



# Stormwater Culvert and Manhole Repairs Using High Density Polyurethane

## OUTSIDE

URETEK for External Rehabilitation



## INSIDE

CentriPipe for Internal Renewal



# Sewer Rehabilitation

“Outside and Inside”

Assess · Rehabilitate · Renew



# Polyurethane Grout

Structural Polymer for Soil Stabilization



# Polyurethane Grout URETEK



## Chemistry: Characteristics

### **Rapid Cure**

Can support loads after 15 minutes; full strength after 24 hours

### **Strength**

Rigid Structural Polyurethane created as material cools

E Modulus, Compressive Strength, Tensile Strength directly proportional to Density

Spread is limited due to speed of reaction

### **Weight**

Lightweight: 4 to 25 pcf (installed density)

### **Water Resistance**

Hydro-Insensitive

Contains water insoluble diluents - can be injected into wet soils and even standing or flowing water

Resists water intrusion into the chemical reaction that forms polyurethane



# Polyurethane Grout URETEK



## Chemistry: Composition

<b>Composition</b>	Resin & Hardener
<b>Mixing Ratio</b>	1:1
<b>Chemical Reaction</b>	Exothermic chemical reaction generates CO <sub>2</sub> gas CO <sub>2</sub> gas causes expansion of material, creating lifting pressure/ strength
<b>Reaction Time</b>	Fast Adjustable – varying injection methods Can be completed in 1 minute
<b>Environmental Impact</b>	Environmentally benign material: <b>NSF-61 certified</b> and only patented hydro-insensitive polyurethane foam





# East Main Culvert

## Durham, NC



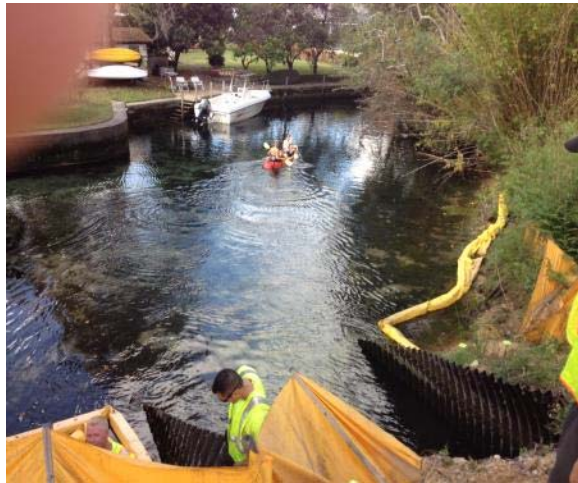
Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• Aging culvert, originally constructed in 1930s.</li> <li>• Large tree growing into the side of the structure.</li> <li>• Actively flowing creek.</li> <li>• Soil loss around the structure.</li> </ul>	<ul style="list-style-type: none"> <li>• Inject URETEK 486Star Polymer to densify the surrounding soils and allow for structural repairs to the box culvert.</li> <li>• Cofferdam and bypass pumping.</li> <li>• Structural repairs to culvert, including rebar and epoxy, crack injection, and shotcrete,</li> </ul>	<ul style="list-style-type: none"> <li>• Designed injection plans for culvert stabilization.</li> <li>• Oversaw tree removal.</li> <li>• Set up cofferdam and bypass pumping.</li> <li>• Coordinated with restoration company on rebar and epoxy.</li> <li>• Performed shotcrete.</li> <li>• Placed rip rap.</li> </ul>	<ul style="list-style-type: none"> <li>• Work was completed in a few weeks.</li> <li>• Culvert was stabilized and restored to functionality.</li> <li>• The city of Durham was able to avoid multi-million replacement of culvert.</li> </ul>





# Cutler Spur Culvert Stabilization

## Crystal River, FL



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"><li>• Concern of weak soil zones underneath a culvert and new two lane road</li><li>• Area is in an environmentally sensitive area known for natural springs and manatee migration</li></ul>	<ul style="list-style-type: none"><li>• Inject URETEK polyurethane from surface to stabilize soils to create a solid support for the culvert</li><li>• Injection points at various locations and depths</li></ul>	<ul style="list-style-type: none"><li>• Specifications</li><li>• Designed injection points quantity and depth</li><li>• Pre-construction meeting with contractor, city and L3 Communications</li><li>• On-site installation</li></ul>	<ul style="list-style-type: none"><li>• <b>Minimal downtime:</b> All work performed in one day</li><li>• <b>Stabilized soil:</b> Final roadway work was able to continue on schedule</li></ul>



# 72" RCP Dam Outfall Pipe Repair Gainesville, GA



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>72" RCP dam outfall pipe had water flowing along the outside of the pipe and entering the weak pipe joints</li> <li>Customer did not want to remove / replace the RCP because was in good condition</li> <li>Customer tried cementitious grout to seal joints and failed (see cementitious grout attempt in pipe haunch of picture on right)</li> </ul>	<ul style="list-style-type: none"> <li>Stabilize and densify surrounding soils, creating a non-permeable layer to stop water movement by use of Deep Injection of high density polyurethane</li> <li>Inject the Uretek 486 material to seal the leaking joints</li> <li>Injections made at 5 &amp; 7 o'clock positions of the pipe</li> </ul>	<ul style="list-style-type: none"> <li>Uretek designed the injection process using a hydrophobic 2 part Star 486 HDP material</li> <li>We were able to fix the joints from inside the pipe and did not need to close the road</li> </ul>	<ul style="list-style-type: none"> <li><b>Quick Installation:</b> Project took 6 hours compared to 4 days to remove and relay the RCP (would not have needed to replace).</li> <li><b>Cost Effective:</b> Project was more cost effective than remove/relay and bringing in additional fill material. Also, slip lining was not a viable option since the water was coming from the outside of the pipe.</li> </ul>





