4.17 Porous Asphalt

Description:
Porous Asphalt is asphalt with reduced sands or fines and larger void spaces to allow water to drain through it. Porous asphalt allows water to infiltrate into the subsoil through the paved surface and base layer. This base, aggregate layer acts as both a structural layer and container to temporarily hold stormwater.
**DESIGN CRITERIA**

- Intended for low traffic areas, or for residential or overflow parking applications, not ideal for areas with a tree canopy or high traffic flow
- Soil infiltration rate of 0.5 in/hr or greater is required if no underdrain is present
- Aesthetically pleasing
- Americans with Disabilities Act (ADA) compliant
- Not appropriate as water quality treatment BMP for drainage discharged from other areas

**ADVANTAGES/BENEFITS**

- Surface flow reduction of peak flows, volume, and stormwater runoff
- Can be used as a pretreatment for other BMPs for pollutants other than TSS
- High level of pollutant removal other than TSS
- Decreases impermeable area

**DISADVANTAGES/LIMITATIONS**

- Potential for high failure rate if not adequately maintained or used in unstabilized areas
- Not recommended for areas with sediment-laden runoff which can clog porous pavement
- Subgrade cannot be over-compacted
- Construction must be sequenced to avoid compaction and clogging of the pavement.

**ROUTINE MAINTENANCE REQUIREMENTS**

- Sweep or vacuum the asphalt to increase life of pavement and avoid clogging
- Keep contributing drainage area free of debris and areas of erosion

**POLLUTANT REMOVAL**

- Total Suspended Solids – 80%
- Total Phosphorus – 50%
- Total Nitrogen – 50%
- Fecal Coliform – Not applicable
- Heavy Metals – 60%

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**STORMWATER MANAGEMENT SUITABILITY**

- Runoff Reduction
- Water Quality
- Channel Protection
- Overbank Flood Protection
- Extreme Flood Protection

**IMPLEMENTATION CONSIDERATIONS**

- Land Requirements: L
- Capital Cost: M
- Maintenance Burden: M

- Residential Subdivision Use: Yes
- High Density/Ultra-Urban: Yes
- Roadway Projects: Yes

- Soils: Not recommended for use with hydrologic soils group ‘D’ and ‘C’ without underdrain.

- Other Considerations: Overflow Parking, Driveways & related uses

**Runoff Reduction Credit**

- 100% of the runoff reduction credit if an underdrain is not used
- 50% of the runoff reduction credit if an underdrain is used

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### 4.15.1 General Description

Porous asphalt is an asphalt driving surface that permits the infiltration of water through the pavement and into the underlying soil. Porous pavement can be used to reduce the effective impervious area on a site, therefore, reducing the design volumes and peak discharges that must be controlled. This will allow a reduction in the cost of other stormwater infrastructure, a fact that may offset the greater placement
cost. Porous pavement can also eliminate problems with standing water, provide for groundwater recharge, control erosion of streambeds and riverbanks, facilitate pollutant removal, reduce thermal pollution of receiving waters, and provide for a more aesthetically pleasing site. It should be noted that porous pavement is not an effective BMP to remove total suspended solids (TSS).

Porous asphalt consists of open-graded coarse aggregate, bonded together by asphalt cement, with sufficiently interconnected voids to make it highly permeable to water (see Figure 4.15-1). Porous asphalt is best applied in areas that experience low amounts of vehicle traffic and low to no tree coverage including:

- Parking pads in parking lots
- Overflow parking areas
- Residential driveways
- Residential street parking lanes
- Recreational trails
- Golf cart and pedestrian paths
- Emergency vehicle and fire access lanes
- Plazas

A major drawback is the cost and complexity of porous asphalt compared to conventional pavements. Porous asphalt requires a very high level of construction workmanship to ensure that they function as designed. In addition, there is the difficulty and cost of rehabilitating the surfaces should they become clogged. Therefore, consideration of porous asphalt should include the construction and maintenance requirements and costs.

Porous asphalt are not recommended and may not be approved for use in areas that experience high amounts of traffic volume, heavy loads, and areas with high amounts of sediment (i.e. construction areas).

