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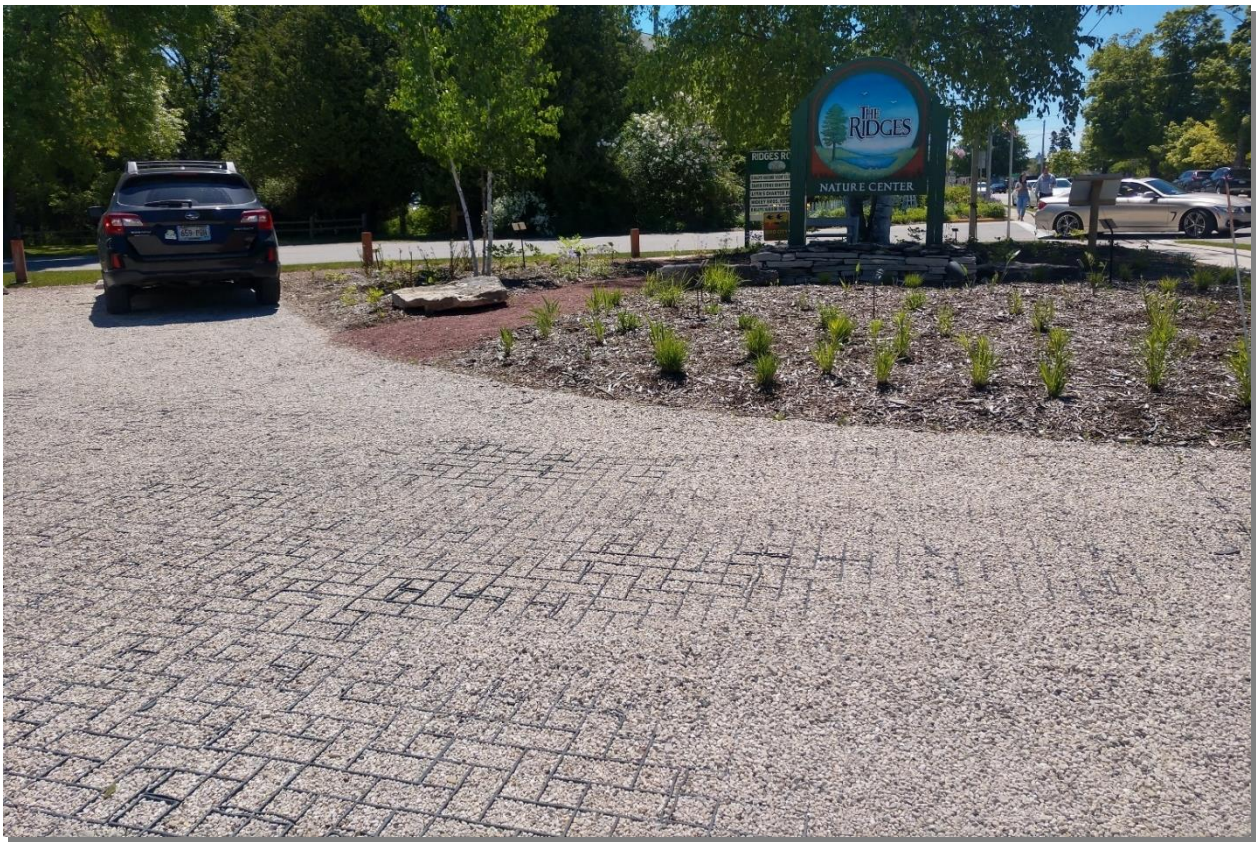
GEOPAVE®

AGGREGATE POROUS PAVEMENT SYSTEM

DESIGN & CONSTRUCTION OVERVIEW



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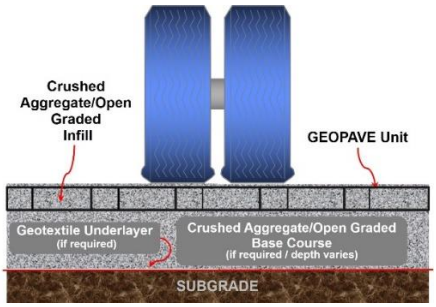
GEOPAVE® Porous Pavement System

The GEOPAVE Porous Pavement System with open-graded aggregate infill provides a permeable and stabilized surface to support both vehicular, and pedestrian traffic.

