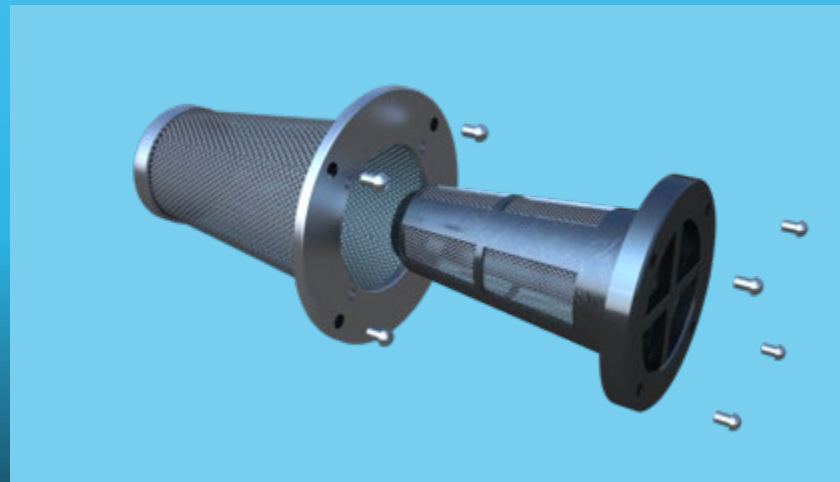


Innovations in Retaining Structure Drainage Extending Asset Service Life

David Heilman, CEO JET Filter Systems

Dheilman@jetfiltersystem.com



”Our infrastructure needs simple solutions that deliver immediate and sustainable results” (2018 NBPPC, Orlando)

1. Quick Refresh
2. Inspection: Signs of Failure
3. New Product Innovation
4. Resources
5. Project Examples

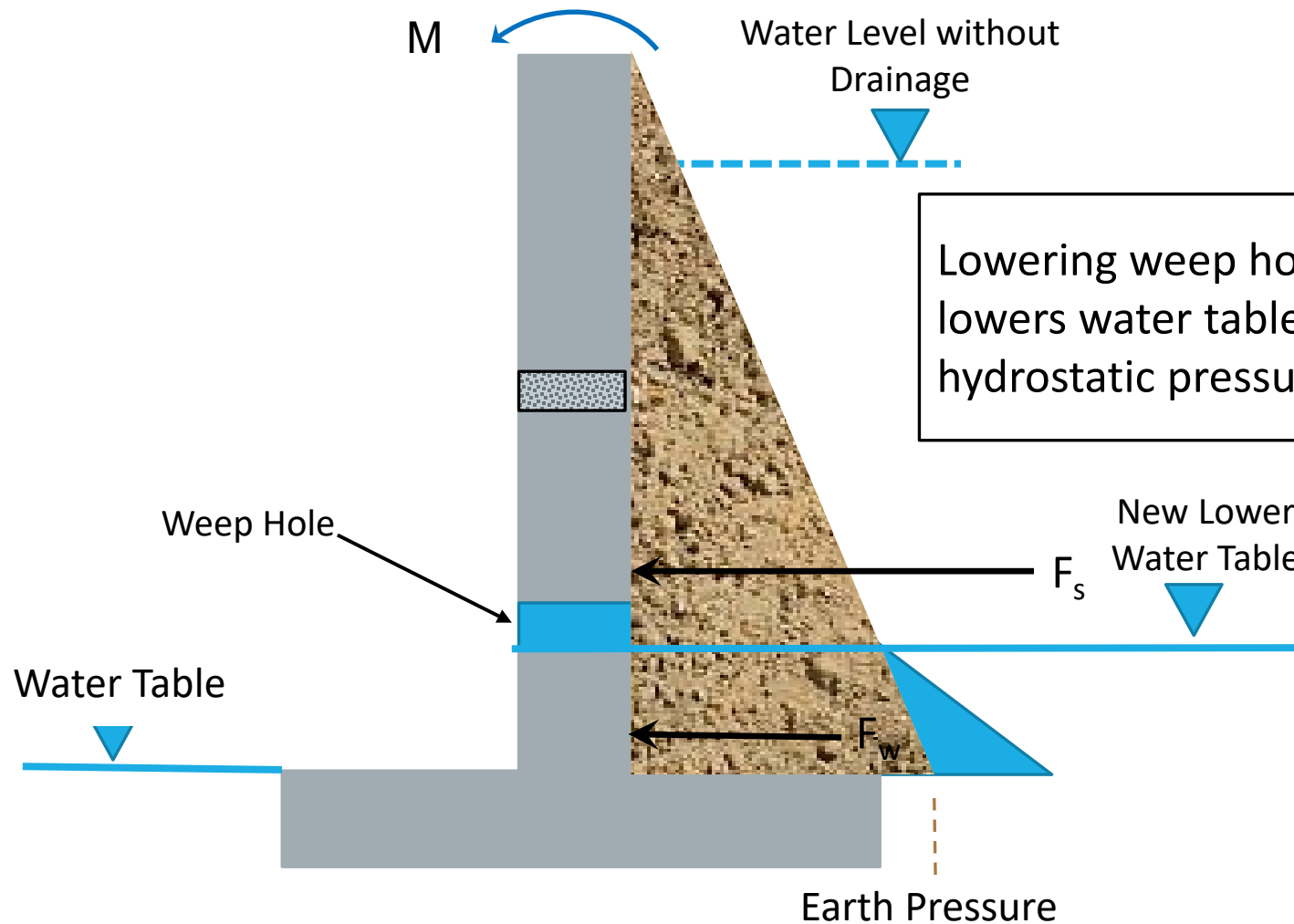
Maintainable Weep Hole Filters.

VARIETY OF EARTH RETAINING STRUCTURES



Plus, tunnels, wing walls and more.

MINIMIZE HYDROSTATIC PRESSURE



Lowering weep hole position, lowers water table and reduces hydrostatic pressure and moment.

Hydrostatic pressure dependent on drainage elevation.

