# Low-Permeability Construction Materials To Address the Potential Spread of Contaminants and Address SPCC Rules

* Unique stone-core design

November 2015

AquaBlok®
Composite Particle System

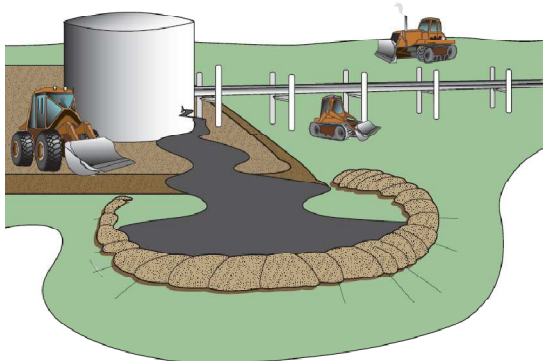
www.aquablok.com

# Presentation Outline

- Problem Statement – Preferential Pathways
- Introduction to AquaBlok / AquaGate
- Overview of applications
- Summary/Questions/Discussion

# Problem – Preferential Pathways

## Spill Prevention, Control, and Countermeasure (SPCC)



SPCC rules are intended to prevent a discharge of oil into navigable waters or adjoining shorelines.

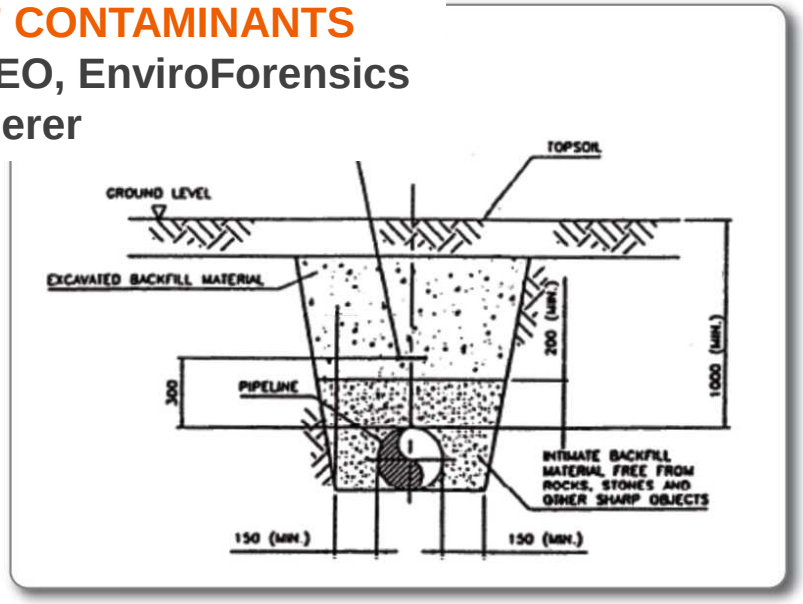
Pipe Penetrations as Failure Point in Berm/Dike

Low-Permeability Materials for Flood Control

# Problem – Preferential Pathways

## PREFERENTIAL PATHWAYS; UNDERGROUND PIPES AND UTILITY LINES CAN BE CONDUITS FOR THE MIGRATION OF CONTAMINANTS

**Written by Stephen R. Henshaw, P.G., President & CEO, EnviroForensics**
**As seen in the March 2013 issue of Cleaner & Launderer**




Typical Pipeline Construction


**Preferential Flow Pathways:**
**Conduits for Groundwater Contamination**
**by Lisa Weatherford**
**Tuesday, February 18th, 2014**

"New research by the U.S. Geological Survey USGS) concerning the vulnerability of our nation's underground drinking water supplies offers a better understanding of how contamination can occur and what we can do to stop it. Yesterday we reviewed three basic measures for drinking water analysis and today we will look at the importance of preferential flow pathways contribute to groundwater contamination."

# AquaBlok Technology Platform

## Composite Particle Coating Approach:

## A Delivery Method for Uniform Placement of Small Quantities of High-Value Materials

- Uniform Distribution
- Flexible/Rapid Installation (Low Cost)
- Custom Blends for Targeted Designs
- Can Vary/Control Permeability
- Placement through Deep Water
- Marine & Freshwater Blends

powder coating

+

aggregate core

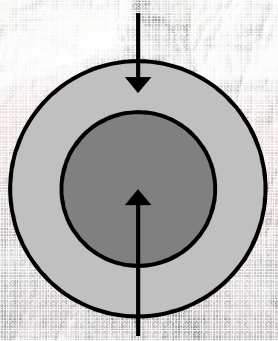
=

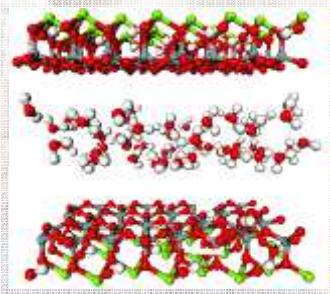
AquaGate+ “composite particle”