Figure 4.15-1

Porous asphalt is designed primarily for impervious area reduction and the subsequent reduction in stormwater treatment volumes and peak discharges, particularly for smaller storm events. These include:
• Placing a perforated pipe near the top of the crushed stone reservoir to pass the excess flows after the reservoir is filled
• Connecting the stone reservoir layer to a stone filled trench
• Adding a sand layer and perforated pipe beneath the stone layer for filtration of the water quality volume

Porous asphalt is typically placed on a gravel (stone aggregate) base course. Runoff infiltrates through the porous asphalt into the gravel base course, which acts as a storage reservoir as it exfiltrates to the underlying soil. The infiltration rate of the soils in the subgrade must be adequate to support drawdown of the entire runoff capture volume within 24 to 48 hours. Special care must be taken during construction to avoid undue compaction of the underlying soils, which could affect the soils’ infiltration capability.

Another type of porous asphalt is called open-graded friction course (OGFC). OGFC is a thin permeable layer of asphalt that encompasses a support structure consisting of uniform, coarse aggregate size with minimal fines, and serves as an overlay to conventional asphalt pavements. OGFC has a high void content that creates permeability allowing for the infiltration of stormwater runoff.

4.15.2 Pollutant Removal Capabilities

As they provide for the infiltration of stormwater runoff, porous asphalt has a high removal of both soluble and particulate pollutants, where they become trapped, absorbed or broken down in the underlying soil layers. Due to the potential for clogging, porous asphalt should not be used for the removal of sediment or other coarse particulate pollutants. OGFC has a TSS removal of 50%. There is no sufficient data for nutrients, fecal coliform, or metals.


4.15.3 Design Criteria and Specifications

- The detailed design of porous asphalt is beyond the scope of this Manual. Refer to The National Asphalt Pavement Associations’ *Porous Asphalt Pavements for Stormwater Management: Design, Construction and Maintenance Guide* for detailed design guidance.

- Porous asphalt systems can be used where the underlying in-situ subsoils have an infiltration rate of at least 0.5 inches per hour. Therefore, permeable paver systems are not suitable on sites with hydrologic group D or most group C soils, or soils with a high (>30%) clay content unless an underdrain is used. During construction and preparation of the subgrade, special care must be taken to avoid compaction of the soils.

- Porous asphalt should typically be used in applications where the pavement receives tributary runoff only from impervious areas. It is recommended that the ratio of the contributing impervious area to the permeable paver surface area should be no greater than 3:1. Porous asphalt systems should be sized for a minimum drawdown time of 24-48 hours and a maximum drawdown time of 4 days.

- If runoff is coming from adjacent pervious areas, it is important that those areas be fully stabilized to reduce sediment loads and prevent clogging of the permeable paver surface.

- It is recommended that the subsoil of the porous asphalt have a slope of 0% and the surface have a slope 0.5% or less, if possible.

- A minimum of 2 feet of clearance is required between the bottom of the gravel base course and underlying bedrock or the seasonally high groundwater table.

- The porous asphalt should be sited at least 10 feet down gradient from buildings or 100 feet from a
The porous asphalt should be at least 100 feet away from drinking water wells.

To protect groundwater from potential contamination, runoff from designated hotspot land uses or activities must not be infiltrated. Porous asphalt should not be used for manufacturing and industrial sites, where there is a potential for high concentrations of soluble pollutants and heavy metals. In addition, porous asphalt is not suitable in areas with karst geology without adequate geotechnical testing by qualified individuals and in accordance with local requirements.

Porous asphalt can be used independently or in conjunction with other stormwater management system components to effectively infiltrate, bypass, or detain and time-release all required storm events.

The following equation can be used to determine if the depth of the storage layer (gravel base course) needs to be greater than the minimum depth:

\[ RR_v \text{ required} = A \cdot [(p_1)(d_1)] \]

Where:

- \( RR_v \text{ required} \) - Runoff reduction volume (ft\(^3\))
- \( A \) - area of porous asphalt (ft\(^2\))
- \( p_1 \) - porosity of base layer (% void)
- \( d_1 \) - depth of base layer (ft)

Note that this formula works for surfaces with a 0% slope.