# NAS – Inflow & Infiltration Restoration Pensacola, FL



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• Inflow &amp; Infiltration into storm drain system</li> <li>• Pavement and manhole structure settlement due to loss of bearing soils</li> <li>• Surface depressions due to soil migrating into storm drain system</li> <li>• Manhole, joint, and lateral line encapsulation and sealing</li> </ul>	<ul style="list-style-type: none"> <li>• Inject URETEK polymer using The URETEK Method to encapsulate and seal faulted joints from inflow and infiltration</li> <li>• The Deep Injection Process at 4 distinct elevations to fill voids and densify weak base soils to prevent additional pavement and structure settlement</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-estimate meeting with NAVFAC</li> <li>• Designed injection locations, quantities and depths</li> <li>• Pre-construction and safety meeting onsite with crew</li> <li>• On-site installation</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Infrastructure Restoration:</b> URETEK polymer compacted and void filled loose surrounding soils to rehabilitate storm drain system</li> <li>• <b>In-situ Technology:</b> Restored and increased soil load-bearing capacity at depth in two days with minimal disruption</li> </ul>



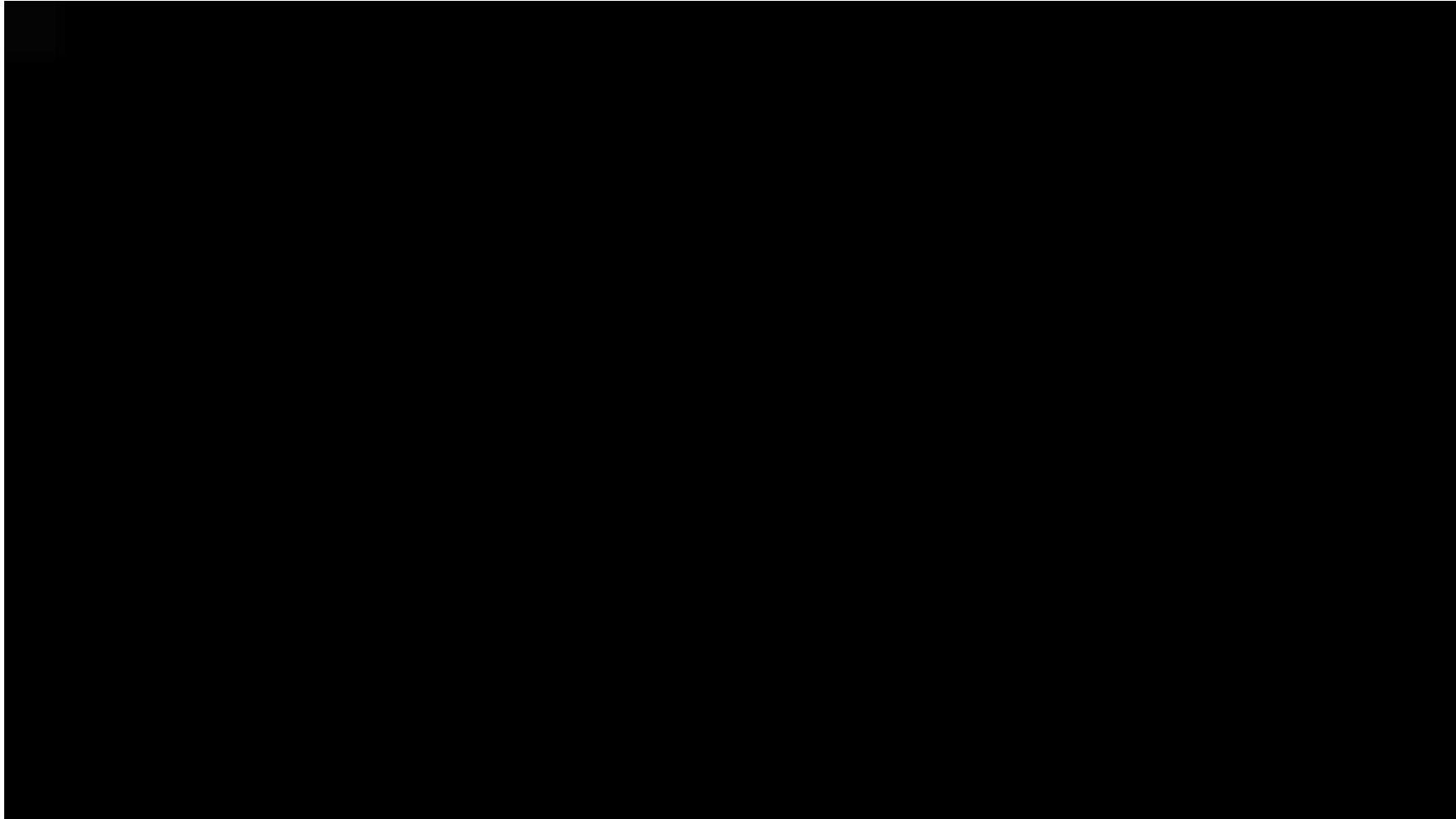
# USAF – Andrews Air Force Base

## Joint Base Andrews, MD



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Runway settlement caused a dip 11 years before scheduled replacement</li> <li>Settlement was caused by faulted joints in 60" reinforced concrete pipe beneath runway</li> <li>USAF wanted to avoid rip &amp; replace due to downtime</li> </ul>	<ul style="list-style-type: none"> <li>Seal pipe and densify compacted soils</li> <li>Lift runway back to original elevation</li> </ul>	<ul style="list-style-type: none"> <li>Specifications</li> <li>Designed injection port quantity and depth</li> <li>Pre-construction meeting</li> <li>On-site installation under strict security</li> </ul>	<ul style="list-style-type: none"> <li><b>Sustainable Solution:</b> work sustained until scheduled replacement took place.</li> <li><b>Minimally Invasive:</b> work performed allowed USAF to avoid ripping up the runway for repair and avoid delays in its operations</li> </ul>