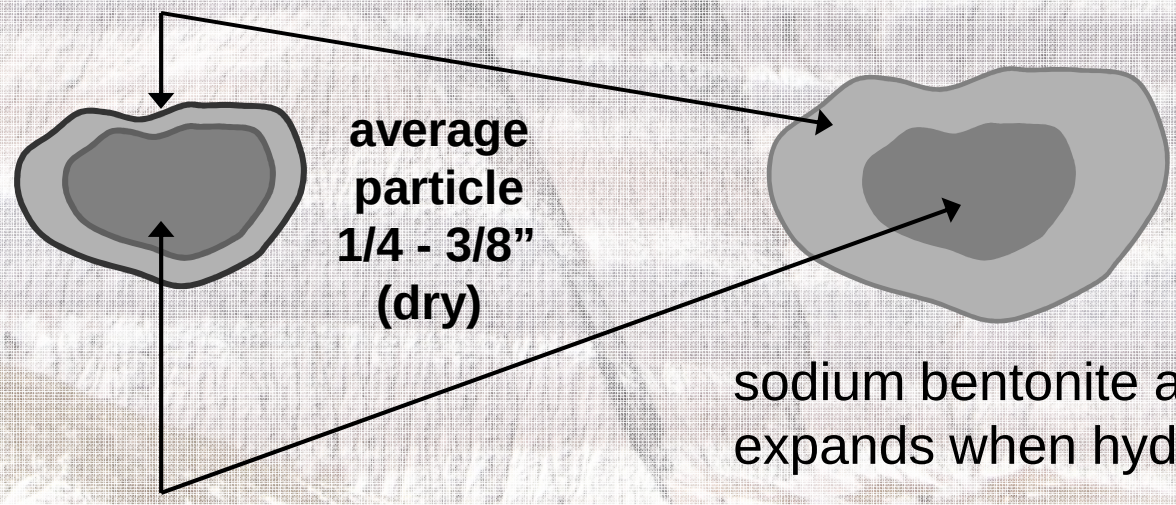
# BENTONITE: 101

## Swell + Compaction = Low Permeability

- Naturally Occurring
- High Swell





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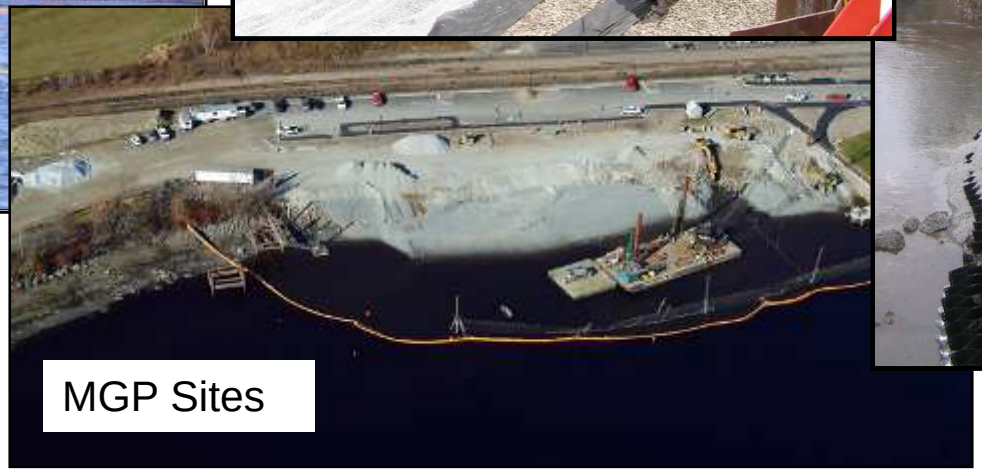
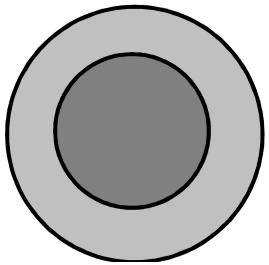
# Low-Permeability for Sealing and Chemical Isolation Barriers

**Applied *through* standing water or in the dry**







**AquaBlok**
**1 min post hydration**

**time**

**AquaBlok**
**24 hr post hydration**

Extreme low-permeability ($5x10^{-8}$ cm/sec)
result of consistent swell and self-compaction

# Values & Technical Advantages

- **Offers Targeted Placement** – can be placed ***through*** or ***directly into flowing water*** - will not drift or dissipate, minimal dusting
- **Easy to Handle/Install** – like stone aggregate
  - install using standard construction equipment
  - no field blending/mixing required
  - ***no mechanical compaction*** the material required
- **Durable**
  - Self-healing (even through drying and re-hydration)
  - Compressive strength (due to internal aggregate core)
- **Safety** – no trench boxes needed

Nature's Duct Tape.
Simple. Unique. Versatile. Effective.

