED POLYETHYLENE ENCASEMENT FOR DUCTILE IRON PIPE

1. DESCRIPTION. This work shall consist of furnishing and installing V-Bio enhanced polyethylene encasement for use with ductile iron water pipe systems. The work under this Section shall be performed in accordance with these provisions and as directed by the Engineer.

2. MATERIALS. V-Bio enhanced polyethylene encasement for use with ductile iron pipe shall meet all the requirements for ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems. V-Bio enhanced polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low-density polyethylene (LLDPE), fused into a single thickness of not less than eight mils. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of antimicrobial compound to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

3. SUBMITTALS. Product data for V-Bio enhanced polyethylene encasement shall be submitted to the Project Manager for approval in accordance with subsection 105.03.

4. CONSTRUCTION REQUIREMENTS. V-Bio enhanced polyethylene encasement used to protect ductile iron water pipe shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices – Ductile Iron Pipe and Fittings. Specifically, the wrap shall be overlapped one foot in each direction at joints and secured in place around the pipe, and any wrap at tap locations shall be taped tightly prior to tapping and inspected for any needed repairs following the tap. All installations shall be carried out by personnel trained and equipped to meet these various requirements.

5. METHOD OF MEASUREMENT. The quantity of Special Provision (V-Bio Enhanced Polyethylene Encasement) to be measured for payment will be the number of linear feet installed in the complete and accepted work.

6. BASIS OF PAYMENT. The accepted quantity of Special Provision (V-Bio Enhanced Polyethylene Encasement) will be paid for at the Contract unit price. Payment will be full compensation for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
900.640 Special Provision (V-Bio Wrap, 6”-8”)	Linear Foot
900.640 Special Provision (V-Bio Wrap, 12”)	Linear Foot
900.640 Special Provision (V-Bio Wrap, 16”)	Linear Foot

DUCT BANK

1. DESCRIPTION. This work shall consist of furnishing and installing underground precast concrete encased conduit systems for cable television, electrical power, communication cable, telephone service and/or fiber optic cable. This work shall also include the furnishing and installing of all conduits, appurtenances, and hardware for transitioning from underground to aerial service. The work shall be performed in conformance with the lines, grades, dimensions, locations, and details shown on the Plans or as determined by the Engineer.

   The terms "Duct" and "Conduit" are used interchangeably in these provisions.

   Work under this Section shall be performed in accordance with these provisions, the Plans, and Section 507, Section 540, Section 541 of the Standard Specifications.

2. MATERIALS. Conduit shall be PVC Schedule 40 Rigid Wall Conduit conforming to NEMA Standard TC-2. Conduit bends (sweeps) shall be galvanized steel with a minimum bend radius of 36 inches.

   Reinforcing Steel shall conform to the requirements of Section 507.

   Precast Concrete shall conform to the requirements of Section 540.

   Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

   Sand borrow shall conform to the requirements of Subsection 703.03.

3. GENERAL REQUIREMENTS. The Contractor shall coordinate and work with each utility company, as necessary, to ensure the conduit systems installed are constructed in accordance with the Plans and the utility company's specifications.

4. EXCAVATION. The conduit trench shall be excavated to the required depth shown on the Plans and to a width sufficient to install the conduit and precast encasement. The depth of excavation shall also be sufficient for an initial 3-inch leveling layer of approved backfill material raked smooth, and a 2-inch sand layer, so that conduit sections will be either level or on a uniform gradient. The Contractor shall maintain a minimum 12 inch spacing between all parallel duct bank runs unless otherwise noted. For parallel concrete encased duct banks, the Contractor shall provide forms to allow 12 inches of backfill material between the concrete encased duct banks.

   All excavation shall be confined to a minimum of surface area as possible, keeping within all applicable safety requirements.

5. INSTALLATION OF CONDUIT. Conduit bends shall match bends as noted on the Plans. Conduits shall be installed with minimum bends, and no more than the maximum allowed as described in each individual utility owner specifications. No sharp bends will be allowed except for at poles. For all other directional changes, a minimum 9-foot radius is allowed, but a 20-foot radius is preferred.

The Contractor shall furnish and install a nylon pull-in cord. The pull-in cords shall be installed, and the completed ducts shall be capped, plugged, and labeled as directed by the Engineer with concurrence of the utility company inspector. Electrical ducts shall have a minimum 500 lb. pull cord. One conduit shall have a measuring tape with a minimum 500 lb. pull capacity.

The Contractor shall install furnished plastic warning tape, describing buried electrical lines, along the entire length of the duct bank. Tape shall be installed approximately 6 inches deep or as directed by the utility companies' inspector.

Duct joints shall be made watertight by the use of brush-applied cement or watertight gaskets as recommended by the manufacturer.

After the conduit system passes visual inspection, and the trench has been backfilled, the Contractor must provide proof that the conduit system is free of blockages or obstructions by successfully inserting and pulling a flexible mandrel through the entire conduit system. The Contractor shall provide the mandrel meeting utility company requirements.

The Contractor shall confirm, before placing duct lines, that the surface on which the structure is to be poured is undisturbed original ground or firmly compacted earth free from voids, rock, or rubble.

The Contractor shall ensure that all clearances shown on the Plans are maintained during concrete placement.

If at the time the cable is being installed in the conduit by the utility, and the cable cannot be pulled through the conduit, then the Contractor shall replace/repair (at the Contractor's expense) the conduit.