DECREASING PERMEABILITY WITH TIME

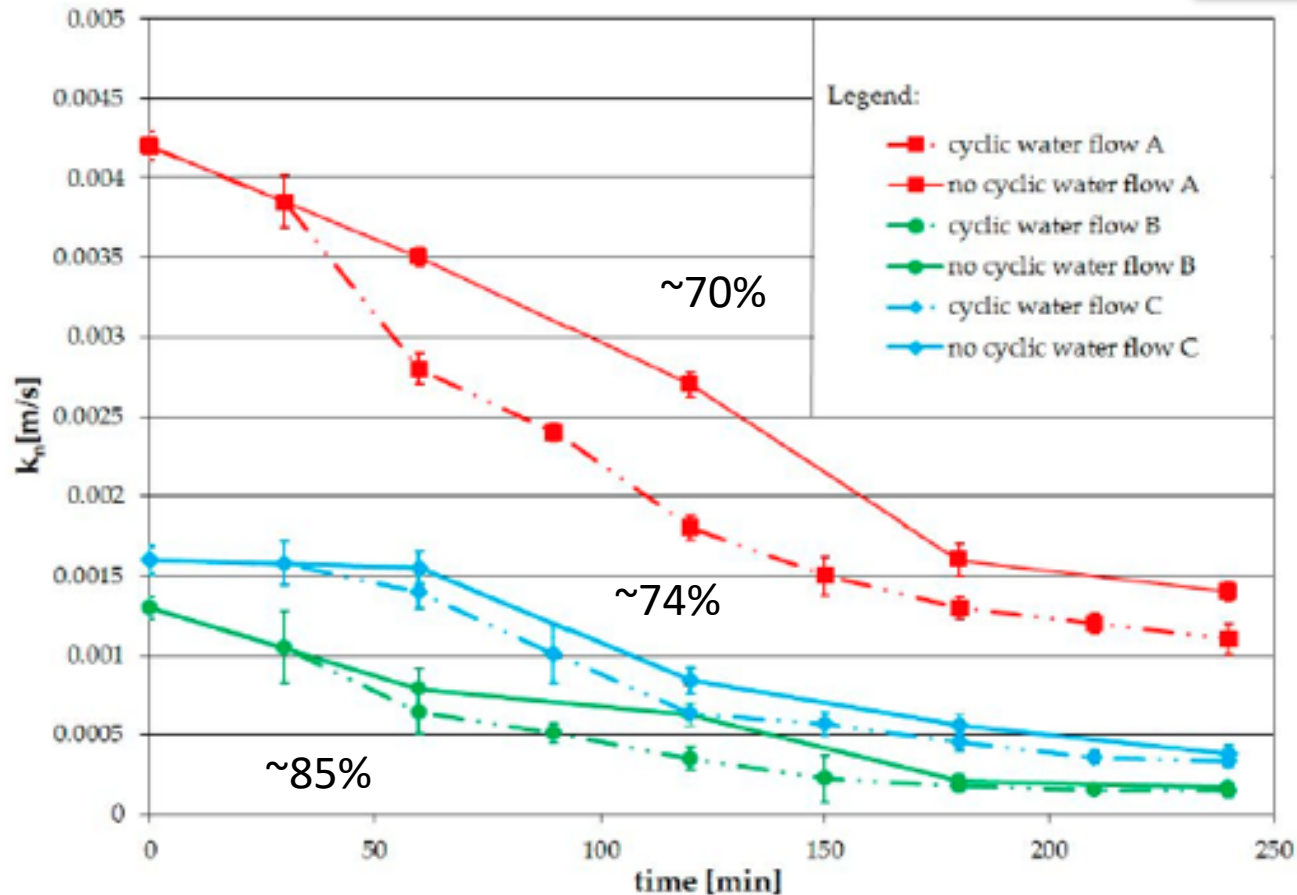


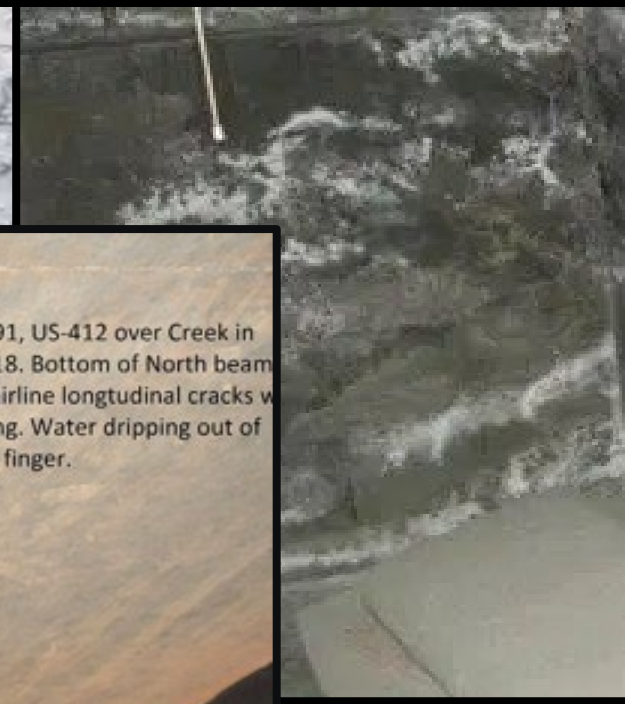
Figure 12. Decreasing of water permeability coefficients with time.

Predetermined flow paths fail over time.