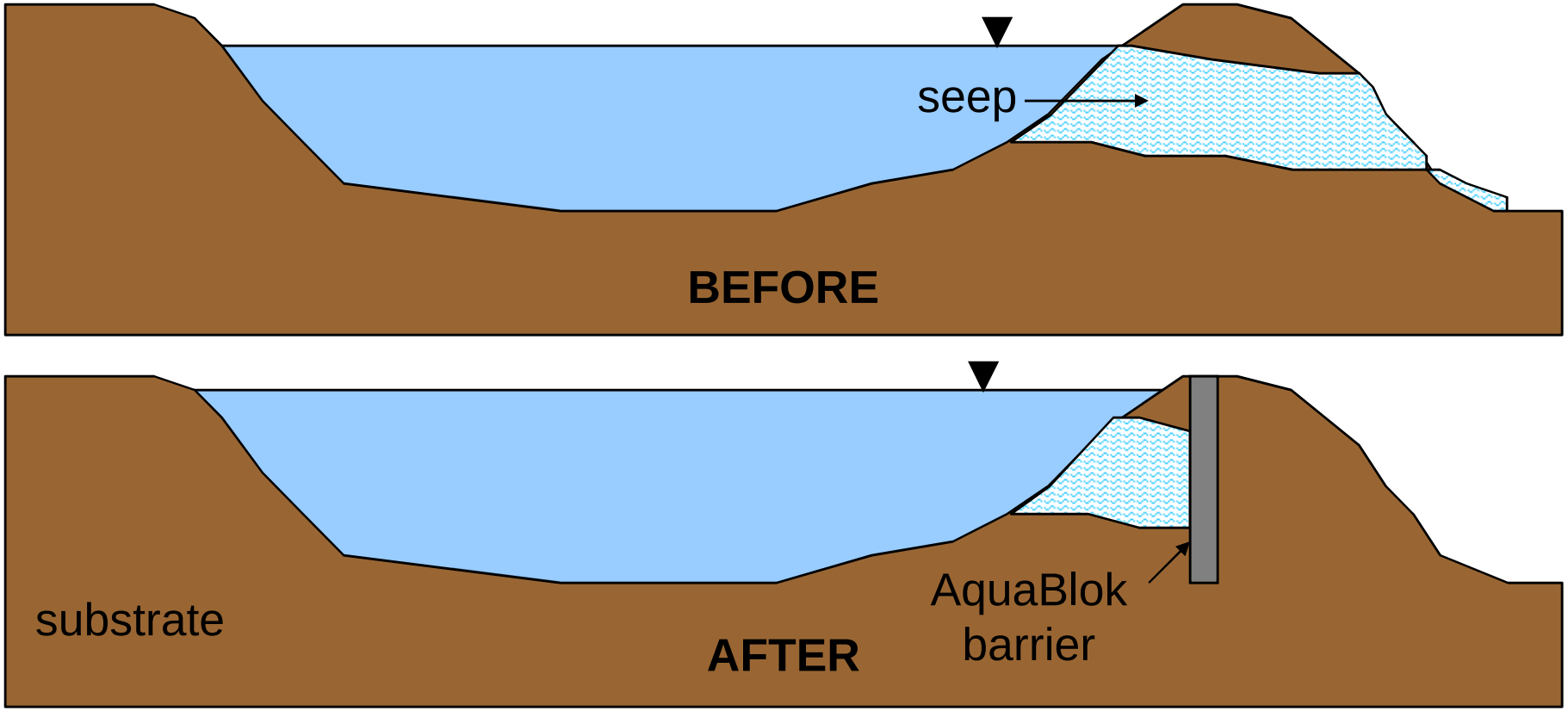
AquaBlok®

# Dams, Berms & Levees


## Vertical Barrier Trench Construction

# Applications & Usage

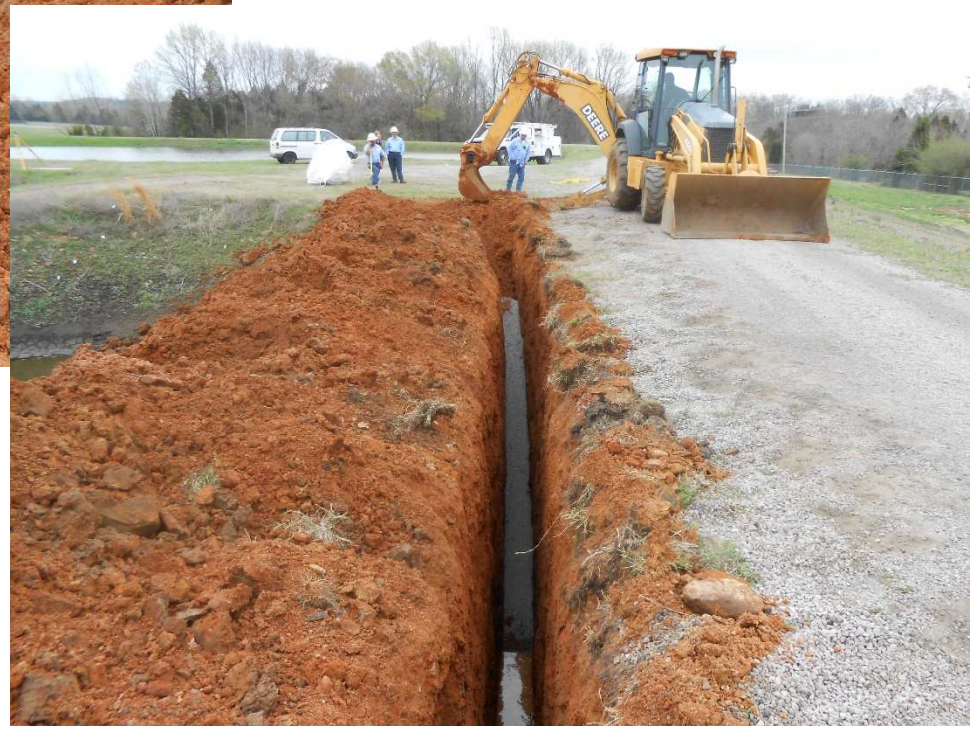
## Vertical Barrier Trench




not to scale

# Application Example

**Fort Smith, AR** – Water Treatment Detention Basin



Post-Repair Water Elevation Returned to Design Levels

# Application Examples

## Preferential Pathway - Flow Along Pipes

**Anti-Seep Collar – Flowing Water**

# Application Examples

## Preferential Pathway - Flow Along Pipes


**Setting / Purpose:** Pipeline cap and Anti-Seep Collar. Objective was to cut off site contaminant pathways during excavation and installation of natural gas pipeline.