6. BACKFILL. After approval by the Engineer, approved material shall be placed over the precast ducts in 6-inch layers and compacted in accordance with Subsection 203.11(d) by using air or mechanical tampers. Prior to placing, backfill material shall be approved by Engineer and the utility companies' inspector. Hand tampers will not be permitted. The material shall be brought to subgrade beneath roadway, grass belt, and any other paved or gravel areas. For grassed areas outside the highway construction limits, the material shall be brought to within 4 inches of the finished grade, a 4-inch layer of topsoil placed, and the area seeded and mulched in accordance with the applicable requirements of Section 651. Paved, concrete, or gravel areas outside the highway construction limits shall be replaced in kind as directed by the Engineer. Backfill for conduit shall have maximum 1½ inch stone.

7. SUBMITTALS. Design drawings shall be submitted and approved prior to fabrication of the precast structures, and in accordance with Section 105 of the Standard Specifications.

8. METHOD OF MEASUREMENT. The quantities of Special Provision (Precast Concrete Encased Duct Bank) of the number and size of ducts specified to be measured for payment will be the number of linear feet installed in the complete and accepted work, measured to the nearest linear foot along the center of the duct bank.

   The pay limit for temporary pavement patching material will be as detailed in the Plans.

9. BASIS OF PAYMENT. The quantities of Special Provision (Precast Concrete Encased Duct Bank) will be paid for at the Contract unit price per linear foot. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including conduit, conduit spacers, transition couplings, elbows and other fittings; caps, plugs, pulling wire, bedding material, concrete encasement, and all other material needed for a complete precast concrete encased duct system; reinforcing, excavation and backfill; placing of concrete, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

   Any additional depth of excavation required to construct conduit under other utilities, and the cost thereof, shall be considered incidental to Special Provision (Precast Concrete Encased Duct Bank), as applicable.

   Payment for turf establishment will be made separately under Contract Items 651.15 Seed, 651.18 Fertilizer, 651.20 Agricultural Limestone, 651.35 Topsoil and, 653.10 Hay Mulch.

   Payment for sawcutting existing pavement and temporary pavement patch will be made separately under Contract Item 900.680 Special Provision (Bituminous Concrete Pavement, Small Quantity).

Payment will be made under:

Pay Item	Pay Unit
900.640 Special Provision (Precast Concrete Encased Duct Bank, 1-4 Ducts)(4”)	Linear Foot

REMOVE AND REPLACE CONCRETE BARRIER SEGMENT

1. DESCRIPTION. This work shall consist of removing sections of the existing barrier and guard rail, fabricating, furnishing, and installing new concrete barrier (either precast or cast-in-place) and box beam rail guardrail as necessary to construct the project or as directed by the Engineer.

2. MATERIALS.Materials shall meet the following requirements:

   (a) Precast Concrete. Precast Concrete shall meet the requirements of Section 540.

   (b) Cast-in-Place Concrete. Cast-in-Place concrete shall meet the requirements of Section 541 for Concrete, Class B, unless otherwise specified in the Contract Documents.

   (c) Reinforcing Steel. Reinforcing Steel shall meet the requirements of Section 507 for epoxy coated bars.

   (d) Bolts, Nuts, Washers. Bolts, nuts, and washers shall meet the requirements of Subsection 714.05.

   (e) Steel elements. Steel used in connectivity plates and channels, and back up posts shall meet the requirements of Subsection 714.03.

   (f) Box Beam Rail. Box beam rail guardrail shall meet the requirements of subsection 728.02.

3. FABRICATION. Fabrication tolerances for all cast-in-place concrete transition barriers, regardless of the method of construction, shall conform to the following finished tolerances:

Bar Reinforcement Cover	-0, + 1/4 inch
Width (Top)	-0, + 1/4 inch
Width (Bottom)	-0, + 1/4 inch
Surface Straightness	1/2 inch in 20 feet
Vertical Alignment	1/2 inch in 20 feet

4. CONSTRUCTION REQUIREMENTS. The barrier shape detailed in the Plans shall not be altered.

5. FORMS. Forms shall conform to the geometry shown on the Plans and the forming requirements of Section 541. 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.

6. REMOVAL OF EXISTING BARRIER. Existing barrier shall be cut at an existing joint. During removal contractor shall take care not to damage adjacent sections of concrete barrier. Barrier sections in front of bridge piers will not be removed without approval of the engineer.
Box beam rail guardrail will be removed from the closest splice to the removed section of barrier and a 3-foot tapered section of box beam rail will be installed to cap the exposed ends.

   When active construction is not occurring on the roadway, gaps that are left where barrier has been removed must be protected with temporary roadside barriers.

7. PRECAST CONCRETE INSPECTION. Precast concrete inspection will be in accordance with Subsection 540.06.

   The Fabricator shall provide a tentative casting schedule to the Engineer and Structural Concrete Engineer for the following casting week a minimum of 3 calendar days prior (a casting week will be Sunday to Saturday). The Fabricator shall maintain a Quality Control file that shall contain at a minimum the piece identification, date and time cast, concrete test results, quantity of concrete used per element, batch quantity printout, cylinder results, and aggregate gradation and moisture.

   Advance notification of at least two (2) weeks shall be provided by the Fabricator to the Agency's Engineer and Structural Concrete Engineer concerning the proposed intention to commence work. A minimum of five (5) working days notification must be provided to the Structural Concrete Engineer by the Fabricator to confirm the fabrication start date.