The GEOPAVE porous pavement system includes the following components:

1. GEOPAVE panel.
2. Open-graded aggregate base.
3. Geotextile (enhanced woven on non-woven) separation layer (if required).
4. Panel anchorage (if required).
5. Sub-drain system (if required).
6. Delineation markers (if required).



GEOPAVE Porous Pavement System

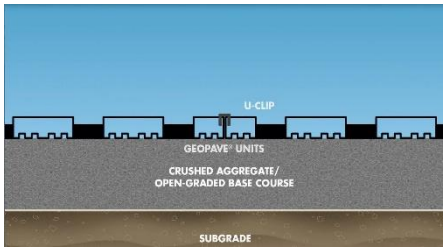
DESIGN Considerations

FUNCTION of the GEOPAVE System Components

Structure

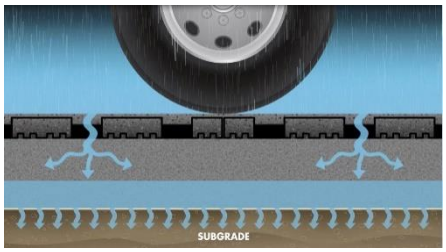
The GEOPAVE panels are designed to:

1. Create a structural framework designed to confine and stabilize open-graded aggregate that provides a permeable surface and stormwater infiltration.
2. Prevent aggregate from migrating downward through the monolithic mesh bottom in the panel structure.
3. Provide load bearing capacity for vehicular traffic exceeding AASHTO H/HS-25 loadings using an open-graded aggregate.
4. The GEOPAVE panels are semi-rigid pavers featuring interconnected cell walls, which are securely joined using durable U-CLIP connectors. This integrated system provides superior load distribution, enabling the use of less base material compared to lighter-weight or rolled systems.



Aggregate Base

For an applied load over an existing subgrade, support is provided by both the GEOPAVE panel and, if necessary, an aggregate base.



The aggregate base also functions as an on-site stormwater retention system, allowing stormwater to be temporarily stored, and gradually infiltrate into the sub grade. The Engineer shall determine if edge restraint is necessary to maintain base stability during installation, compaction, and under anticipated vehicle loads.

Function of the GEOPAVE Infill

An open-graded, crushed aggregate with little to no fines content is recommended to provide a highly permeable system that facilitates rapid stormwater infiltration.

OPTIONAL Components

Geosynthetic Separation Layer (if required)

In certain conditions, a geosynthetic layer may be necessary between the sub grade and base. The geosynthetic layer can serve one or more functions depending on site requirements: 1) reinforcement using enhanced woven geotextiles, 2) separation/filtration using enhanced woven or non-woven geotextiles and, 3) drainage geosynthetics using geonets or piping. The geotextile shall be installed in accordance with Manufacturer recommendations. Slit tape woven geotextiles are not advised due to their poor drainage characteristics.

Sub-Drain (if required)

If the GEOPAVE panels are installed over non-porous soils and an excavation creates conditions where water may become trapped, sub drainage becomes a necessary component of the system. Proper sub-drainage helps prevent water accumulation that could degrade the subbase and compromise its bearing capacity.

SPECIFICATION Details:

Material Properties & Panel Dimensions

GEOPAVE panels are manufactured using materials that meet the physical and chemical specifications. Each GEOPAVE panel shall have a minimum deflection 1.0 in (25 mm) without failure when supported at 40 in (0.50 m) centers at 70°F (21°C). All panels within a single pallet shall exhibit consistent coloration.

GEOPAVE panels shall have physical dimensions as specified in Tables 1. Each panel shall feature a herringbone-style cell pattern consisting of both small and large cells, incorporating a monolithic mesh bottom and vented sidewalls. The mesh bottom consists of square openings measuring 0.25 in x 0.25 in (6.35 mm x 6.35 mm) openings. Small cells include vented side wall openings that are 1.0 in (25 mm) high and 0.50 in (12 mm) wide, with either 4 or 6 openings per cell to facilitate infill lock-up and lateral drainage between cells. Large cells contain 12 vented sidewall openings per cell.

