4.1. *Permeable Pavement Systems*

Permeable Pavement provides the structural support of conventional pavement, but allows stormwater to drain directly through the surface into the underlying stone base and soils, thereby reducing storm water runoff. There are permeable varieties of asphalt, concrete, and interlocking pavers. Permeable pavements are designed with an open graded stone sub-base that allows water to pass through to the native soil and/or provides temporary storage. Some of the benefits to using permeable pavements include: a reduction in the amount of storm pipes and inlet structures required; the ability to have more parking areas built to accessible slopes (due to flatter grades achievable with porous surfaces); improved growing conditions of plant material in landscape islands due to air and water available through porous surface; pedestrian safety due to improved winter and wet weather pavement conditions.

KEEP INDIANAPOLIS BEAUTIFUL HEADQUARTERS: 1029 FLETCHER AVE. INDIANAPOLIS, IN- INTEGRATED STORMWATER MANAGEMENT- FEATURES PERVIOUS CONCRETE, CISTERN AND RAIN GARDENS TO MEET STORM WATER REGULATIONS

Key Elements:

- Porous structural surface with high infiltration rate.
- Porous surface and stone sub-base suitable for design traffic loads. Can be used on most travel surfaces with slopes less than 5%.
- Uncompacted, level sub-grade allows infiltration of storm water.
- Open-graded aggregate sub-base provides storage.
- Additional storage and control structures can be incorporated to meet flood control.
- Positive overflow prevents system flooding.

Table 4.2.1: Permeable Pavement Potential Application and Storm Water Regulation

Potential applications			**Storm water regulations**		
				Infiltration	No Infiltration
Residential Subdivision:	Yes		Water Quality Benefit	Yes	No
Commercial:	Yes		Volume Reduction	Yes	Yes
Ultra Urban:	Yes		Attenuation Benefit	Yes	Yes
Industrial:	Yes				
Retrofit:	Yes				
Highway Road:	Limited, where approved				

Acceptable Forms of Pre-treatment

- Maintenance

Permeable Pavement in the Urban Landscape

Permeable pavement systems are used to promote infiltration of storm water runoff. This technique is very effective in reducing the volume of storm water entering a sewer system and is being studied for its effectiveness for removing pollutants. During a rain event, storm water flows through the porous surface, drains into the crushed stone sub-base beneath the pavement, and remains stored until storm water can infiltrate into the soil or, in the case of detention, until it can overflow into a specified drainage outlet. Porous asphalt and concrete mixes are similar to their impervious counterparts, but do not include the finer grade particles. Interlocking pavers have openings that are filled with stone to create a porous surface.

BRENTWOOD SCHOOL-PLAINFIELD, IN-PERMEABLE PAVER SYSTEM APPLICATION

Permeable pavement systems are suitable for any type of development. They are especially well suited for parking lots, walkways, sidewalks, basketball courts, and playgrounds. Proper training of owner, users and maintenance staff will help to prolong the life of the system.

PURDUE UNIVERSITY-WEST LAFAYETTE, IN PERVIOUS CONCRETE APPLICATION

Alternate for Paved Surfaces

Almost any surface that is traditionally paved with an impervious surface can be converted to a porous pavement system. Porous surfaces are particularly useful in high density areas where there is limited space for other storm water management systems. Porous pavement can be used for parking lots, basketball courts, playgrounds, plazas, sidewalks and trails. Interlocking porous pavers can be used to provide an interesting aesthetic alternative to traditional paving. Porous pavement can be designed to meet the loading requirements for most parking lots and travel surfaces. However, for lots or loading areas that receive a high volume of heavy traffic and/or turning movements (as in a restaurant drive-thru lane), porous pavement can be used for parking stalls and conventional pavement for travel lanes and loading areas. In this case the impervious surfaces could be graded toward the porous surfaces.

MORTON ARBORETUM- CHICAGO, IL PERMEABLE PAVER SYSTEM APPLICATION

Direct connection of roof leaders and/or inlets

The stone sub-base storage of permeable pavement systems can be designed with extra capacity, and roof leaders and inlets from adjacent impervious areas can be tied into the sub-base to capture additional runoff. These stone beds can be sized to accommodate runoff from rooftops via direct connection or to supplement other storm water Best Management Practices (BMPs). Pretreatment may be necessary to prevent particulate materials from these surfaces from clogging the sub-base of the porous pavement system. All permeable pavement systems must include a positive overflow.

Direction of Impervious Runoff to Permeable Pavement System

Adjacent impervious surfaces can be graded so that the flow from the impervious area flows over the porous pavement and into the sub-base storage below if sufficient capacity is created. Typically, it is recommended that the impervious area does not exceed 3 to 5 times the area of the porous pavement receiving the runoff.

