BIO-AQUIFER STORM SYSTEM

Specifications for Construction

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Providing labor, materials, tools and equipment to furnish and install a permeable concrete paving stone system as indicated on the plans and as specified herein.

1.02 RELATED SECTIONS

Section ____ -- Earthwork and subgrade preparation

Section ____ -- Concrete curbs

1.03 APPLICABLE STANDARDS AND SPECIFICATIONS

A. American Society for Testing and Materials (ASTM)

1.04 DEFINITIONS

A. *Base Course*: Layer of open-graded aggregate beneath the bedding course layer, comprised of small- to medium-particle-sized stone (typically 1/2" to 1"). Recommended depth of the sub-base layer shall be four inches (4"), but shall not exceed six inches (6").

B. *Bedding Course*: Layer of open-graded aggregate directly beneath the unit pavers, comprised of small particle-sized stone chips (typically ¼" to 3/8" rock). Also commonly called the "setting bed." Recommended depth of the bedding course layer shall be 2".

C. *Bundle*: Several layers of paver clusters stacked vertically, packaged, and tagged for shipment. Also commonly called a "cube."

D. *Chamfer*: A 45-degree beveled edge around the top of a paver unit, usually 1/8" to ¼" wide. It facilitates snow removal, helps prevent edge chipping, and delineates the paving's individual units.

E. *Cluster*: The group of pavers forming a single layer from a bundle of pavers or the group of pavers held by the clamp of a paver laying machine.

F. *Flats*: The portion of the side faces of a paver other than the spacer bars.

G. *Laying Face*: The working edge of the pavement where the laying of pavers is occurring.

H. *Mechanical Installation*: The use of specialized machines to lift clusters of pavers from the bundles and place them on the prepared bedding course. These specialized machines are designed specifically for this application.

I. *Method Statement*: The paver installer's and manufacturer's plan for construction and quality control of the pavers.

J. *Spacer Bars*: Small protrusions on each side of pavers which are used to keep them uniformly spaced while minimizing chipping and spalling. Mechanically installed pavers must have spacer bars.

K. *Sub-base Course*: Layer of open-graded aggregate beneath the base course layer, comprised of large particle-sized stone (typically 2-1/2" to 3" fractured rock). Depth shall vary depending upon site conditions and specific requirements. Minimum depth of the sub-base course shall be twelve inches (12").

L. *Void Filler*: Open-graded aggregate used to fill the openings in the paver units. The bedding course aggregate may be used as the void filler. Smaller particle-sized stone chips (1/8" to ¼") are preferable, if available.

M. *Wearing Course*: The top surface of the paver surrounded by a chamfer.

1.05 SUBMITTALS

A. Submit the following in accordance with Division 1.

1. The dimensions of the manufacturer's proposed mold assembly including pattern, dimensions of all cavities including radii, spacer bars and the top portion of the mold known as the head or shoe.

2. The Method Statement.

3. The Quality Control Plan.

4. Material samples of pavers, void filler aggregate, bedding course aggregate, base and sub-base course aggregate, including a current sieve analysis of each showing conformance to the specifications.

5. A detailed description of the manufacturer's quality control procedures.

6. Examples of the manufacturer's record-keeping forms.

7. Examples of the installer's record-keeping forms.

1.06 QUALITY ASSURANCE

A. Quality Control Plan

The installer and manufacturer shall establish, provide and maintain a quality control plan. The quality control plan shall provide reasonable assurance that the materials and completed construction submitted for acceptance will conform to the contract requirements. Although guidelines are established and certain requirements are specified, they are minimal, and the installer and manufacturer shall assume full responsibility for meeting all requirements.

The installer and manufacturer shall agree upon a method for measuring the clusters at the factory and in the field. That method shall be submitted in writing to the owner for approval.

The Quality Control Plan shall contain at a minimum, but not limited to, the following elements:

1. The manufacturer's quality control procedures.

2. The manufacturer's production records showing at a minimum the date of manufacture, a mix design designation, mold number, mold cycles, and sequential pallet numbers. Copies of such records shall be made available to the owner upon request.