The GEOPAVE panels shall be connected using U-CLIPS at both side-to-side and end-to-end connections, specifically where the short cell sidewalls of adjacent panels align. Each panel requires a total of 12 U-CLIPS for proper installation. The connection points will vary based on the selected laying pattern (See Laying Patterns). Any warping at the panel joints whether end-to-end or side-to-side shall not result in a gap exceeding 0.25 in (6 mm) between the outer walls. The finished GEOPAVE system shall form a uniformly connected, laterally integrated porous pavement system.

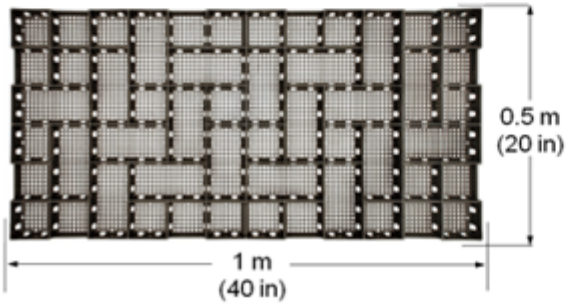
GEOPAVE Aggregate Infill

The infill material shall consist of an open-graded, crushed aggregate with particle sizes ranging from 0.375 to 0.50 inches (9.5 to 13 mm) with little to no fines (>5%).

Table 1 GEOPAVE Specification Summary

Item	Specification & Details
Material	Up to 100% Recycled Polyethylene *
Color	Ranges Dark Shades Gray to Black
Chemical Resistance	Superior
Carbon Black for Ultraviolet Light Stabilization	1.5% - 2.0%
Minimum Crush Strength (Empty) @ 70°F (21°C)	175 psi (1,202 KPa)
Minimum Crush Strength (Aggregate Filled) @ 70°F (21°C)	5,160 psi (35,625 KPa)
Flexural Modulus @ 70°F (21°C)	35,000 psi (240,000 kPa)
Nominal Dimensions (width x length)	20 in x 40 in (0.5 m x 1.0 m)
Nominal Depth	2.0 in (50 mm)
Nominal Coverage Area	5.38 ft² (0.5 m²)
Cells per Panel	50
Small Cell Size	3.25 in x 3.25 in (83 mm x 83 mm)
Large Cell Size	3.25 in x 6.5 in (83 mm x 165 mm)
Top Open Area	90.5%
Bottom Open Area	32.6%
Bottom Mesh Opening Size	0.25 in x 0.25 in (6.35 mm x 6.35 mm)
Nominal Weight	7.6 lb (3.4 kg)
Runoff Coefficient @ 2.5 in/hr (64 mm/hr) Rainfall	0.15
Panels per Pallet	46

- * The percentage of recycled content may vary based on availability of recycled materials.
- Dimensions and weight are subject to manufacturing tolerances and can be influenced by recycled components.
- End-to-end or side-to-side warp of the GEOPAVE panel shall not exceed 0.5 in (6 mm).
- Avoid specifications that state material compressive strength alone. Material compressive strength, with applied safety factors must be adequate to resist both compressive and lateral loads. Ultra-high compressive strength adds little value to a porous pavement system.



Nominal Dimensions

Cell Configuration

Aggregate Base Material

The base material shall consist of an open-grade crushed aggregate with particle sizes ranging from 0.375 to 1.0 in (9.5 mm to 25 mm) with little to no fines. The base material shall have a D_{50} of 0.5 in (13 mm). The aggregate shall be compacted in accordance with the Engineer's specifications. Upon compaction, the surface must be uniform, free of irregularities, and without protrusions from larger aggregate particles. All base edges shall be properly constrained to maintain structural integrity.

Table 2 GEOPAVE Aggregate Base Recommendation

Load Rating[1]	Depth of Base	
	Aggregate	
	CBR[2] 2 – 4	*CBR[1] >4*
Heavy Fire Truck Access & H/HS-25, H/HS-20 loading. Typical 110 psi (758 kPa) maximum tire pressure. Single axle loadings of 40 kips (178 kN), tandem axle loadings of 48 kip (220 kN). Gross vehicle loads of 90,000 lbs (40.1 MT).	6 in (150 mm)	6 in (150 mm)
Light Fire Truck Access & H/HS-15 loading. Typical 85 psi (586 kPa) maximum tire pressure. Single axle loadings of 24 kips (110 kN). Gross vehicle loads of 60,000 lb (27.2 MT).	6 in (150 mm)	4 in (100 mm)
Utility & Delivery Truck Access & H/HS-10 loading. Typical 60 psi (414 kPa) maximum tire pressure. Single axle loadings of 16 kips (75 kN). Gross vehicle loads of 40,000 lbs (18.1 MT).	4 in (100 mm)	2 in (50 mm)
Cars & Pick-up Truck Access. Typical 45 psi (310 kPa) maximum tire pressure. Single axle loadings of 4 kips (18 kN). Gross vehicle loads of 8,000 lbs (3.6 MT).	2 in (50 mm)	None[3]
Trail Use. Pedestrian, wheelchair, equestrian, bicycle, motorcycle, and ATV/UTV traffic.	None[3]	None[3]