INTERCARE-INDIANAPOLIS, INDIANA PERMEABLE PAVEMENT SYSTEM

ELMHURST COLLEGE-ELMHURST ILLINOIS-PERMEABLE PAVER SYSTEM

PURDUE UNIVERSITY- WEST LAFAYETTE IN PERVIOUS CONCRETE DRAINAGE IMPROVEMENT

Components of a Permeable Pavement System

Different porous surfaces are used for porous pavement systems, but all rely on the same primary components:

- Inflow/Surfacing
- Storage
- Infiltration/Outflow

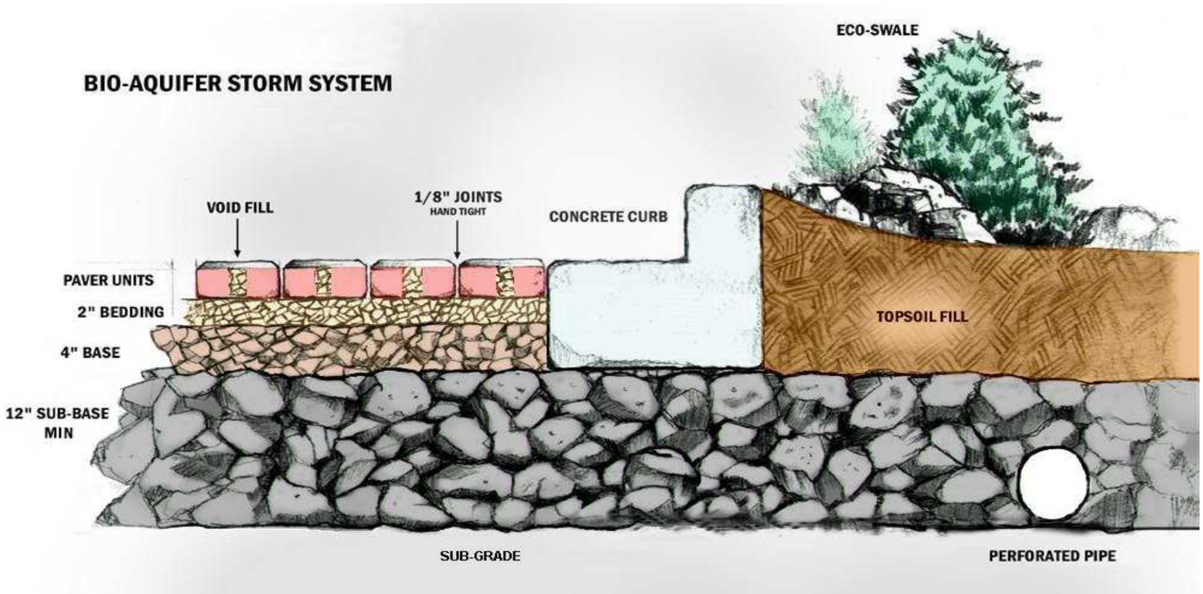


Figure 4.2.1: Permeable Paver System Cross Section

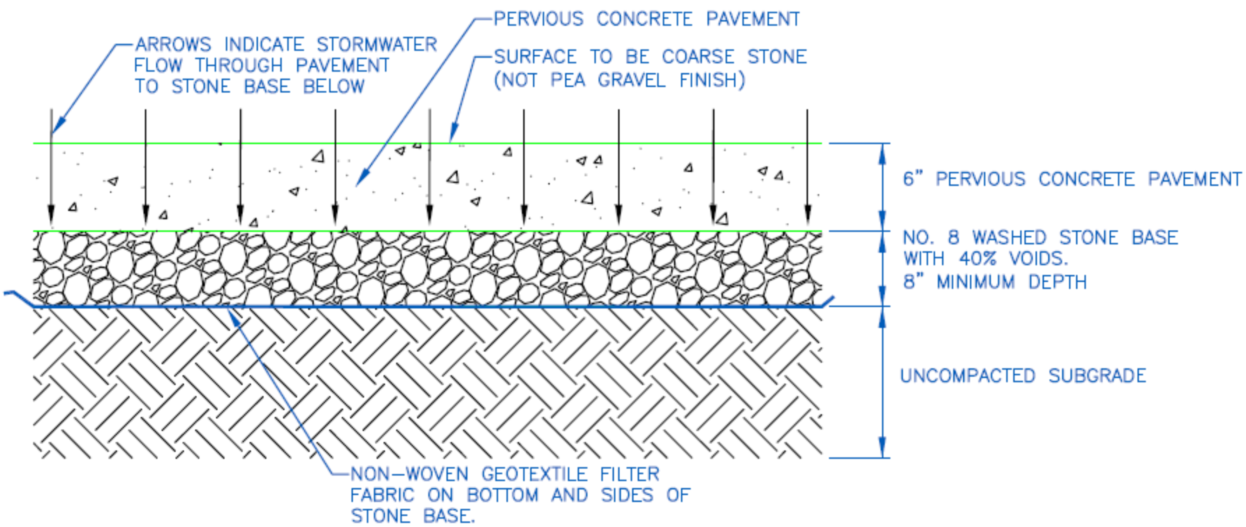


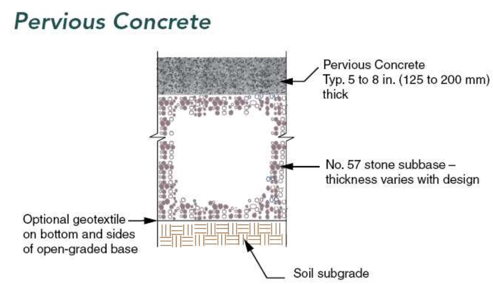
Figure 4.2.2: Pervious Concrete System Cross Section

Inflow/Surfacing

There are many different types of structural surface materials that allow water to flow through void spaces within the material. Any of these alternatives serve as a form of conveyance and filtration for the storage bed below. Several of the most commonly used porous structural surfaces are described below, but this does not represent an exhaustive list of the porous surfaces appropriate for storm water management applications.

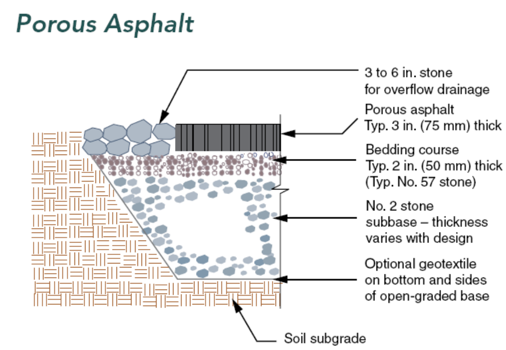
Porous concrete (a/k/a Portland Cement, Pervious Concrete, or PCPC)

Porous concrete was developed in the U.S. by the Florida Concrete Association in the 1970s. While its early applications remained in Florida and other southern areas, the last ten years have seen an increase in the use of porous concrete in freeze-thaw regions. According to the ACI Committee Report 522R-06, the term "pervious concrete" typically describes a zero-slump, open graded material consisting of Portland cement, coarse aggregate, little or no fine aggregate, admixtures and water. Like porous asphalt, porous concrete is produced by substantially reducing the number of fines in the mix in order to establish voids for drainage. Porous concrete has a coarser appearance than its conventional counterpart.



