

This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

.....

## SECTION 32 12 43 (SECTION 02795) - POROUS PAVING

SPECIFIER NOTE:

*resource management:* Pervious pavement (also referred to as porous paving and permeable paving) is a porous surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot storm water to infiltrate directly and receive water quality treatment. There are various porous pavement options, including: porous asphalt, pervious concrete, and grid paver systems.

Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration.

Grid paver systems are concrete interlocking paving blocks or plastic paving forms with open areas designed to allow grass to grow within the void areas.

Alternatively, loose fill permeable surfacing includes: gravel, cobbles, wood, mulch, brick, and natural stone.

For additional information, refer to the EPA National Pollutant Discharge Elimination System (NPDES) - Post-Construction Storm Water Management in New Development & Redevelopment.

<http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm>

and the Stormwater Management for Federal Facilities under Section 438 of the Energy Independence and Security Act, <http://www.epa.gov/owow/nps/lid/section438/>

*toxicity/IEQ:* It has been theorized that pervious pavement, especially pervious paving systems provide biofiltration similar to graywater systems. Two studies have been conducted on the long-term pollutant removal of porous pavement, both in the Washington, DC, area. They suggest high pollutant removal, although it is difficult to extrapolate these results to all applications of the practice.

*performance:* Systems may be subject to failure when water freezes within them in cold climates. Verify with product manufacturers for maximum load on pervious paving systems; contact the Florida Concrete Paving Association for information regarding pervious concrete paving.

Pervious pavement can be used to provide ground water recharge and to reduce pollutants in storm water runoff. Some data suggest that as much as 70 to 80 percent of annual rainfall will go toward ground water recharge. These data will vary depending on design characteristics and underlying soils. For additional information, refer to the Storm Water Technology Fact Sheet - Porous Pavement, EPA 832-F-99-023

<http://yosemite.epa.gov/water/owrccatalog.nsf/065ca07e299b464685256ce50075c11a/e60fc08b01f9edc385256d83004fd8ed!OpenDocument>

Porous pavement should be sited at least 2 to 5 feet above the seasonally high ground water table, and at least 100 feet away from drinking water wells.

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section includes:

1. Porous paving systems.
  - a. Concrete.
  - b. Asphalt.
2. Unit paver systems.
3. Loose fill permeable surfacing.

## 1.2 SUBMITTALS

- A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

**SPECIFIER NOTE:**

Green building rating systems often include credit for materials of recycled content. USGBC-LEED™ v3, for example, includes credit for materials with recycled content, calculated on the basis of pre-consumer and post-consumer percentage content and it includes credit for use of salvaged/recovered materials. Green Globes US also provides points for reused building materials and components and for building materials with recycled content.

1. Recycled Content:
  - a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.
  - b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
  - c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
  - d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.

**SPECIFIER NOTE:**

Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation. Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor. USGBC-LEED™ v3, for example, includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes US also provides points for materials that are locally manufactured.

2. Local/Regional Materials:
  - a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
  - b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
  - c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
  - d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

**SPECIFIER NOTE:**

On hot summer days, urban air can be 2-10 degrees Fahrenheit hotter than the surrounding rural areas. Not to be confused with global warming, scientists call this phenomenon the "urban heat island effect." Heat islands form as vegetation is replaced by low reflectivity materials such as dark colored paving. These surfaces absorb – rather than reflect – the sun's heat, causing surface temperatures and overall ambient temperatures to rise. The displacement of trees and shrubs eliminates the natural cooling effects of shading and evapotranspiration (a natural cooling process in which water transpires from a leaf's

surface and evaporates into the atmosphere, reducing ambient temperature). Refer to the EPA's Heat Island Reduction Initiative for additional information, <http://www.epa.gov/heatisland/index.htm>

USGBC-LEED™ v3 includes credit for reducing the heat island effect. To qualify, vegetated surfaces and/or high-albedo materials are necessary. USGBC identifies high-albedo materials for non-roof areas as materials with a Solar Reflectance Index (SRI) of at least 29. The SRI is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371.