[1] The GEOPAVE system can be installed in areas where loadings exceed those listed above. In these situations, contact Presto Geosystems for specific recommendations.

[2] CBR stands for California Bearing Ratio (CBR). There are various methods for determining CBR, ranging from sophisticated laboratory methods to simpler field identification methods involving hand manipulation of the soil. Presto does not recommend any specific method, but it is important the user to have a high degree of confidence in the results obtained from the chosen method. If soil strength values other than CBR are available, use correlation charts to convert these to CBR.

[3] **A minimum of 2 in (50 mm) of aggregate base should be placed below the GEOPAVE panels as a drainage layer and an infiltration storage area. Greater depth may be required depending upon design rainfall needs and sub-base permeability.**

Design Considerations for System Structural Integrity

Elements Important to Structural Integrity

To effectively support loads, the GEOPAVE panel (or any other porous paver system) must have six primary characteristics as outlined below:

1. **SUITABLE WALL STRENGTH:** The wall strength must be capable of supporting wheel loads from the heaviest vehicles expected to travel over the porous pavement system. These loads will apply direct compression forces on the walls from tires and equipment outriggers, along with lateral forces resulting from breaking and acceleration. The walls design should ensure resistance to both vertical and lateral deformation under these loadings. Extra caution is advised when selecting systems with thin wall construction.

2. **SUFFICIENT PANEL STIFFNESS:** The panel must be stiff enough to accommodate deflections without panel breakage or separation when subgrade soils shift under load. If the panel is too flexible, the subgrade will absorb the vehicle load, potentially leading to failure. Conversely, excessive panel rigidity may cause the panel to break under typical loads, especially in low temperatures. Extra caution is advised when selecting systems that are either too flexible or too rigid.

3. **SIGNIFICANT JOINT STRENGTH:** The joint must be capable of effectively transferring load between panels while remaining engaged under typical deflection conditions. Some deflection is expected due to the natural flexibility of plastics and soils. A high shear-strength at the joint enhances load distribution, minimizing stress on the base and subgrade. If the joint lacks adequate shear strength, each panel may bear loads independently, increasing the risk of structural failure. Extra caution is advised when selecting systems with minimal or no physical material in the joint.

4. **SUPPORTING BASE:** The supporting base must have adequate edge restraints and a large contact area with the subgrade to effectively distribute heavy wheel loads at the top of the panel down to the subgrade. This design approach enhances overall stability. Extra caution is advised when selecting systems with minimal contact area between the panel and the subgrade.

5. **LARGE OVERALL AREA:** A larger overall panel area, combined with other key design features, ensures maximum load distribution. If panel separation occurs and the panels function independently, larger panel areas will reduce the stress on the subgrade. Extra caution is advised when using systems with smaller contact areas due to their limited ability to dissipate loads effectively.

6. **MONOLITHIC MESH BOTTOM:** The panel shall feature a properly sized, monolithic mesh bottom designed to encapsulate the aggregate infill and prevent material loss through the base during repeated loading and freeze-thaw cycles. Without a mesh bottom, the panels may gradually lift over time. Extra caution is advised when using systems without monolithic mesh bottoms.

Elements Not Important to Structural Integrity

Avoid material specifications that state material compressive strength only if a sand base is specified. Instead, ensure that the material compressive strength, including safety factors is sufficient to support both vertical and lateral loads. In porous pavement systems, extremely high compressive strength provides minimal added benefit. Table 1 outlines the strength characteristics of the GEOPAVE porous pavement system, demonstrating a balanced designed system that meets all critical requirements for structural integrity and performance

Installing the GEOPAVE® System

Prepare the Subgrade

Excavate the area, allowing for the GEOPAVE panel thickness and the base depth (where aggregate base is required).