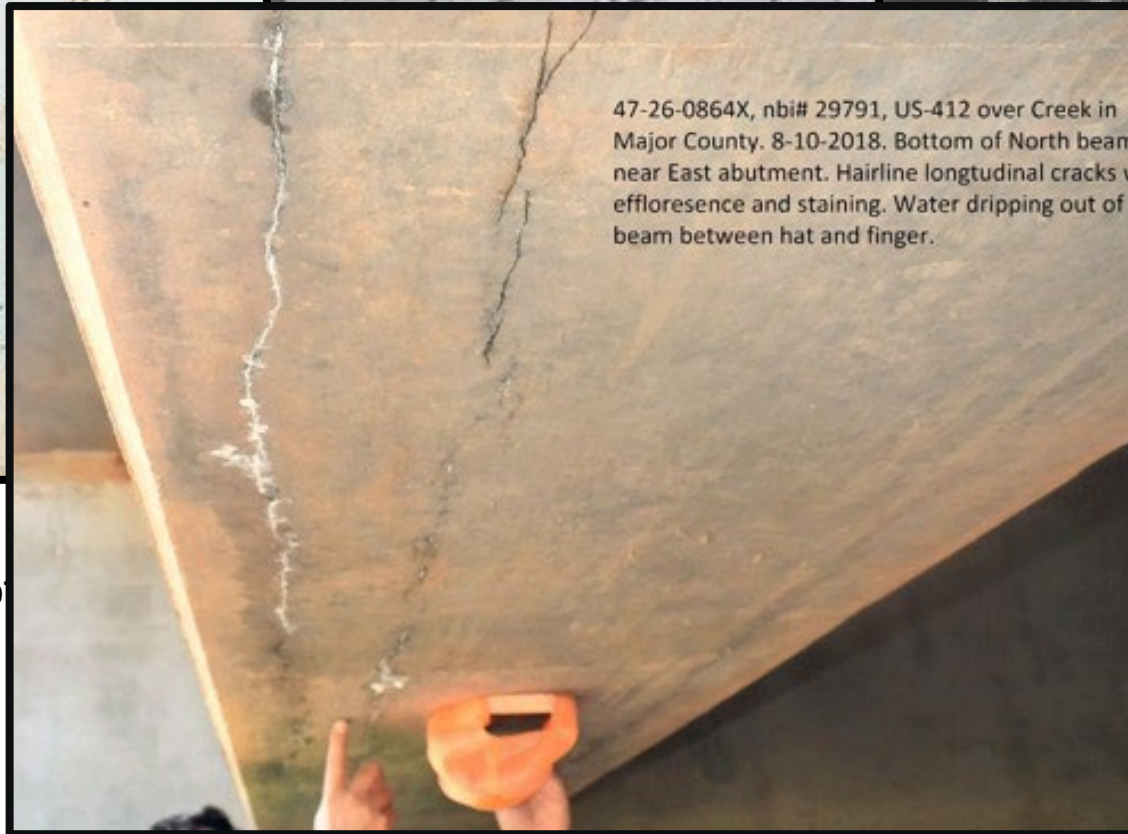
SIGNS OF EXCESS MOISTURE



Flaking
paint/stucco on
walls



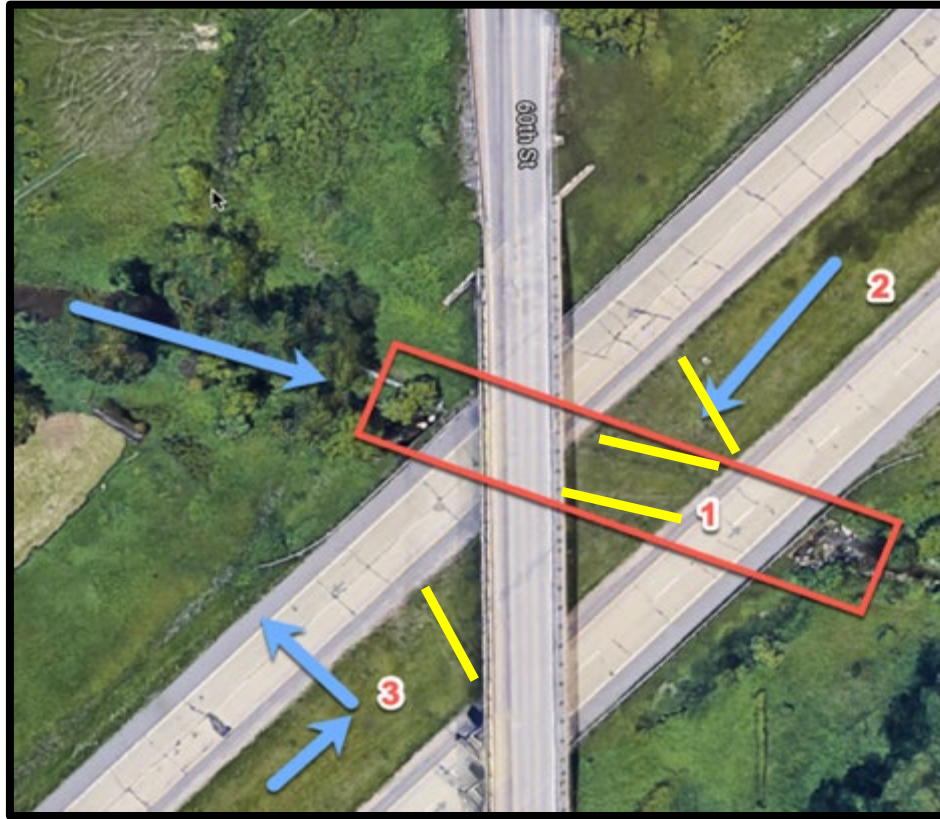
Concrete
efflorescence



47-26-0864X, nbi# 29791, US-412 over Creek in Major County. 8-10-2018. Bottom of North beam near East abutment. Hairline longitudinal cracks with efflorescence and staining. Water dripping out of beam between hat and finger.

Moisture seeping through wall indicates presence of water above drain height.

SIGNS OF EXCESS MOISTURE



Vegetation adapted due to various levels of moisture

Saturated soils around structure



Change in vegetation can give insight into water flow.

SIGNS OF PRESSURE BUILDUP



Pressure build up can damage slowly or suddenly.

SIGNS OF FAILED SOIL FILTRATION



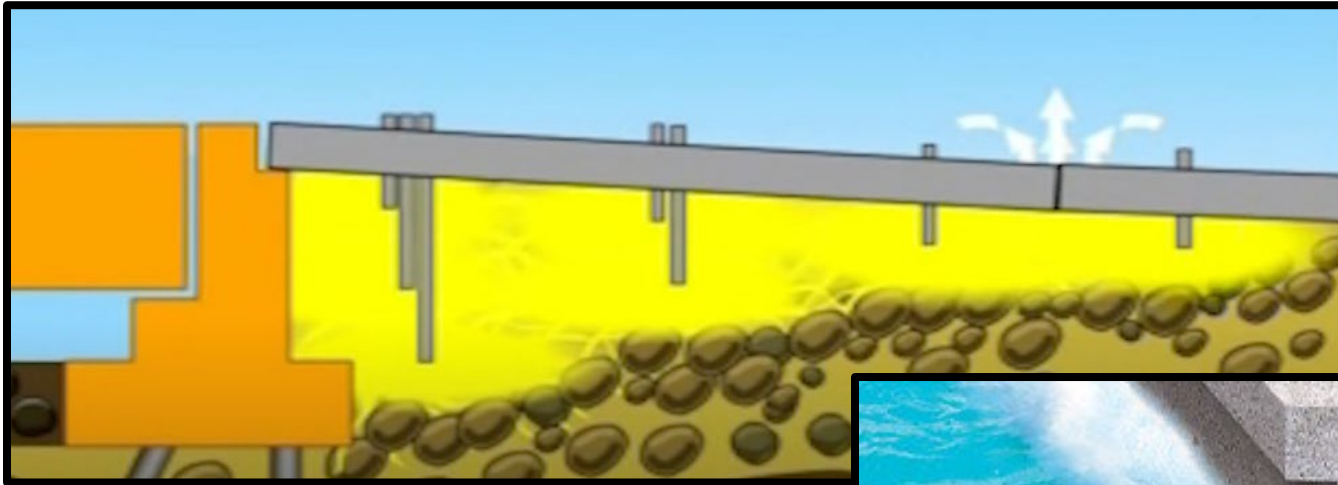
Soil filtration fails when water pressure breaks through or goes around the geotextile.

PIPING->VOIDS->SINKHOLES



Piping->voids->Sinkholes

MUDJACKING & INJECTION GROUTING



Mudjacking

Injection Grouting



New drainage paths must be created after mud jacking or injection grouting.

OPTIONS?



Clean?

Difficult and not effective

Plug?

Shortens service life

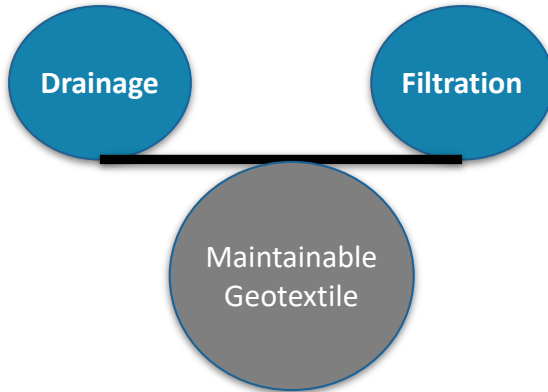
Excavate?

Expensive, difficult & time consuming

Core new outlet?

Relieves pressure quickly but does not prevent soil loss

Most options do not work or are not practical.



What if you could:

- Cost-effectively extend a structures life?
- Quickly & easily maintain a drainage system?
- Provide fast drawdown?
- Inspect drainage performance at anytime?



Maintainable Weep Hole Filters are the solution!

MAINTAINABLE WEEP HOLE FILTERS

Protective Housing

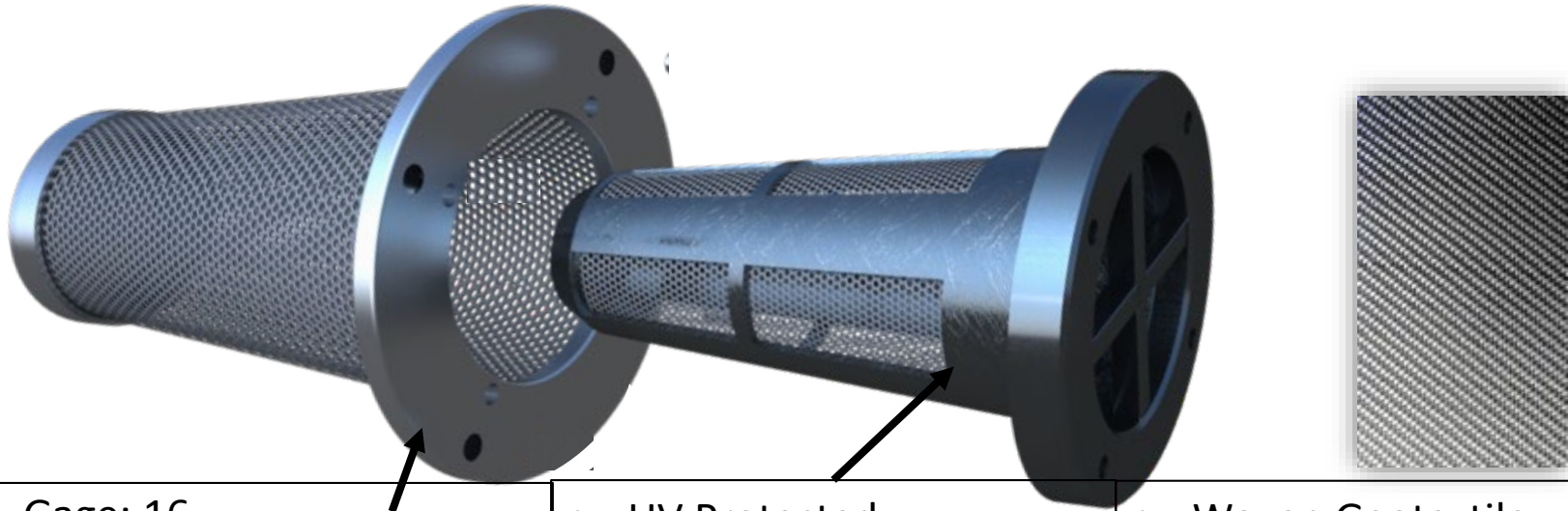
- 316L Stainless

Cleanable Filter Cartridge

ABS (Acrylonitrile butadiene Styrene)