For roofing, USGBC provides credit for low-slope roofs with a minimum SRI of 78 and for steep-slope roofs with a minimum SRI of 29.

Green Globes – US also requires measures to reduce heat build-up on the roof (i.e. either high-albedo roofing materials (reflectance of at least 0.65 and emissivity of at least 0.9), OR a green roof, OR a combination of both high-albedo materials and green roof ).

To qualify for an Energy Star label:

- Low Slope roofs must have an initial solar reflectance of  $\geq 0.65$ . After 3 years, the solar reflectance must be  $\geq 0.50$ .
- Steep Slope roofs must have an initial solar reflectance of  $\geq 0.25$ . After 3 years, the solar reflectance must be  $\geq 0.15$ .

3. Albedo data: Provide information identifying the **[SRI] [solar reflectance]** of the following products provided under work of this Section:

a. Pavement.

B. Operating and Maintenance Manuals Submittals:

SPECIFIER NOTE:

The marking system indicated below is intended to provide assistance in identification of products for making subsequent decisions as to handling, recycling, or disposal.

Society of Plastic Inc. resin codes are easily recognized by the consumer. These are the numerical designations within chasing arrows. At the present time there is not a separate resin code for PLA (bio-resins). PLA (bio-resins) are classified as #7 (Other). Nor are there specific indications for additives or blends. The Society of Plastics resin code symbols are common for plastic packaging materials; for example:



ASTM D1972 standard specifies a resin code that provides substantially more information regarding the plastic resin, including blends and additives. ASTM D1972 labeling protocols are not common for packaging materials; however, they are recognized and utilized in the construction industry and other industry sectors. Many construction products are labeled according to ASTM D1972. Such detailed information is anticipated to be necessary data for future deconstruction (and recycling) efforts. Therefore, plastic construction products and plastic components of assemblies should be labeled in accordance with ASTM D1972. Example for a polypropylene containing 30 mass percentage of mineral powder use:

>PP-MD30<

- a. Verify that plastic products, including plastic components in assemblies, to be incorporated into the Project are labeled in accordance with ASTM D1972. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.
  - 1) Products made from compositions containing a single filler, reinforcing, or other modifying material in a concentration of more than one percent by mass shall be marked with the abbreviated term for the polymer, followed by a dash, then the abbreviated term or symbol for the additive, with its percentage by mass, arranged as shown in the example and set off with brackets. For example, a polypropylene containing 30 mass percentage of mineral powder use would be labeled: >PP-MD30<

### 1.3 QUALITY ASSURANCE

- A. Installer Certification:
  1. For porous paving installations, provide Pervious Concrete Contractor Certification from the National Ready Mixed Concrete Association.
- B. Field-Constructed Mockup: Install minimum 225 square feet to demonstrate typical joints, surface finish, texture, color, permeability, and standard of workmanship.
  1. When Architect determines that mockup does not meet requirements, demolish and remove it from the site and install another until the mockup is accepted.
  2. Keep accepted mockup undisturbed during construction as a standard for judging completed paving.
  3. Accepted mockup may be incorporated into final work when approved by Architect.

## PART 2 - PRODUCTS

### SPECIFIER NOTE:

EO 13423 includes requirements for Federal Agencies to use “sustainable environmental practices, including acquisition of biobased, environmentally preferable, energy-efficient, water-efficient, and recycled-content products”

Specifically, under the Sustainable Building requirements per Guiding Principle #5 Reduce Environmental Impact of Materials, EO13423 directs Federal agencies to “use products meeting or exceeding EPA’s recycled content recommendations” for EPA-designated products and for other products to “use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project.”

Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. <http://www.ofee.gov/execorders.asp> It expands upon the environmental performance requirements of EO 13423.

[http://www1.eere.energy.gov/femp/regulations/printable\\_versions/eo13423.html](http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html)

EO 13514 sets numerous federal requirements in several areas, including sustainable buildings and communities. Federal agencies must implement high performance sustainable federal building design, construction, operation and management, maintenance, and deconstruction, including:

- Ensuring all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.