The surface of the subgrade should be lined with filter fabric or an 8-inch layer of sand (ASTM C-33 concrete sand or GADOT Fine Aggregate Size No. 10) and be completely flat to promote infiltration across the entire surface.

Porous asphalt must use some method to convey larger storm event flows to the conveyance system. One option is to use storm drain inlets set slightly above the elevation of the pavement. This would allow for some ponding above the surface, but would accept bypass flows that are too large to be infiltrated by the porous asphalt, or if the surface clogs.

For the purpose of sizing downstream conveyance and BMPs, porous asphalt areas can be assumed to be 40% impervious. In addition, credit can be taken for the runoff volume infiltrated from other impervious areas using the methodology in Section 3.1.

The cross-section typically consists of two layers. The aggregate reservoir can sometimes be avoided or minimized if the sub-grade is sandy and there is adequate time to infiltrate the necessary runoff volume into the sandy soil without by-passing the water quality volume. Descriptions of each of the layers is presented below:

**Porous Asphalt Layer** – The porous asphalt layer consists of porous mixture of asphalt. This layer is usually 4-8 inches deep depending on the required bearing strength, pavement design requirements, and manufacturer’s specifications.

**Reservoir Layer** – The reservoir gravel base course consists of washed, bank-run gravel, 1.5 to 2.5 inches in diameter with a void space of about 40% (GADOT No.3 Stone). The depth of this layer depends on the desired storage volume, which is typically the water quality volume (WQ) at a minimum, but is not limited to that volume. Typical depths for the reservoir layer range from 2 to 4 feet. Aggregate contaminated with soil shall not be used. A porosity value (void space/total volume) of 0.32 should be used in calculations unless aggregate specific data exist.
Filter Fabric – Filter fabric can be used in certain applications, as site conditions warrant. General guidance for the use of filter fabrics is below. Actual use should be under the guidance of a Georgia licensed engineer.

Geotextiles consisting of permeable materials should line the sides of the aggregate base to prevent migration of adjacent soils into it and subsequent permeability and storage capacity reduction. Geotextiles are not recommended under the aggregate base in an infiltration design because they can accumulate fines and inhibit infiltration.

Geomembranes consisting of impermeable materials should be used to accomplish the following:

- Provide a barrier on the side and bottom of the aggregate base in a detention design to prevent infiltration into the subgrade typically due to soil instability, the presence of stormwater hotspots, or potential for groundwater contamination. Geomembrane barriers reduce the credit for TSS removal from 85% to 70%.
- Line the sides of the aggregate base whenever structure foundations of conventional pavement are 20 ft or less from the porous asphalt (to avoid the risk of structural damage due to seepage). The isolated use of geomembranes for this purpose will not reduce the credit for TSS removal in the system.

Geogrids may be used on top of subgrade soils for additional structural support, especially in very weak, saturated soils. All manufacturer requirements must be followed in design and installation.

Underlying Soil – Porous Asphalt cannot be used in fill soils. The underlying soil should have an infiltration capacity of at least 0.50 in/hr. as initially determined from NRCS soil textural classification, and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 5000 square feet, with a minimum of two borings per facility (taken within the proposed limits of the facility). Test borings are recommended to determine the soil classification, seasonal high ground water table elevation, and impervious substrata, and an initial estimate of permeability. Often a double-ring infiltrometer test is done at subgrade elevation to determine the impermeable layer, and, for safety, one-half the measured value is allowed for infiltration calculations.

