

Seattle Permits

— part of a multi-departmental City of Seattle series on getting a permit

PERMEABLE PAVEMENT IN THE RIGHT-OF-WAY

Effective Date 5/30/2010

The 2009 Seattle Stormwater Code introduced new requirements for stormwater management. The code requires all Single-family residential projects and all other projects with 7,000 square feet or more of land disturbing activity or 2,000 square feet or more of new plus replaced impervious surface to implement green stormwater infrastructure (GSI) to infiltrate, disperse, and retain drainage water onsite to the maximum extent feasible. GSI includes bioretention, soils, permeable pavement and green roofs.

In addition, the Department of Planning and Development, updated the Green Factor Standards in 2009. The Green Factor is a landscape requirement designed to increase the quantity and quality of planted areas in Seattle while allowing flexibility for developers and designers to meet development standards. It currently applies to new development in commercial and neighborhood commercial zones outside of downtown, and is proposed for multifamily residential zones and the South Downtown planning area.

Permit applicants in affected zones must demonstrate that their projects meet the Green Factor by using the Green Factor Score Sheet. The scoring system is designed to encourage permeable paving, green roofs, vegetated walls, preservation of existing trees, and layering of vegetation along streets and other areas visible to the public.

Because the revised Stormwater Code and the updated Green Factor requirements promote the use of GSI both on private property and within the City of Seattle Right of Way, SDOT has incorporated design guidelines for GSI in the current version of the City of Seattle Right-of-Way Improvement Manual (ROW IM).

This Client Assistance Memo provides additional information for permeable paving in the Right-of-Way. It includes:

- the approved permeable pavement wearing courses for ROW applications,
- the siting requirements for permeable pavement, and
- SDOT's permitting review process for GSI.

Additional design guidelines can be found in the [ROWIM Manual - Section 6.4 Green Stormwater Infrastructure](#).

PERMEABLE PAVING WEARING COURSE APPROVED LIST

Permeable Cement Concrete is currently the only acceptable permeable pavement that is approved only as a walking surface in the ROW. Additionally, permeable cement concrete is the only approved material that may be used to meet stormwater code requirements.

Permeable pavement is not approved for use as a driving surface, including driveways and parking lanes. Permeable pavement will not be approved within the footprint or landings of accessible ramps.

Excluding designated walking surfaces within the ROW, all other permeable pavement types identified in the GSI permeable pavement table will be considered for approval. The table can be found at:

http://www.seattle.gov/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu02_019966.pdf

However, these types of permeable pavements will not be approved to meet Stormwater code requirements.

The approved specifications for permeable cement concrete are provided in *Attachment A*. Other materials are currently under review by SDOT and will be included in this CAM as soon as they are

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approved for use in the Right of Way as a designated walking surface.

SITING REQUIREMENTS FOR PERMEABLE PAVING

The following siting considerations should be made when determining if Permeable Paving is a suitable material:

- Area of installation – The City requires that the area of installation must be at least 2,000 square feet or one block frontage, whichever is less.
- Longitudinal Slope – the longitudinal slope must not exceed 5%
- Existing Trees and Tree Canopy – In areas with mature trees the root zone must be considered. Retention of tree roots necessary to support the health and future growth of the tree may dictate the limits of the paved area as well as the drainage capacity for permeable paving. Additionally, areas shaded by trees may be limited to a specific type of permeable paving or may be considered unsuitable altogether.

SDOT STREET USE PERMITTING REQUIREMENTS

All GSI infrastructure (including permeable pavement) installed in the right of way as a Stormwater Code requirement or for Green Factor Credits, must obtain a SDOT Street Improvement Permit prior to construction. Refer to CAM 2200 for information regarding the SDOT Street Improvement Permitting Process. Permeable paving requires 60% Complete SIP approval. Refer to CAM 2211 and CAM 2213 for requirements to obtain 60% Complete SIP approval.

The following Specifications have been approved by SDOT for use of the placement of Permeable Cement Concrete Sidewalks. These Specifications should be used in conjunction with the City of Seattle, Standard Specifications and Plans for Municipal Construction, 2014 Edition.

The following is an excerpt from the City of Seattle Standard Specifications for Municipal Construction.

SECTION 5-06 PERVIOUS CEMENT CONCRETE SIDEWALK

5-06.1 DESCRIPTION

Section 5-06 describes work consisting of constructing pervious cementitious sidewalk and walkway applications including excavation, subgrade preparation, geotextile, and aggregate discharge subbase, that shall allow surface water to permeate through the pervious surface into the supporting materials to allow infiltration or detention of surface waters.

5-06.2 MATERIALS

Materials shall meet the requirements of the following Sections:

Portland Cement and Blended Hydraulic Cement	9-01
Fine Aggregate for Portland Cement Concrete	9-03.1(2)
Aggregates for Pervious Pavements	9-03.1(5)
Crushed Gravel (Mineral Aggregate)	9-03.11
Premolded Joint Filler for Through, Construction and Expansion Joints	9-04.1(2)
Curing Materials and Admixtures	9-23
Water	9-25
Construction Geotextiles	9-37

Portland cement shall be Type II, Type IP, or Type IS.. Blended hydraulic cement shall conform to the requirements of Section 9-01.2(4).