   The Inspector shall have the authority to reject any material or work that does not meet the requirements of these specifications.

   Prior to shipment of any members, the Materials and Research Engineer will have approved all applicable material certifications.

8. CONCRETE BARRIER INSTALLATION. Replacement sections of concrete barrier will match the length of the sections that were removed. Replacement sections will be doweled into adjacent sections of existing concrete barrier as shown in plans.

9. METHOD OF MEASUREMENT. The quantity of Special Provision (Remove and Replace Concrete Barrier Segment) to be measured for payment will be the number of linear feet of barrier installed in the complete and accepted work, measured along the face of the barrier.

10. BASIS OF PAYMENT. The accepted quantity of Special Provision (Remove and Replace Concrete Barrier Segment) will be paid for at the Contract unit price per linear foot. Payment will be full compensation for removing existing barrier, installation and removal of temporary roadside barrier, and fabricating, furnishing, transporting, handling, and installing the replacement barrier and guardrail, including field measurements; furnishing parts and constructing the connectivity connections; furnishing and installing back up posts; and furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
900.640 Special Provision (Remove and Replace Concrete Barrier Segment)	Linear Foot

CONSTRUCTION VIBRATION AND CRACK MONITORING

1. DESCRIPTION. This work shall consist of conducting pre-construction building surveys, developing appropriate vibration trigger levels, and installing vibration and crack monitoring devices to record conditions prior to and during construction activities at the project site. Vibration producing activities such as blasting, pile driving, vibratory compaction, pavement breaking, or operation of heavy construction equipment required for the construction of this project have the potential for creating damage to surrounding infrastructure and buildings. The Contractor is advised that structures are in very close proximity to the proposed work and that construction activities shall be conducted to preclude damage to these structures. The Contractor is responsible for all damage caused by the Contractor's activities.

2. MATERIALS. The Contractor shall install instruments capable of measuring, recording, and producing a hard copy of the frequency and peak particle velocity in three mutually perpendicular axes (Instruments that record "Vector sum" only measurements are not acceptable). These instruments shall be capable of measuring Linear Scale (dB-L) sound levels.

   The Contractor shall provide crack monitoring equipment from the following, or an approved equal:

   Tell-Tale Crack Monitors
   RST Instruments Ltd.
   Tel.: (800)665-5599
   www.rstinstruments.com

   Avongard Crack Monitor
   Avongard Products U.S.A.
   Tel.: (800)244-7241
   www.avongard.com

3. SUBMITTALS. The Contractor shall submit their proposed construction vibration monitoring plan for the structural health of nearby buildings and structures to the Engineer for review and approval a minimum of 14 days prior to the start of construction. The submittals shall include the following:

   (a) The qualifications of the Vibration Specialist. Include a list of three projects (with references) in the past five years where the Vibration Specialist has successfully developed vibration criteria and monitored construction activities on projects similar to the scope of the current project.

(b) A description of the monitoring equipment and current calibration documentation.

(c) Plan view showing number and locations of seismographs and crack gages being monitored.

(d) Proposed vibration limits for the particular construction activities under consideration.

(e) A list of structures, utilities, and all other facilities which in the judgment of the Vibration Consultant require a pre and post construction condition survey. Particular attention shall be given to historic structures, structures in poor condition, structures supported by vibration sensitive materials which could cause settlement or loss of support, and structures which contain sensitive equipment or processes.

(f) Procedures to be implemented if it is determined that the proposed construction activity cannot be reasonably implemented without exceeding vibration limits that are necessary to protect adjacent facilities.

4. CONSTRUCTION REQUIREMENTS.

(a) Pre-Construction Condition Survey. The Contractor shall conduct a pre-construction condition survey of any buildings, structures, or utilities within the vicinity of the construction operations creating vibrations. The survey limits and method used shall be acceptable to the Contractor's insurance company, the Agency, and local authorities. The Contractor shall be responsible for any damage resulting from construction activities. The pre-construction condition survey records shall be made available to the Engineer for review. Occupants of local buildings shall be notified by the Contractor prior to the commencement of activities which may generate excessive vibrations.

(b) Public Relations. The Contractor is required to contact residents and property owners, or operators of the buildings identified by the Contractor’s insurance company. This contact will be made prior to the beginning of any vibration producing activity. The Contractor shall furnish to the Engineer a list of those contacted.

The Contractor shall maintain a log of all vibration related complaints, contacts, and actions, and shall furnish copies to the Engineer upon request.

5. MONITORING CRITERIA.

(a) The Contractor shall provide the services of an independent qualified Vibration Specialist to perform pre-construction surveys of nearby buildings, develop site specific vibration limits that are protective of nearby structures, especially historical structures, and monitor the vibrations along active work zones and any crack monitoring identified as necessary during pre-construction building inspections or created by current construction activities. The Vibration Consultant shall have at minimum a two-year associate's college degree in science or engineering and at least 10 years of experience in seismic monitoring. The Vibration Specialist shall interpret the seismograph records to ensure that the seismograph data will be effectively utilized in the control of the construction activities with respect to the existing structures. The Vibration Specialist used shall be subject to the approval of the Engineer. The Vibration Specialist shall supervise the placement and operation of the seismographs and crack monitoring equipment.

The Contractor and Vibration Specialist shall be mindful of the condition of the structures located within the project limits and shall set appropriate vibration limits in the Vibration Monitoring Plan so that the Contractor does not damage existing above and/or below ground features of these structures during construction.