- When working with a subgrade that has poor permeability, provide adequate drainage from the excavated area if there is the potential to collect water.
- The subgrade should be relatively dry and free from any standing water.

Finish-grade the surface of the subgrade specifically when the GEOPAVE panel is to be installed without additional base material. Level and clear the area of large objects such as rocks, pieces of wood, etc. to enable the GEOPAVE panels to connect properly and remain stationary after installation.

The sub grade shall be compacted to the Engineer’s specifications. Caution should be exercised to ensure that the porous subbase not be over compacted such that porosity is hindered.

Geotextile Separation Layer (if specified)

The geotextile should be installed in accordance with Manufacturer's recommendations, ensuring the specified overlaps are maintained. The overlap must be based on subgrade CBR and AASHTO M288 requirements.

Sub-Drainage Component (if specified)

If required and/or specified by the project engineer, install the specified geonet, sub-drain or outlet piping in accordance with the plans and specifications. Ensure that a proper slope is maintained throughout the drainage system and the outlet is free from any obstructions to allow free drainage.

Prepare the Base

If required, install the specified aggregate base over the prepared sub grade, compact in accordance with the Engineer's specifications.

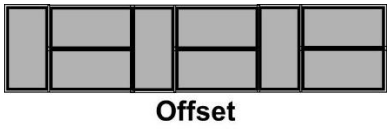
The Engineer shall determine if edge restraint is required to ensure the base is stable during installation, compaction and under expected vehicle loads. The Engineer shall be responsible for the design and stability of the base. Upon compaction, the surface must be uniform, free of irregularities, and without protrusions from larger aggregate particles.

Install the GEOPAVE Panels

Orientation & Laying Pattern of Panels
Place the GEOPAVE panels with the square hole to the ground. Install panel pattern as indicated on the drawings.

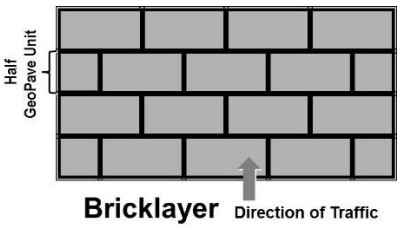
OFFSET PATTERN:

For narrow access lanes, stagger the panels to create an offset pattern. This layout enhances structural stability and visual alignment within confined spaces.



BRICKLAYER PATTERN:

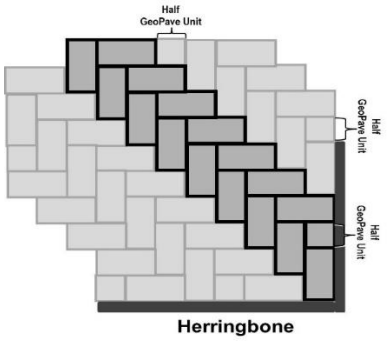
For one-way lanes, stagger the panels in a bricklayer pattern so its length runs perpendicular to the direction of travel. This configuration enhances load distribution and structural integrity.



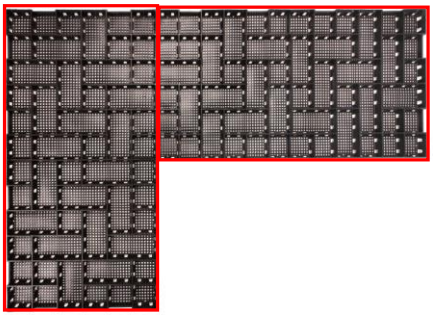
HERRINGBONE PATTERN:

For areas with multi-directional traffic, stagger the panels to form a herringbone pattern. This layout reduces continuous straight seams to one and a half block lengths, enhancing load distribution and durability.

The staggered pattern is developed by using half GEOPAVE panels by field cutting a full panel and placing them as shown. The panels should be trimmed to follow site contours and accommodate obstructions. This final seam pattern maximizes load transfer and structural support.



Positioning of Panels



If applicable, ensure that all adjacent hard-surfaced paving work around the perimeter is completed before installing the GEOPAVE panels.

Place the first row of GEOPAVE panels against a stationary edge, when available. Ensure the panel corners and seams are flush with the intended surface elevation to prevent protrusions. Abut adjoining panels to form the desired laying pattern.