Allowable Pozzolans:

1. Fly ash, if used, shall be Class F as specified in Section 9-23.9.
2. Ground granulated blast furnace slag, if used, shall be as specified in Section 9-23.10.
3. Microsilica fume shall not be allowed.

See Sections 9-01 and 9-23 for additional constraints.

Fine aggregate for pervious concrete shall be Class 1 as specified in Section 9-03.1(2).

Coarse aggregates for pervious concrete shall conform to the requirements of Section 9-03.1(3).

Unless otherwise specified or shown on the Drawings, aggregates for the discharge subbase gravel shall meet the requirements of Mineral Aggregate Type 24 per 9-03 or substitute material approved by the Engineer. Aggregates for the discharge subbase gravel shall meet the requirements of Mineral Aggregate Type 24 per 9-03 or substitute material approved by the Engineer.

Premolded joint filler for isolation joints shall conform to the requirements of Section 9-04.1(2).

Curing materials shall be sheet materials as specified in Section 9-23.1.

Hydration stabilizing admixtures shall meet the requirements of ASTM C494, Type B or Type D.

Microfibers shall conform to the requirements of ASTM C 1116, Type III and shall be ½ inch in length.

Unless otherwise specified or shown on the Drawings, geotextile shall be nonwoven and shall meet the requirements of Tables 1 and 2 of Section 9-37.2 for Moderate Survivability and Class C.

5-06.3 CONSTRUCTION REQUIREMENTS**5-06.3(1) PERVIOUS CONCRETE MIX DESIGN**

The Contractor shall propose a mix design for pervious concrete and shall submit the mix design to the Engineer for acceptance prior to constructing the test panels. Pervious concrete shall not be placed in the test panels without a mix design that has been reviewed and accepted by the Engineer.

5-06.3(1)A MIX DESIGN CRITERIA

The Contractor shall include the following elements and results of the described procedures in the proposed mix design:

1. The cementitious content, including pozzolans if used, shall be a minimum of 500 pounds per cubic yard.
2. The mix shall incorporate a hydration stabilizing admixture.
3. The mix shall incorporate ½ inch microfibers at a rate of 1.5 pounds per cubic yard.
4. The mix shall be designed to have a total void content greater than 15 percent and less than 30 percent, in place, as constructed. (Void content of the mix will be determined from a minimum three (3) samples of four (4) inch diameter core samples from a finished test panels of the proposed mix design using the following method; see Section 5-06 .3(4) A1.)
5. The water / cement ratio shall be between 0.27 and 0.35.
6. Fine aggregate may be added to the mix, but shall not exceed three (3) cubic feet per cubic yard.
7. No more than 25 percent of portland cement in the mix, by weight, may be replaced by fly ash, ground granulated blast furnace slag, or a combination of both.

5-06.3(1)B JOB MIX FORMULA (JMF)

Once accepted by the Engineer, the mix design shall become the Job Mix Formula (JMF) and shall not be modified in any way. The JMF shall be determined from information submitted under Section 5-06.3(2) and from results of test panels testing as described in Section 5-06.3(7)B. The JMF shall include the following:

1. Batch weights of all constituents.
2. Portland cement type and brand.
3. Pozzolan type and source.
4. Microfiber brand.
5. Admixture type and brand.
6. Aggregate source(s) and gradation(s).
7. Fresh density of the pervious concrete.
8. Unit weight of the hardened pervious concrete.

Modifications to the JMF will not be allowed and any modified mix placed in the Work will be rejected. Proposed modifications to the JMF shall be submitted as a new mix design and shall require a new test panels to validate the proposed mix design and determine the new JMF. If accepted by the Engineer, the new mix design shall become the JMF. Only one (1) JMF shall be valid at any time. Admixture dosages may be modified as needed to maintain mix properties.

5-06.3(2) SUBMITTALS

In accordance with Section 1-05.3, the Contractor shall submit the following items to the Engineer for acceptance prior to placing any pervious concrete pavement or test panels:

1. The source of all materials proposed for use in constructing pervious concrete sidewalks.
2. Batch weights for all constituents of one (1) cubic yard of the proposed pervious concrete mix.
3. The specific gravity (SSD) of all aggregates to be used in the proposed pervious concrete mix.
4. The proposed gradation of coarse and fine (if used) aggregates used in pervious concrete.
5. The designed volume in cubic feet of 1(one) cubic yard of the proposed pervious concrete mix.
6. The target voids content of the cured proposed cured pervious concrete mix.
7. The design water / cement ratio of the proposed mix design.
8. The fresh density of the proposed pervious concrete mixture as determined using the jiggling procedure outlined in ASTM C29.
9. The proposed gradation of aggregates to be used in the discharge subbase gravel.
10. Catalogue cuts for all proposed admixtures and geotextiles.

11. Chemical analyses of the portland cement and pozzolans, if used, for the current lot to be used in the production of the proposed pervious concrete mix. The Contractor shall maintain this submittal throughout the duration of the project as lots change.
12. Manufacturer certification(s) that the current lot of portland cement and pozzolans, if used, conform to the requirements of Section 5-06.2. The Contractor shall maintain this submittal throughout the duration of the project as lots change.
13. Current certification by the National Ready Mix Concrete Association (NRMCA) for the batch plant to be used in the production of pervious concrete.
14. Current certifications by the NRMCA for the trucks to be used in transporting pervious concrete from the batch plant to the point of placement.
15. Current certifications by the NRMCA for the Contractor's personnel who will be installing sidewalk for "Pervious Concrete Installer" and "Pervious Concrete Technician", as applicable.