(b) The Contractor shall provide a description of proposed construction methods, including amplitude descriptions of each vibration producing activity, and a vibration monitoring plan for each activity, including the format for reporting the vibration readings. Vibration monitoring devices (i.e., seismometers) shall be placed at locations nearest buildings or structures closest to active construction to optimize evaluation and assessment of potential damage to surrounding features. Additional devices may be required as directed by the Engineer.

(c) In order to establish background conditions, vibration monitoring equipment should be set to record data for at least one full week prior to construction activities. A full report of this information will be provided to the Engineer prior to any construction activities beginning. If the Contractor’s construction means and methods create ground vibrations that result in damage to surrounding buildings or structures, the Engineer will direct that all activities related to those causing the vibration to be stopped. The Engineer may also, at any time, halt construction activities if vibration levels exceed those developed by the Vibration Specialist or if there are signs of damage to surrounding buildings and structures. In the event of work being stopped as a result of ground vibrations, the Contractor shall submit to the Engineer a report giving the construction parameter data and include the proposed corrective action for future construction events. In order to proceed with any further vibration producing activities, written permission must be obtained from the Engineer.

(d) Vibration monitoring equipment shall be capable of continuously recording the peak particle velocity and providing a permanent record of the entire vibration event. Copies of all vibration records and associated construction activity (blasting, pile driving, pavement breaking, compaction, etc.) data shall be provided to the Engineer in a format approved by the Engineer.

(e) The Vibration Specialist shall measure the magnitude of each vibration event with vibration instruments, generally located adjacent to the closest or most critical structures. The vibration monitors shall be amplitude and frequency sensitive and shall be operated during vibration producing activities that produce measurable ground vibrations. If the Contractor chooses to have concurrent vibration producing activities at more than one location adjacent to buildings, the Contractor shall notify the Engineer prior to the commencement of such activities. The Engineer may require additional vibration monitoring instruments at each location depending on site parameters. No vibration producing activities may be started until the appropriate instrumentation is provided by the Contractor and approved by the Engineer.

(f) All vibration instruments shall be powered with rechargeable batteries, and the Contractor shall supply extension geophone and microphone cables so that the instruments can be placed within structures if outside temperatures drop below 32°F.

(g) All vibration instruments shall be supplied with current calibration documents and shall be recalibrated on a six-month use interval. All geophones shall be securely coupled to the ground or structure being monitored.

(h) The Contractor shall be responsible for instrument maintenance. If the Contractor does not maintain a sufficient number of instruments to monitor the buildings/structures adjacent to the vibration producing activity, the Engineer may direct that all vibration activities cease until a sufficient number are working. The Contractor’s Vibration Specialist will be responsible for placing the instruments at measuring locations designated in the monitoring plan and reading and recording the pertinent vibration levels during pile driving and other construction activities designated by the engineer.

(i) Crack displacement monitoring gages will be installed as appropriate across any significant existing cracks in buildings or structures identified and deemed necessary by the Vibration Specialist, Contractor and Engineer during the Pre-Construction Building Inspections and agreed to by the Property Owner. Readings from the crack monitoring devices should be taken at the time of installation (at least one week prior to construction activities), again, just prior to construction start-up and at intervals during construction established by the Vibration Specialist. The consultant shall take and record readings of all instrumentation during the performance of the work and a report shall be provided to the Engineer within 24 hours of completing the readings.

(j) The Contractor shall also be required to install additional crack monitoring devices as necessary and directed by the Engineer as a result of cracks that are identified or develop during construction.

6. METHOD OF MEASUREMENT. The quantity of Special Provision (Construction Vibration and Crack Monitoring) to be measured for payment will be on a lump sum basis in the complete and accepted work.

7. BASIS OF PAYMENT. The accepted quantity of Special Provision (Construction Vibration and Crack Monitoring) will be paid for at the Contract lump sum price. Payment will be full compensation for developing safe vibration limits, installing the monitors, recording the vibrations and crack movement, making all necessary submittals, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
900.645	Special Provision (Construction Vibration and Crack Monitoring)	Lump Sum

PRECAST CONCRETE GRAVITY RETAINING WALL

1. DESCRIPTION. This work shall consist of designing, fabricating, furnishing, and erecting a precast concrete gravity retaining wall at the location specified and in conformance with the lines and grades shown on the Plans or as directed by the Engineer.

2. DESIGN REQUIREMENTS. The design shall be performed in accordance with the AASHTO *LRFD Bridge Design Specifications*, and the design criteria specified in the Plans.

   Acceptable prefabricated earth retaining systems are those included in the "VAOT Approved Retaining Wall Systems", available on the Agency's website at the following address: https://outside.vermont.gov/agency/VTRANS/external/docs/construction/03GeotechEng/Engineering/Approved%20Wall%20System%20List.pdf

   Prefabricated earth retaining systems shall employ concrete facing. All wall components shall have a minimum design life of 75 years.

   No additional right-of-way, beyond that which has already been acquired for the construction of this project, will be available for the construction of an alternate wall system.

3. MATERIALS. Materials shall meet the following requirements:

   (a) Precast Concrete. Precast concrete shall meet the requirements of Section 540. The texture of the exposed wall face shall be similar to that of the Redi-Rock Ledgestone blocks. The color of the exposed face shall be similar to that of Solachrome Cool Taupe. The color shall be integrated into the concrete.