# 48" RCP Pipe Rehab Video

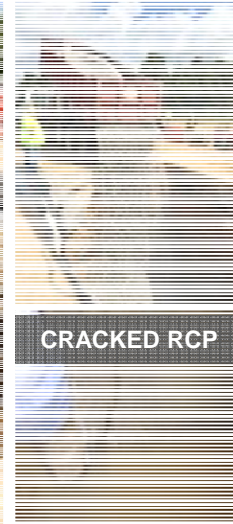
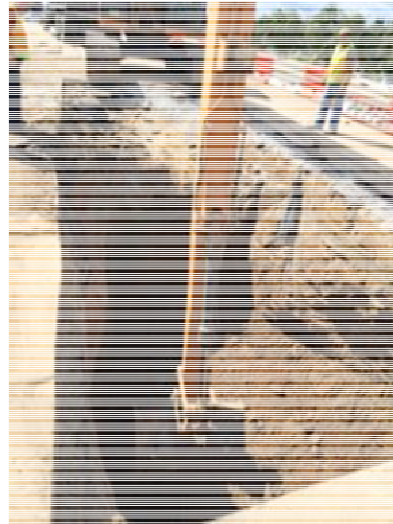
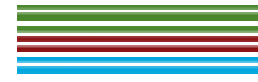






# Hwy 61 – Emergency Sinkhole Repair

## Natchez, MS

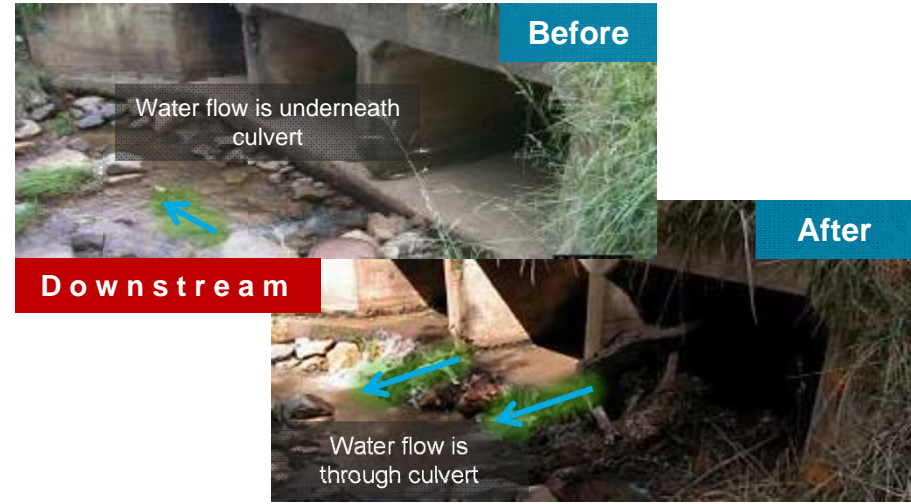
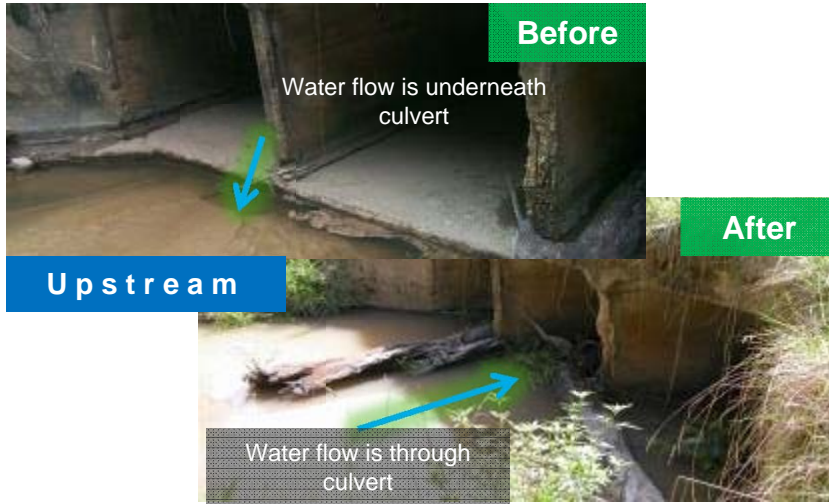


Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Sinkhole formed on HWY61 in Natchez, MS</li> <li>24" RCP misaligned due to a leaky joint that degraded the support soils and caused voids beneath the pipe</li> <li>The RCP shifted and caused a sinkhole that shut down a portion of the highway route to a nearby hospital</li> </ul>	<ul style="list-style-type: none"> <li>Mechanically align the pipe utilizing a trackhoe</li> <li>Stabilize and seal the pipe utilizing URETEK's Deep Injection method</li> <li>Fill excavated area with #57 stone aggregate and stabilize the aggregate at every 4-5ft of fill</li> </ul>	<ul style="list-style-type: none"> <li>Specifications</li> <li>Utility locates</li> <li>Pre-construction meeting</li> <li>MDOT construction support</li> <li>Emergency Response</li> </ul>	<ul style="list-style-type: none"> <li><b>Sealed and rehabilitated stormwater drainage system</b></li> <li><b>Stabilized support soils:</b> bound #57 aggregate to form a solid monolithic mass below highway</li> <li><b>Quick Installation:</b> Project was completed over 2 Days</li> </ul>



# AL DOT 4<sup>th</sup> Division SR22

## Alexander City, AL

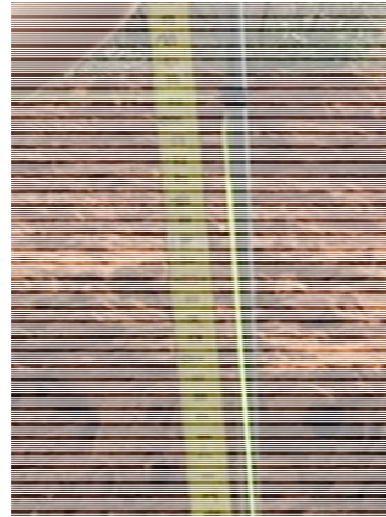


Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Extensive voids and extremely weak soil zones underneath a culvert and two lane road</li> <li>Water flowing completely under rather than through culvert</li> <li>Culvert &amp; road settled 2.5"</li> </ul>	<ul style="list-style-type: none"> <li>Inject hydro-insensitive URETEK polyurethane through floor surface of culvert surface to cutoff flow of water, fill voids, and stabilize soils to create a solid support for the culvert</li> <li>Lift culvert and pavement full 2.5" to original elevation</li> </ul>	<ul style="list-style-type: none"> <li>Designed injection points quantity and depth</li> <li>Pre-construction meeting with DOT and local authorities to minimize disruption</li> <li>On-site installation with no bypass required</li> </ul>	<ul style="list-style-type: none"> <li><b>Minimal downtime:</b> All work performed in 6 hours</li> <li><b>Stabilized soil:</b> Final roadway work was able to continue on schedule</li> <li><b>No Road Closure:</b> Traditional repair methods would created 50 mile detour to closest river crossing</li> </ul>