**Installation Notes:**

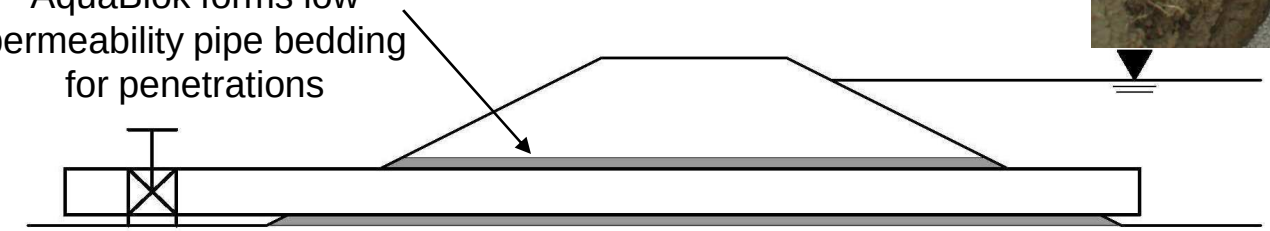
- Coffer Dam approach used to isolate pipe trench from surrounding soil
- Continuous measurement of AquaBlok performed to insure design thickness of cap
- AquaBlok placed in lifts with each layer hydrated to insure hydraulic conductivity
- No additional anti-seep collars were placed along pipeline

# Application Examples

## Landfill Gas Pipe Sealing

Flow Prevention Can Include Gas Release

Below: Sealing Gas Piping in Landfill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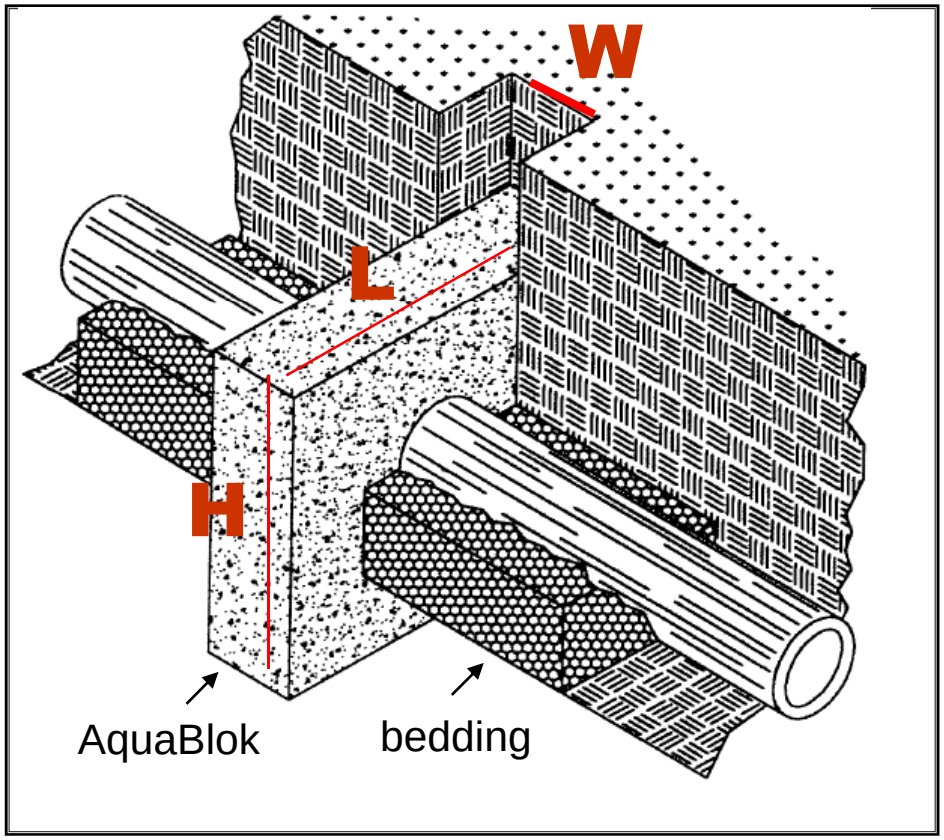
# Application Examples