Geotextile Filter Fabric

Mirafi FW300



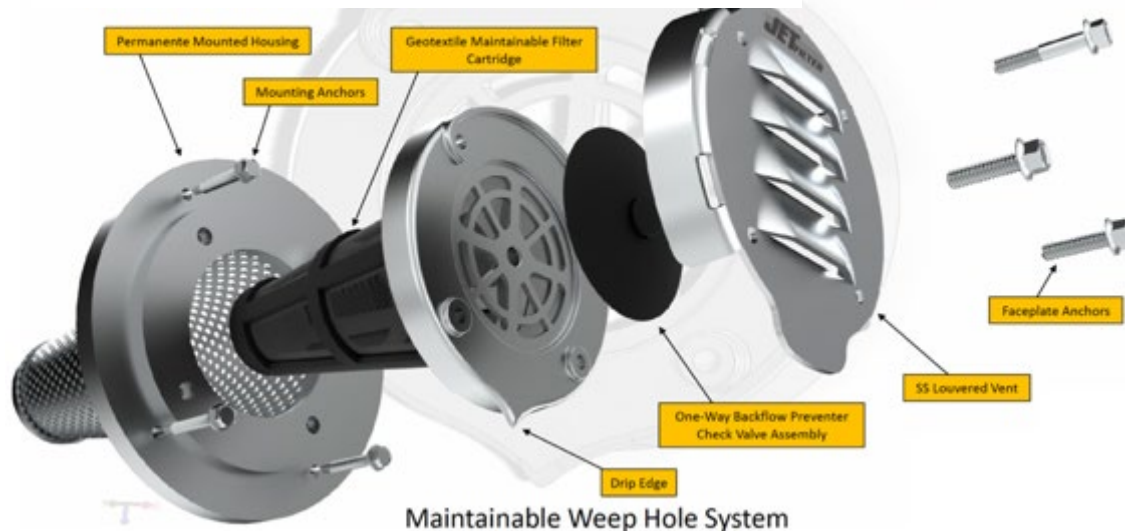
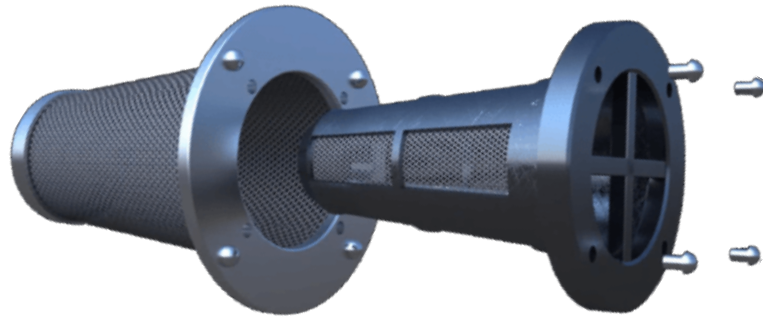
- Gage: 16
- Surface area: 40 sq. in.
- ¼ dia. Holes, 5/16" spacing
- 58% opening (~23.5 sq. in.)
- ~2.4 times drain opening

- UV Protected
- ABS Black
- Tinsel (Break) (4350 psi)
- Impact 17 ft lb./in²
- ASTM D4673, ABS0120, B43420

- Woven Geotextile
- Apparent opening size 30
- Permeability 1.5
- Flow Rate 115 gal/min/ft²
- Tear Strength 125 lbs.

Sustainable components will extend service life.

OPEN VS. CLOSED END



Benefits:

- Relieves hydrostatic pressure
- Geotextile fabric to stop erosion
- Removable & Cleanable
- Replace filter fabric anytime
- Evaluate performance anytime

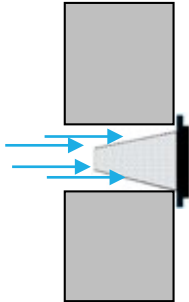
Closed End Benefits:

- Blocks storm surge
- Prevents backflow during high tide
- Prevents silt/sludge buildup
- Vermin Control
- Stops mosquito breeding

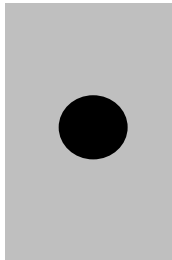
Always know exactly how your drainage system is working.

BENEFITS OF THE CONICAL SHAPE

Ease of installation and space for flow in thick concrete walls



Simple 2-dimensional traditional geotextile.