5-06.3(3) EQUIPMENT

The Contractor shall provide all equipment necessary for handling materials and performing all parts of the Work.

Vibrators shall not be used for placement of pervious concrete.

5-06.3(3)A BATCHING PLANT

Pervious concrete shall be mixed in a batch plant meeting the provisions of Section 6-02.3(4)A.

5-06.3(3)B MIXER TRUCKS

Pervious concrete shall be transported to the location of placement by a rolling drum mixer truck with current (within 12 months) certification by the NRMCA. Non-agitating trucks shall not be used for the transport of pervious concrete.

5-06.3(3)C SIDE FORMS

Pervious concrete sidewalks shall be constructed using side forms. Slip form paving will not be allowed. Forms for pervious concrete sidewalks shall be made of steel or wood and shall be in good condition, clean and be capable of being anchored in place so that they will be true to grade, line and slope. Forms that are bent, warped, unclean or otherwise deemed inadequate by the Engineer, shall not be used. If pervious concrete is to be placed against a curb or other existing structure, the curb or structure shall be used as a side form for the pervious concrete sidewalk paving.

Prior to inspection by the Engineer, the Contractor shall inspect all forms for line, grade and slope. No pervious concrete shall be placed until the forms are inspected and accepted by the Engineer.

5-06.3(3)D FINISHING EQUIPMENT

Finishing equipment for pervious concrete sidewalk paving shall be designed for the intended work, shall be clean and in good operating condition.

Vibrating screeds shall not be used for striking off the pervious concrete. Equipment used for striking off the pervious concrete shall leave a smooth surface at the planned grades and shall not cause excess paste to be left on, or drawn to, the surface. The strike off apparatus shall be set up to allow the forms to be overfilled by $\frac{1}{2}$ to $\frac{3}{4}$ inch, or as necessary, to allow for compaction of the pervious concrete to grade.

If rollers are used to compact, the rollers shall be of sufficient weight and width to compact the pervious concrete to grade without marring the surface. Rollers used for compacting pervious concrete shall not cause the surface to close or otherwise clog and shall produce a surface that is free of ridges or other imperfections. Rollers used for producing contraction joints shall be designed and manufactured for the purpose, shall have sufficient weight to produce the joint and shall not otherwise damage or mar the surface.

Tamps, hand finishing equipment and tools for joints shall be in good repair and adequate for the intended use.

5-06.3(3)E JOINT SAWING EQUIPMENT

Equipment for sawing joints in pervious concrete sidewalks shall be power driven concrete saws. Concrete saws shall not tear, spall or otherwise damage the pervious concrete. The Contractor shall maintain concrete saws in good operating condition and shall keep an adequate supply of blades on hand. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. There shall be an adequate number of concrete saws and equipment on the project so that sawing may occur at a rate to prevent random cracking of the pervious concrete sidewalk; including contingency in the event of a breakdown.

5-06.3(3)F SMOOTHNESS TESTING EQUIPMENT

The Contractor shall provide a 10 foot straight edge to be used for measuring the profile of the pervious concrete sidewalk. The straight edge device shall be designed so that it may be easily moved from location to location without marring the surface of the freshly compacted pervious concrete. The 10 foot straight edge shall be accepted by the Engineer prior to placing pervious concrete.

5-06.3(4) MEASURING AND BATCHING MATERIALS

Measuring and batching materials for pervious concrete sidewalks shall conform to the requirements of Section 5-05.3(4)A.

5-06.3(4)A ACCEPTANCE

For acceptance, pervious concrete sidewalk will be divided into lots as determined by the Engineer. A single lot will typically be represented by the lesser of: one (1) day's production or 360 square yards of pervious concrete in place. Where the Contractor has more than one crew placing pervious concrete, lots may be associated with each crew. Representative lot size will be determined to the nearest square yards. If no sample is taken on a Day that Day's quantities may be included in the next or previous Day's lot(s). Acceptance of a lot of pervious concrete sidewalk will be based on the following criteria:

1. **Grade:** Pervious concrete sidewalk shall be true to planned grades plus or minus ½ inch and shall not deviate from grade more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkway, curbs, driveways or other pavements, the pervious concrete sidewalk will be flush and provide a transition that will not deviate in more than ¼ inch in ten (10) feet.
2. **Line:** Pervious concrete sidewalk margins shall be true to planned lines plus or minus ½ inch at any point.
3. **Slope:** Pervious concrete sidewalk shall be sloped as shown on the Drawings. Slope shall be consistent to within 1/4 inch in ten (10) feet.
4. **Conformance to JMF:** The pervious concrete used shall conform to the JMF within the limits as set forth in Section 6-02.3(5)C and as determined from the accepted test panel.
5. **Thickness** (test panel only or when determined by the engineer): Three (3) core samples of four (4) inches in diameter may be taken from each test panel or lot for acceptance in accordance with ASTM C42. The Contractor shall provide measures to collect slurry and debris during coring operation in order to avoid sealing adjacent pavement. Each Core Sample shall be equal to the minimum section depth or more as specified in the Drawings (minimum 5 inches). After core's length and diameter is measured, trim cores to uniform depth as specified in Section 5-06.3(4) A1 for determining the weight. Core holes shall be filled by the Contractor with concrete meeting the JMF and shall match adjacent pavement texture and grade.
6. **Unit Weight** (test panel only or when determined by the engineer): The unit weight of each core sample taken for acceptance will be determined using the method described in Section 5-06.3(4)A1. The unit weight of the core sample for each lot shall be within eight (8) pounds per cubic foot of the unit weight as accepted in the JMF.
7. **Infiltration Rate:** The infiltration rate of each lot will be tested at four (4) random locations within the lot as described in Section 5-06.3(4)A2. The average of all four (4) tests shall be greater than 100 inches per hour.
8. **Fresh Density:** The fresh density will be measured using the jigging procedure outlined in ASTM C29 at the point of placement shall be within or equal to five (5) pounds per cubic foot of the fresh density indicated by the JMF.
9. **Manufacturer's Certificate of Compliance:** Each load of pervious concrete transported to the location of placement shall have an original Manufacturer's Certificate of Compliance as specified in Section 6-02.3(5)B delivered with the load. Photo copies, carbon copies or facsimiles are not acceptable.
10. **Appearance:** Each lot of finished pervious concrete sidewalk will be inspected for appearance by the Engineer. The pervious concrete sidewalk shall have a consistent surface texture, shall have no more than five (5) percent of the surface area within each panel (joint to joint) filled with paste, shall not be raveled, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, and shall be free of cracks.

Quality Assurance Testing: Before final acceptance by the Engineer, the Contractor shall pressure wash the pervious concrete sidewalk. Pressure washing shall be provided and completed by using portable washer equipment working at a minimum of 3000 psi at 1.0 gpm. The nozzle shall be held a maximum of three (3) inches off the concrete surface. The Contractor shall pressure test three (3) locations per lot or as determined by the Engineer. Any sections of pervious concrete that breaks up, ravel, or does not infiltrate shall be removed and replaced with acceptable pervious concrete to the nearest joints. The Engineer will determine the acceptability of the concrete after pressure washing.

The Contractor shall decide, after placing the pervious concrete, when to perform the quality assurance pressure wash testing for the acceptance.

5-06.3(4) A1 VOID CONTENT OF THE MIX; LAB TEST:

The test panels will not be accepted unless each of the cores has a void content between 15 and 30 percent.

Determine the bulk specific gravity (G_B) of the core using the method described in ASTM D1188. Core samples shall be trimmed to 4-1/2 inches in depth to provide increased uniformity of test results. Trimming shall be squared and from the bottom of each pavement core samples.

Dry the core samples at a temperature not to exceed 65 C (150° F) until a constant mass ($\pm 0.1\%$) is obtained and allow to cool to ambient temperature. Remove paraffin coating from core samples.

Weight the core and record weight to the nearest 0.1 g.

Use the pycnometer apparatus as described in ASTM D2041.

Place core samples in calibrated pycnometer and cover completely with water. If the core sample is too large to be placed into the pycnometer, it may be broken into pieces and placed into the pycnometer together or the pieces may be evaluated separately.

Place the lid on pycnometer and fasten it on a mechanical agitation device.

Turn on the agitation device and slowly apply a vacuum to the pycnometer until the vacuum reaches 3.7 ± 0.3 kPa (27.5 ± 2.5 mm Hg). The vacuum should be reached in less than 2 minutes.

After the vacuum is achieved, maintain vacuum and agitation for a period of 15 ± 2 minutes.

Slowly release the vacuum and determine the weight of the sample and pycnometer as described in paragraph 9.5.1 or paragraph 9.5.2 in ASTM 2041.

Calculate specific gravity (G_{mm}) as described in paragraph 10.1.1 or paragraph 10.1.2 in ASTM 2041, as appropriate.

If multiple procedures are run for separate pieces of the core, the weighted average of all of the runs will be the specific gravity (G_{mm}) of the core as a whole.

$$G_{mm} = \frac{\sum(G_{mm1} \times Wt_1 + G_{mm2} \times Wt_2 + \dots + G_{mmi} \times Wt_i)}{Wt_{total}}$$

The percentage of air voids will be calculated as:

$$Voids = \frac{G_{mm} - G_B}{G_{mm}} \times 100\%$$

Where:

V = Voids in the Sample (%)

G_{mm} = Specific Gravity of the Core Material Less Air Voids

G_B = Bulk Specific Gravity of the Core as determined by ASTM D1188

This Void Content lab test information shall be part of the Mix Design submittal.