# Jackson Lakes Box Culvert Lift

## Pensacola, FL



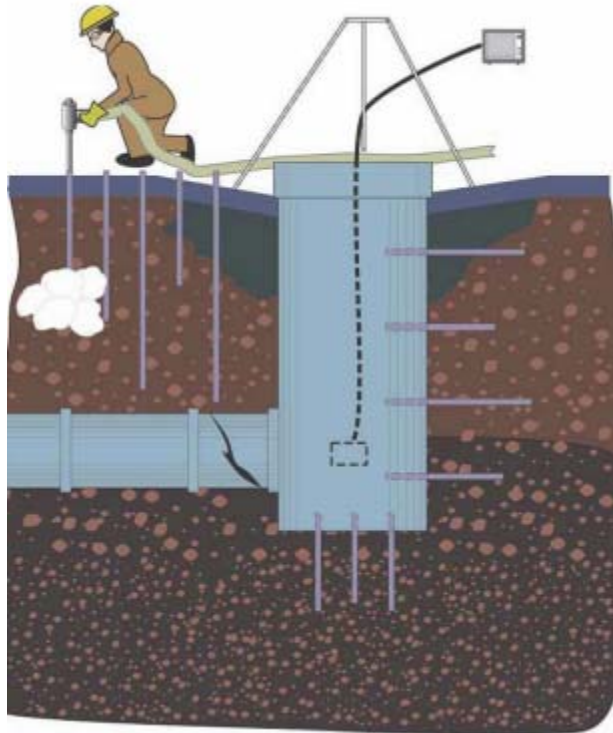
Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• Significant undermining and soil displacement from under culvert caused by a flood event April 2014 of rain over 20" in 2 days.</li> <li>• Voids and lose of supporting soils caused approx. 2' of settlement at the southwest corner of culvert.</li> </ul>	<ul style="list-style-type: none"> <li>• Inject using The Deep Injection Process to lift and realign the southwest corner of culverts.</li> <li>• Inject on 4' grid using a string line to void-fill, stabilize and ensure a uniform lift.</li> <li>• Onsite testing identified an average of a 2' void across all four barrels.</li> </ul>	<ul style="list-style-type: none"> <li>• Designed injection points quantity and depth</li> <li>• Pre-construction meeting with Escambia County Engineering Department.</li> <li>• Holland Pump assisted with dewatering.</li> <li>• H2O Environmental completed masonry repairs.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>24" Lift of quadruple barrel box culvert</b></li> <li>• <b>25% the cost of rip and replace</b></li> <li>• Typical flow of Jackson Creek and overflow of rainwater restored.</li> </ul>



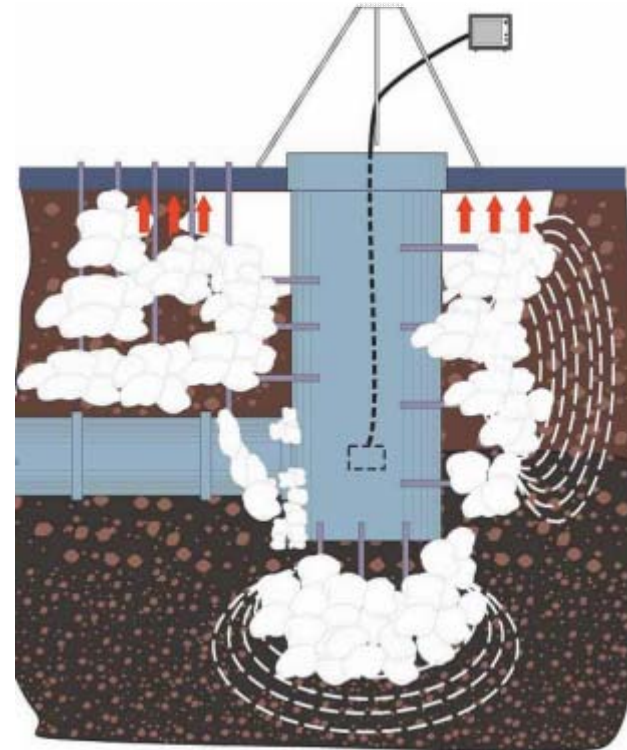
**Sealing and Stabilizing**  
Rehabilitate the *OUTSIDE*



**Before**



**After**

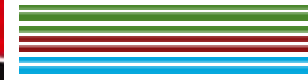


**Without proper void fill, the structure and road are not supported to the originally designed weight-bearing capacity**



# City of Dunlap – I&I Mitigation

## Dunlap, TN



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Excessive groundwater inflow identified at two pump stations and a manhole</li> <li>High water table throughout much of the system.</li> <li>One pipe collar had 100+ GPM of groundwater inflow</li> </ul>	<ul style="list-style-type: none"> <li><b>Seal leaking pipe collars and cracks.</b></li> <li>Use the <b>URETEK Deep Injection® Process</b> to place material into the soils around the structure, at specific depths, to seal the leak from the outside</li> <li>Use the <b>URETEK Method</b> to place material directly through the structure walls and/or bases where it then reacts, expands, and seals the leaks.</li> </ul>	<ul style="list-style-type: none"> <li>Public Works Director attended URETEK technical presentation.</li> <li>URETEK provided case studies from similar projects.</li> <li>Pre-estimate site visit to evaluate magnitude of I&amp;I issues and plan logistics.</li> </ul>	<ul style="list-style-type: none"> <li><b>Fast Repair:</b> Work performed in 3 structures in ½ a day.</li> <li><b>Inflow Mitigation:</b> The operation successfully stopped groundwater inflow at all 3 structures</li> <li><b>Minimally Invasive:</b> No excavation or bypass pumping required for this operation</li> </ul>