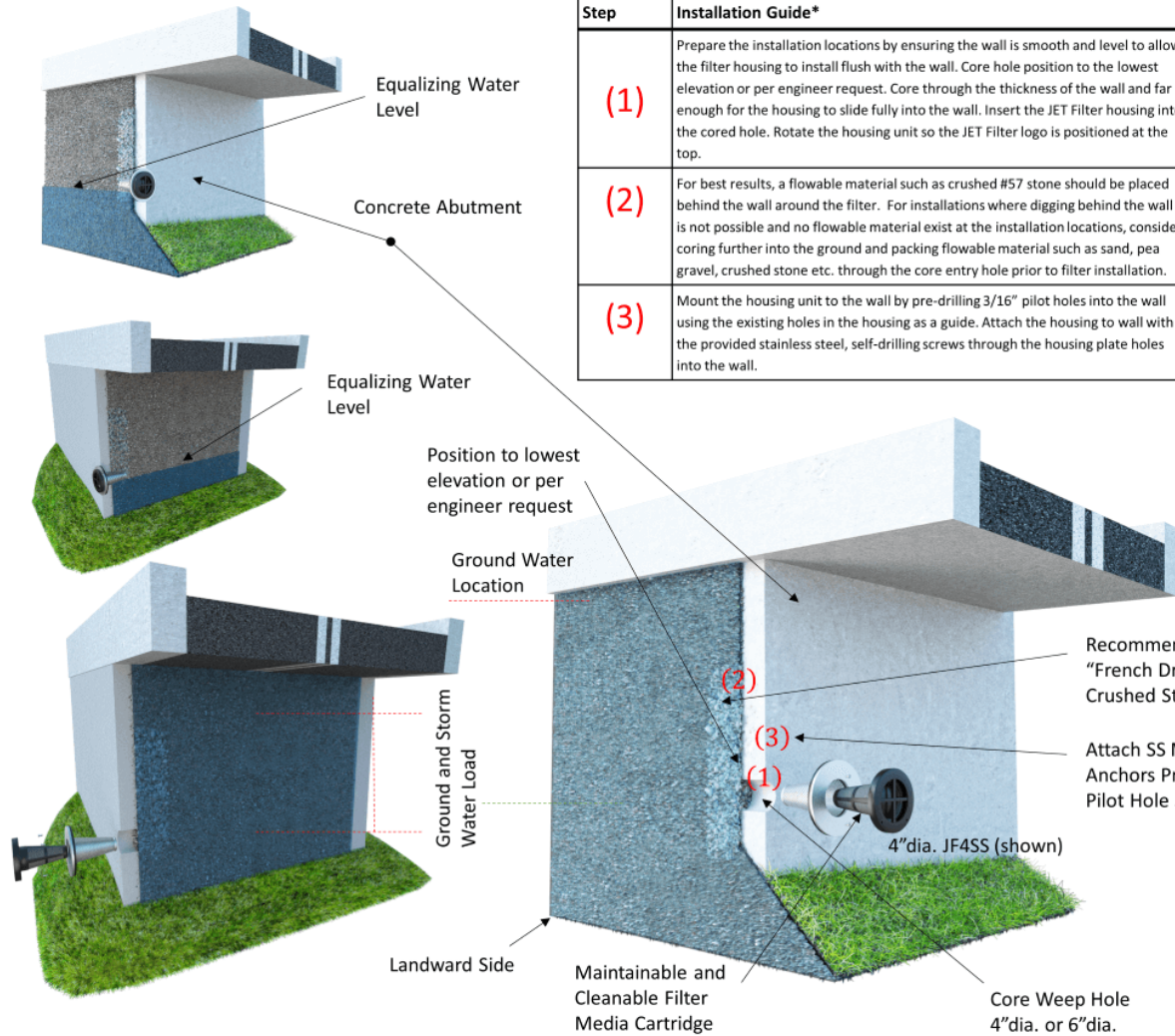


Flow Rate Capacity (Gallons/Minute@ 2.5 psi) Traditional 2D vs. Jet Filter 3D Technology			
Weep Hole Diameter	Jet Filter Conical 3D (Housing & Filter Cartridge)	Traditional 2D Weep Hole w/Geotextile	Percent Flow Increase
3"	59.3	38.6	154%
4"	121.9	63.5	192%
6"	264	140.5	188%



Small Footprint with Large Surface Area

EXAMPLE ABUTMENT INSTALLATION



Step	Installation Guide*
(1)	Prepare the installation locations by ensuring the wall is smooth and level to allow the filter housing to install flush with the wall. Core hole position to the lowest elevation or per engineer request. Core through the thickness of the wall and far enough for the housing to slide fully into the wall. Insert the JET Filter housing into the cored hole. Rotate the housing unit so the JET Filter logo is positioned at the top.
(2)	For best results, a flowable material such as crushed #57 stone should be placed behind the wall around the filter. For installations where digging behind the wall is not possible and no flowable material exist at the installation locations, consider coring further into the ground and packing flowable material such as sand, pea gravel, crushed stone etc. through the core entry hole prior to filter installation.
(3)	Mount the housing unit to the wall by pre-drilling 3/16" pilot holes into the wall using the existing holes in the housing as a guide. Attach the housing to wall with the provided stainless steel, self-drilling screws through the housing plate holes into the wall.



JET Filter System LLC.
14 North Central Ave
Casey, Illinois 62420
United States
800-475-2029

Standard Weep Hole Component Installation Detail

US PAT#7,615,148
Made in the USA

Recommended "French Drain" #57 Crushed Stone

Attach SS Mounting Anchors Pre-Drill Pilot Hole 3/16"

4" dia. JF4SS (shown)

Description:

Bridge Abutment
Wing Wall

Date: 3/1/2017

Drawn By: DWG

*Due to varying local conditions, each installation is unique. An engineer or contractor knowledgeable on local conditions should be consulted prior to installation. JET Filter System assumes no responsibility for product installation or use.

Installation is easy. One-way valve available in 3", 4" & 6" units.

- All drainage systems require routine cleaning and maintenance to relieve clogging
- However, traditional drainage systems can only be maintained at the exit point. What is behind the wall can not be maintained.



Filter Maintenance is simple & easy

How long does it take?

2 to 3 minutes per filter.

How frequently?

Every 2-5 years (depending on soil hydrology)

How to perform maintenance:

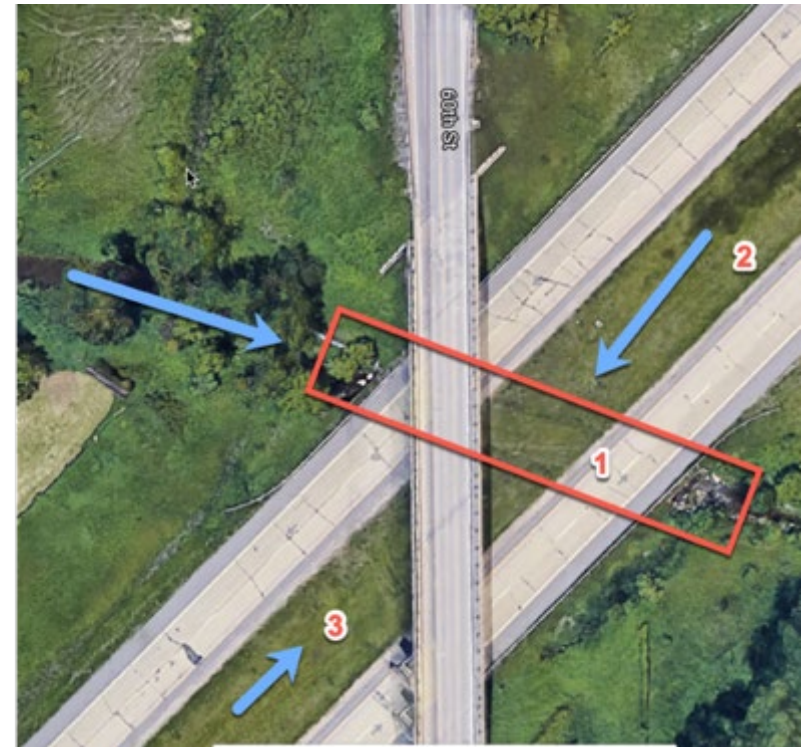
- Unscrew 4 bolts ~ 15 seconds
- Pull out filter & brush off ~ 1 minutes
- Reinstall filter & tighten 4 bolts ~30

Maintenance in 2-3 minutes every few years.

US-31/MACATAWA NORTH BRANCH



- 172' twin box culvert
- Constructed in 1963
- 52 existing 3" weep-holes
- Class II & aggregate backfill
- High groundwater
- High pressure against walls



Significant water flowing along median to culvert walls.

BOX CULVERT SITUATION

Over time,

- Soil leached through weep holes
- Many manually plugged
- Water leaking through cracks & seams



Pressure relieved through wall/ ceiling cracks & seams.

INSTALLATION



Cored/re-cored 52 - 4" holes.

MICHIGAN DOT INSTALLATION



Michigan DOT maintenance crew installation.

ONGOING EVALUATION



Significant water draw down in 48 hours.

WATER SAMPLES



Initial blush caused by backfill disturbance.

WATER SAMPLES AFTER 1 WEEK



Periodic inspection: flow rate, soil filtration & fabric clogging.

INSPECTION & CLEANING



Project cost just over \$20,000 all inclusive.

FOLLOWING ON ITD PROJECT

- Michigan DOT is starting with 3 new box culvert projects that will have precast weep holes.
- Arkansas DOT has completed 2 new box culvert installations with pre-cast weep holes.



Must use Schedule 40 PVC
with diameter matching unit
size

Michigan DOT is leading the way on precasting for weep holes filter.

FAILED CULVERT DRAINAGE SYSTEM

Location: I-94, Coopersville MI

Owner: Michigan Department of Transportation

Issue: 4"x4.5" square weep holes failed, soil eroding into culvert.