5-06.3(4) A2 INFILTRATION RATE OF THE MIX; FIELD TEST :

Pervious concrete mix shall also have an infiltration rate equal to or greater than 100 inches per hour, in place, as constructed. The locations for conducting the infiltration tests shall be determined by the Engineer. The Contractor shall coordinate and schedule inspections with the Engineer a minimum of five (5) Working Days in advance. The infiltration rate will be measured in the following manner:

The testing procedure shall be as follows:

- a) Place a pre-measured amount of water into the container. Water shall be free of suspended solids. The volume of water shall be determined to 2 significant figures.
- b) Pour the water onto the surface in one spot. Control the discharge rate by manually adjusting the angle of the spout so that the diameter of the pool of water is between 10 to 30 inches is maintained. Empty the container holding the spout over the spot until the pool of water vanishes.
A 16-inch to 24-inch inch diameter tube (typically PVC 3-inch to 6-inch in height) and plumber's putty may be used to control the diameter of the pool ("controlled method") as desired by the Engineer. When using the controlled method, the height of the water in the tube should be maintained at approximately $\frac{1}{4}$ inch.
- c) Start the stopwatch when the water initially touches the concrete surface and stop it when the pool disappears from the surface.
- d) Measure the longest dimension (d1) of the dampened area. Measure the width (d2) of the pool perpendicular to d1. (use inside diameter of tube for controlled method)
- e) Repeat this procedure at a minimum of 4 separate locations.

Infiltration Rate (IR) shall be calculated as follows:

$$IR = (V \times 3,326,400) / (p \times d1 \times d2 \times t) \text{ inches per hour.}$$

- IR is Infiltration Rate
- V is the volume of water in gallons (typically 1 gallon or more)
- d1 and d2 are the dimensions that were measured in inches.
- p is approximately 3.14159
- t is the time in seconds

5-06.3(4)B REJECTION

Pervious concrete sidewalk that does not meet the acceptance criteria put forth in Section 5-06.3(4)A will be rejected by the Engineer on a lot by lot basis. At the discretion of the Engineer, a localized area of pervious concrete sidewalk not meeting the requirements of items 1, 2, 3 and 8 of Section 5-06.3(4)A may be broken into a subplot bounded by planned joints.

Pervious concrete sidewalk that has been rejected by the Engineer, or the Contractor, shall be removed and replaced at no additional cost to the Owner.

5-06.3(5) MIXING PERVIOUS CONCRETE

Pervious concrete shall be batched and centrally mixed at a semi-automatic or automatic batching plant with a current (within 2 years) certification from the NRMCA. Pervious concrete shall not be shrink mixed or transit mixed.

The mixing time, after all materials have been delivered to the drum, shall not be less than 50 seconds or more than 90 seconds. The pervious concrete aggregates shall be uniformly coated with paste and shall be of the required consistency. After mixing, the pervious concrete shall be delivered to a truck meeting the requirements of Section 5-06.3(3)B for transport to the job site. Pervious concrete shall be placed no more than 90 minutes from the time water is added to the cement. Pervious concrete shall not be retempered.

5-06.3(5)A LIMITATIONS OF MIXING PERVIOUS CONCRETE

Pervious concrete shall not be mixed, placed, compacted or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and accepted lighting system is in operation.

Mixing and placing concrete shall be discontinued when a descending air temperature in the shade away from artificial heat reaches 50°F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 45°F.

Mixing and placing pervious concrete shall only occur when the ambient air temperature, as measured at the placement location away from the shade and away from artificial cooling sources, is less than 80°F.

The temperature of pervious concrete shall not be less than 60°F when placed and shall at no time be greater than 90°F.

Pervious concrete shall not be mixed with aggregates less than 32°F.

5-06.3(6) AGGREGATE DISCHARGE SUBBASE

Pervious concrete sidewalk shall be constructed on an aggregate discharge subbase over the prepared subgrade. The aggregate discharge subbase shall be constructed to the lines, grades and thickness shown on the Drawings. Aggregate discharge subbase shall be as specified in Section 5-06.2

Aggregate discharge subbase material shall be a minimum of 6-inches placed over the preplaced geotextile as specified. Geotextile shall be as specified in Section 5-06.2. Aggregate discharge subbase shall be placed in lifts not to exceed 12 inches non-compacted. The aggregate discharge subbase shall be compacted to the satisfaction of the Engineer. The compaction equipment shall be of sufficient weight and dimensions so as not to break or degrade the aggregate. In areas that are not accessible to equipment, other mechanical means may be used to compact the aggregate discharge subbase. Equipment used for compaction of the aggregate discharge subbase shall be accepted by the Engineer prior to use.

The aggregate discharge subbase shall be true to grade and slope plus or minus 0.5 inches after compaction. Where the grade is low, the surface of the aggregate discharge subbase shall be scarified to a depth of two (2) inches, additional material added and recompact. If there are high areas, the material shall be removed and the area recompact.

The Contractor shall take care to protect the aggregate discharge subbase from damage and contamination. Damage to the aggregate discharge subbase shall be repaired to the satisfaction of the Engineer at no additional cost. Contaminated aggregate discharge subbase shall be removed and replaced to limits as determined by the Engineer. The aggregate discharge subbase shall be inspected and accepted by the Engineer prior to placing any pervious concrete sidewalk.

5-06.3(6)A SUBGRADE PREPARATION

Subgrade for pervious concrete sidewalk shall be excavated, graded and compacted as specified in Section 8-14.3(2) except that the subgrade shall be compacted to a relative density of 92 percent of optimum density of the subgrade soil as determined by ASTM D 698. Prior to placing the geotextile fabric, the surface of the subgrade shall be scarified to a depth of ¼ to ½ inch. Once scarified, materials or equipment shall not be stored or permitted within the prepared subgrade area so as to avoid re-compaction of the scarified areas and diminishing the infiltration rate of the subgrade.

