SWMPAVE
EAGLE BAY STORMWATER SYSTEM

SWMpave Design Guidelines (State of Virginia)

1. Identify Stormwater Treatment Requirements

a. Water Quality: Using the Virginia Runoff Reduction Method (VRRM) or other local and state standards, quantity the stormwater management requirements for water quality compliance. For DEQ Specification #7, the minimum treatment for water quality measured over the contributing drainage area is as follows:

Criteria	Level 1	Level 2
Total Phosphorus (TP) Removal	59%	81%
Total Nitrogen (TN) Removal	59%	81%
WQ Treatment Volume Required (Tv)	(1.0)(Rv)(A) / 12	(1.0)(Rv)(A) / 12
Minimum Infiltration Rate	< 0.5 in/hr	> 0.5 in/hr

b. Water Quantity: Additional quantity detention requirements for channel protection are built into the Virginia Runoff Reduction Method (VRRM) or other local and state standards. In addition, you may be able to avoid designing quantity pipe or storm drainage systems by conveying the 10-year storm (or larger) through the SWMpave system.

2. Soil and Geologic Conditions

Develop site mapping using survey or GIS data, and previously published studies as the basis for your design.

a. Sub-grade soil descriptions (A, B, C, D): Conduct subsurface or geotechnical investigations of permeable pavement site area to determine soil types, or utilize the NRCS web soil survey to determine the Hydrologic Soil Groups (HSG):

http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=VA

b. Sub-grade Infiltration Rates: Conduct subsurface or geotechnical investigations of the soil infiltration rates for design, or use an assumed infiltration rate based on the uniform soil classification system, to be verified during construction.

c. Sub-grade Bearing Capacity: Conduct subsurface or geotechnical investigations of the subgrade to determine the saturated California Bearing Capacity (CBR) or the Resilient Modulus, or use an assumed bearing capacity based on the uniform soil classification system, to be verified during construction. If compacted soils will be used for the sub-grade, then use CBR or resilient modulus testing of the compacted subgrade in your design.

d. Check Groundwater Table: A minimum 2 foot separation is required between the bottom of the SWMpave system and the seasonal high water table. The designer should set finished grades to meet or exceed this requirement in the design.

e. Other Geologic Considerations: Designate impermeable liners for SWMpave systems near building foundations, footings, or other types of structures which might be negatively impacted by creating high infiltration rates or saturated soil conditions around the SWMpave system. Also utilize impermeable liners in karst topography or hot spots as defined by NPDES permit requirements.

3. Structural Design

a. Determine Traffic Data: Based on the functional classification of the roadway or the projected traffic in a parking lot, determine the number of Equivalent Single Axle Loads (ESAL's) for the design.

b. Determine the Structural Design Method: Utilize either the UC Davis method recently developed by ICPI for PICP pavement systems, or the flexible pavement design method by AASHTO to determine the minimum depth of stone required for your project, based on ESAL's and soil strength (CBR). Document assumptions governing the pavement design calculations.

c. Minimum Reservoir Storage: Compare the minimum depth of stone for structural design to the hydrologic design, and utilize the thicker pavement section for the project (worst case).

d. Use of Geogrids: If recommended by your engineer for use in soft or yielding soils, you can inclue a geogrid in the pavement section to bridge loads and reduce the stone thickness for structural design at this point. You should still be sure the depth of stone meets the hydrologic design requirements before moving to Step #6.

4. Hydrologic Design

a. Determine drainage areas: Layout the site to determine the SWMpave surface area, and the contributing drainage area to each system. Virginia limits contributing drainage areas to 2.5:1 (Level 1) and 2:1 (Level 2). Also treat runoff from impervious areas where possible to achieve compliance, without the erosion and sedimentation potential from pervious (turf) areas. Where SWMpave is used to treat pervious areas, consider adding a gravel diaphragm or filter strip to the design for pre-treatment of sediment runoff.

b. Determine the Hydrologic Design Type: Based on the soil and geologic conditions and assumptions, determine if the design is a full infiltration, partial infiltration or no infiltration system.

c. Minimum Reservoir Storage: Determine the depth of reservoir stone required for each SWMpave system, based on the contributing drainage areas and the stormwater management and detention objectives established for the project. Utilize a 35 to 40% void

ratio in the open-graded and thoroughly washed stone to determine the required depths. Do not store water in the #8 bedding stone, or the #57 choker course where possible.

5. Underdrain Design

a. Size Drain Pipes: Determine the rate of discharge required for excess runoff not infiltrating into the underlying soils for your design storms, and size perforated or slotted pipe drains to have a 36 to 48-hour drain time. Consider pipe size, pipe slopes (0.5% minimum), spacing of multiple pipes, and pipe inverts in your design. Inverts set above the bottom of the reservoir layer are often called "overdrains" or "raised outlets" and create sumps that improve the water quality benefits of partial infiltration systems. Hydrologic soil groups C and D typically require an underdrain.

b. Size Drainage Appurtenances: Add observation wells, cleanouts, and other types of fittings and appurtenances to the system in order to observe and maintain the permeable pavement over time.

6. Consider Check Dams

a. Check Surface Slopes: Surface slopes below 2% are recommended and should never be more than 5% in order to be sure the wearing surface is capturing sheet flow runoff for a variety of larger storm events. Joints are fully ADA compliant, meaning they are fairly narrow and will not work as well on steeper slopes.

b. Check Subgrade Slopes: Where possible subgrade longitudinal slopes should be 1% or less, and do not need to match the slope of the finished surface in your design. Cross slopes should be 0% wherever possible. In the case of subgrade slopes between 2% and 5%, we would recommend the use of check dams to trap water throughout the system and avoid having large amounts of stored water running to the low end of the pavement system where it can surcharge.

7. Perform a Geosynthetic Design

a. Choose a Geogrid: Choose a geogrid that provides the structural design strength required and incorporate design details in accordance with all manufacturer's recommendations.

b. Choose a Geotextile for the Sides: Geotextiles are used on the sides of the open grading, washed stone as a barrier for sediment and fines in the adjacent soils. Choose a geotextile fabric based on the sieve analysis of adjacent soils and AASHTO M-288.

c. Choose a Geotextile for the Bottom: If a geotextile is also used on the bottom of the SWMpave system, choose a product with the strength and apparent opening size to allow infiltration without allowing sediment to enter the reservoir stone, in accordance with AASHTO M-288. Alternatively consider using a graded filter with #57 stone, #8 stone and C-33 sand to separate underlying soils from the reservoir stone.

8. Specify the Wearing Surface

a. Choose a Block Type: Choose from Eagle Bays' available block types for SWMpave, including the highly recommended Aqua Bric Type 4-L. Use a 3-1/8" thick paver for

vehicular applications in a herringbone pattern. Machine laid patterns of Aqua Bric Type 4-L and ECO-Bay are manufactured in an herringbone pattern.

b. Choose Preferences: Work with an Eagle Bay sales representative if you want to choose colors, styles, laying patterns, finishes, and other characteristics necessary for the project's design, and to also address aesthetics with your SWMpave system.

c. Apply Design Tools: Use the SWMpave standard details to develop design plans and drawings for each part of the system, and develop a technical specification from the SWMpave outline specifications, reading italicized text with instructions on how to develop certain sections of the written specification. Send your plans and written specifications to the SWMpave sales team for additional coordination and pricing to utilize for project implementation.