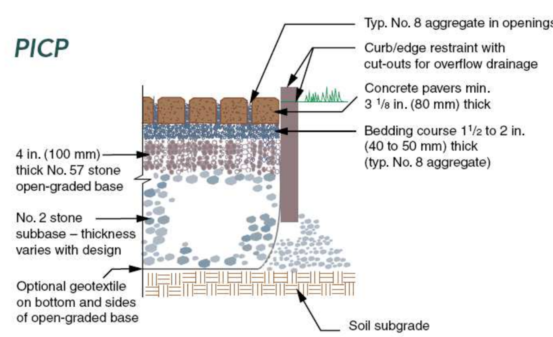
Porous asphalt

Porous asphalt pavement was first developed in the 1970s and consists of standard bituminous asphalt in which the fines have been screened and reduced, allowing water to pass through very small voids. Recent research in open-graded mixes for highway application has led to additional improvements in porous asphalt through the use of additives and binders. Porous asphalt is very similar in appearance to conventional, impervious asphalt.



Permeable pavers

Permeable pavers are interlocking units (often concrete) with openings that can be filled with a pervious material such as gravel. These units are often very attractive and are especially well suited to plazas, patios, small parking areas, etc. There are also plastic grids that can be filled with gravel to create a fully gravel surface that is not as susceptible to rutting and compaction as traditional gravel lots. Gravel used in interlocking concrete pavers or plastic grid systems must be well graded to ensure permeability.



Reinforced turf

Reinforced turf consists of interlocking structural units with openings that can be filled with soil for the growth of turf grass and are suitable for traffic loads and parking. They are often used in overflow or event parking as well as emergency access for fire trucks. Reinforced turf grids are made of concrete or plastic and are underlain by a stone and/or a sand drainage system for storm water management. While both plastic and concrete units perform well for storm water management and traffic needs, plastic units may provide better turf establishment and longevity, largely because the plastic will not absorb water and diminish soil moisture conditions. The grids protect the root structure of the grass and minimize the impact on the grass by traffic loads.