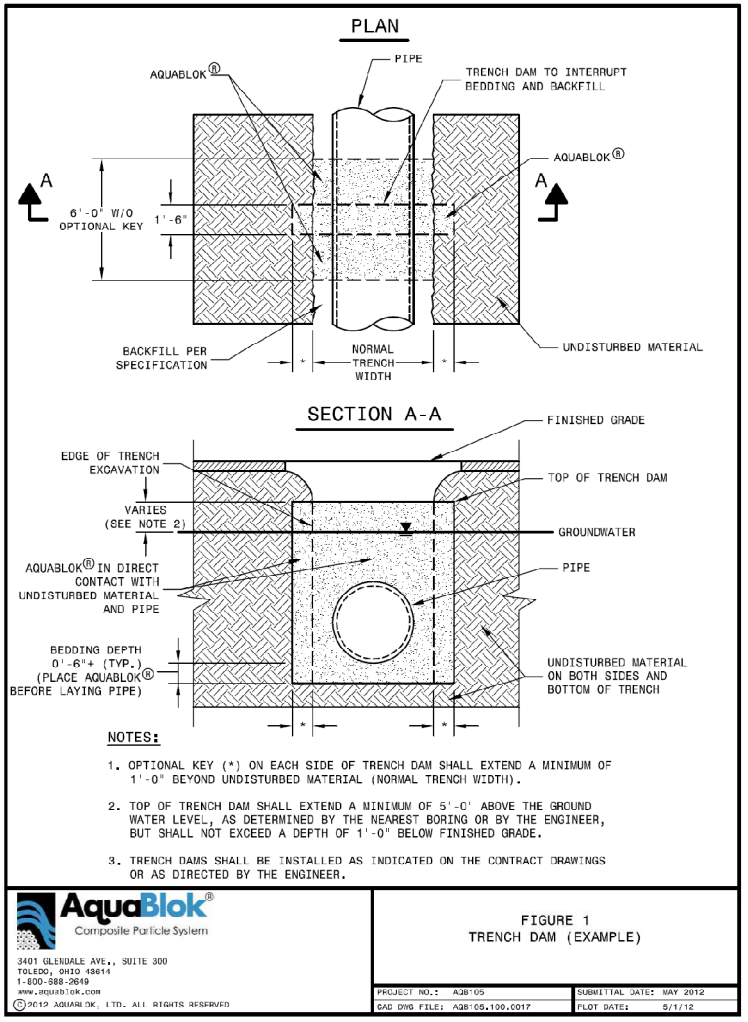
## Pipeline & Utility-Related




**Trench Dams/Anti-Seep Collars**

# Design/Installation of Anti-Seep Collar

## Elimination of Pipe Bedding as Preferential Pathway

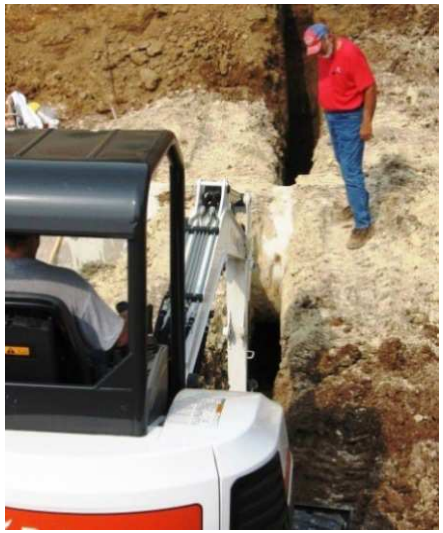


# Installation: Anti-Seep Collar/Berm Stability

Location: West Norriton, Pennsylvania
Setting: Retention/Detention Basin

Right: AquaBlok placement from a bulk bag by excavator – note discharge snout directing product into trench cut perpendicular to the overflow discharge pipe.

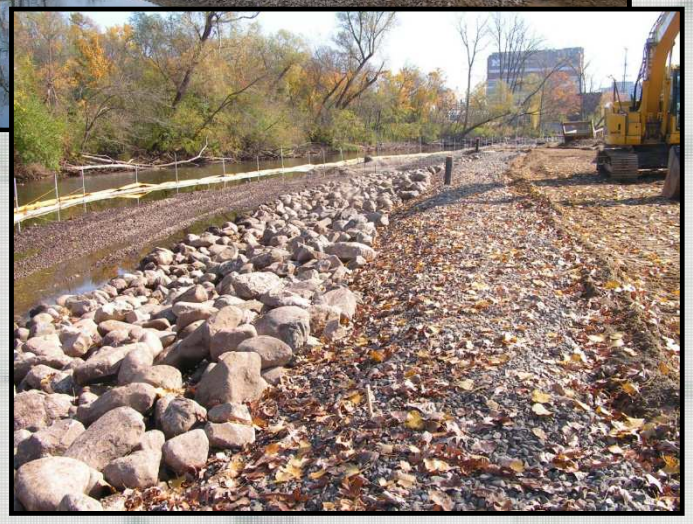


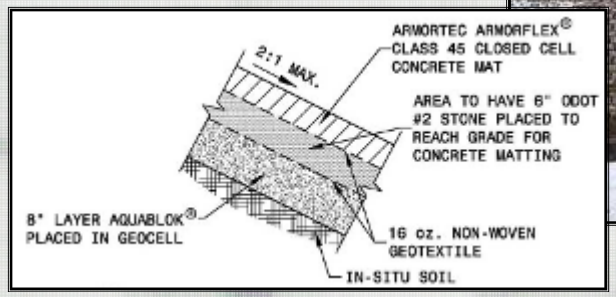


Left: Mini excavator used (narrow bucket) to create trench for AquaBlok placement.
Right: Completed anti-seep collar around pipe.

# Application Example

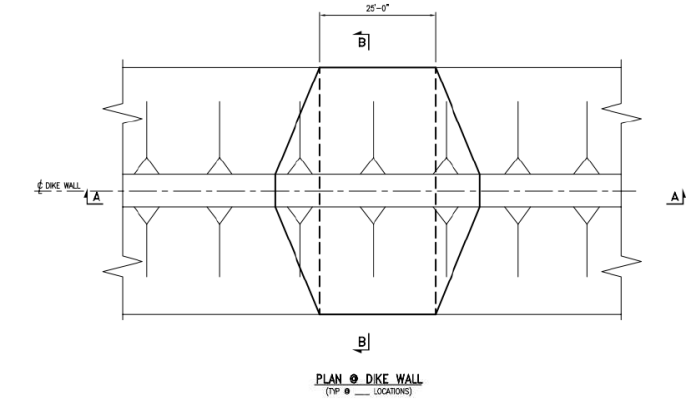
## Berms, Banks & Slope Stability



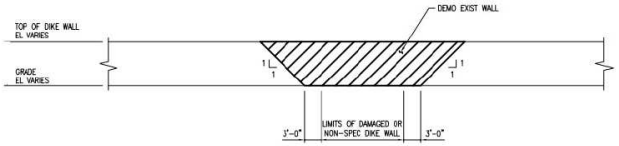



## Cellular Confinement/Slope Protection

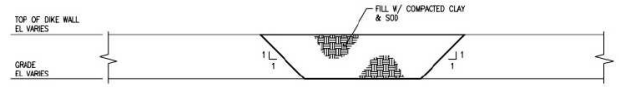
# Dike Wall / Berm Repairs – Alternative Construction Approach