3. A description of the anticipated growth in the cluster size and a plan for managing the growth so as to not interfere with placement by paving machine(s), if mechanically installed.

4. The installer's quality control procedures, including but not limited to, dimensional control methods, paving machine(s) head adjustment, typical daily work schedule to insure that all pavers placed on the bedding course on any given day are adjusted as required and vibrated, and installation of void filler completed at the end of that work day.

5. Provision for identifying and recording actual daily production and the bundle numbers of pavers used in each day's installation.

B. Sampling and Testing

The manufacturer shall employ an independent testing company, qualified to undertake tests in accordance with the applicable standards specified herein. Test results shall be provided to the installer and the owner, upon request.

Pavers shall be checked for density and dimensional variation, compressive strength (ASTM C140), density and absorption (ASTM C140) and abrasion resistance (ASTM C418).

1. The initial testing frequency shall be one set of tests for each 100,000 full-sized pavers delivered to the site or at any time a change in the manufacturing process, mix design, cement, aggregate or other material occurs.

2. The following number of full-sized pavers shall be randomly sampled for each test: five (5) for dimensional variation; three (3) for density and absorption; three (3) for compressive strength; and three (3) for abrasion resistance.

3. If all pavers tested pass all requirements for a sequence of 400,000 pavers, then the testing frequency may be relaxed to one set of tests for each 200,000 full-sized pavers. If any pavers fail any of the required tests, then the testing frequency shall revert to the initial testing frequency.

4. When any of the individual test results fail to meet the specified requirements, the cluster of pavers represented by that test sample shall be rejected. The manufacturer shall provide additional testing from both before and after the rejected test sample to determine the sequence of the paver production run that should be considered unacceptable.

5. Additional testing, as described above, shall be carried out at no additional expense to the owner. The sequence of pavers found to be defective shall, if they have been delivered to the site, be removed from the site promptly at no expense to the owner or installer.

6. Pavers shall be sound and free from defects that would interfere with the proper placing of the pavers or impair the strength or performance of the construction.

C. Method Statement

The installer and manufacturer shall prepare a Method Statement describing the overall plan to complete the work. This plan shall include at a minimum:

1. The quality control plan.

2. A description of the anticipated mold life, rate and effect of mold wear on pavers produced, individual mold runs, and a mold rotation plan.

3. Clear diagrams showing the proposed starting point of the installation, the proposed direction of installation, progress on a week-by-week basis, and the dimensional controls to be used to maintain specified joint width and straight joint lines.

4. A method of measuring the clusters at the factory and in the field.

5. A description of the anticipated growth in cluster size due to mold wear and a plan for dealing with that growth or other dimensional variances.

6. A description and the personnel and equipment to be employed for each portion of the work including manufacture, installation and quality control.

7. The manufacturer's proposed production rate and mold life for this project and supply data demonstrating experience on similar past projects. Installer shall state the proposed installation rate.

8. The installer's intention to machine-lay or hand-lay the pavers and provide qualifying experience to date for the appropriate method of proposed installation.

D. Qualifications

Every manufacturer and installer shall demonstrate that they have supplied and/or installed ecological pavers for projects of a similar nature, with regard to installation and production capacity of at least 300,000 square feet. Qualifications shall be submitted at the time of bid, without exception.

Paver Manufacturer's Qualifications

1. The manufacturer shall demonstrate a minimum of 5 years successful experience in the manufacture of interlocking concrete block pavers.

2. The manufacturer shall have sufficient production capacity and established quality control procedures to produce, transport, and deliver the required number of pavers with the quality specified, without causing a delay to the work.

3. The manufacturer shall have suitably experienced personnel and a management capability sufficient to produce the number of quality pavers as depicted on the contract drawings and as specified herein.

Paver Installer's Qualifications

1. Installers shall be required to provide their installation history, including references in writing with contact information, demonstrating to the satisfaction of the owner their ability to perform the paver installation and related work indicated in the plans and specifications.

2. The installer shall have suitably experienced personnel and a management capability sufficient to execute the work shown on the contract drawings and specified herein.

3. The installer's foreman shall demonstrate, including references, a minimum of 5 years experience in the installation of unit paver systems similar in size and nature to this project.

