

RECLAIMED STABILIZED BASE, PORTLAND CEMENT

****Note: This specification requires the inclusion of both the PORTLAND CEMENT FOR BASE STABILIZATION and FOG SEAL SURFACE TREATMENT specifications under Section 900.**

****From Berlin STP 2935(1)
Berlin NH STP 2938(1)
Berlin NH STP 2947(1)**

xx. DESCRIPTION. This work consists of removing a volume of material by cold lanning (when specified), and pulverizing a combination of virgin aggregate or soil (if/where specified), reclaimed asphalt pavement, reclaimed aggregate material, and subgrade material to the specified lines, grades, and dimensions as specified on the Plans. Once pulverized, cement shall be incorporated as per the Agency provided design mix formula (DMF) as subject to Contractor quality controls, and the materials mixed together to create a homogeneous cement stabilized base. This work also consists of compacting, shaping, finishing, fine grading, and curing of the stabilized base to the grades and dimensions shown on the Plans.

xx. MATERIALS. The cement stabilizing agent shall meet the requirements of PORTLAND CEMENT FOR BASE STABILIZATION of Section 900.

Emulsified asphalt shall meet the requirements of FOG SEAL SURFACE TREATMENT of Section 900.

RSB Supplemental Aggregate Material shall meet the requirements specified herein.

Subbase of Crushed Gravel, Coarse Graded shall meet the requirements of Subsection 704.05.

xx. PRELIMINARY CONSTRUCTION REQUIREMENTS. For quantity calculation purposes a cement content of approximately 4.0% was used to estimate the required Portland cement tonnage for this work. The actual cement content to be used within the process shall be determined by the Agency or its designated Agent and provided to the Contractor by the Engineer within 14 calendar days of the initial sampling process as defined below and as per Quality Control (QC) Plan approval.

To afford being provided the cement Reclaimed Stabilized Base (RSB) DMF by the Agency, the Contractor shall simulate those reclaimed aggregates that would be expected to result from the first pass of the reclamation process. Any simulation process proposed and ultimately accepted shall be that as inherent in the QC Plan as specified below. Upon acceptance

of any simulation process, simulation of reclaimed aggregates will be in concert of the 14 day requirement of the QC Plan submission and may be performed prior to, or post, the milling (cold plane), process as proposed by the Contractor and accepted by the Engineer through QC Plan approval or otherwise.

Locations at which the simulation process shall be required will, at a minimum, be at quarter points on the project as is specified further herein. Additional investigative locations are at the discretion of the Engineer and shall be processed by the Contractor in conjunction with those selected quarter points. The number of locations to be selected for simulation sampling will be that as included within the Contractor QC Plan but will not be less than four per any project length. The Contractor may utilize the simulation areas as selected above to perform preliminary sieve analysis to satisfy the requirements of the supplemental aggregate material gradations as specified below, but will not be relieved of the requirements of that analysis specified below as is required post the first full pass of the reclamation process and resultant final analysis of that material.

Agency personnel and equipment shall be allowed free and full access to the project site at no additional compensation due the Contractor to allow for any and all sampling required to assess compliance with the provisions of this specification. The Contractor will afford the Agency all traffic control operations and provide means to extract samples as requested to achieve this effort.

The cement content used in production may vary from the DMF throughout the project and be adjusted by the Contractor based on the results of compressive strength testing or other variables as identified by the Agency or the Contractor. The target 7 day compressive strength of the cement treated base is 275 psi. A minimum compressive strength of 175 psi and a maximum compressive strength of 350 psi is considered acceptable.

The initial reclamation pass shall blend the in-situ material into a homogeneous mixture by way of a maximum 40 feet per minute pass of the reclamation equipment, unless otherwise demonstrated by the Contractor that a different process speed will result in a sieved material that more closely resembles those preliminary samples as obtained above. Additionally, the first reclamation pass shall be subject to all applicable provisions of this specification, excluding the addition of the cement stabilizing agent and the establishment of the final line and grade.