Storage

In addition to distributing mechanical loads, coarse aggregate laid beneath porous surfaces is designed to store storm water prior to infiltration into soils or discharging to a storm water BMP. The aggregate is wrapped in a non-woven geotextile to prevent migration of soil into the storage bed and resultant clogging. In porous asphalt and porous paver applications, the storage bed also has a choker course of smaller aggregate to separate the storage bed from the surface course. The storage bed can be designed to manage runoff from areas other than the porous surface above it, or can be designed with additional storage and control structures that meet the parameters required within the Storm water Design and Specification Manual.

Positive Overflow

Positive overflow must be provided for porous pavement systems. Positive overflow conveys runoff from larger storms out of the system, prevents flooding and prevents water from standing within the porous structural surface which minimizes freeze-thaw impacts. One solution for a positive overflow is a stone buffer along the edges of a porous pavement lot. The stone, typically river rock or a stone with aesthetic value, is connected to the stone sub-base below the pavement to allow a path for excess water to flow out of the system. The stone should allow positive overflow to occur at an elevation below the structural surface. A perforated pipe system can also convey water from the storage bed to an outflow structure. The storage bed and outflow structure can be designed to meet the detention requirements of the Storm Water Design and Specification Manual. Inlets can be used to provide positive overflow if additional rate control is not necessary. More information about large underground storage systems can be found in the Subsurface Infiltration Fact Sheet.

SIDE BY SIDE COMPARISON OF STANDARD ASPHALT WITH POROUS ASPHALT

Recommended Design Procedure

Design of porous pavement systems is critical if they are to function properly and efficiently. The area and shape are dependent on the site design, and selection of the surface material is dependent on intended site uses and desired appearance. The depth of the stone base can be adjusted depending on the management objectives, total drainage area, traffic load, and soil characteristics. The following design procedures are general guidelines that designers can follow.

- Determine if site is acceptable for use of porous pavements.

Siting for Porous Pavements

Porous pavements are not suited for every site. Site evaluation is critical for the success of porous pavement. Porous pavements should not be used until the site has met the minimum standards required for their use. Some minimum standards are:

- High water table depth to bottom of stone storage layer must be 4 feet or greater.
- For optimal performance locate systems on well-drained permeable soils with field verified permeability rates.
- Land surrounding and draining to the pavement doesn't exceed 20% slope.
- Minimum setback of 100 feet from wells used to supply drinking water or as required by local agency. Not recommended for use in well-head protection zones.
- Minimum setback of 10 feet from down-gradient of building foundations or as required by building code.
- Determine the detention and water quality requirements on the site. See the Storm Water Design and Specification Manual for more information.
- Create a Conceptual Site Plan for the entire site and determine what portion of the detention/retention sizing requirements porous pavement will meet.
- Investigate the feasibility of infiltration in the area proposed for a porous pavement (hotspot investigation, infiltration test, and geotechnical analysis).
- Create a conceptual design for the porous pavement system.

Table 4.2.2: Suggested Starting Porous Pavement Design Values	
Area (surface area and infiltration area)	Largest feasible on site
Choker/Aggregate Bed Depth	8-36 inches

- Estimate the total storage volume and adjust area and/or depths as needed to provide required storage. Assume a void ratio of approximately 40% for #8 washed stone.
- Design system with a level bottom; use a terraced system on slopes. Provide a positive slope for the bottom if the underlying soils have a high clay content or low permeability in general.
- Using infiltration area and the saturated vertical infiltration rate of the native soil, estimate how long the surface ponding and soil storage will take to drain. The maximum drain down time for the entire storage volume is 72 hours, but the Engineer may choose a shorter time based on site conditions and Owner preference. If storage does not drain in the time allowed, adjust aggregate depth and/or surface area. Adjust the design until the volume and drainage time constraints are met. Ensure that the storage volume does not occur within the porous structural surface, but is entirely contained within the stone sub-base below it. Underdrains placed at the top of the aggregate bed can serve to minimize or prevent standing water in the structural surface.
- Per City of Fort Wayne requirements, at least one underdrain shall be used for all porous pavement systems. Additional underdrains may be required based on layout and individual site conditions.
- Design distribution and overflow piping to minimize chance of clogging.
- Check that any release rate requirements (including release through any underdrain) are met by the system as designed. Typically, the underdrain pipe can be set at an elevation higher than the stone bottom to allow detention within the stone. See the Storm Water Design and Specification Manual.

- Design adequate storm water quality BMP(s) downstream of the porous pavement to treat the water quality volume per the Storm Water Design and Specification Manual.
- Complete construction plans and specifications.