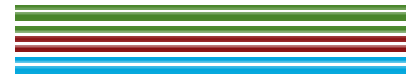






# Manhole Infiltration Repair

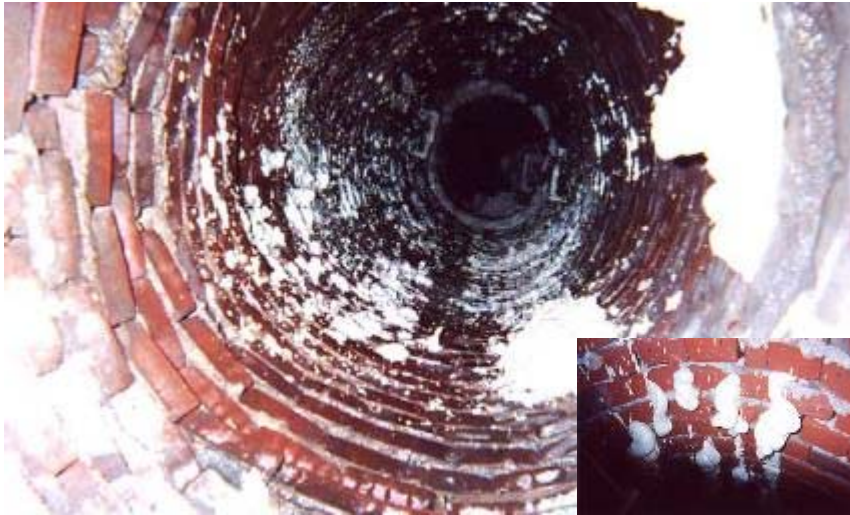
## Clarksville, IN



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>TV inspection showed large amounts of Inflow and Infiltration (I&amp;I) in 7 manholes</li> <li>I&amp;I caused flow to exceed pump station design</li> <li>High ground water table (at grade in some locations)</li> <li>Failure in structure joints and pipe to structure joints</li> </ul>	<ul style="list-style-type: none"> <li>Inject URETEK 486Star Polymer directly through manhole walls and through base of structure, beneath pipe invert to fill voids and seal leaks</li> <li>Where other methods failed, GWS successfully mitigated infiltration</li> </ul>	<ul style="list-style-type: none"> <li>Designed injection quantity, depth, and location to address I&amp;I in the 12" sanitary manhole intersections as well as the structure joints</li> </ul>	<ul style="list-style-type: none"> <li>Work completed in a day and a half</li> <li>Stopped high pressure leaks in minutes</li> <li>Significantly reduced I&amp;I flowing through sanitary system to pump station saving the City over \$90K per month</li> <li><b>Since repair, 49 pump hours per week reduced to 17</b></li> <li><b>Cost savings of \$100k per month since repair</b></li> </ul>



# Manhole B-8, Neyland Drive Knoxville, TN



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• Sheared 8" lateral line was causing extensive voids and loose soil around manhole</li> <li>• 25' Manhole was under threat of collapse</li> <li>• Stabilize manhole without collapsing</li> </ul>	<ul style="list-style-type: none"> <li>• Inject around the perimeter of manhole and stabilize loose soils and the manhole, utilizing strict penetrometer measurement</li> <li>• Fill 75' of 8" line</li> </ul>	<ul style="list-style-type: none"> <li>• Specifications</li> <li>• Designed injection port quantity and depth</li> <li>• Pre-construction meeting</li> <li>• On-site installation</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Minimal downtime:</b> All work performed in one day</li> <li>• <b>Stabilized soil:</b> Stabilized brick manhole and avoided roadway settlement. Additionally sealed the perimeter from further water intrusion.</li> </ul>



# USACE SATOC – Manhole Sealing Ft. Rucker, AL



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Inflow and infiltration at 25' deep manhole and 5ea storm drain lines</li> <li>Multiple, recurring sinkholes caused by Inflow &amp; Infiltration with 30' radius of manhole</li> </ul>	<ul style="list-style-type: none"> <li>Inject URETEK polyurethane through manhole to seal</li> <li>Deep Injection Process along rim of each of the 5ea pipes at engineered locations within 30' radius of manhole and down to 30' depths to displace water, fill voids &amp; stabilize soils outside of pipe.</li> <li>URETEK used in conjunction with CIPP lining</li> </ul>	<ul style="list-style-type: none"> <li>Pre-Estimate Meeting with <b>USACE</b> to determine project scope</li> <li>Designed injection quantity and method to meet <b>USACE</b> specification</li> <li>Pre-construction meeting</li> <li>On-site installation</li> </ul>	<ul style="list-style-type: none"> <li><b>Minimal intrusion:</b> Work performed in two days with no excavation</li> <li><b>Manhole Sealing:</b> Provided Positive Side Seal</li> <li><b>Soils stabilized:</b> Soils stabilized to prevent future seepage and stability to soil</li> </ul>





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**AP/M Permaform**  
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Trenchless Sewer Lining Systems

# AP/M Permaform CentriPipe Process



## First

- Place 12,000 psi cementitious flowable fill
- Repair damaged invert, stop infiltration and stabilize the soil/invert
- Necessary step for success
- New floor that is contoured to radius to enhance flows *\*\*\*If invert only treatment; can stop here*



## Second

- High speed spin caster is placed at downstream end
- High Strength mortar is centrifugally cast around the interior of the pipe; applied at 1/2" passes
- Application head speed can be adjusted based on thickness needed
- Spin caster can stop/start without joints/gaps