Geotextile shall be placed on the prepared subgrade prior to placing aggregate discharge subbase as shown in the Drawings. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer. Overlaps of the geotextile shall be a minimum 1 foot or to the manufactures recommendation, whichever is greater.

5-06.3(7) PLACING, SPREADING, AND COMPACTING PERVIOUS CONCRETE

Standard methods of placing, spreading, and compacting shall be as described herein. However, the contractor may submit for review and approval by the Engineer, alternative methods of work that deviate from the standard methods described in this specification. Such methods shall be demonstrated through the test panels trial and will require final acceptance by the Engineer.

Alternate methods that are rejected through the test panels will be discontinued. Methods described in this specification shall be used.

5-06.3(7)A CONTRACTOR'S QUALIFICATIONS

The Contractor shall employ no less than one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew during all pervious concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Installers, who shall be on site working as members of each placement crew during all pervious concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Technicians and one (1) Pervious Concrete Installer, who shall be on site working as members of each placement crew during all concrete placement unless otherwise specified. For those crews having personnel with NRMCA certified Pervious Concrete Technician certifications, the placement crew shall also successfully pass a Performance Evaluation required under NRMCA Pervious Concrete Installer certification.

The pervious cement concrete sidewalk test panels installed at the project site may be utilized as the "mock-up" placement required for the NRMCA "mock-up" Performance Evaluation exam for Pervious Concrete Installer certification. If the "mock up" placement installed for NRMCA certification does not meet the project specifications, the "mock up" placement shall be removed at the Contractor's expense and a new pervious concrete sidewalk test panels shall be installed, tested and submitted for acceptance.

Documentation of NRMCA certifications for the Contractor's personnel shall be submitted per Section 5-06.3(2) prior to proceeding with production placement of the pervious concrete sidewalks.

If, in the opinion of the Engineer, personnel used for installing pervious concrete sidewalk are unqualified, inattentive to quality, or unsafe, they shall be removed or reassigned from installation of pervious concrete sidewalk at the written request of the Engineer.

5-06.3(7)B TEST PANELS

Production placement of pervious concrete shall not occur until the Contractor has completed a test panels of pervious concrete sidewalk that meets all of the acceptance criteria herein and is accepted by the Engineer. The Contractor should allow time in his schedule for the construction and acceptance of the test panels.

The Contractor shall construct test panels of pervious concrete sidewalk with a minimum area of 225 square feet. Test panels may be placed non-contiguously. The width of the test panels shall be equal to the nominal width of the sidewalk to be placed. The test panels shall be equivalent and representative of the production pervious concrete sidewalk in all aspects including subbase depth and preparation. The Engineer shall observe and accept each element of pervious concrete sidewalk construction. Construction and evaluation of the test panels will occur as follows:

- Notify the Engineer at least ten (10) Working Days before installing pervious concrete sidewalk test panels

- Coordinate the location of the test panels with the Engineer.

- Install the test panels in accordance with the Specifications and Drawings.

- Notify the Engineer when each element of the test panels is ready for inspection.

- Remove, replace, and dispose of any unsatisfactory portions of test panels as determined by the Engineer and at no additional cost.

- Failure to install acceptable test panels of pervious concrete will indicate an unqualified installer.

Production sections of this Work shall not be placed until achieving a complete test panels that fully complies with the Drawings and Specifications and has written acceptance issued by the Engineer.

The completed test panels shall be used to validate the pervious concrete mix design and establish the JMF. Unless others determined by the Engineer, three (3), four (4) inch, cores will be cut in accordance with ASTM C42 and these cores will be used to validate the mix design under the design criteria set forth in Section 5-06.3(1)A and the acceptance criteria of 5-06.3(4)A. The average unit weight of the cores as determined by ASTM D1188 shall be within eight (8) pounds per cubic foot of the average of the three (3) cores. The average unit weight of the cores shall be the unit weight used for the JMF. Core holes shall be filled by the Contractor with concrete meeting the proposed JMF and shall match adjacent pavement color, texture and grade.

Three (3) infiltration tests will be conducted in the test panels for acceptance. Each of the infiltration tests shall meet the minimum infiltration rate requirement noted in Section 5-06.3(4)A.

The completed and accepted test panels shall be maintained and protected throughout the duration of the Work and may not be demolished and disposed of without written permission from the Engineer. If the test panels are incorporated into the Work, it shall remain in place accepted as a single lot.

5-06.3(7)C PLACING, SPREADING AND COMPACTING

Prior to placing pervious concrete, the Engineer will inspect and accept all formwork and subbase/subgrade. All surfaces that will contact the finished pervious concrete shall be damp with no standing water. Pervious concrete shall not be placed on standing water or frozen materials.

Pervious concrete sidewalk shall be placed on the prepared subbase as close to its final position as possible in a continuous operation so as to minimize evaporation. Where necessary, the pervious concrete may be spread with square edged shovels or rakes prior to strike off. The pervious concrete shall be struck off or screeded to a depth sufficient to allow for compaction to grade.