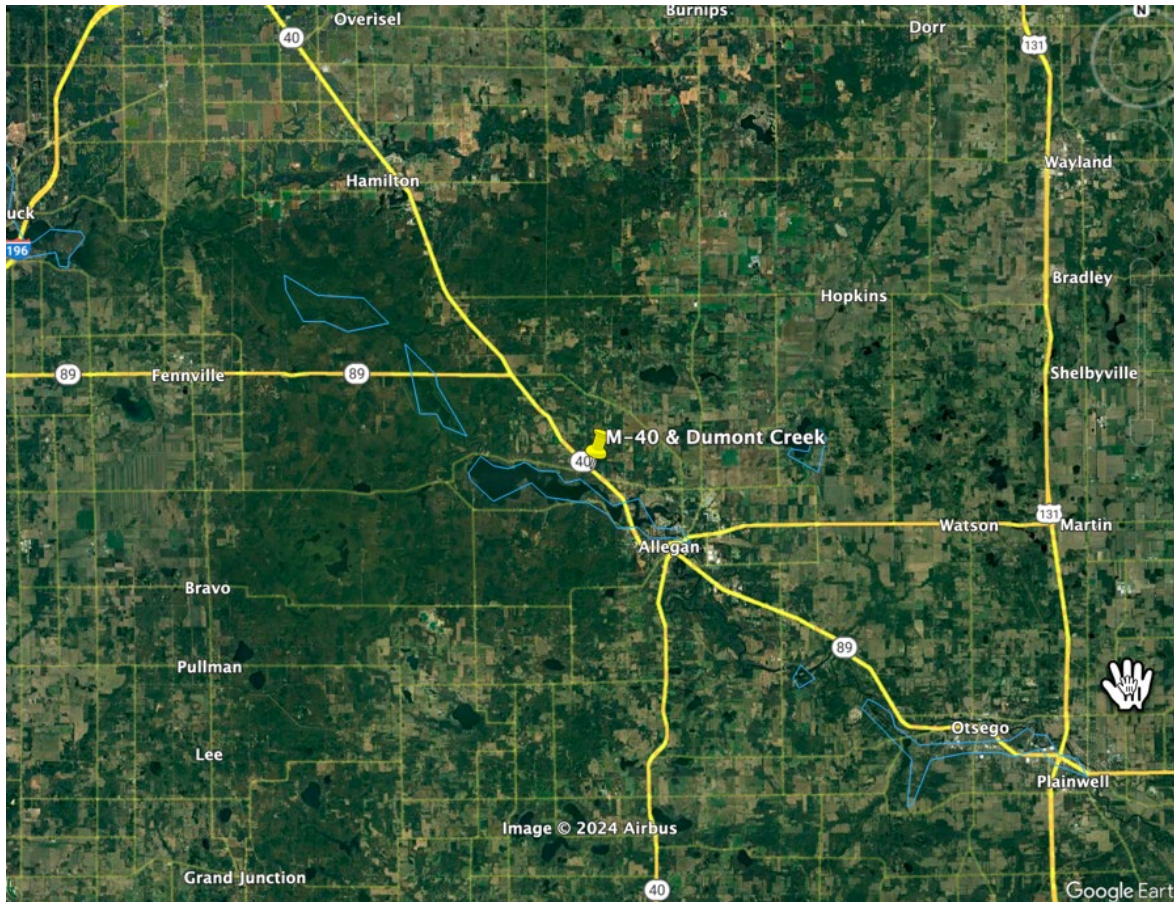
Solution: Installed 39, 2.5" S.S Open-End units into concrete culvert wall.

Results: Successfully installed 7x7 adaptor plates with units.

Date: 2018



M-40 DUMONT CREEK ALLEGAN



Rick Weaver, MDOT
Corby Energy Services

October 2023

66 3" closed end with
custom flange

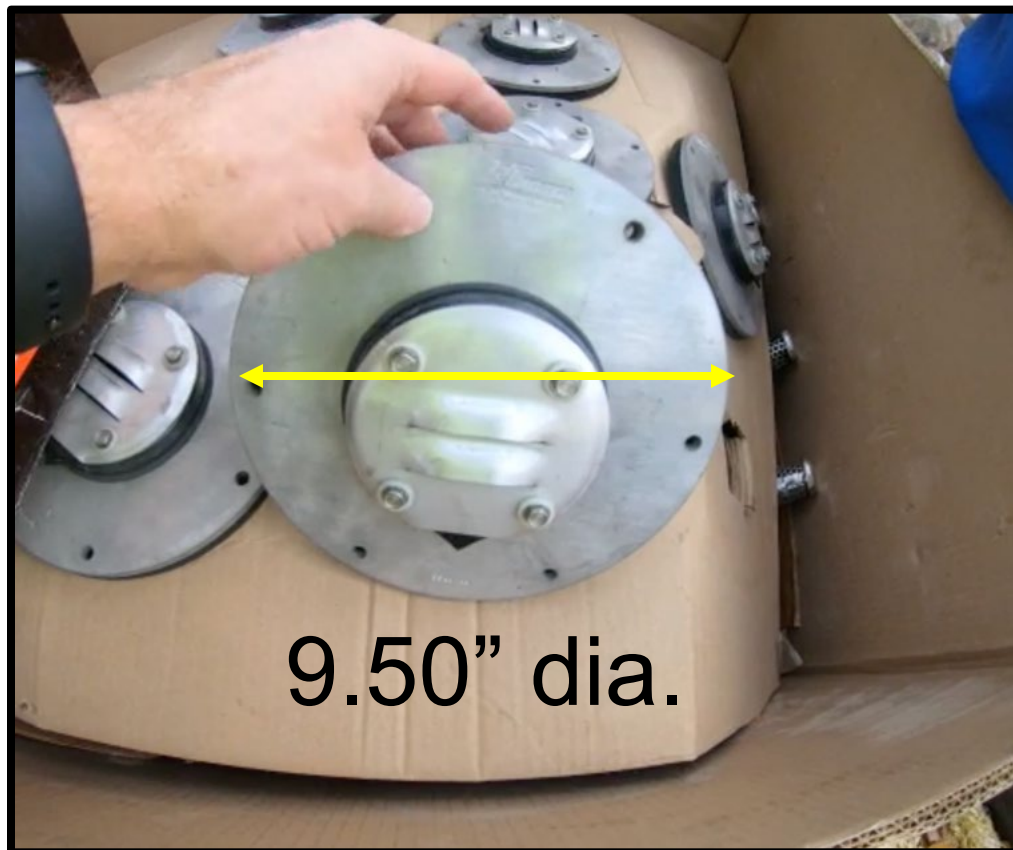
Repair project almost complete when soil loss started.

M-40 DUMONT CREEK ALLEGAN



Soil loss through existing 4" square weep holes.

M-40 DUMONT CREEK ALLEGAN



Installed 66, 3" units with modified flange.

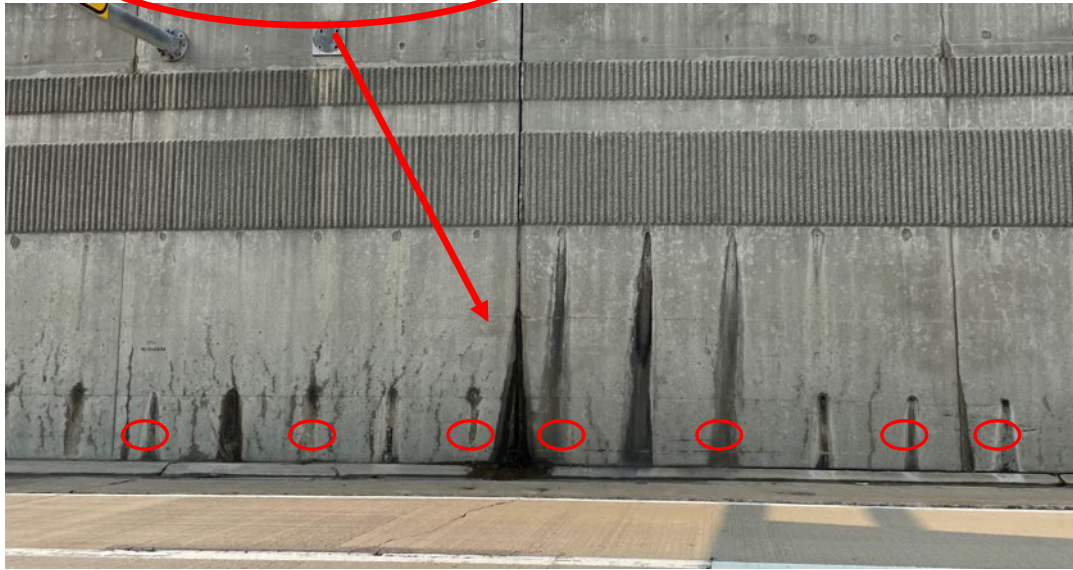
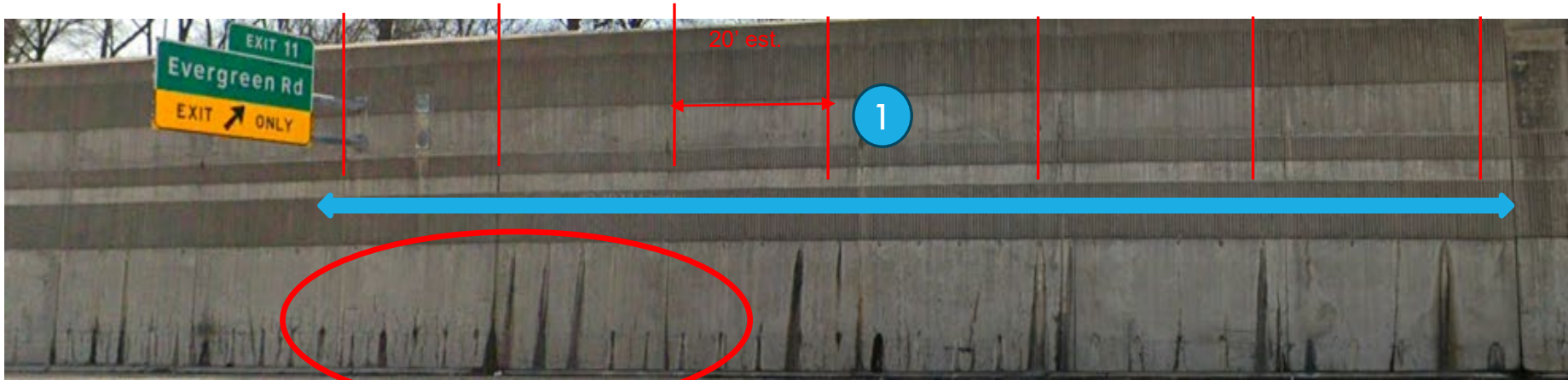
I-696 LODGE FREEWAY