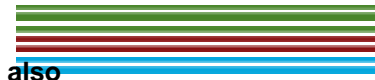


# 36" CMP – NYSDOT I-684

## Westchester County, NY



C also



BEFORE



AFTER

Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• New York I-684 is one of the state's busiest thoroughfares</li> <li>• 300' of 36" CMP under I-684</li> <li>• Work performed in December, so cold temperatures</li> <li>• Emergency project</li> <li>• Bends present, including a 45 degree</li> </ul>	<ul style="list-style-type: none"> <li>• Worked the 300' in 5 sections</li> <li>• Staging areas in the median and adjoining land</li> <li>• PL-12,000 used for inverts</li> <li>• PL-8,000 used for 1" of total thickness</li> <li>• PL-8,000 sets up in a few hours</li> </ul>	<ul style="list-style-type: none"> <li>• New York State DOT</li> <li>• <b>Work performed by another applicator – Arold Construction Company</b></li> </ul>	<ul style="list-style-type: none"> <li>• Remove and replace was ruled out due to extreme project cost and disruption</li> <li>• Cured in place (CIPP) more not feasible due to bends</li> <li>• Bends did not allow for slipline</li> </ul>





# 48" Brick Storm Sewer Warsaw, IN



BEFORE



AFTER

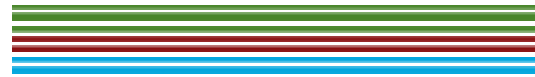
Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• 48" brick and mortar storm sewer</li> <li>• 1,500' long sewer below a roadway</li> <li>• Cracks at bottom of pipe and long cracks running the length of the pipe</li> <li>• Inflow and Infiltration (I&amp;I)</li> </ul>	<ul style="list-style-type: none"> <li>• Long cracks sealed with MS-10,000</li> <li>• Plugged holes, filled cracks, and stabilized loose brick; more I&amp;I than expected</li> <li>• Cleaned pipe with high-pressure jetting</li> <li>• PL-8000 applied</li> </ul>	<ul style="list-style-type: none"> <li>• Warsaw Public Works</li> <li>• Thin wire wet gauge inserted into grout to determine thickness</li> <li>• <b>Work performed by another applicator – ProForm Pipe Lining Inc.</b></li> </ul>	<ul style="list-style-type: none"> <li>• CentriPipe designed 1" thickness with two passes of 0.5"</li> <li>• Overall project took 5 weeks; CentriPipe portion took 1 week and rest of time spent plugging and patching pipe</li> </ul>

 **CentriPipe**  
Installation Video





# 66" CMP Restoration Lake City, GA



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Part of Atlanta metro so densely populated</li> <li>20' deep, 220' long, 66" CMP</li> <li>Parking lots were failing above the pipe and buildings settling</li> <li>Completely corroded inverts and sidewalls curling up into the interior</li> </ul>	<ul style="list-style-type: none"> <li>First - Cut out curled-in pieces</li> <li>Second - Install 54" tunnel liner plates used to stabilize structure</li> <li>Third – Grout annular void</li> <li>Fourth – PL-8000 applied</li> </ul>	<ul style="list-style-type: none"> <li>Clayton County Water Authority</li> <li><b>Work performed by another applicator – Utility Asset Management (UAM)</b></li> </ul>	<ul style="list-style-type: none"> <li>Commercial building above so trenching out of question</li> <li>Capacity could not be reduced, so sliplining was ruled out</li> <li>CentriPipe designed 1" thickness</li> </ul>





# 156" Multi-Plate – FDOT SR16 – Clay County, FL



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• 156" (13') diameter Multi-Plate with leaks; 96' long</li> <li>• Leaks created a void along side of road 10' deep by 20' wide</li> <li>• Minimal cover</li> <li>• 2 lane rural road so did not want to rip and replace</li> </ul>	<ul style="list-style-type: none"> <li>• Manually applied CentriPipe – one sprayed with hose, then second hand troweled</li> <li>• PL-8000 was mix used</li> <li>• Built cofferdam to stop the water from entering pipe</li> <li>• 1.5" thickness</li> </ul>	<ul style="list-style-type: none"> <li>• Worked with Florida DOT, Clay County</li> <li>• Transfield Services was General Contractor</li> <li>• Custom engineered to help with min. cover</li> <li>• <b>Work performed by another applicator – TV Diversified</b></li> </ul>	<ul style="list-style-type: none"> <li>• Headwall and wing walls by others</li> <li>• CentriPipe more economical than remove replace</li> <li>• 25% less than slip lining</li> <li>• Project took 2 weeks</li> <li>• Performed in March 2010</li> </ul>



# Multi-Plate CMP - ODOT

## Cincinnati, OH



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>Multi-Plate CMP fails at bolts and seams</li> <li>Rehab needed to be structural and waterproof</li> <li>Twin arch culverts</li> <li>12' 6" wide by 7' 11" tall, both 90'</li> </ul>	<ul style="list-style-type: none"> <li>Diverted water into other culvert while working in one</li> <li>PL-8000 applied on pipe</li> <li>Crystal-X, a waterproofing admixture from ConShield Technologies was used</li> </ul>	<ul style="list-style-type: none"> <li>Ohio Department of Transportation</li> <li>Self-tapping screws put in at 2" height to verify thickness</li> <li><b>Work performed by another applicator – Indiana Reline</b></li> </ul>	<ul style="list-style-type: none"> <li>CentriPipe designed 2" thickness</li> <li>Concrete and other waste could not flow downstream so was captured with plastic sheet in invert before water rerouted</li> <li>Work performed in 2013</li> </ul>