   (b) Reinforcing Steel. Reinforcing steel shall meet the requirements of Sections 507. Corrosion resistance shall be Level I unless otherwise specified in the plans.

   (c) Geotextile. Geotextile for wall construction shall be a non-woven fabric meeting the requirements of Section 720 for Geotextile for Roadbed Separator, unless otherwise specified by the wall supplier.

   (d) Backfill. Select granular backfill material used in walls shall be per the manufacturers' recommendations on the approved fabrication drawings, or at a minimum conform to the requirements of Section 704.18

   (e) Drainage Aggregate. Drainage aggregate material used in walls shall be per the manufacturer's recommendations on the approved fabrication drawings, or at a minimum conform to the requirements of Table 704.16A.

4. SUBMITTALS. Working Drawings shall be submitted in accordance with Section 105. The submittal shall include, but not be limited to, all of the following that apply to the particular wall system being constructed:

(a) Complete design calculations substantiating that the proposed design satisfies the design parameters in the Contract. The wall design calculations shall be signed, stamped, and dated by a Professional Engineer.

(b) A plan view of the wall showing the details within the limit of the retaining wall system and the centerline of any drainage pipe which is behind or passes under or through the wall.

(c) An elevation view of the wall which shall include the elevations at the top of the wall, at all horizontal and vertical break points and at least every 50 feet along the face of the wall, and at all steps in the leveling pads. The elevation view shall also include the designation as to the type of panel or block, the length of soil reinforcing elements, the distance along the face of the wall to where changes in length of the soil reinforcing elements occur, and an indication of the final ground line and maximum calculated bearing pressures.

(d) A typical cross section or cross sections showing the existing ground conditions and proposed grades.

(e) All details for foundations and leveling pads, including details for steps in the footings or leveling pads, as well as design maximum and minimum bearing pressures.

(f) All details for the wall system including all dimensions necessary to construct the wall.

(g) Details of the drainage systems or other facilities required to accommodate the system.

(h) The details for connection between the wall and the soil reinforcements as needed.

(i) The details for diverting soil reinforcements around obstructions such as guard rail posts, piles, catch basins, and other utilities.

(j) All reinforcing details, including type, strength, locations, and lengths of reinforcement used.

(k) Any general notes required for the construction of the wall.

(l) A listing of the summary of quantities for each wall.

(m) Fabrication drawings shall demonstrate compatibility in how the retaining wall will adjoin adjacent structures designed by others.

(n) Fabrication drawings shall include callouts indicating the applicable AASHTO/ASTM material grades.

Submittals for precast concrete shall meet the requirements of Subsection 540.04.

Approval of the Contractor's Working Drawings shall not relieve the Contractor of any responsibility under the Contract for the successful completion of the work.

5. INSPECTION. Precast concrete inspection will be in accordance with Subsection 540.06.

The Fabricator shall provide a tentative casting schedule in accordance with Subsection 105.03 to the Engineer and Structural Concrete Engineer for the following casting week a minimum of 3 calendar days prior (a casting week will be Sunday to Saturday). The Fabricator shall maintain a Quality Control file that shall contain at a minimum the piece identification, date and time cast, concrete test results, quantity of concrete used per element, batch quantity printout, cylinder results, and aggregate gradation and moisture.

Advance notification of at least 14 calendar days shall be provided by the Fabricator to the Agency's Engineer and Structural Concrete Engineer concerning the proposed intention to commence work. A minimum of 5 working days notification must be provided to the Structural Concrete Engineer by the Fabricator to confirm the fabrication start date.

The Inspector shall have the authority to reject any material or work that does not meet the requirements of these specifications.

Prior to shipment of any members, the Materials Acceptance Unit will have approved all applicable material certifications.

6. ACCEPTANCE REQUIREMENTS.

(a) Backfill. Foundation soil, leveling pad, and backfill material shall be compacted in accordance with the manufacturer's recommendations and at a minimum to not less than 95% of the material's maximum dry density as determined by AASHTO T 99, Method

(b) Field density determination will be made in accordance with AASHTO T 310, Nuclear Method. Moisture and density shall be sampled following the Materials Sampling Manual or at the direction of the Engineer.

(c) Concrete. Concrete will be sampled in accordance with AASHTO T 141; tested for slump in accordance with AASHTO T119, for air content in accordance with AASHTO T 152, and for compressive strength in accordance with AASHTO T 23. The concrete will be tested once for every 25 cubic yards placed.

(d) Geotextile. The Geotextile shall meet the design requirements and be on the Approved Products List.

7. METHOD OF MEASUREMENT. The quantity of Special Provision (Precast Concrete Gravity Retaining Wall) to be measured for payment will be the actual number of square feet of wall surface area in the complete and accepted work above the finished grade.

8. BASIS OF PAYMENT. The accepted quantity of Special Provision (Precast Concrete Gravity Retaining Wall) will be paid for at the Contract unit price per square foot. Payment will be full compensation for designing, fabricating, and installing the materials specified, including but not limited to geotextile fabric, concrete, integrated color, backfill material, and expansion material; excavation; drainage system connection; miscellaneous materials including drain pipe, backfill for drain pipe, and railing and associated hardware; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
900.670 Special Provision (Precast Concrete Gravity Retaining Wall)	Square Foot

CAST-IN-PLACE CONCRETE RETAINING WALL

1. DESCRIPTION. This work shall consist of designing, detailing, fabricating, furnishing, and erecting a cast-in-place concrete retaining wall at the location(s) specified and in conformance with the lines and grades shown on the Plans or as directed by the Engineer.