Pervious concrete shall be placed in a single lift. Contractor's personnel shall take care to avoid foot traffic in the pervious concrete to prevent non-uniform compaction and to keep contaminating material from the mix. Foot traffic on fresh concrete shall not be allowed after it has been struck off.

Within 20 minutes of discharge from the truck, the concrete shall be compacted, finished and covered for curing. The compacted effort shall be sufficient to compact the fresh pervious concrete to grade, not draw excessive paste to the surface and to leave a smooth finish. In areas where the roller cannot be brought to bear, hand tamping, or other methods accepted by the Engineer, may be used to compact the pervious concrete. Edges and plastic formed joints shall be finished by hand tooling with a ½ inch radius edging tool. Defects shall be repaired immediately.

Pervious concrete shall be placed continuously. Where placement has been halted for a period of 15 minutes, a header shall be placed between the forms and a construction joint formed. Construction Joint shall be located at the same spacing of where a contraction joint would be. The pervious concrete shall be compacted and finished to the header before placement may continue. Upon resuming placement, the header may be carefully removed and a construction joint formed at that location. Any sloughing or sagging of the previously placed pervious concrete at the header location shall be corrected prior to placing new pervious concrete against the joint.

5-06.3(8) JOINTS

Joints shall be of three (3) types: construction, contraction, isolation. Construction joints shall be formed at the end of a day's work or when necessary to stop production for any reason. Contraction joints shall be used to control random cracking. And, isolation joints shall be used where the pervious concrete abuts existing facilities or where shown on the Drawings. Wherever possible, the angle between intersecting joint shall be between 80 and 100 degrees.

5-06.3(8)A CONSTRUCTION JOINTS

Construction joints shall be located as near as possible to the location of a planned contraction or isolation joint. Construction joints are to be formed by placing a header between the forms, at right angles, to the full depth of the finished pervious concrete, and set to the height of the forms. Pervious concrete shall be placed against the header and compacted and finished as normal, including edging. Upon resuming paving, the header shall be carefully removed and new pervious concrete placed directly against the existing pervious concrete. The new pervious concrete shall be compacted and finished against the hardened pervious concrete as if it were a form. If an isolation joint is planned at this location, then the premolded joint filler shall be placed against the existing pervious concrete and the new pervious concrete shall be placed against the premolded joint filler. The joint shall be tooled on both sides of the premolded joint filler.

5-06.3(8)B CONTRACTION JOINTS

Contraction joints shall be placed every 20 feet unless otherwise shown on the Drawings. Contraction joints shall have a depth of 1/3 the thickness of the pervious concrete and have a width of no more than 1/8 inch. Contraction joints may be formed in the plastic concrete using a roller designed for this purpose or by other methods accepted by the Engineer. Plastic formed contraction joints shall be tooled on both sides of the joint with a radius of ½ inch.

At the option of the Contractor, contraction joints may be saw cut after the pervious concrete has hardened. If saw cutting the contraction joints, saw cutting shall occur as soon as the concrete is sufficiently cured so that it may be cut without raveling or dislodging aggregate from the finished surface. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. To minimize drying, curing materials shall be removed only as needed to make cuts and shall be replaced immediately after cutting.

5-06.3(8)C ISOLATION JOINTS

Isolation joints shall be placed where the pervious concrete abuts existing structures or where shown on the Drawings. Isolation joints shall continue through the depth of the pervious concrete using a 3/8 inch premolded joint filler. Isolation joints may be formed by inserting the premolded joint filler into the plastic concrete or by forming a construction joint and affixing the premolded joint filler against one side of the joint and placing fresh pervious concrete against it. Isolation joints and filler shall be flush with the surrounding pervious concrete and shall not deviate from the acceptance criteria for smoothness as shown in Section 5-06.3(4)A. The edges of the pervious concrete on either side of the premolded joint filler shall be hand tooled with a ½ inch radius.

5-06.3(9) RESERVED

5-06.3(10) RESERVED

5-06.3(11) RESERVED

5-06.3(12) SURFACE SMOOTHNESS

The surface of the pervious concrete sidewalk will be checked immediately after compaction for grade and slope using the 10 foot straightedge specified in Section 5-06.3(3)F. Where the surface is found to be out of specification as determined by the criteria specified in Section 5-06.3(4)A, it shall be immediately corrected by recompacting, removing excess pervious concrete, or by adding pervious concrete; as necessary.

If it is necessary to correct grade or slope by removing excess pervious concrete, the surface shall be recompacted and the edges retooled. If the grade or slope is to be corrected by the addition of pervious concrete, the surface shall be lightly scarified and the new material added. The surface shall be recompacted to grade and the edges retooled. Any corrections to the surface shall

occur before the pervious concrete has set or has dried. Pervious concrete sidewalk that is out of specification with regard to grade or slope will be rejected to the nearest joints.

Pervious concrete sidewalk that has been corrected shall not be distinguishable from the adjacent, undisturbed pervious concrete sidewalk. If in the opinion of the Engineer, the corrected pervious concrete sidewalk is distinguishable from the adjacent Work, the repaired area will be rejected to the nearest joints.