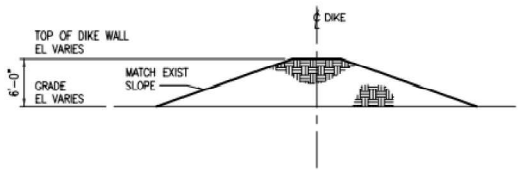

PLAN @ DIKE WALL
(TYP @ ___ LOCATIONS)



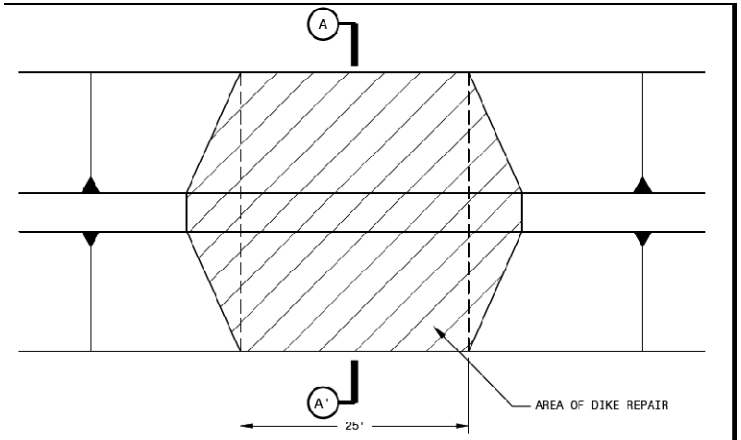

SECTION A–A DEMOLITION
(LINEAR FEET= )
(CUBIC FEET= )
(SK-1054- )



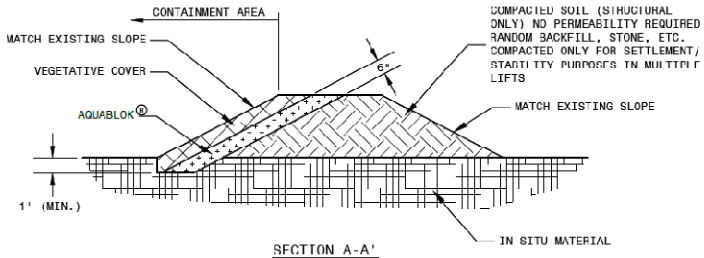

SECTION A–A REBUILD
(LINEAR FEET= )
(CUBIC FEET= )
(SK-1054- )




SECTION B–B
(LINEAR FEET= )
(CUBIC FEET= )
(SK-1054- )




PLAN AT DIKE WALL
NOT TO SCALE




SECTION A-A'
NOT TO SCALE

NOTE:

FILL SIDESLOPES WITH AQUABLOK® AND VEGETATIVE SOIL CONCURRENTLY WITH COMPACTED SOIL.

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SWANTON, OHIO 43558
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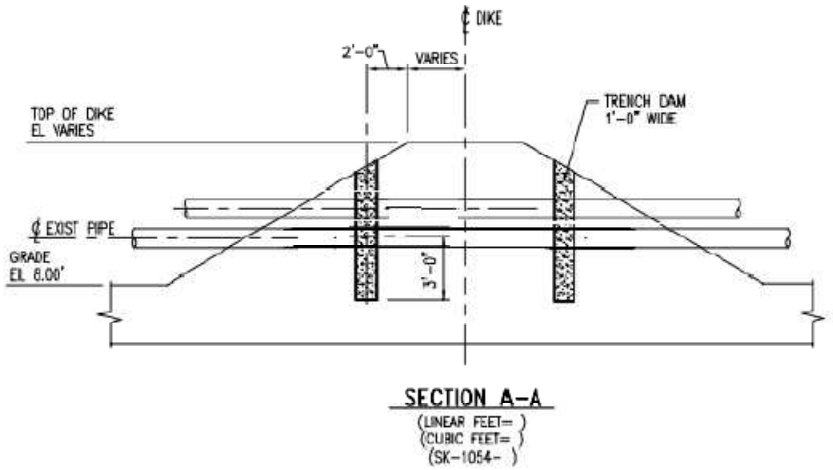
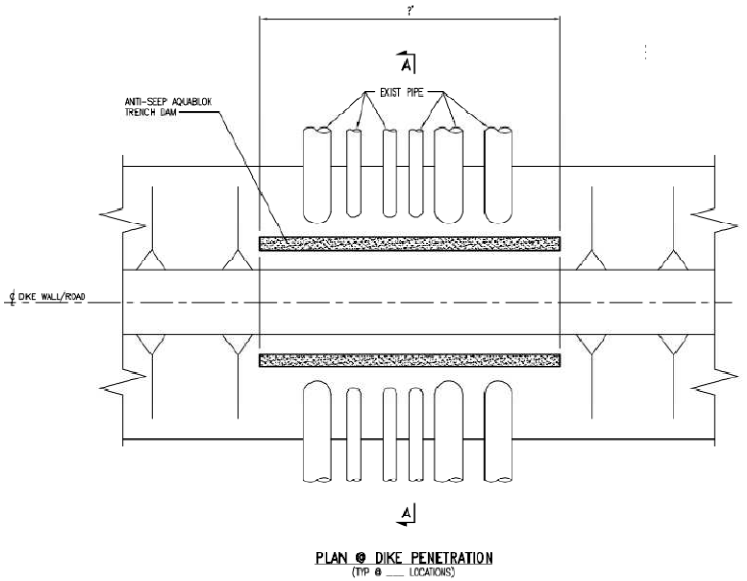
ALTERNATIVE DIKE REPAIR DETAILS