Subsequent to completing the first reclamation pass, and prior to adding any supplemental aggregate material, the Contractor shall perform sieve analysis on the reclaimed material at "quarter points", as previously defined, of the project length at locations as selected by the Engineer. The sieves used in the analysis shall be those as contained in Table 704.05A designated for Crushed Gravel for Subbase - Fine Graded. Sieve analysis reports shall be provided to the Engineer upon their completion. The accepted singular gradation, for the project, of all test results will be proposed and submitted by the Contractor to the Engineer for acceptance and approval and the below QC Plan amended to indicate such. The proposed and accepted singular gradation shall identify that existing "first pass" material identifying a Job Mix Formula (JMF) for each sieve of Table 704.05A-Fine.

To afford field compliance with the sieve analysis results pertaining to Table 704.05A, any obvious soil particles remaining in place post the initial reclamation pass which exceed the 2 inch sieve designation shall be extracted and wasted. Waste particles shall include those as obvious surface or slightly subsurface particles which may be detected by hand tools.

As per the Contract Plans and provisions, the project route will be subject to correcting geometric deficiencies. As such, the material utilized by the Contractor to correct and construct the Plan line and grade shall be manufactured to the point that it equals the aforementioned accepted final sieve analysis gradation to within the following tolerances as based on the accepted JMF of each sieve:

Sieve Designation	Percent by Mass (Weight) Passing
50 mm (2 inch)	100
37.5 mm (1-1/2 inch)	JMF +/- 8%
4.75 mm (No. 4)	JMF +/- 6%
150 µm (No. 100)	JMF +/- 4%
200 µm (No. 200)	JMF +/- 3%

Areas identified on the Plans or by the Engineer to receive a full depth undercut correction will be subject to a subbase of dense graded material as an initial base material topped by 12 inches of the sieved material as identified in the table above. For estimating purposes, Subbase of Dense Graded Crushed Stone has been calculated at a 12 inch depth for those areas designed to receive the treatment or otherwise to be received at locations as directed by the Engineer.

- xx. DEFINITIONS. The following definitions apply solely to this specification:

Pass - A single pass is herein defined as full width coverage, in a defined path with the required overlap, in a single (forward or reverse direction.)

Cycle - A cycle is defined as full width coverage, in the same path with the required overlap, in both forward and reverse directions.

Reclaimer - A piece of equipment designed to pulverize and mix HMA pavement with base or subbase materials by crushing and breaking mechanics to a specific depth and width with the addition of water and cement as specified herein.

- xx. WEATHER LIMITATIONS. The Contractor shall not perform cement stabilization from October 1 to May 15 unless requested in writing and subsequently approved by the Engineer. Cement stabilization shall not be performed when soil temperatures are expected to be less than 5°F (40°F) within the next 72 hours unless requested and subsequently authorized in writing by the Engineer.

Cement stabilization shall not occur when rainfall will disturb the cement spreading, cause objectionable runoff, over-saturate the pulverized or mixed materials, lead to unstable conditions that will compromise the safety of the roadway for public use, or compromise the stability of the treated material. The Contractor shall monitor the weather and sequence operations accordingly and provide necessary repairs to the work product that has been damaged by inclement weather as specified herein. The quality control program shall adequately address these factors.

- xx. QUALITY CONTROL PROGRAM. The work to be completed by the Contractor under this item shall be governed by a Quality Control Program completed by the Contractor. The quality control program shall have a Quality Control (QC) Plan, process control measures, and qualified personnel to record and act on the results of the program. The Contractor shall submit the QC Plan a minimum of 14 days prior to any planned cold planing. The Contractor shall not commence cold plane operations until such time that the QC Plan is approved by the Engineer.

The QC Plan shall address each phase of the construction including cold planing, reclaiming (mixing), rough grading, adding supplemental materials, applying cement, dispersing cement, final grading, compacting reclaimed material, and protection of reclaimed surface. The QC Plan shall address all reasonably anticipated factors including but not limited to weather, materials quality, material availability, traffic, equipment availability, and materials delivery. Process control requirements that are directly affected by contingency factors such as moisture content, gradation, time delay, and compaction must have specific action limits defined for field implementation. Additionally, suspension limits shall also be identified in the QC Plan considering the same criteria defined above.