- Ensuring all new construction, major renovations, or repair or alteration of Federal buildings comply with the Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings <http://www1.eere.energy.gov/femp/pdfs/mouhighperfsustainfedfac.pdf>
- Ensuring at least 15% of existing agency buildings and leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress towards 100% compliance across its building inventory.

## 2.1 POROUS CONCRETE PAVING

### SPECIFIER NOTE:

Coordinate with Engineer for mix design requirement to satisfy project needs.

- A. Installed system:
1. Albedo: Minimum **[Solar Reflectance of 0.3] [Solar Reflectance Index (SRI) of 29]**.
  2. Permeability: Minimum permeability rate **[60] [xxxx]** percent or not less than an infiltration rate of 1.1 inc./hr. for a 20-year design life. Determine the field water infiltration rate of in place pervious concrete in accordance with ASTM C1701.
  3. Density and void content: Determine the density and void content of freshly mixed pervious concrete in accordance with ASTM C1688. Verify that mixture proportions are as designed.

## 2.2 POROUS ASPHALT PAVING

### SPECIFIER NOTE:

Coordinate with Engineer for mix design requirement to satisfy project needs.

- A. Asphalt Cement:

### SPECIFIER NOTE:

Green building rating systems often include credit for materials of recycled content and may distinguish allowable credit for post-consumer and post-industrial (or pre-consumer) recycled content. USGBC-LEED™ v3, for example, factors 100 percent of post-consumer recycled content but only 50 percent of pre-consumer (post-industrial) recycled content into calculations for its recycled content materials credit. LEED v3 grants one credit to a project for using materials with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial content constitutes at least 10 percent of the total value of the materials in the project; 10% (post-consumer + 1/2 post-industrial). It grants an additional point for 20% (post-consumer + 1/2 post-industrial).

Green Globes US also provides points for reused building materials and components and for building materials with recycled content.

Recycled content is typically determined by calculating the weight of the recycled material divided by the total weight of the product and expressed as a percentage by weight. (The recycled content “value” of a product as assessed under LEED is determined by multiplying the recycled content percentage and the cost of the product.)

Verify with manufacturer for product availability and recycled content.

1. Recycled Content: Minimum **[5] [10] [xxxx]** percent post-consumer recycled content, or minimum **[20] [40] [xxxx]** percent pre-consumer recycled content at Contractor’s option.
- B. Recycling Agents: Comply with ASTM D5505; Class ER **[1] [2] [3]**.
1. Hot recycling agents: Comply with ASTM D 4552 for hot recycling; Grade RA **[1] [5] [25] [75] [250] [500]**. Evaluate blends in accordance with ASTM D 4887.
- C. Installed system:
1. Permeability: Minimum permeability rate **[60] [xxxx]** percent.

## 2.3 UNIT PAVER SYSTEMS

- A. Concrete paver systems:
  - 1. Concrete grid paver units: Comply with ASTM C1319.
  - 2. Interlocking concrete paver units: Comply with ASTM C 936.
  - 3. Average compressive strength of 8,000 psi (55 MPa) with no individual unit under 7,200,psi (50 MPa).
  - 4. Maximum 1 percent loss in dry mass per unit in minimum 50 freeze-thaw cycles when tested according to ASTM C 67.
- B. Plastic paver forms:
  - 1. Recycled Content: Minimum [5] [10] [xxxx] percent post-consumer recycled content, or minimum [20] [40] [xxxx] percent pre-consumer recycled content at contractor's option.
- C. Installed system:
  - 1. Permeability: Minimum permeability rate [60] [xxxx] percent or not less than an infiltration rate of 1.1 inc./hr. for a 20-year design life.