Table 4.2.3: Required Stone Storage Gradation	
U.S. Standard Sieve Size	**Percent passing**
2 ½" (63 mm)	100
2" (50 mm)	95 - 100

Materials

Subsurface Storage Beds

- All aggregates within infiltration beds shall meet the following:

1. Uniformly graded, crushed, washed coarse aggregate
2. Maximum wash loss of 0.5%
3. Minimum Durability Index of 35
4. Maximum abrasion of 10% for 100 revolutions and maximum of 50% for 500 revolutions.

- Choker course aggregate, where needed, shall meet the specifications of AASHTO No. 57.
- Storage stone should meet the specifications of AASHTO No. 3. Additional storage materials are further discussed in the Subsurface Infiltration Fact Sheet.

Table 4.2.4: Required Choker Course Gradation	
U.S. Standard Sieve Size	**Percent passing**
1 ½" (37.5 mm)	100
1" (25 mm)	95 - 100
½" (19 mm)	25-60
4 (4.75 mm)	0 - 10
8 (2.36 mm)	0 - 5

Porous pavement mix designs are often 'local' to a region as aggregate properties vary depending on the region. Also, advances in mix designs of porous pavements continue to evolve. Therefore, the information listed below for porous asphalt and pervious concrete pavements should be used as a foundation for the mix designs and local suppliers should be consulted to finalize the mix design for the project.

Porous Bituminous Asphalt

- Bituminous surface shall be laid with a bituminous mix of 5.75% to 6% by weight dry aggregate. In accordance with ASTM D6390, drain down of the binder shall be no greater than 0.3%. Aggregate grain in the asphalt shall be a minimum 90% crushed material and have the following gradation.

Table 4.2.5: Porous Bituminous Aggregate Gradation	
U.S. Standard Sieve Size	**Percent passing**
½ (12.5 mm)	100
3/8" (9.5 mm)	92 - 98
4 (4.75 mm)	34 - 40
8 (2.36 mm)	14 - 20
16 (1.18 mm	7 - 13
30 (0.60 mm	0-4
200 (0.075 mm)	0-2

- Neat asphalt binder modified with an elastomeric polymer to produce a binder meeting the requirements of PG 76-22 as specified in AASHTO MP-1. The elastomer polymer shall be styrene-butadiene-styrene (SBS), or approved equal, applied at a rate of 3% by weight of the total binder.
- Hydrated lime should be added at a dosage rate of 1% by weight of the total dry aggregate to mixes containing granite. Hydrated lime shall meet the requirements of ASTM C 977. The additive must be able to prevent the separation of the asphalt binder from the aggregate and achieve a required tensile strength ratio (TSR) of at least 80% on the asphalt mix when tested in accordance with AASHTO T 283. The asphaltic mix shall be tested for its resistance to stripping by water in accordance with ASTM D-1664. If the estimated coating area is not above 95 percent, anti-stripping agents shall be added to the asphalt.
- The asphaltic mix shall be tested for its resistance to stripping by water in accordance with ASTM D-3625. If the estimated coating area is not above 95 percent, anti-stripping agents shall be added to the asphalt.

Porous Concrete

- Portland Cement Type I, II or III conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595.

- No. 8 coarse aggregate (3/8 to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8 to no. 50) per ASTM D 448.

- As mentioned above, due to the variations in aggregate, mix designs for pervious concrete vary in the different regions of the country. There is no ideal mix that will produce the same result in all locations. Local concrete suppliers who are certified to produce pervious concrete can provide a mix design that will meet the desired pavement performance. Typically for pervious concrete pavements in central Indiana the:
    - water/cement ratio varies from 0.26 to 0.40
    - concrete mixture void content varies from 15% to 25%
    - cement content is 350 lbs/cubic yard minimum for vehicular traffic loading
    - use of a hydration stabilizing admixture (HSA) is strongly recommended

Test pours are recommended to ensure adequate strength, porosity and appearance of the pervious concrete.

The Indiana Ready Mixed Concrete Association has a system of certifying installers for pervious concrete. The certified installers are listed on their website at www.irmca.com. Only certified installers shall be used for the pervious concrete installations which are to serve as storm water infrastructure and detention facilities.

Paver and Grid Systems

- Paver and grid systems shall conform to manufacturer specifications.

- A minimum flow through rate of 5 in/hr or a void percentage of no less than 10%.

Non-Woven Geotextile

- Geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:

    - Grab Tensile Strength (ASTM-D4632) ≥ 120 lbs
    - Mullen Burst Strength (ASTM-D3786) ≥ 225 psi
    - Flow Rate (ASTM-D4491) ≥ 95 gal/min/ft^2
    - UV Resistance after 500 hrs (ASTM-D4355) ≥ 70%
    - Heat-set or heat-calendared fabrics are not permitted

Pipe

- Distribution pipe within bed shall be continuously perforated and have a smooth interior with a minimum inside diameter of 4-inches. High-density polyethylene (HDPE) pipe shall meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S.