The process control sampling and testing activities in the Contractor developed Quality Control Program shall be no less stringent than those in the Agency's Materials Sampling Manual. The frequency of the process control sampling and testing shall be designed so that the Contractor meets or exceeds all acceptance requirements. The Contractor shall define an appropriate sampling and testing frequency for quality control purposes. The Contractor is responsible for field confirmation of design conditions and revision of the mix design to accomplish the project objectives. See part (d) Confirmation Sampling and Testing of this Section.

- (a) QC Plan Administrator. The QC Plan administrator shall be identified in the QC Plan as being qualified by way of past experience on cement RSB projects coupled with NETTCP certification for aggregate technician or aggregate field technician, or have it be alternately demonstrated that field staff, through supervision and under responsible charge of the plan administrator, has such qualifications or equivalent credentials.

- (b) Quality Control Records. Quality control records shall include all sampling events, testing results, and process changes with accurate time and location data. Interim quality control records shall be completed at the end of each calendar week at the Contractor's facilities and available upon request by the Engineer. All QC records shall be bound and submitted at the completion of the project.
- (c) Minimum Process Control Parameters. Minimum process control parameters are:
- (1) Initial RSB Sampling Process Affording Agency Design(s).
 - (2) Gradation and Asphalt Content results.
 - (3) Moisture Content behind the reclaimer.
 - (4) Cement application rate.
 - (5) Water Addition rate and distribution.
 - (6) Mixing - via drum speed, reclaimer ground speed, depth.
 - (7) Accurate Moisture Density Curves and targets.
 - (8) Final density after compaction.
 - (9) Curing Plan (Same day cement and compacted base).
 - (10) Strength Gain at 72 hours on Soil Cement Test Specimens, using split molds, in accordance with ASTM D559 Wetting and Drying Compacted Soil-Cement Mixtures.
- (d) Confirmation Sampling and Testing. Confirmation sampling and testing requirements/frequencies shall be incorporated into the Quality Control Program to identify and confirm that the design requirements/objectives (175 psi min/350 psi max) are being met.

xx. CONSTRUCTION REQUIREMENTS.

- (a) General. Any manholes, valve covers, or other buried structures shall be protected from damage prior to beginning work.

Construction operations shall be sequenced such that after any cold planing activities, the entire roadway width is reclaimed and compacted to the depth specified during the first pass. Aggregate material required to correct geometric deficiencies shall be added in 12 inch maximum lift thicknesses as directed by the Engineer.

The resultant base material shall be graded to the cross slope and profile as shown on the Plans or as directed by the Engineer. The length of reclaimed base pulverized shall not exceed the length that can be completely pulverized, mixed, and compacted in the same working day. The compacted material shall provide a stable surface for traffic as directed by the Engineer.

If the completed cement stabilized base is unacceptable for any reason, construction shall not continue until the cause of the deficiency(ies) is(are) determined and corrected and the QC Plan revised to reflect the cause, effect, and remedy.

The Contractor shall protect any surface or buried structures (bridges, culverts, slabs, utilities, shallow drainage pipes, etc.) during pulverization and chemical stabilization, including stopping pulverization and reclamation at these obstructions when required. When approaching any surface or shallow buried structures, the Contractor shall terminate mechanical pulverization or mixing a minimum distance of two (2) feet from said structure. The Contractor shall remove the unpulverized material through other means and take care not to damage the structure. Replace the removed material with full depth treated material that has been fully mixed and treated with the applicable chemical. Damage to these surface and buried structures will be repaired at the sole expense of the Contractor.

- (b) Geometry and Limits of Pulverization, Reclamation and Grading. The cement stabilized material shall extend to the Plan depth and width of the roadway and shall not be more than 2 inches narrower than the proposed edge of cement stabilized material nor more than 6 inches wider than the Plan edge of cement stabilized material. Cement stabilized material that spreads over the edges and creates a surface crust that is less than the full depth indicated on the Plans is not considered to be full depth cement stabilized material and shall be reclaimed to produce Plan requirements as directed by the Engineer.