Extensive drainage issues behind retaining walls.

PILOT LOCATION

Recommend installing 18, 6" units across 6 sections. Three per section.



Install 2' right & left of seam plus one in center of panel. Units should be centered 4"-6" above the base.

Pilot project is in evaluation. Next meeting in May.

DICKENSON COUNTY

6 bridges each ~ 100 yrs old
Approaches subjected to heavy traffic
Approaches experienced significant drop



Four bridges cost <\$15,000 all inclusive.

Designer: Choose the size of maintainable drain, add proper source code. Add/Remove/Edit options shown in red as listed below according to project specific needs. Once that is done, ensure there is no remaining red text and delete this note. Submit for review and approval.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
MAINTAINABLE DRAIN, STEEL

Source Code 1 of 2 APPR:DMG:RWS:11-01-19

a. Description. This work consists of furnishing and installing a weep hole maintainable drain filter assembly, including all necessary hardware at the location(s) shown on the plans. This item includes all work required to core drill a weep hole in the existing [INSERT PROJECT SPECIFIC STRUCTURE SUCH AS RETAINING WALL, ABUTMENT WALL, SHEET PILE WALL], and install the maintainable drain filter assembly. Ensure all work and materials are in accordance with the standard specifications, except as modified herein.

b. Materials. Provide drain filter housings fabricated from [stainless steel in accordance with AIS 316.] [steel in accordance with ASTM A 36. Ensure ASTM A 36 steel filter housings are powder coated and in accordance with American Architectural Manufacturers Association 2605 specifications.] Drain filter housings must consist of a flat mounting plate flange to permanently mount the assembly to the existing structure shown on the plans in accordance with the size and shape of the weep hole. If required for mounting purposes, ensure adapter plates are made of the same material as the drain filter housings. Ensure drain filter housings consist of a perforated conical shell, extending into the existing structure a minimum of 3 inches, and providing a minimum of 30 square inches of perforated surface area. Ensure perforations in the conical shell portion of the housing are at least 1/8 inch diameter, but not greater than 3/8 inch diameter, and account for greater than 50 percent of the conical shell surface area. Ensure mounting hardware is stainless steel.

Provide a flexible and compressible gasket to ensure a watertight seal between the mounting plate and the existing structure.

Provide a rigid plastic cartridge type insert containing geotextile fabric that attaches to the steel drain filter flange and is removable to allow for periodic inspection and maintenance. Ensure the cartridge is flame retardant and ultraviolet (UV) resistant. Provide woven geotextile fabric in accordance with section 910 of the Standard Specifications for Construction except as modified in the table below.

Table 1: Geotextile Physical Requirements

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Permittivity (minimum – maximum)	ASTM D4491	sec-1	0.25 - 1.5
Apparent Opening Size (maximum)	ASTM D4751	mm	0.212

[Ensure the removable geotextile fabric cartridge includes a one-way check valve to prevent water

and debris from entering the filter. Protect the one-way check valve by a cover.] [Ensure the removable geotextile fabric cartridge is open ended.]

[Provide stone backfill material that is Coarse Aggregate Class 6A in accordance with section 902 of the Standard Specifications for Construction.]

Submit a General Certification to the Engineer for acceptance of the above materials. Ensure the General Certification is accompanied by the product data sheets for all materials associated with the weep hole maintainable drain filter. Visually inspect all materials prior to installation to ensure they are free from defects. General Certification and Visual Inspection basis of acceptance are as defined in the *Materials Quality Assurance Procedures Manual*.

c. Construction. Core drill the (2½ inch)(4 inch)(6 inch) diameter weep hole(s) in the existing (INSERT PROJECT SPECIFIC STRUCTURE SUCH AS RETAINING WALL, ABUTMENT WALL, SHEET PILE WALL, etc.) at the locations and to the thickness shown on the plans. Ensure the weep hole is flushed with water to remove any dust or debris prior to installing the drain filter. Minimize the amount of soil loss during construction.

Install the drain filter flange flush with the existing structure. Orient the drain filter in accordance with the manufacturer's recommendations. [Mount the drain filter using stainless steel screws with washers appropriate for the material of the existing structure. Utilize the drain filter housing flange as a template for drilling holes.] [Weld the drain filter to the existing steel structure with (INSERT DESIRED WELD SIZE AND LENGTH).]

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	Pay Unit
Maintainable Drain, Steel, ___ inch	Each

Maintainable Drain, Steel, ___ inch includes all labor, equipment and materials necessary to complete the work as described.

2023 COST SCENARIO

Cost Scenario Assumptions	
Structure length ft	100
Weep hole spacing ft	6
Number of units	16

Filter Type	Open		Closed	
	3"	4"	3"	4"
Cost per unit	\$ 179.80	\$ 239.80	\$ 229.80	\$ 289.80
Total Product Cost	\$ 2,876.80	\$ 3,836.80	\$ 3,676.80	\$ 4,636.80

Additional costs

- Coring
- Shipping
- Optional Pea gravel or AASHOT #57

Typical project needs

- Pre-cast concrete 1 per section
- Wing Walls 1-2 units per section
- Concrete abutments 3 -4 units

Installations	Projects	Units
World-wide	5722	298,882
United States	5233	268,213
Michigan	430	7710
Michigan Transportation	28	773

Coring can be done inhouse or contracted.

DEL DOT CULVERT



Installing permeable backfill post construction.