5-06.3(13) CURING

Immediately after the pervious concrete sidewalk has been compacted and checked for grade and slope, the sheet curing material as specified in Section 9-23.1 shall be applied. If the surface appears dry, lightly mist the surface with water prior to applying the sheet curing material. The sheet curing materials shall be fixed in place by method(s) that shall not damage the pervious concrete sidewalk and is accepted by the Engineer. The pervious concrete shall be placed, struck off, finished and the curing materials in place within twenty (20) minutes of the time the pervious concrete is discharged from the truck. This time may be shortened if conditions exist that promote excessive drying. Forms and sheet curing material(s) shall remain in place for a minimum of ten (10) Days.

With the exception of saw cutting equipment, all traffic shall be kept off of the pervious concrete sidewalk during the curing period. For saw cutting contraction joints, only the amount of sheet curing material necessary to accomplish the saw cutting shall be removed and the surface of the exposed pervious concrete sidewalk shall be kept moist for the entire duration of the exposure.

Any testing for acceptance shall not occur until the end of the curing period.

5-06.3(14) COLD WEATHER WORK

When concrete is being placed and the ambient air temperature is expected to drop below 50° F during the day or night, the Contractor shall, at no expense to the Owner shall be protected from the concrete from freezing. The Contractor shall provide a Cold Weather Plan prior to placing concrete when ambient air temperature below 50° F may occur or when requested by the Engineer.

Under the Cold Weather Plan, the Contractor shall, at no expense to the Owner, provide a sufficient supply of straw, hay, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. Straw, hay, blankets, or other suitable blanketing material shall be spread over the pavement to a sufficient depth to keep the concrete from freezing. The blanket material shall be covered with a layer of burlap or plastic sheeting, weighted or anchored to prevent the wind from displacing the insulation. The Engineer may require recording thermometers if daytime temperature is below 50°.

The protection shall be maintained for 10 Days. The Contractor shall replace any concrete damaged by freezing at no additional cost to the Owner.

The Contractor shall be responsible for the quality of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense in accordance with this Section.

5-06.3(15) RESERVED

5-06.3(16) PROTECTION OF PERVIOUS CONCRETE SIDEWALK

As part of the Construction Stormwater Erosion Control Plan (CSECP), rain runoff, surface water of any kind and sediment shall be prevented from entering the area of pervious pavement construction, including excavation, until the pervious concrete application has cured and the adjacent areas that sheet flow/drain onto the pervious pavement are permanently stabilized from erosion and plantings are established. Once pavement is placed, protective covers shall continually be maintained until adjacent areas are permanently stabilized and pavement has been accepted.

The Contractor shall take every precaution to protect the pervious concrete sidewalk from damage, including the introduction of foreign materials to the surface, throughout the course of the work. Pervious concrete sidewalk that is damaged or has been adversely impacted by the introduction of foreign materials shall be rejected and replaced to the nearest joint.

5-06.3(17) RESERVED

5-06.4 MEASUREMENT

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for "Pervious Concrete Sidewalk" will be by the square yard for the surface of pervious concrete walk placed. Deduction will be made for blocked out areas, castings or other discontinuities in the sidewalk nine (9) square feet or larger.

5-06.5 PAYMENT

Compensation for the cost necessary to complete the work described in Section 5-06 will be made at the bid item prices Bid only for the Bid items listed or referenced as follows:

"Pervious Concrete Sidewalk", per square yard.

The Bid Item price for "Pervious Concrete Sidewalk" shall include all costs for the work required to construct the pervious concrete sidewalk as specified in this Section, including but not limited to; performing mix designs, testing, excavation, and subgrade preparation; and, furnishing and installing geotextile, aggregate discharge subbase, and pervious concrete.

Payment of the volume of earthwork involved in excavating Material above the top surface of the sidewalk will be made in accordance with Section 2-04.5 "Common Excavation" as defined in Section 2-04.1(2).

9-03.1(5) COARSE AGGREGATES FOR PERVIOUS CONCRETE

9-03.1(5)A GENERAL

Aggregate for pervious concrete shall meet the requirements of Sections 9-03.1(3)A, 9-03.1(3)B and 9-03.1(3)C.

9-03.1(5)B GRADING

Aggregate for pervious concrete shall conform to one of the following gradations:

% - TOTAL PERCENT PASSING BY WEIGHT	AGGREGATE GRADATION	
	AASHTO NO. 8 SIZE AGGREGATE GRADATION	
SIEVE SIZE	MIN.	MAX.
1/2" Square	100%	—
3/8" Square	85%	100%
U.S. No. 4	10%	30%
U.S. No. 8	0%	10%
U.S. No. 16	0%	5%
U.S. No. 50	—	—
U.S. No. 200	0%	0.5%

In individual tests, a variation of four (4) percent under the minimum percentages or over the maximum percentages will be allowed on sieves size No. 16 and larger. For sieves smaller than No. 16, the maximum percentage passing shall not exceed the limits shown for any single test. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two (2) times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer accepts, the pervious concrete aggregate may be blended from other sizes if:

The resulting aggregate meets all requirements for the specified grading;

Each size used makes up at least five (5) percent of the blend;

The Contractor supplies the Engineer with the gradation for the proposed sizes, along with their proper proportions before producing the aggregate. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it accepted before proportioning and mixing the concrete.