The design depth and line of cement stabilized material shall be fully homogenous of cement stabilizer, shaped, graded and compacted to within 1 inch of the design depth.

- (c) Equipment.

- (1) Compaction. The Contractor shall utilize a vibratory pad-foot roller having a dynamic force of 25 000 kg (25 ton) for breakdown compaction and shall perform finish rolling using a single or tandem steel drum static roller of 11 to 13 tonnes (12 to 14 tons). A pneumatic tire roller will be utilized as specified further herein or as elected by the Contractor to achieve design requirements.

- (2) Reclamation. The Contractor shall utilize a self-propelled, traveling rotary reclaimer or equivalent machine capable of cutting through existing roadway material to depths of up to 406 mm (16 inches) with one pass. The equipment shall be capable of pulverizing "in-place" the existing pavement, base, and subgrade, and mixing any added materials to the specified depth. The cutting drum shall have the ability to operate at various speeds (rpm), independent of the machine's forward speed, to control oversized material and gradation.

The Contractor shall use a machine equipped with a computerized integral water proportioning system capable of regulating and monitoring the water application rate relative to depth of cut, width of cut, and speed. The water pump on the machine shall be connected to the supply tanker or distributor by a hose, and mechanically or electronically interlock the flow of material with the forward ground speed of the machine. The spray bar shall be mounted to allow the water to be injected directly into the cutting drum/mixing chamber. The Contractor shall provide equipment capable of mixing water, dry additives, and the pulverized pavement materials into a homogenous mixture. The Contractor shall maintain cutting drum in good operational condition at all times throughout the project. Equipment such as road planers or cold-milling machines designed to mill or shred the existing roadway materials rather than crush or fracture it is not allowed.

The Contractor shall provide and utilize equipment that will produce the completed cement stabilized base as specified herein. In addition, the equipment shall be capable of automatically metering liquids with a variation of not more than $\pm 2\%$ by mass (weight) of liquids.

Calibration records shall be provided to the Engineer before use of any equipment as requested. The Contractor shall maintain all equipment in a satisfactory operating condition.

The reclaimer drum shall rotate in the opposite direction of the reclaimer tires. Additional passes shall be provided as necessary to pulverize the material to meet the gradation as submitted for and approved as the JMF's.

The Contractor shall inspect the condition of the cutting teeth on a daily basis, replace all worn and broken cutting teeth, and keep the cutting drum fully maintained and in good working condition at all times. The inability of the reclaimer to produce the required design objectives will subject the equipment to rejection by the Engineer and require QC Plan amendments to address equipment faults.

- (d) Stabilization. The stabilizing agent shall be Portland cement and shall be placed using a spreader truck designed to ensure a uniform distribution across the roadway and minimize fugitive dust. Pneumatic application, including through a slotted pipe, will not be permitted. Other systems such as slurry applications, fog systems, or vacuum systems may also be considered acceptable. The Contractor shall provide a method for verifying that the correct amount of cement is being applied uniformly to the entire depth of the reclaimed layer and shall also provide a means for the Engineer to continually monitor, in real time, the forward speed of the reclaimer. At no time shall the reclaimer forward speed progress at a rate greater than 30 feet per minute.

Water shall only be added through the reclaimer during a second pass or cycle of the reclaimer to uniformly achieve the specified moisture content. The period of time from placement of the cement to the second pass of the reclaimer shall not exceed 30 minutes. Water distribution readings shall be independent of the reclaimer, with acceptable moisture contents considered by the Engineer to be within the range of +0%/-2% of optimum design values. Moisture contents shall be continuously monitored by automated equipment or as otherwise accepted by the Engineer and reported per the QC Plan requirements. Excess moisture will subject all reclamation operations to cease and will be cause for a reevaluation of that day's operations. Previously placed cementitious material not having been subject to all compaction operations subject to same day rainfall will be reworked to meet all provisions of this Section. This second pass of reclamation shall uniformly blend all materials into a homogenous mass until an apparent uniform distribution has occurred.