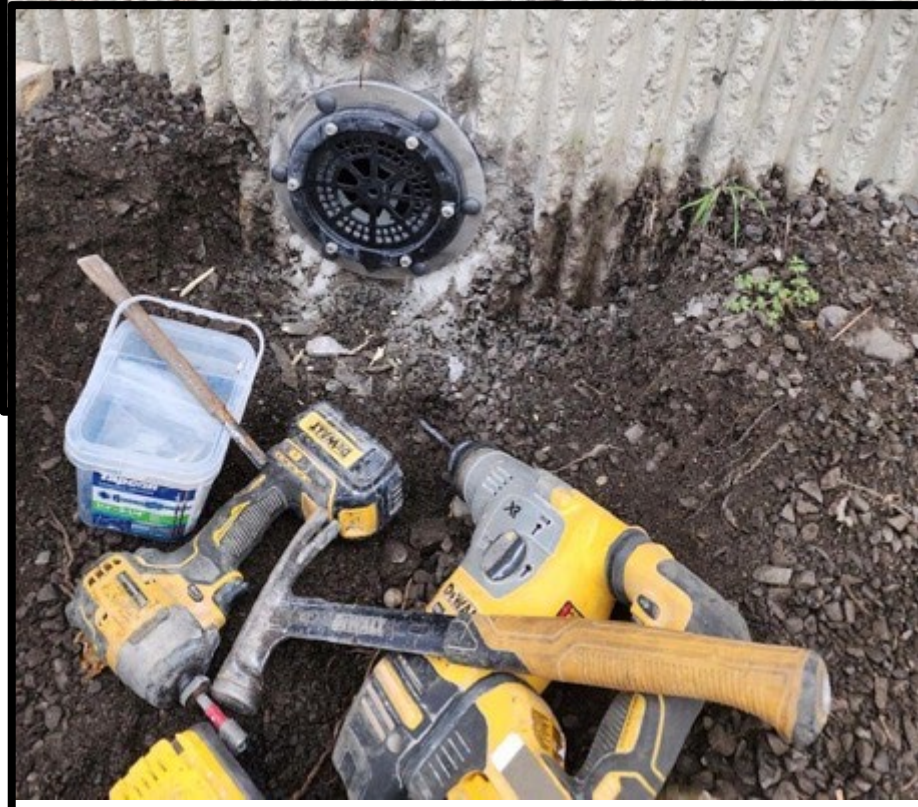
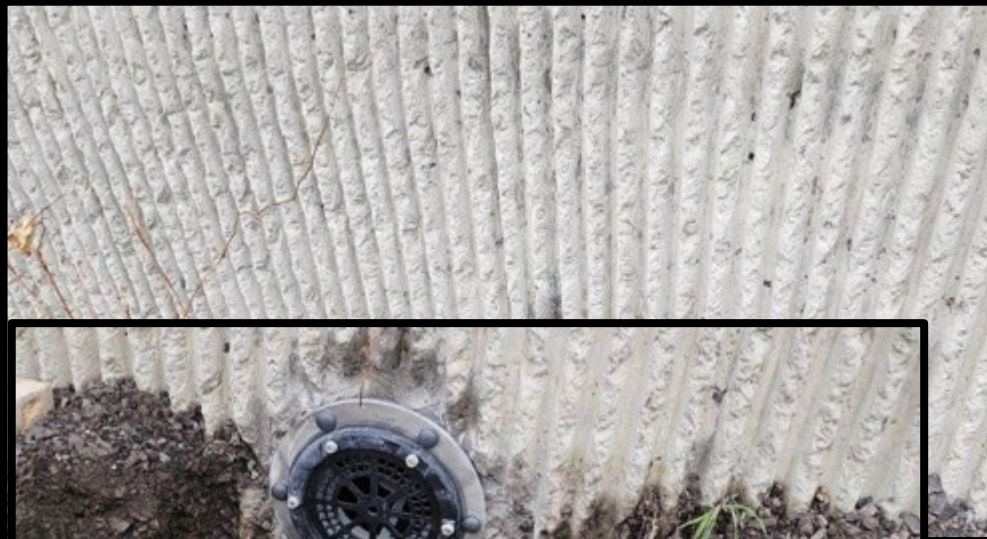
INDIANA DOT MSE WALL REPAIRS



Kenilworth Road over US 31 St. Joseph Co.

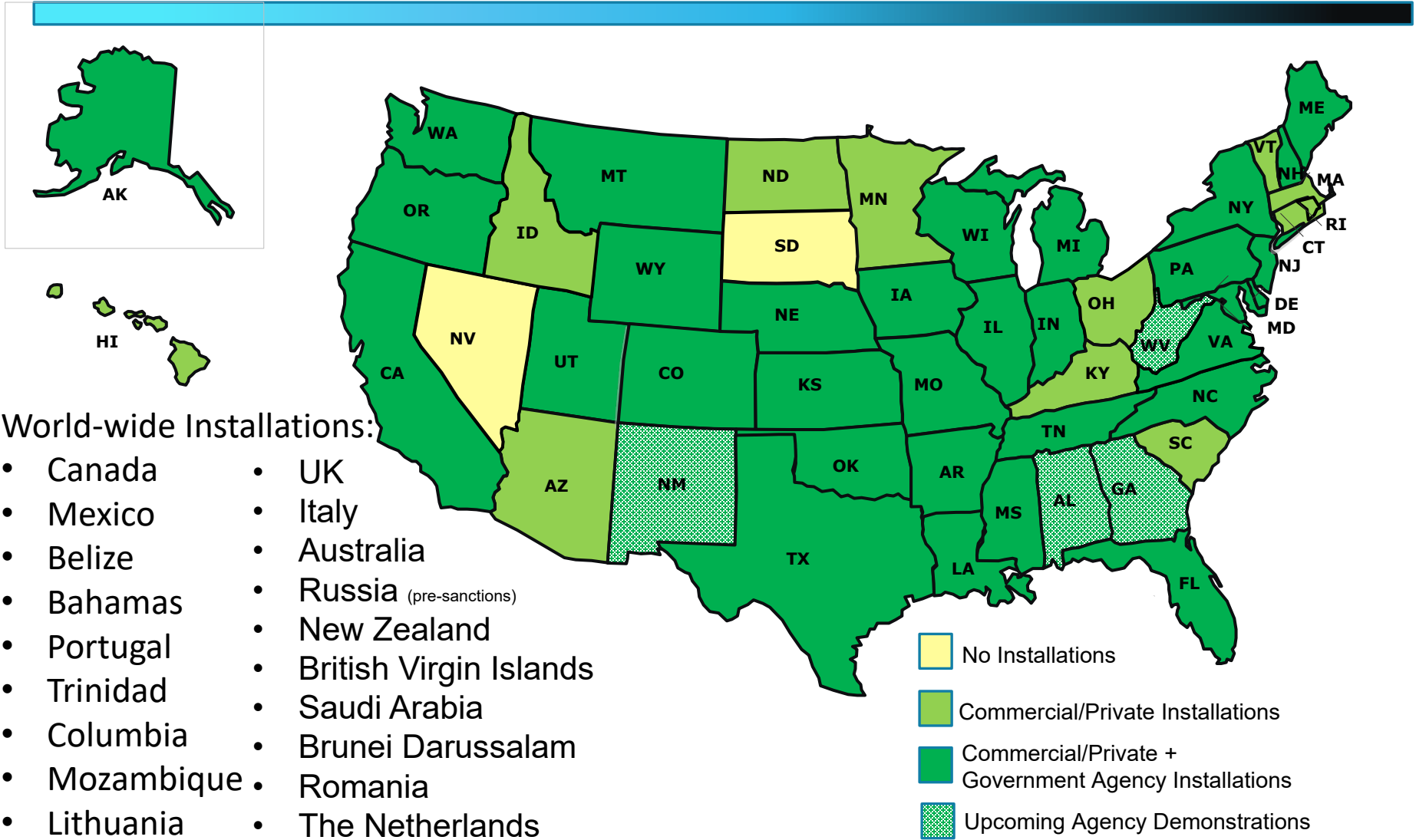
In Fall 2021, Indiana DOT launched a 3-year preservation program on MSE bridge abutments.

Wall movement, failed soil filtration. Fill voids, seal seams, provide drainage.



It is necessary to smooth down rough surfaces.

MAINTAINABLE DRAIN INSTALLATIONS



Over 300,000 installed in 21 countries in 5 continents.