# Concrete Box Culvert - FDOT

## Bradenton, FL



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>6' x 6.75' Concrete Box</li> <li>61' long</li> <li>One of state's busiest commuting routes</li> <li>Culvert handles tidal surge and storm activity</li> <li>Culvert was experiencing severe MIC corrosion</li> </ul>	<ul style="list-style-type: none"> <li>Rebuild a box culvert under State Road 64</li> <li>PL-10,000 hand applied</li> <li>Metal reinforcement cage out of Grade 60 mesh</li> <li>By-pass water system used 60" pneumatic pipe plugs</li> </ul>	<ul style="list-style-type: none"> <li>FDOT</li> <li>Engineer was Stantec</li> <li>Gibbs &amp; Register, Inc (G&amp;R) was the General Contractor</li> <li><b>Work performed by another applicator – TV Diversified</b></li> </ul>	<ul style="list-style-type: none"> <li>Manually applied</li> <li>35% less than shotcrete</li> <li>5" thick walls and 18" radius top corners to improve load distribution</li> <li>No traffic impact</li> <li>Project completed in 3 weeks</li> </ul>





 **Insight** the first CAT scan for infrastructure

# Inversa Systems

Asset Integrity Assessment Tool

## Approach

### Three Part Condition Assessment

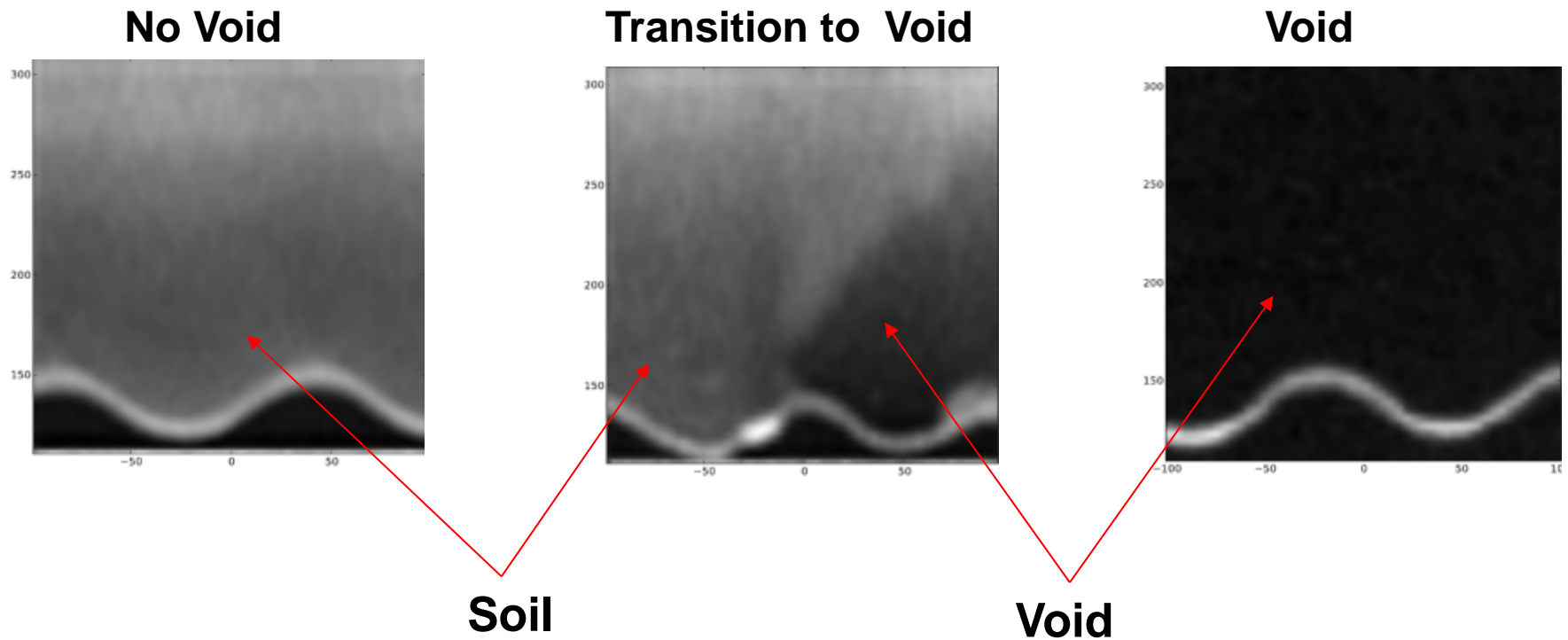
1. Visual Inspection
2. Acoustic Inspection
3. BCT Imaging with Insight™  
(BCT is Backscatter Computed Tomography)