Construction Guidelines

General Guidelines for all Porous Pavements

The construction guidelines for the installation of the subsurface infiltration beds are applicable to all porous pavement systems. Guidelines are also provided specifically for pervious concrete and porous asphalt.

Subbase Excavation and Construction

- Areas for porous pavement systems shall be clearly marked before any site work begins to avoid soil disturbance and compaction during construction.

- An on-site pre-construction conference is recommended in order to inform the contractor and subcontractors of the special precautions that are required when working around porous pavements. This includes landscape crews, as the improper placement of mulch onto the porous pavement could result in localized clogging. During the pre-construction conference, the porous pavement siting requirements should be reviewed to ensure that no adverse impacts could occur to surrounding properties (basements, etc.).

- Identify the sources of storm water point discharges that could drain toward the pavement surface (roof leaders, etc.). Provide a bypass for these storm water sources during the placement and curing period of the porous pavement.

- Excavate porous pavement subsurface area to proposed depth. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake or equivalent and light tractor.

- Existing subgrade shall NOT be compacted or subject to excessive construction equipment prior to placement of geotextile and stone bed. If it is essential that equipment be used in the excavated area, all equipment must be approved by the Engineer. Use of equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires will cause excessive compaction and shall not be used.

- Bring subgrade of stone infiltration bed to line, grade, and elevations indicated in the Drawings. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before placing the stone. The bottom of the infiltration bed shall be at a level grade.

- Place geotextile and recharge bed aggregate immediately after approval of subgrade preparation to prevent accumulation of debris or sediment. Prevent runoff and sediment from entering the storage bed during the placement of the geotextile and aggregate bed.

- Place geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of 16 inches. Fabric shall be secured at least 4 feet outside of bed. This edge strip should remain in place until all bare soils contiguous to beds are stabilized and vegetated. As the site is fully stabilized, excess geotextile can be cut back to the edge of the bed.

- Install aggregate course in lifts of 6-8 inches. Compact each layer with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.

- After placement and appropriate curing of structural pavement surface (7 days for pervious concrete and 48 hours minimum for porous asphalt hardening), test infiltration ability by applying clean water at a rate of at least 5 gpm over surface. The water applied to the surface should infiltrate without creating puddles or runoff.

- Do not use the porous pavement area for equipment or materials storage; no soil shall be deposited on porous pavement surfaces.

Guidelines for Installation of Pervious Concrete

- Pervious concrete pavement shall be installed by certified contractors only.

- A pre-paving conference with the contractor and engineer is recommended one week prior to beginning placement of pervious concrete. It is recommended that the contractor have the pervious concrete supplier, the foreman and the entire concrete crew that will form and place the concrete in attendance at this meeting.

- Once placed, the pervious concrete shall remain covered and undisturbed for seven (7) days. The covering should be a waterproof polyethylene sheeting with a minimum thickness of 6 mil. This curing period is essential for adequate strength and durability.

- The use of signage is encouraged during the seven day period to minimize the potential damage to the curing concrete occurring from pedestrian traffic.

Guidelines for Installation of Porous Asphalt

- Install and compact choker course aggregate evenly over surface of stone bed. Choker base course shall be sufficient to allow for even placement of asphalt, but no thicker than 1-inch in depth.

- Appropriate vehicles with smooth, clean dump beds shall be used to transport the asphalt mix to the site. Control cooling of asphalt by covering mix. Porous asphalt mix shall not be stored for more than 90 minutes before placement.

- The porous bituminous surface course shall be laid in one lift directly over the storage bed and stone base course and compacted to a 2½-inch finished thickness.

- Compaction of the surface course shall take place when the surface is cool enough to resist a 10-ton roller. One or two passes is all that is required for proper compaction. More rolling could cause a reduction in the surface porosity and permeability, which is unacceptable

- After rolling asphalt, no vehicular traffic is permitted on the surface until cooling and hardening has taken place (minimum 48 hours).

- The use of signage is encouraged during the seven day period to minimize the potential damage to the curing concrete occurring from pedestrian traffic.

Maintenance

As with most storm water management facilities, porous pavement systems require regular maintenance to extend their life. The following table displays maintenance recommendations for porous pavement systems.

Table 4.2.6 : Porous Pavement Maintenance

Activity	Schedule
Mow grass in paver or grid system that has been planted with grass.	As needed
Vacuum porous asphalt or concrete surface with commercial cleaning unit (pavement washing systems and compressed units are not recommended).	Twice per year is recommended with minimum of once per year after last snowfall or by April 30th
Maintain records of all inspections and maintenance activity.	Ongoing

Sediment Control

Superficial dirt does not necessarily clog the voids in porous surfaces. However, dirt that is ground in repeatedly by tires can lead to clogging. Therefore, trucks or other heavy vehicles should be prevented from tracking or spilling dirt onto the pavement. Furthermore, all construction or hazardous materials carriers should be prohibited from entering a porous pavement lot. Also, by providing a 'rumble strip' surface at the entrance of a porous parking lot, the debris from tires can be isolated and later collected to avoid potential clogging of the entire lot.