1.07 DELIVERY, STORAGE AND HANDLING

1. Concrete paving stones shall be delivered to the site, with or without pallets, in such a way that no damage occurs to the product during hauling and unloading.

2. All pavers shall be delivered to the site in approximately the chronological order in which they were manufactured. They shall be staged on site, as per the method statement.

3. Each bundle of pavers shall be marked with a weather-proof tag identifying at a minimum the manufacturer, the date of manufacture, the mold number, the project name and phase for which the pavers were manufactured and the sequential bundle number.

PART 2 – PRODUCTS

2.01 ECOLOGICAL PAVERS

A. All interlocking paving stones shall comply with the quality specifications for solid concrete interlocking paving units as required per ASTM C 936.

1. *Portland Cement*: Conform to ASTM C 150.

2. *Aggregates*: Conform to ASTM C 33 for normal weight concrete aggregate (no expanded shale or lightweight aggregate) except that grading requirements shall not necessarily apply.

3. *Water*: Clean and free from any deleterious matter.

4. *Other Constituents*: Air-entraining admixtures, integral water repellents and finely ground silica shall have a proven record of performance and shall conform to the relevant ASTM standards.

5. *Compressive Strength*: At the time of delivery to the work site, the average compressive strength of the pavers shall not be less than 8,000 psi, with no individual unit less than 7,200 psi. Testing procedures shall be in accordance with ASTM C 140 specifications.

6. *Absorption*: The average absorption shall not be greater than five percent (5%), with no individual unit result greater than seven percent (7%) per ASTM C 140 specifications.

7. *Resistance to Freezing and Thawing*: The manufacturer shall satisfy the purchaser by laboratory testing that the paving units have adequate resistance to freezing and thawing per ASTM C 67-83 specifications. The specimens shall have no breakage and not greater than one percent (1%) loss in dry weight of any individual unit when subjected to 50 cycles of freezing and thawing.

8. *Dimensional Tolerances*: Pavers shall be prismatic in plan and formed with straight, uniform edges. The tolerance for the flat portions of the sides shall not exceed 1/32" as measured with a steel straight edge. "Slumped" pavers exceeding this tolerance will be rejected. The length, width and thickness of the paving stones shall meet the allowable tolerances specified in ASTM C 936.

9. *Color:* Monochromatic colors from standard range of colors and/or natural gray.

10. No paver shall be used for this project which has been manufactured in a mold that exceeds the mold life specified in the Method Statement, without written approval of the installer and owner.

11. The measurement across a cluster for any mold shall not increase more than ½" for the entirety of the use of the mold for this project.

2.02 VISUAL INSPECTION

All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacture, or minor chipping resulting from customary methods of handling in shipment, delivery and installation, shall not be deemed grounds for rejection.

2.03 AGGREGATE MATERIALS

A. Bedding Course and Void Filler Aggregate

The bedding course and void filler aggregate shall be free of organics and soluble salts, or other contaminants likely to cause efflorescence. The grading requirement shall be in compliance with the following gradation chart.

ASTM Sieve Size	Percent Passing (by weight)
1/2 inch	100 – 100
3/8 inch	94 – 100
¼ inch	39 – 94
No. 4	23 – 39
No. 8	8 – 23
No. 16	0 - 8

B. Base Course Aggregate

The base course aggregate shall consist of open-graded stone and meet the following gradation chart.

ASTM Sieve Size	Percent Passing (by weight)
1-1/2 inch	100 – 100
1 inch	90 – 100
3/4 inch	48 – 90

½ inch	27 – 48
¼ inch	12 – 27
No. 4	0 - 12

C. Sub-Base Course Aggregate

The sub-base course aggregate shall consist of open-graded stone and meet the following gradation chart.

ASTM Sieve Size	Percent Passing (by weight)
4 inch	100 – 100
3 inch	80 – 100
2-1/2 inch	50 – 80
2 inch	20 – 50
1-1/2 inch	5 - 20
1 inch	0 – 5

PART 3 – EXECUTION

3.01 – SUBGRADE

The installer shall verify that the subgrade has been shaped and compacted in conformance to the lines, grades and cross-sections shown on the plans, to provide for the construction of the Bio-Aquifer Storm System pavement structure.