### Results:

- Conclusive and quantifiable data
- Information for repair/replace decision

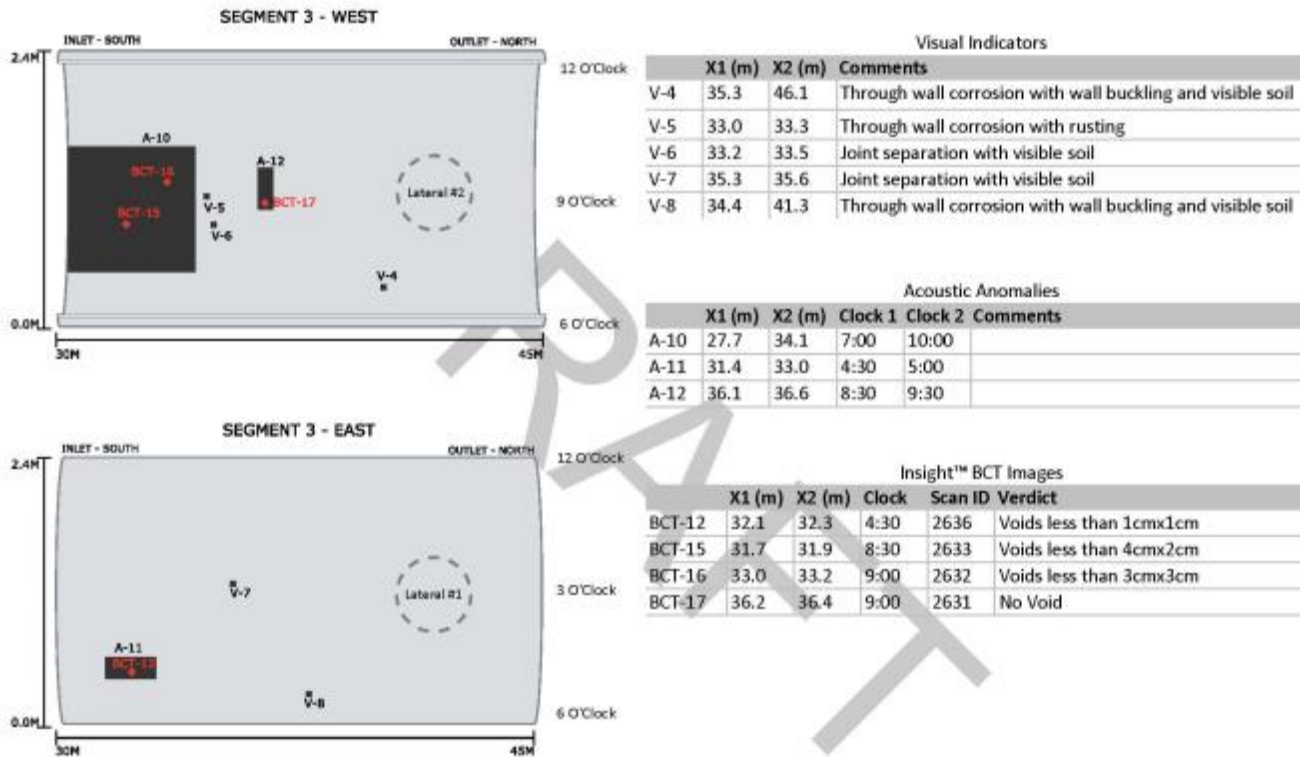


## Backscatter Computed Tomography Image Transition





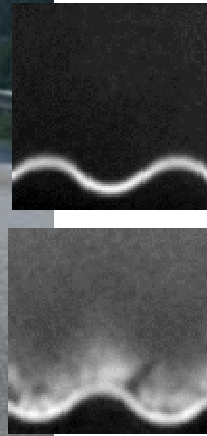
From the inspection, a pipe map is developed to give a visual display of the problem areas and the suspected problems.





# Culvert Emergency Assessment

## Route 365, York County

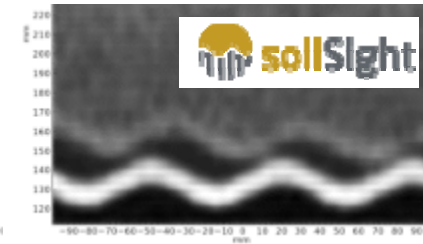
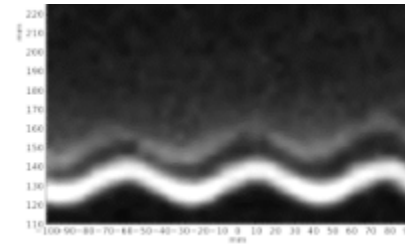
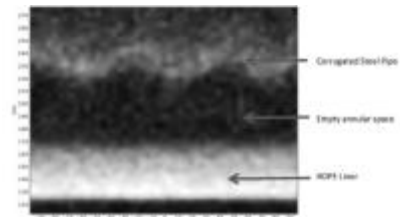
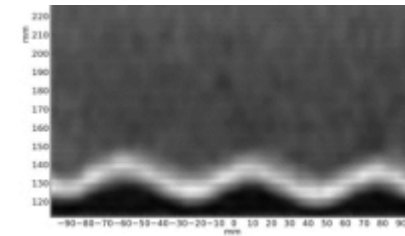


Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• CMP structure supporting major highway</li> <li>• Highly disruptive and costly to replace CMP structure – virtually impossible to dig up</li> <li>• Pipe is 8ft diameter and 136ft length</li> <li>• Depth of CMP is 23 ft below asphalt surfaced</li> </ul>	<ul style="list-style-type: none"> <li>• Structural condition assessment, including all conventional methods as well as diagnostic soil imaging</li> <li>• Prioritization of risk and list of assets in stable condition provided</li> <li>• Options that optimize safety and spending are chosen as the preferred method</li> </ul>	<ul style="list-style-type: none"> <li>• Generally, pipe in good condition. Minor defects to pavement, embankment and pipe. Pipe well aligned, no significant ovality.</li> <li>• Fifteen acoustic anomalies identified - all chosen for BCT imaging.</li> <li>• Confirmed five void regions in the pipes supporting soil.</li> <li>• Two of voids span corrugations, representing structural instability.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Sewer Rehabilitation:</b> By conducting full condition assessment, a clear path towards a safe and cost effective operation was shown</li> <li>• <b>In-situ Technology:</b> Trenchless rehabilitation techniques used to extend the service life of asset</li> </ul>



# USACE/ MSD Levee Structure

## Louisville, KY



Project Challenges	Solution	Support	Outcome
<ul style="list-style-type: none"> <li>• <b>CMP structures used as flood gates</b> within a levee structure were of unknown condition.</li> <li>• Especially, <b>soil side integrity</b> was unknown.</li> <li>• The grouting procedure used in sliplines was being evaluated to ensure the annular space was completely filled.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Soilsight</b> procedures provided information about the <b>structural condition of the levee structures</b>.</li> <li>• Identified where there was an elevated risk of failure during a flood event.</li> <li>• Rehabilitation recommendations made to optimize safety.</li> <li>• This included the recommendation of filling soil side voids with a material that matched the native clay.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>5 sections of CMP</b> were evaluated. 5-6ft diameter under approx. 22ft of fill.</li> <li>• One pipe had been previously lined with an HDPE Slipline</li> <li>• 39 acoustic anomalies total</li> <li>• BCT confirmed <b>14 soil voids</b></li> <li>• The annular space between the slipline was shown to have a void location indicating <b>poor grouting</b> procedure.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>A unique soil failure was documented</b> which was characterized by the soil expanding and contracting seasonally around the pipe. The pipe was shown to have slipped down slope.</li> <li>• <b>This Information</b> allowed the rehabilitation of the soil to be properly planned.</li> <li>• <b>USACE Slipline Grouting Procedure was Changed</b> based on the findings.</li> </ul>



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