2. DESIGN REQUIREMENTS. The design shall be performed in accordance with the AASHTO LRFD Bridge Design Specifications, and the design criteria specified in the Plans.

3. MATERIALS.Materials shall meet the following requirements:

   (a) Precast Concrete. Any Precast Concrete elements shall meet the requirements of Section 540. The texture of the exposed wall face shall be similar to that of the Redi-Rock Ledgestone blocks. The color of the exposed face shall be similar to that of Solachrome Cool Taupe. The color shall be integrated into the concrete.

   (b) Cast-in-Place Concrete. Cast-in-Place concrete shall meet the requirements of Special Provision (Performance-Based Concrete, Class PCS) unless otherwise specified in the Contract Documents. The texture of the exposed wall face shall be similar to that of the Redi-Rock Ledgestone blocks. The color of the exposed face shall be similar to that of Solachrome Cool Taupe. The color shall be integrated into the concrete.

   (c) Reinforcing Steel. Reinforcing Steel shall meet the requirements of Section 507.

   (d) Backfill. Backfill shall meet the following requirements:

      (1) Gradation Limits. Select granular backfill material used in walls shall be reasonably free from organic and otherwise deleterious materials, and shall conform to the following gradation limits as determined in accordance with AASHTO T 27:

Sieve Size	Percent Passing
4 inch (101.6 mm)	100
3 inch (75 mm)	75–100
No. 40 (0.425 mm)	0–60
No. 200 (.075 mm)	0-12

      (2) Plasticity Index. The Plasticity Index (P. I.), as determined in accordance with AASHTO T 90, shall not exceed six.

(3) Soundness. The 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 percent after five (5) cycles, as determined in accordance with AASHTO Tl04.

Select granular backfill shall have a minimum uniformity coefficient, C_u, of 2.

In addition to these requirements, backfill for walls using metallic soil reinforcing shall meet the following:

Property	Requirement	Test Method
Resistivity at 100% saturation	Minimum 3000 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

Backfill not conforming to this specification shall not be used unless approved in writing by the Engineer and wall supplier.

Backfill material shall be compacted in accordance with the manufacturer's recommendations and Contract specifications.

(e) Geotextile. Geotextile shall be a non-woven fabric meeting the requirements of Section 649 for Geotextile for Roadbed Separator, unless otherwise specified by the wall supplier.

(f) Soil Reinforcing and Attachment Devices for MSE wall systems. All reinforcing and attachment devices shall be carefully inspected to ensure they are true size and free from defects that may impair their strength and durability.

(1) Reinforcing Mesh Elements. Reinforcing mesh elements shall be shop fabricated from cold drawn steel rod conforming to the minimum requirements of AASHTO M 32M/M 32 and shall be welded at the junctions between longitudinal and transverse wires in accordance with AASHTO M 55M/M 55. Galvanization shall be applied after mesh fabrication and shall conform to the minimum requirements of AASHTO M 111M/M 111. The galvanizing thickness shall be determined and specified based on the design life requirements of the structure.

(2) Loop Embeds. Loop embeds shall be fabricated from cold drawn steel rod conforming to AASHTO M 32M/M 32. Loop embeds shall be welded in accordance with AASHTO M 55M/M 55. Loop embeds shall be galvanized in accordance with AASHTO M 232M/M 232.

(3) Reinforcing Strips. Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to AASHTO M 223 or equal. Galvanization shall conform to the minimum requirements of AASHTO M 111M/M 111. The galvanizing thickness shall be determined and specified based on the design life requirements of the structure.

(4) Tie Strips. The tie strips shall be shop fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M 111M/M 111 or AASHTO M 232M/M 232. The minimum coating thickness shall be 0.610 kg/m².

(5) Fasteners. Fasteners shall consist of galvanized hexagonal cap screw bolts and nuts conforming to the requirements of AASHTO M 164 or equivalent. Fasteners shall be galvanized in accordance with AASHTO M 232M/M 232.

(6) Joint Material. Joint material shall meet the requirements of Subsection (s) 707.06, 707.07, 707.08, or 707.09, unless otherwise specified in the Contract Documents or as part of an approved retaining wall system.

(8) Joint Cover. Horizontal and vertical joints between panels shall be covered by a geotextile. The geotextile may be either a non-woven needle punched polyester geotextile or a woven monofilament polypropylene geotextile meeting the requirements of Section 720 for Geotextile Under Stone Fill. The wall supplier shall approve adhesive used to hold the geotextile filter fiber material to the rear of the facing panels prior to backfill placement.

5. SUBMITTALS. Working Drawings shall be submitted to the Structures Engineer in accordance with Section 105. The submittal shall include all detailed design computations and details, dimensions, quantities, and cross sections necessary to construct the wall. In addition, the submittal shall include, but not be limited to, all the following that apply to the particular wall system being constructed:

(a) Complete design calculations substantiating that the proposed design satisfies the design parameters in the Contract Documents. The wall design calculations shall be signed, stamped, and dated by a Professional Engineer. The Contractor shall not start work on any earth retaining system for which Working Drawings are required until the Engineer has approved such drawings.

(b) A plan view of the wall showing the limit of the widest module, tiebacks, nails, mesh, or strip and the centerline of any drainage pipe which is behind or passes under or through the wall.