Site grades can be raised to the design subgrade elevation using clean native earth fill (free of deleterious material). This fill should be placed in lifts not exceeding six inches (6”) and compacted to a minimum of ninety-five percent (95%) Standard Proctor density. The final subgrade profile should be uniformly compacted to a minimum of ninety-eight percent (98%) Standard Proctor density and proof-rolled to delineate soft areas. Removing the unstable soil and replacing with clean, dry compacted earth fill shall be performed to repair these areas.

The requirements to include sub-drains in the pavement design would depend on the subgrade soil conditions. It is recommended that an experienced, qualified geotechnical engineer determine the requirements for sub-drains. If required, the sub-drain pipe shall consist of a four-inch (4") diameter PVC perforated pipe wrapped with filter fabric. The pipe would be placed at subgrade elevation and surrounded with a minimum of four inches (4") of approved open-graded stone. The sub-drain shall drain into a catch basin or other frost-free positive outlet.

3.02 – PLACEMENT OF SUB-BASE COURSE

The thickness of the sub-base course layer will depend upon the subgrade soil conditions and the anticipated traffic loadings. It is recommended that a site assessment be carried out by an experienced, qualified geotechnical engineer to determine the requirements of the base course.

The base course shall consist of a minimum thickness of twelve inches (12") and be compacted using a vibratory smooth-drum roller. It shall be installed in lifts not to exceed six inches (6"). Upon completion of the sub-base course installation, the area shall be proof-rolled using a heavy rubber-tired vehicle (such as a loaded tandem truck) to identify any areas requiring additional compaction. The sub-base course shall be installed to the elevation and cross-section per the plan documents.

3.03 – PLACEMENT OF BASE COURSE

The base course shall consist of a thickness of four inches (4"), placed in one lift, and be compacted using a vibratory smooth-drum roller. The base course shall be installed to the elevation and cross-section per the plan documents.

3.04 – PLACEMENT OF BEDDING COURSE

The bedding course shall be spread loose in a uniform layer to give a depth after compaction of the paving units of about two inches (2"). The contractor shall screed the bedding course using either an approved mechanical screed beam apparatus or by the use of screed guides and boards.

The screeded bedding aggregate shall not be subjected to any traffic by either mechanical equipment or pedestrian use prior to the installation of the paver units. The voids left after the removal of the screed rails shall be filled with loose aggregate as the paver bedding course proceeds.

3.05 – PLACEMENT OF ECOLOGICAL PAVERS

All edge restraints shall be constructed as shown on the plans and in place prior to the installation of the pavers. Poured-in-place concrete curbs are recommended for the Bio-Aquifer Storm System.

The pavers shall be installed in approximately the order in which they were manufactured. No cluster shall be installed next to a cluster that was manufactured more than 1,000 cycles before or after.

Lay pavers in the pattern as shown on the drawings. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines shall be used upon the bedding course to maintain straight joint lines. Joint spacing between pavers shall be between 1/8" and ¼"; however, the joint width may need to be increased to 3/8" (if necessary) to maintain straight joint lines. Lines and grades shown on the plans shall be established and maintained during the installation of the wearing course.

Pavers shall be cut using a table-mounted masonry saw. Block splitting shall not be permitted. All cut faces shall be vertical. Dry cutting of the pavers shall be performed utilizing a dust collection system.

Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide a full and complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, the void filler shall then be placed into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.

The pavement surface shall be compacted to achieve consolidation of the bedding course and paving stones and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor capable of a minimum of 4,500 pounds of compaction force. No compaction shall be permitted within three feet (3') of unrestrained edges of the pavement.

After compaction, inspect the pavers for damaged units and remove and replace those units. On completion of vibration after void filling, the surface tolerances shall be plus or minus ½" from finish levels. The pavers shall be flush to ¼" above edge restraints.

Additional void filler material shall be swept in the paver voids to within ½" from the bottom of the chamfer on the paving stones. Upon completion, the wearing course surface shall be swept clean of all excess materials. Remove from the site all surplus materials, equipment and debris resulting from these operations.