Winter Maintenance

Winter maintenance for a porous parking lot may be necessary, but is usually less intensive than that required for a standard asphalt lot. By its very nature, a porous pavement system with subsurface aggregate bed has better snow and ice melting characteristics than standard pavement. Once snow and ice melt, they flow through the porous pavement rather than refreezing. Therefore, ice and light snow accumulation are generally not as problematic. However, snow will accumulate during heavier storms. Abrasives such as sand or cinders shall not be applied on or adjacent to the porous pavement. Snow plowing is acceptable, provided it is done carefully (i.e. by setting the blade about one inch higher than usual). Salt is not recommended for use as a deicer on the porous pavement. Non-toxic, organic deicers applied either as blended, magnesium chloride-based liquid products or as pretreated salt, are preferable. Any deicing materials should be used in moderation.

Repairs

Potholes are not common; though settling might occur if a soft spot in the subgrade is not removed during construction. Damaged areas that are smaller than 50 square feet can be patched with a porous or standard asphalt mix, depending on the location within the porous area. In many cases the loss of porous surface will be insignificant. If an area greater than 50 square feet is in need of repair, approval of patch type must be sought from either the engineer or owner. <u>Porous pavement must never be seal coated under any circumstances</u>. Any required repair of drainage structures should be done promptly to ensure continued proper functioning of the system.

Note:
Design of permeable pavement systems are not limited to the examples shown within this text. Successful storm water management plans will combine appropriate materials and designs specific to each site.

4.2.1 Permeable Pavement Designer/Reviewer Checklist

Type of pervious pavement(s) proposed: _______________________________________

Source of mix design or material source: _______________________________________

Item	Yes	No	N/A	Notes
Appropriate application of pervious pavement (e.g., use, traffic loading, slopes)?				
Infiltration rates measured?				
Soil permeability acceptable?				
If not, appropriate underdrain provided?				
Adequate separations from wells, structures, etc.?				
Natural, uncompacted soils specified for base?				
Level infiltration area (bed bottom)?				
Excavation in pervious pavement areas				
Hotspots/pretreatment considered?				
Storage depth limited to 8-36”?				
Drawdown time less than 72 hours?				
Positive overflow from system?				
Erosion and Sedimentation control?				
Feasible construction process and sequence?				
Geotextile specified?				
Clean, washed, open-graded aggregate specified?				
Properly designed/specified pervious pavement surface?				
Maintenance accounted for and plan provided?				
Signage provided to prevent construction traffic and compaction?				

Green Infrastructure Checklist

<u>Permeable Pavements:</u>

Site requirements for use:

- High water table depth to bottom of stone storage layer must be 4' or greater. (This is to prevent high water table from filling up detention storage area in stone.)
- If buildings adjacent to pavement have basements, make sure that the porous pavement is a minimum of 10' from the building/basement. Also, depending on soil type, a waterproof membrane may be needed on the side adjacent to the building. This should be evaluated on a case by case basis.
- If adjacent buildings don't have basements, the porous pavement should be located a minimum of 5' from the building.

Design Considerations:

- Slope of porous pavement can be flatter than traditional pavement. This helps the stone bed below it to be most efficiently used for stormwater storage. Some slope is recommended to allow for positive drainage if pavement clogs in some areas.
- Size detention basin (stone base below pavement) based on stormwater flow entering pavement. For #8 washed stone base, the void area in the stone is typically 40% of the stone volume. The stone must be wrapped in geotextile to ensure that voids in stone remain open for water storage and don't get clogged over time. The contractor can provide a sample of the stone to verify the void space for the stone used if needed.
- **No storage of stormwater on top of the pavement** (as is allowed with traditional pavement).
- **No storage of stormwater within porous pavement section**. The design must include a positive overflow from the stone bed to prevent water backing up into pavement section. (This is to prevent issues with freeze-thaw.) This could be an underdrain pipe or simply the stone base exposed so it can overflow to the lawn.
- It is recommended to discharge the overflow from the pavement stone base into a rain garden or bioretention area to improve water quality.
- If soils are adequate for infiltration there might not be runoff from the pavement (if all of it infiltrates). In this case (which is likely rare, but possible) there is no water quality volume or required treatment since there is no runoff.