Fully installed GEOPAVE panels should be at or below the existing elevation

Fixing GEOPAVE Panels to Corners & Curves

If applicable, the GEOPAVE panels can be field cut to fit around corners and curves. Edge restraints are required to create a closed “cell” that can be infilled.

If cutting the panels is not desired, the panels can be offset such that the GEOPAVE coverage approximates the corner or curve feature. Edge restraints are required.

GEOPAVE panels can be cut to fit around existing structures, such as manhole covers. Connect the cut GEOPAVE panels as usual.

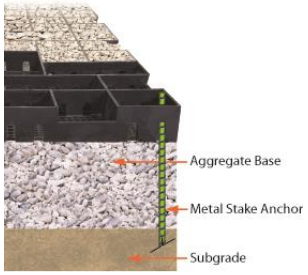
Connect Panels with U-CLIPS

Secure adjoining GEOPAVE panels together using the U-CLIP connection device. A total of 12 U-CLIPS are required for each panel. U-CLIPS shall be set in place by hammer at all the half-wall locations and driven completely so that adjacent sections have horizontally level profiles.

Exercise caution to assure that no material is trapped between adjacent panels prior to the placement of U-CLIPS.

Anchoring Panels

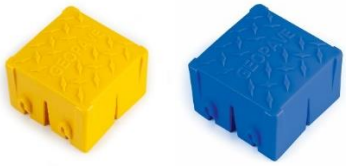
If specified, secure the GEOPAVE panels with ATRA Speed Stakes, No. 4 rebar, or earth anchors to prevent movement of the panels. Refer to Figure 11. Anchoring may be necessary if the GEOPAVE panels are placed on a slope (5-10%). Actual anchorage pattern will be based on the vehicle loading, sub grade strength, and slope angle. Contact Presto Geosystems for anchorage recommendations.



The anchors can be driven through the cell-wall vent holes either in the middle of the GEOPAVE panels or along the perimeter as required.

Anchoring panels in-place should occur after installation of all the panels within the defined area.

Optional SNAP Delineators



If specified, install GEOPAVE SNAP Delineators as required in the panels to indicate parking lines.

The delineators are snapped into GEOPAVE panels and are held in place with tabs that match vents in the GEOPAVE cells. Delineators may be placed in the square or rectangle cells. Place the delineators as frequently as required to meet visual and local agency requirements.

SNAP Delineators should be placed after installation of the panels and before installation of the infill material.

Infill the GEOPAVE Panel

Infill the GEOPAVE panels with the specified material. Infilling should take place immediately after the panels are installed to minimize movement of the panels. During periods of hot weather, the GEOPAVE panels shall be filled immediately after being placed to avoid thermal expansion of the panels.

Place each successive pile of aggregate at the edge of previously filled GEOPAVE panels and spread with a skid steer, small tractor, or small loader. Spread the infill material evenly across the panels. Hand raking should be performed to assure that the infill is at the top of the cell walls. The panels can be driven on without being filled.

Delineation

While the GEOPAVE SNAP delineator provides effective visibility, additional delineation methods may be desired. These can include delineation markers, in-ground or above ground

curbing, shrubbery, vegetation, perimeter lighting, or other suitable systems to enhance visibility and site definition.

Maintenance

Aggregate Surface

The panel surface should be inspected periodically to identify signs of cell infill loss. If any loss is detected, additional aggregate material should be added to maintain system performance.

Snow Removal

If snow removal is necessary, use standard methods including shovels, snowblowers and snowplows, ensuring the blades are kept 1-inch (25 mm) above the surface.

When snowplowing the panels, use a plow blade with a flexible rubber edge and 1-inch skids on the corners to prevent direct contact with the grass and panels.

Limited Warranty

Presto Geosystems warrants each GEOPAVE® panel which it ships to be free from defects in materials and workmanship at the time of manufacture. Presto’s exclusive liability under this warranty or otherwise will be to furnish without charge to Presto's customer at the original f.o.b. point a replacement for any section which proves to be defective under normal use and service during the 10-year period which begins on the date of shipment by Presto. Presto reserves the right to inspect any allegedly defective panel to verify the defect and ascertain its cause.

This warranty does not cover defects attributable to causes or occurrences beyond Presto's control and unrelated to the manufacturing process, including, but not limited to, abuse, misuse, mishandling, neglect, improper storage, improper installation, improper alteration, or improper application.

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