(c) An elevation view of the wall which shall include the elevation at the top of the wall at all horizontal and vertical break points and at least every 50 feet along the face of the wall, all steps in the leveling pads, the designation as to the type of panel, the length of soil reinforcing elements, the distance along the face of the wall to where changes in length of the soil reinforcing elements occur, and an indication of the final ground line and maximum calculated bearing pressures.

(d) A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.

(e) All details for foundations and leveling pads, including details for steps in the footings or leveling pads, as well as design maximum and minimum bearing pressures.

(f) Details of the drainage systems or other facilities required to accommodate the system.

(g) The details for connection between the wall and the soil reinforcements.

(h) The details for diverting soil reinforcements around obstructions such as piles, catch basins, and other utilities.

(i) All reinforcing details, including reinforcing bar bending details.

(j) Any general notes required for the construction of the wall.

(k) A listing of the summary of quantities on the elevation sheet for each wall.

Any construction drawings required for elements meeting the requirements of Section 540 shall be submitted and shall meet the requirements of Subsection 540.04.

All design and construction details will be checked by the Agency's Structures and Geotechnical Sections. Approval of the detailed design and plans, and notification to begin the work, will be made by the Structures Section. The Contractor shall allow the Agency 30 calendar days to review and approve the Working Drawings.

Approval of the Contractor's Working Drawings shall not relieve the Contractor of any responsibility under the Contract for the successful completion of the work.

6. PRECAST CONCRETE INSPECTION. Precast concrete inspection will be in accordance with Subsection 540.06.

The Fabricator shall provide a tentative casting schedule to the Engineer and Structural Concrete Engineer for the following casting week a minimum of 3 calendar days prior (a casting week will be Sunday to Saturday). The Fabricator shall maintain a Quality Control file that shall contain at a minimum the piece identification, date and time cast, concrete test results, quantity of concrete used per element, batch quantity printout, cylinder results, and aggregate gradation and moisture.

7. METHOD OF MEASUREMENT. The quantity of Special Provision (Cast-in-Place Concrete Retaining Wall) to be measured for payment will be the number of exposed square feet of wall surface area complete and in place in the accepted work. The height of exposed face shall be the difference between the top of the wall and the finish grade along the front face of the retaining wall.

8. BASIS OF PAYMENT. The accepted quantity of Special Provision (Cast-in-Place Concrete Retaining Wall) will be paid for at the Contract unit price per square foot. Payment will be full compensation for designing, detailing, fabricating, and installing the materials specified, including but not limited to the geotextile fabric, backfill material, concrete, bar reinforcement and welded steel wire fabric, drainage pipe, drainage aggregate, underdrain, drainage system connection, precast concrete facing panels, soil reinforcements, attachment devices, fasteners, bearing blocks, shims, geomembrane, geotextile, and expansion material; any excavation, sheeting, bracing, dewatering, and siltation control; preparing and submitting Working Drawings; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any grouting work, such as fairing out unevenness between adjacent concrete pieces and filling leveling screw holes, shear keys, transverse anchor recesses, and dowel holes, is considered incidental to the work for Special Provision (Cast-in-Place Concrete Retaining Wall).

Payment will be made under:

Pay Item	Pay Unit
900.670 Special Provision (Cast-in-Place Concrete Retaining Wall)	Square Foot

BITUMINOUS CONCRETE PAVEMENT, SMALL QUANTITY

1. 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 reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

   The work under this Section shall be performed in accordance with these provisions, the Plans, and the appropriate provisions of Section 406 of the Standard Specifications, except as modified below.

2. REQUIREMENTS FOR SUPERPAVE BITUMINOUS MIXTURES.

   (a) Acceptance Testing. For evaluating mixtures and pavement produced under this special provision, the following acceptance practices replace the acceptance testing listed in Subsection 406.03C and Subsection 406.14(a) with the procedures listed below and the criteria specified in Table 1.

      (1) Sampling. The material will be sampled at the frequency specified by the Engineer, but in no case shall the frequency be less than that specified in Table 1. Each sample or lot will be considered representative of a particular quantity of material outlined in Table 1, or as determined by the Engineer.

      (2) Acceptance Quality Characteristics. For items listed as Acceptance Quality Characteristics (AQC), if the material meets or exceeds the Acceptable Quality Level (AQL), it will be deemed compliant, and paid full price. If any AQC fails to meet the Rejectable Quality Level (RQL), the material will be deemed unacceptable, and shall be rejected unless otherwise directed by the engineer. Test results that fall between the AQL and RQL will be deemed acceptable and subject to negative pay adjustment.

      (3) Pay Factors. When they are included in the Contract, the following pay factors will apply to all accepted material, except as noted below:

         a. Mixture Properties Pay Factor (PFMP). This pay factor will be calculated based on air voids. Box samples will be subject to full Pay Factor determination.

         b. Mat Density Pay Factor (PFMD). This pay factor does not apply to material used for leveling courses, side roads, independent shoulders paved separately, or handwork. The Engineer may elect to waive the pay factor for other material at their discretion. Cores will not be taken within 6 inches of a longitudinal joint or within 50 feet of a transverse joint, except on bridges.

Bridge decks or approaches will not be cored within 10 feet of a bridge joint or transverse joint, and bridges less than or equal to 20 feet in length will not be cored.