| PROJECT NO.: AQD100 | SUBMITTAL DATE: MAY 2015 |
|---|---|
| CAD DWG FILE: AQB105.100.3020 | PLOT DATE: 5/18/15 |

# Trench Dam
# Construction Considerations -

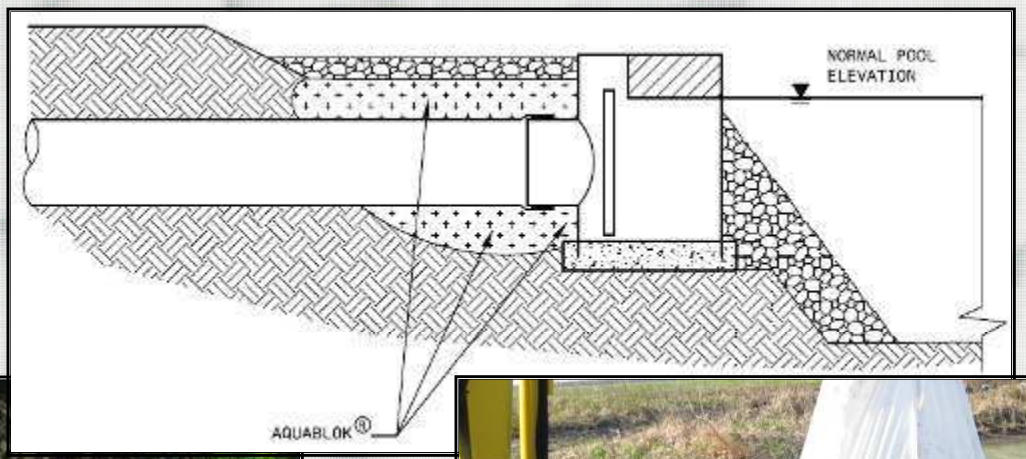



1. **Width of Dam** – 6-inch thickness will provide hydraulic conductivity of approximately $5x10^{-8}$ in hydrated state.
2. **Bedding Depth / Distance Under Pipes** – Typically recommended to be a minimum of 6-inch.
3. **Trench Width** – Where collars are keyed into surrounding soils, it is recommended that AquaBlok extend a minimum of 1-ft beyond undisturbed material.

# AquaBlok®

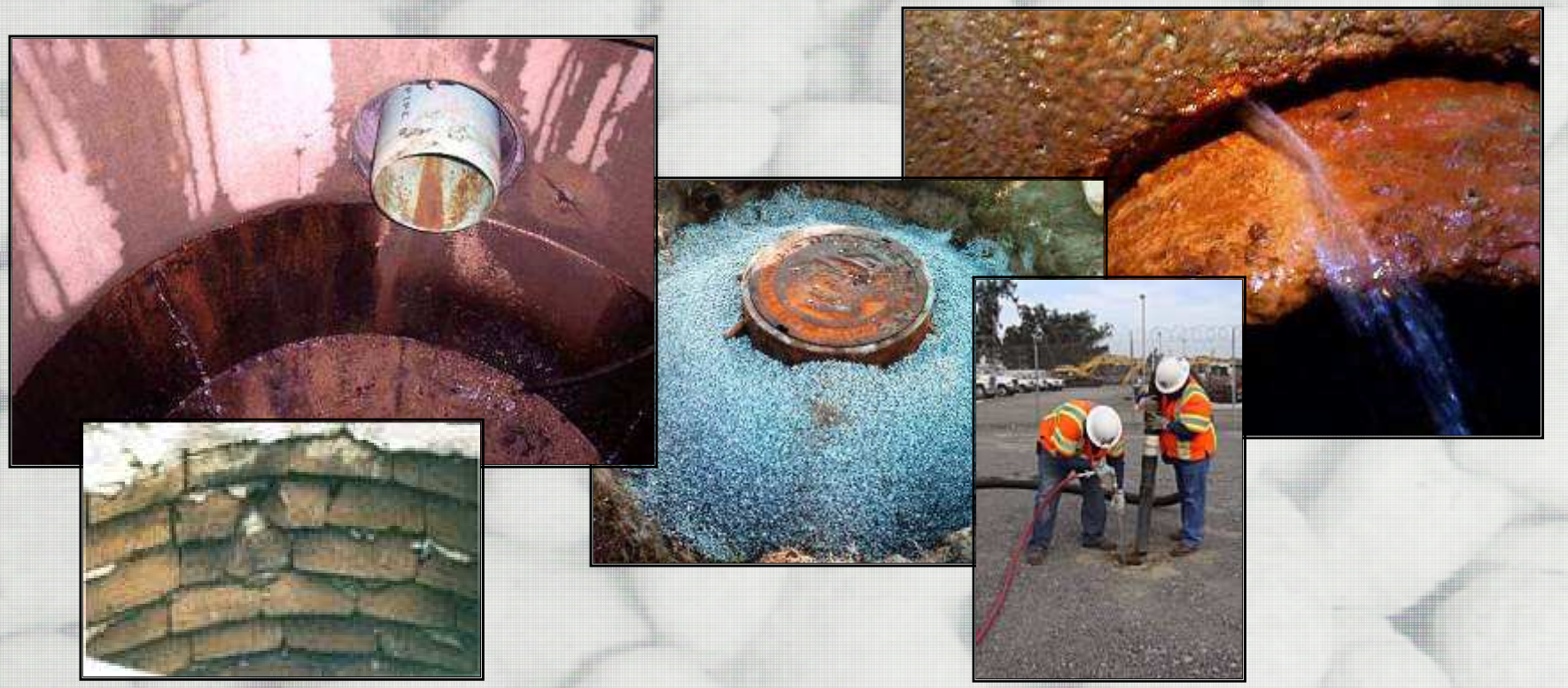
## Utility-related Applications/I & I




## Reinforcing/Bedding Control Structures

# AquaBlok®

## Utility-related Applications/I & I



## Loose Mortar, Stub Outs, Fatigue Cracks

# AquaBlok®

## Other Geotechnical Applications

## Flood Mitigation – Improved Protection of Critical Infrastructure

# Handling/Installation Factors

**Handling / Installation Advantages:**

- Place directly through water column
- Self-compacts on bottom – hydration fills voids to create stable erosion resistant cap layer
- Conventional construction equipment used for placement
- Easy to confirm uniformity of installation (core samples)
- Handles like sand or gravel
- Can be manufactured on-site for significant cost savings