- The pit excavation should be limited to the width and depth specified in the design. Excavated material should be placed away from the open trench as not to jeopardize the stability of the trench sidewalls. The bottom of the excavated trench should not be loaded so as to cause compaction, and should be scarified prior to placement of reservoir base material. The sides of the trench shall be trimmed of all large roots. The sidewalls shall be uniform with no voids and scarified prior to backfilling. All porous asphalt systems should be protected during site construction, and should be constructed after upstream areas have been stabilized.
- An observation well consisting of perforated PVC pipe 4 to 6 inches in diameter should be placed at the downstream end of the practice and protected during construction. The well should be used to determine actual infiltration rates for use in final design of the porous asphalt system.
- A warning sign should be placed at the facility that states, “Porous Paving used on this site to reduce pollution. Do not resurface with non-porous material. Call XXX-XXXX for more information.”
- If OGFC is used, consult the GDOT Manual on Drainage Design for Highways for design specifications.

4.15.4 Design Procedures

Step 1: Determine the goals and primary function of the porous asphalt

Consider whether the porous asphalt is intended to:
• Meet a runoff reduction* target or water quality (treatment) target. *\textbf{Note that minimum infiltration rates of the surrounding native soils must be acceptable and suitable when used in runoff reduction applications.}

• Provide a possible solution to a drainage problem

Check with local officials and other agencies to determine if there are any additional restrictions and/or surface water or watershed requirements that may apply. In addition, consider if the porous asphalt has any special site-specific design conditions or criteria. List any restrictions or other requirements that may apply or affect the design.

The design of the porous asphalt should be centered on the restrictions/requirements, goals, targets, and primary function(s) of porous asphalt. By considering the primary function, as well as, topographic and soil conditions, the design elements of the porous asphalt can be determined (i.e. underdrain, overflow, etc.)

\textbf{Step 2. Determine if the development site and conditions are appropriate for the use of a porous asphalt}

Consider the application and site feasibility criteria in this chapter. In addition, determine if site conditions are suitable for porous asphalt. Create a rough layout of the porous asphalt dimensions taking into consideration existing trees, utility lines, and other obstructions.

\textbf{Step 3. Calculate the Stormwater Runoff Reduction Target Volume}

\textbf{Calculate the Runoff Reduction Volume using the following formula:}

\[ \text{RR}_v = \frac{(P) \ (R_v) \ (A)}{12} \]

Where:
- \( \text{RR}_v \) = Runoff Reduction Target Volume (ft³)
- \( P \) = Target runoff reduction rainfall (inches)
- \( R_v \) = Volumetric runoff coefficient which can be found by:
  \[ R_v = 0.05 + 0.009(I) \]
  Where:
  - \( I \) = new impervious area of the contributing drainage area (%)
- \( A \) = Site area (ft²)
- \( 12 \) = Unit conversion factor (in/ft)

The designed runoff reduction volume should meet or exceed the following equation:

\[ \text{RR}_v \text{required} = A \ [(p1)(d1)] \]

Where:
- \( \text{RR}_v \text{required} \) - Runoff reduction volume (ft³)
- \( A \) - area of porous asphalt (ft²)
- \( p1 \) - porosity of base layer (% void)
- \( d1 \) - depth of base layer (ft)

Note that this formula works for surfaces with a 0% slope.

\textbf{Step 4. Outlet Design}

Determine which type of outlet design will be used for the porous asphalt. There are two types of outlet design that are generally used if infiltration is not possible without additional assistance. They are an underdrain system and overflow system. The underdrain system should include a series of perforated pipes to remove additional stormwater runoff that could not otherwise infiltrate into the surrounding soil. An overflow system directs water that cannot be infiltrated into the subsoil and moves it to another location, for instance another BMP or storm sewer system.

\textbf{Step 5. Erosion and Sediment Control/Base Protection}
Determine the stormwater discharges to the construction site that could potentially erode and clog the system. Take the proper steps to stabilize the site and prevent erosion when construction begins.

Step 6. Select Porous asphalt and finalize design
Select the porous asphalt design based on the specific site conditions. Make sure that the soil is stabilized by using filter fabric or other method as determined by the designer.

**4.15.5 Inspection and Maintenance Requirements**

All best management practices require proper maintenance. Without proper maintenance, BMPs will not function as originally designed and may cease to function altogether. The design of all BMPs includes considerations for maintenance and maintenance access. For additional information on inspection and maintenance requirements, see Appendix XX.