Construction Considerations:

- Qualified contractors are a MUST. This means that their crew must have experience placing the pavement, not just the foreman.
- When using Portland Cement Pervious Concrete (PCPC) the pavement must remain covered for 7 days during the curing period. During this time it is critical that any stormwater be diverted from the pavement – especially roof leaders that contribute point discharges.
- Erosion control is a must - any sediment laden water shall not be allowed to flow onto the porous pavement.
- No mulch or landscaping storage shall be allowed on the pavement as it could clog the pores of the pavement and thereby reduce its ability to convey and store stormwater.
- The pavement should be tested after construction by pouring water over it to see if there are any areas that need to be cleaned or repaired due to construction activities.

4.2.2 Permeable Pavement Maintenance Inspection Checklist

Permeable Pavement - O & M Manual

Address of Property

BMP Narrative:

Regular inspection and maintenance is critical to the effective use of porous pavement. It is the responsibility of the property owner to maintain all storm water facilities in accordance with the minimum design standards required by the City of Fort Wayne and this Operations & Maintenance Manual. The local jurisdiction has the authority to impose additional maintenance required where deemed necessary. The city has the right to inspect the system and to require replacement if it fails or is a threat to public safety. Portland Cement Pervious Concrete Pavement (PCPC) is considered to be failing if water can be seen standing on it or in it (within the concrete pavement section), unless the storm event is above a 100-year event. If maintenance does not correct the problem, full or partial replacement may be required.

Porous pavement shall be in accordance with the following inspection and maintenance criteria:

Inspection Activities	**Suggested Frequency**
• Inspect to ensure that pavement was installed and working properly. • Inspect areas for potential erosion or damage to vegetation.	Post-construction
• Visibly inspect porous pavement surface after major storm event for evidence of sediment, debris (e.g., mulch, leaves, trash, etc.), ponding of water, oil-dripping accumulations, clogging of pores and other damage. • Inspect overflow devices (pipes and inlets) for obstructions or debris that would prevent proper drainage when filtration capacity is exceeded. • Ensure that the contributing area upstream of the porous pavement is free of sediment and debris.	Annually and after large storm events
• Verify that the porous pavement dewaters between storms.	Monthly
• Inspect the surface for structural integrity. Inspect for evidence of deterioration or spalling.	Annually
Maintenance Activities	**Suggested Frequency**
• Remove excess sediment from construction area and stabilize adjacent areas with vegetation.	Post-construction
• Prevent soil from being washed onto pavement by ensuring that adjacent areas are stabilized. Keep landscape areas well maintained with lawn clippings removed to prevent clogging pavement. • Rake and remove fallen leaves and debris from deciduous trees and shrubs to reduce the risk of clogging. • Remove debris and clear obstructions from overflow devices (pipes and inlets).	Annually, as needed
• Vacuum sweep porous concrete pavement (with proper disposal of removed material), followed by high pressure hosing (when needed) to free pores on the surface.	2-3 times per year
• If ponding persists, clogged concrete pavement must be repaired or	If failure exists

replaced.	

Address of property

Inspector:
Date:
Time:
Weather: Rainfall over previous 2-3 days? Site conditions:
Owner change since last inspection?: Y N

Mark items in the table below using the following key:

- **X** Needs immediate attention
- – Not Applicable
- ✓ Okay
- **?** Clarification Required

Porous Pavement Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency
PAVEMENT SURFACE	Y	N	Y	N	**M**
1. Signs of clogging (e.g. standing water)?					
2. Debris (mulch, trash) accumulation?					
3. Sediment accumulation?					
4. Standing water present?					
ADJACENT AREAS					**A, AMS**
5. Erosion from underdrain?					
6. Exposed soil in areas discharging or adjacent to the porous pavement area?					
7. Is porous pavement adversely affected by any adjacent site feature?					
DEWATERING					**A, AMS**
8. Does runoff discharge from pavement area 24 to 48 hours after the end of a storm event?					
OUTLETS/OVERFLOW SPILLWAY					**A, AMS**
9. Is outlet for storm sewer system free from debris and in good working order?					
OTHER					**A**
10. Have there been complaints from residents?					
11. Public hazards noted?					
12. Other (describe)?					

Inspection Frequency Key A= Annual, M= Monthly, AMS= After Major Storm

COMMENTS:

OVERALL CONDITION OF FACILITY:

In accordance with approved design plans? Y / N

In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N

Compliance with other consent conditions? Y / N

Comments: ____
____
____

Dates by which maintenance must be completed: ____/ ___ / ___

Dates by which outstanding information as per consent conditions is required by: ____ / ___ / ____

Inspector's signature: ______________________________________

Consent Holder/Engineer/Agent's signature: _______________________________________

Consent Holder/Engineer/Agent's name printed: ______________________________

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