#### 2.4 LOOSE FILL PERMEABLE PAVING

- A. Coarse Aggregate: Crushed concrete or blast furnace slag complying with ASTM D692; Recycled porcelain or other non-traditional aggregate material complying with ASTM D6155.
  - 1. Recycled Content: Minimum [5] [10] [xxxx] percent post-consumer recycled content, or minimum [20] [40] [xxxx] percent pre-consumer recycled content at contractor's option.
- B. Mulch: As specified in Section 32 90 00 (02900) – Planting.
- C. Installed system:
  - 1. Albedo: **[Minimum Solar Reflectance of 0.3] [Solar Reflectance Index (SRI) of 29]**
  - 2. Permeability: Minimum permeability rate [60] [xxxx] percent or not less than an infiltration rate of 1.1 inc./hr. for a 20-year design life.

#### 2.5 ACCESSORIES

- A. Paver Bedding And Joint Sand: As recommended by paver manufacturer and as follows:
  - 1. Clean, non-plastic, free from deleterious or foreign matter, natural or manufactured from crushed rock.
  - 2. Sieve according to ASTM C 33, No. 8 stone; bedding and joint aggregate conforming to gradation, 1/2 inch 100 percent passing, 3/8 in. 85-100 percent, No. 4 10-30 percent, No. 8 0-10 percent, No. 16 0-5 percent. Joint material may also conform to No. 89 crushed stone or finer material at contractor's option.
  - 3. Screenings and stone dust are not permitted.
  - 4. Sand having material passing the No. 200 (0.075 mm) sieve is not permitted.

**SEPCIFIER NOTE:**

Where a reservoir is used, the stone reservoir below the pavement surface should be composed of layers of small stone directly below the pavement surface, and the stone bed below the permeable surface should be sized to attenuate storm flows for the storm event to be treated. Typically, porous pavement is sized to treat a small event, such as a water quality storm (i.e., the storm that will be treated for pollutant removal), which can range from 0.5 to 1.5 inches. As in infiltration trenches, water can be stored only in the void spaces of the stone reservoir.

- B. Reservoir stones: ASTM C 33 No. 57 crushed concrete or other recycled materials, gradation 1 1/2 in. 100 percent passing, 1 in. 95-100 percent, 1/2 in. 25-60 percent, No.4 0-10 percent, No.8 0-5 percent.
  - 1. Recycled Content: Minimum **[5] [10] [xxxx]** percent post-consumer recycled content, or minimum **[20] [40] [xxxx]** percent pre-consumer recycled content at contractor's option.

**SPECIFIER NOTE:**

Water is conveyed to the stone reservoir through the surface of the pavement and infiltrates into the ground through the bottom of this stone reservoir. A geosynthetic liner and sand layer should be placed below the stone reservoir to prevent preferential flow paths and to maintain a flat bottom.

- C. Geotextile fabric: Comply with AASHTO M288 based on application and installation conditions. Verify compatibility between geotextile and adjacent soils for filtration, clogging and permeability.
- D. Edge restraints: **[Concrete] [xxxx]**.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Verify compacted subgrade, granular base or stabilized soil is acceptable and ready to support paving and imposed loads.
  - 1. Verify subsoils have a permeability between 0.5 and 3.0 inches per hour.
  - 2. Compact to minimum 95 percent Standard Proctor Density per ASTM D 698 for pedestrian areas.
  - 3. Compact to 95 percent Modified Proctor Density per ASTM D 1557 for areas subject to heavy vehicular traffic.
  - 4. Verify that geotextiles, if applicable, have been placed in accordance to specifications and drawings.
- B. Reservoir stones: Verify gradients and elevations of base are correct.
  - 1. Install so that the bottom of the stone reservoir is flat and graded such that infiltrated runoff will be able to infiltrate through the entire surface.
- C. Install edge restraints per the drawings and manufacturer's recommendations.

### 3.2 INSTALLATION

- A. Install pervious paving system(s) in accordance with manufacturer's recommendations and as indicated.
- B. Final Surface:
  - 1. Tolerances: Maximum variation **[3/8 inch (10 mm)] [xxxx]** under a 10 ft (3 m) long straight edge.
  - 2. Install surface elevation of the paving system 1/8 to 1/4 inch (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

END OF SECTION