Longitudinal joints between successive reclamation passes shall overlap a minimum of 6 inches. The Contractor shall provide a sufficient number of mixing cycles so that the minimum 6 inch overlap is achieved. Longitudinal cold joints are not allowed in the cement stabilized base. The Contractor shall sequence the operations in order to complete all pulverization and mixing activities across the full width of the roadway within 36 hours.

The Contractor shall ensure a full and homogeneous distribution of the cement stabilizing agent. In concert with this requirement, the stabilizing reclaimer shall be equipped with a means for the Engineer to continually monitor reclamation depth or, alternately, the QC data shall be immediately available at all times.

- (e) Compaction. For production field operations, for both the first and second pass of the reclamation equipment, the moisture content shall be within the range of the optimum moisture content to 2% below the optimum moisture content. The Contractor shall monitor the moisture content using a moisture meter. If the optimum moisture content is not attained, then the material shall be reworked to bring the moisture content back into specification prior to completing the control strip as defined below.

Prior to each of the first five day's of production, and subsequently every third day of production, and included as part of both the first and second reclaim/roller pass, the Contractor shall conduct a 300 foot long control strip. The control strip for the cement stabilization operation shall begin upon completion of the second reclamation, including the cement mixed as prescribed, and the finished profile shall be rolled until such time that Contractor's NDG readings reveal an increase in dry density of less than 1 pcf for the final roller pass at the optimum moisture content. This density will be used as the revised target maximum density (RTMD) for that day's production. The processed material shall be uniformly compacted to a minimum of 98% of the TMD, as determined in accordance with AASHTO T 310, based on a moving average of five (5) consecutive tests, with no individual test result below 96%.

The Engineer will provide observation and testing services to evaluate compaction of the stabilized soils. If the density of an area is less than the minimum density, but the base course is uniform in texture, stable, and otherwise acceptable, then the Contractor shall provide additional passes of the compaction equipment. If additional compaction does not achieve the minimum specified density, then the Contractor shall revise compaction criteria via the completion of another control strip as directed by the Engineer to establish a new TMD. A minimum of five (5) tests will be taken at random locations to determine the TMD of the control strip.

Prior to field density testing and whenever a gradation sample is taken by the Engineer, the Contractor shall determine the asphalt content of the reclaimed material in accordance with AASHTO T 308.

If the Engineer determines that the TMD is apparently incorrect as evidenced by achieving the TMD with little or minimum compaction effort, then the Engineer shall require a control strip to verify or establish a new minimum density.

The Contractor shall commence rolling at the low side of the course and leave 80 to 150 mm (3 to 6 inches) from any unsupported edge(s) unrolled initially to prevent distortion. Compact the entire reclaimed area using uniform passes of compaction equipment as determined from the control strip, ensuring that uniform density is achieved throughout. Complete compaction of cement stabilized reclaimed material shall occur within two hours of the water/additive mixing operation, or the operation shall cease until such time that operations may be adjusted to achieve this requirement.

After compaction, the roadway surface shall be rolled with pneumatic-tired rollers to create a close-knit texture.

- (f) Curing and Treatment of Stabilized Base. The Contractor shall protect the cement stabilized surface from drying by continuously watering until a surface sealing coat can be applied.

The Contractor shall provide a curing plan as a portion of their QC Plan. The Contractor shall provide the curing plan for the Engineer's approval two (2) weeks prior to performance of reclamation. The Plan shall specify the type of sealant, application rate, manufacturer's recommendations, means to apply the sealant, and traffic control measures to ensure that the sealant does not damage vehicles traveling on the roadway. During application provide material samples to the Engineer upon request. Provide material weigh slips and certification tickets to the Engineer upon request.

The Contractor shall protect and maintain the cement stabilized base in good condition until all work is accepted. Such maintenance shall be performed by the Contractor at the Contractor's expense. Maintenance shall include immediate repairs of any defects that may occur. If it is necessary to replace any processed material, the replacement shall be full depth, with vertical cuts, using cement treated material with a compressive strength equivalent to the cement stabilized base material. No skin patches will be permitted. Portions of the cement stabilized base damaged by rain shall be reconstructed at the Contractor's expense.