(4) Rounding and Reporting of Values. Results from all calculations shall be rounded and reported as specified below:

a. Report all pay factors to 0.0001 and all pay adjustments to 0.01. For intermediate calculations used to obtain pay factors and pay adjustments, Quality Indices shall be rounded to 0.01, and all other values should retain the maximum available precision.

b. For rounding, the use of AASHTO Rounding Rule D shall not be permitted. 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 (0.1):

5.35 rounds to 5.4 -5.35 rounds to -5.4

5.34 rounds to 5.3 -5.34 rounds to -5.3

TABLE 1 – ACCEPTANCE QUALITY CHARACTERISTICS

Quality Characteristic	Min. Sampling Frequency	Evaluation Method	Type of Criteria	Lower Specification Limit (LSL)	Upper Specification Limit (USL)	AQL	RQL
Air Voids	1 per 500 tons	Single Test Deviation	Acceptance	JMF–1.0%	JMF+1.0%	D = 0	D = -1
Mat Density – All Courses	Minimum 4 per paving course, 1 per 500 tons	PWL	Acceptance	91%	-	PWL = 80	PWL = 50

(5) Evaluation Method.

a. Single Test Deviation. The value obtained from the tested sample will be compared to the JMF, USL and LSL using the following formulas.

$$D = 1 - \frac{|TR - JMF|}{0.5(USL - LSL)}$$

where:

D = Deviation of the sample from the specification limits. If the calculated value of D > 0.0, then D will be set equal to 0.

TR = Sample test result

JMF = Job mix formula

USL = Upper specification limit

LSL = Lower specification limit

b. Percent Within Limits. Determination performed in accordance with Subsection 406.03C(d).

(6) Pay Factor Determination.

a. Mixture Properties Pay Factor. Once the Deviation for Air Voids has been determined, the Mixture Properties Pay Factor for acceptable material will be calculated using the formula below.

$$PF_{MP} = 0.1D_{AV}$$

where:

PF_{MP} = Mixture Properties Pay Factor

D_{AV} = Deviation for Air Voids

b. Mat Density Pay Factor. Once the PWL for Mat density has been determined, the Mat Density Pay Factor for acceptable material will be calculated using the formula below.

For $80\% \leq PWL_{MD} \leq 100\%$

$$PF_{MD} = 0.00150\ PWL_{MD} - 0.1200$$

For 80% ≤ PWL_{MD} < 50%

$$PF_{MD} = 0.0050\ PWL_{MD} - 0.4000$$

where:

PWL_{MD} = Total percent within specification limits for mat density

PF_{MD} = Mat Density Pay Factor

3. METHOD OF MEASUREMENT. The quantity of Special Provision (Bituminous Concrete Pavement, Small Quantity) to be measured for payment will be the number of tons for a lot of mixture (each type) complete in place in the accepted work (Q) as determined from the weigh tickets.

   The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

   When applicable, the measured quantity of Special Provision (Bituminous Concrete Pavement, Small Quantity) placed (Q) will be multiplied by the Mixture Properties Pay Factor, (PF_{MP}), and the Contract Bide Price (B), to determine a Mixture Pay Adjustment, (PA_{MP}) as follows:

$$PA_M = PF_{MP} \text{ x } Q \text{ x } B$$

   When applicable, the measured quantity of Special Provision (Bituminous Concrete Pavement, Small Quantity) placed (Q) will be multiplied by the Mat Density Factor, (PF_{MD}), and the Contract Bide Price (B), to determine a Mat Density Pay Adjustment, (PA_{MD}) as follows:

$$PA_D = PF_{MD} \text{ x } Q \text{ x } B$$

4. BASIS OF PAYMENT. The measured quantity of Special Provision (Bituminous Concrete Pavement, Small Quantity) 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.

   Payment for Pay Adjustments shall be debited against the Contract prices (lump units) bid for the Pay Adjustment items.

The cost of repairing core areas will not be paid for separately but will be considered incidental to Special Provision (Bituminous Concrete Pavement, Small Quantity).

The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Special Provision (Bituminous Concrete Pavement, Small Quantity).

The costs associated with obtaining samples for acceptance testing will be incidental to the cost of Special Provision (Bituminous Concrete Pavement, Small Quantity).

When not specified as items in the Contract, the costs of correcting deficiencies in the existing pavement, cleaning and filling joints and cracks, sweeping and cleaning existing paved surfaces, the emulsified asphalt applied to tack these surfaces, and tacking of manholes, curbing, gutters,

and other contact surfaces will not be paid for directly but will be incidental to Special Provision (Bituminous Concrete Pavement, Small Quantity).

Special Provision (Bituminous Concrete Pavement, Small Quantity) mixture approved by the Engineer for use in correcting deficiencies in the aggregate subbase or base course constructed as part of the Contract will not be paid for as Special Provision (Bituminous Concrete Pavement, Small Quantity), but will be incidental to the Contract item for the specified type of base course.

Special Provision (Bituminous Concrete Pavement, Small Quantity) mixture used to correct deficiencies in an existing pavement or to adjust the grade of a bituminous concrete surface completed under the Contract will be paid for at the Contract unit price for Special Provision (Bituminous Concrete Pavement, Small Quantity).

Payment will be made under:

Pay Item		Pay Unit
900.650	Special Provision (Mat Density Pay Adjustment, Small Quantity) (N.A.B.I.)	Lump Unit
900.650	Special Provision (Mixture Pay Adjustment) (N.A.B.I.)	Lump Unit
900.680	Special Provision (Bituminous Concrete Pavement, Small Quantity)	Ton