Following final finishing of the cement stabilized surface, the surface shall be cured by being kept continuously moist for a period of two (2) days with a water spray that will not erode the surface of the cement stabilized base. The Contractor will continue the curing process during any off hours to achieve the minimum cure period.

(g) Micro-cracking. Immediately following the two day wet cure period, a micro-crack process shall be performed over the entire width of stabilized base, by three cycles over the cement stabilized base surface with a 12 ton roller traveling at 2 to 3 miles per hour, high vibration, and maximum amplitude. Microcrack roller overlap at the roadway crown will not be permitted. Light watering shall again be performed to afford visual inspection of the micro-cracking.

(h) Emulsion Seal. Following the two day wet cure period and once the cement stabilized base surface has cured sufficiently to the satisfaction of the Engineer, the surface shall be swept and CSS-1h emulsified asphalt shall be applied at a rate of 0.15 gal/yd² (+/- 0.025 gal/yd²). The bituminous base course, or that course as specified, shall be placed within 10 calendar days of application of the emulsion seal. At the option of the

Contractor, the two day wet cure period may be waived to allow for an immediate (same day) application of the emulsion seal. Micro-cracking over any emulsion seal will be permitted by the Agency pending full coverage of the seal is still evident upon completion of the micro-crack operation.

(i) Traffic Considerations. Completed portions of the cement stabilized base can be opened immediately to low speed local traffic and to construction equipment, provided that the curing operations are not impaired. The Contractor shall protect any finished portion of the cement stabilized base upon which any construction equipment or public traffic is required to travel to prevent marring, distortion, or damage of any kind. Immediately and satisfactorily correct any damage, instability, and surface irregularities prior to paving.

(j) Pre-Paving Coordination. The Contractor shall provide and coordinate a fully loaded triaxial dump truck to proof-roll the finished stabilized layer, under the observation of the Engineer, prior to allowing paving on the stabilized material. The Contractor shall verify that the lateral limits of the full depth cement stabilized base meet the required tolerances specified herein. The Contractor shall report all deviations in offset and width to the Engineer, prior to paving. The Contractor will be responsible for replacing, at the sole cost of the Contractor, all areas of cement stabilized base material that do not meet the lateral limit tolerance, unless the deviation was approved by the Engineer in writing.

xx. METHOD OF MEASUREMENT. The quantities of Special Provision (Reclaimed Stabilized Base) and Special Provision (Reclaimed Stabilized Base, Portland Cement) to be measured for payment will be the number of square meters (square yards) constructed to the depth specified, complete in place in the accepted work.

The quantity of Special Provision (RSB Supplemental Aggregate Material) to be measured for payment will be the number of metric tons (tons) used in the complete and accepted work, as determined from the load tickets.

- xx. BASIS OF PAYMENT. The accepted quantities of Special Provision (Reclaimed Stabilized Base) and Special Provision (Reclaimed Stabilized Base, Portland Cement) will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, handling, transporting, and placing the necessary materials; pulverizing and adding or removing moisture; shaping, placing, and compacting the designated materials; constructing test strips; conducting a quality control program; maintaining the finished base until it is paved over, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Water used to adjust the moisture content prior to stabilization, for stabilization when water is used as the stabilizing agent, for compacting the pulverized material, and for dust control after the reclamation will not be paid for directly, but will be considered incidental to the appropriate Reclaimed Stabilized Base pay item.

When calcium chloride is identified in the Plans as a dust control agent, it will be paid separately under the appropriate Contract item.

Payment for cement stabilizing agent will be made separately under Contract item 900.680 Special Provision (Portland Cement for Base Stabilization).

The accepted quantity of Special Provision (RSB Supplemental Aggregate Material) will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, blending, transporting, testing, placing, grading, and compacting the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for subbase material used in undercut areas as required will be paid separate under Contract item 301.35.

Payment for emulsified asphalt will be made separately under Contract item 900.683 Special Provision (Fog Seal Surface Treatment).

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
900.675 Special Provision (Reclaimed Stabilized Base)	Square Yard
900.675 Special Provision (Reclaimed Stabilized Base, Portland Cement)	Square Yard
900.680 Special Provision (RSB Supplemental Aggregate Material)	Ton