# AquaBlok®

## Geotechnical Data

- Dry State Characteristics
- Permeability
- Percent Swell
- Shear Strength
- Erosion Resistance
- Swell Pressure
- Bearing Capacity
- Compaction
- Freeze/Thaw Response

**All testing conducted by independent, AASHTO-certified soils lab**

# AquaBlok®

Composite Particle System

# better Bentonite



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# Geotechnical Properties- Results

*Shear strength testing - CU triaxial tests*

- AquaBlok 2080 FW: phi = 25.8°, cohesion = 140 psf
- AquaBlok 3070 FW: phi = 5.5°, cohesion = 280 psf

*Shear strength testing - UU triaxial tests*

- AquaBlok 2080 FW: phi = 0°, cohesion = 520 psf
- AquaBlok 3070 FW: phi = 0°, cohesion = 300 psf

*Unconfined shear strength – unconfined compression tests*

- AquaBlok 2080 FW: $C_u$ = 220 psf
- AquaBlok 3070 FW: $C_u$ = 360 psf

# Geotechnical Properties

| AquaBlok - Basic Geotechnical Properties | | |
|---|---|---|
| AquaBlok Blend (#8 Core Aggregate) | 2080 | 3070 |
| Percent Swell from Initial Hydration (%)[1] | 5% | 8% |
| Swell Pressure Exhibited (psf) | ***320*** | ***650*** |
| Shear Stresses: | | |
| Short-Term Condition (undrained) | | |
| Cohesion (psf) | 250 | 200 |
| Friction Angle (degree) | 0 | 0 |
| Long-Term Condition (drained) | | |
| Effective Cohesion (psf) | 100 | 200 |
| Effective Friction Angle (degree) | 13 | 2.5 |
| Bearing Capacity (psf) | ***200*** | ***300*** |

[1] Based on 1.86" Dry Thickness with 1/4" aggregate base load of 30lb/SF

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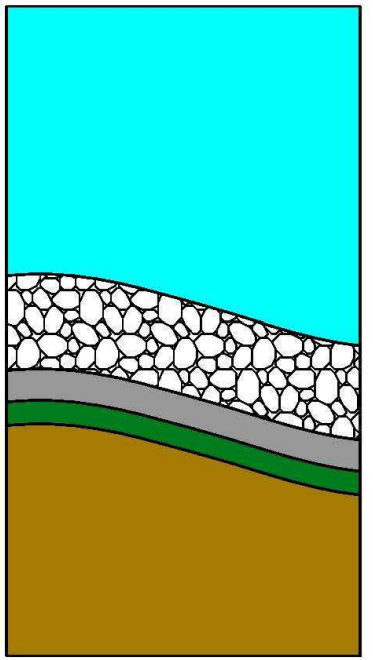
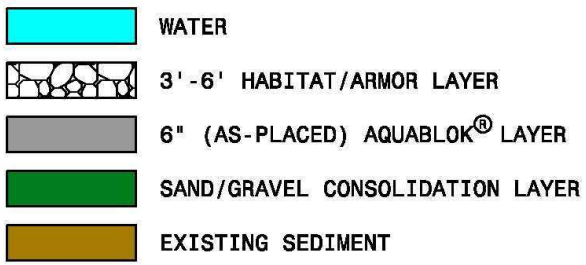
# Geotechnical Properties
## Overburden Scenarios – Water Column

| AquaBlok Blend (#8 Core Aggregate) | 2080 | 3070 | 2080 | 3070 |
|---|---|---|---|---|
| AquaBlok Layer Thickness As-Placed (in.) | 6 | 6 | 6 | 6 |
| Percent Swell from Initial Hydration (%)[2] | 5% | 8% | 5% | 8% |
| Thickness Post-Swelling (in.) | 6.3 | 6.5 | 6.3 | 6.5 |
| Swell Pressure Exhibited (psf) | ***320*** | ***650*** | ***320*** | ***650*** |
| Overburden Thickness (ft.) | ***3*** | ***3*** | ***6*** | ***6*** |
| Overburden Unit Weight (pcf)[3] | 130 | 130 | 130 | 130 |
| Overburden Pressure (psf) | ***390*** | ***390*** | ***780*** | ***780*** |
| Net Swell Pressure (Swell Pressure - Overburden Pressure) (psf) | -70 | 260 | -460 | -130 |
| % Primary Consolidation at Net Overburden Pressure (psf) | 5.5% | 0.0% | 5.5% | 0.8% |
| Thickness Post-Overburden Loading (in.) | 6.0 | 6.5 | 6.0 | 6.4 |

1. Buoyancy effects not considered. Bearing capacity will increase with an increase in water depth.
2. Percent Swell from Basic Geotech Properties - includes 30lb/SF Load during swell.
3. Based on 1-3' Rip Rap Overburden/Armor at 1.75 tons/CU Yard.



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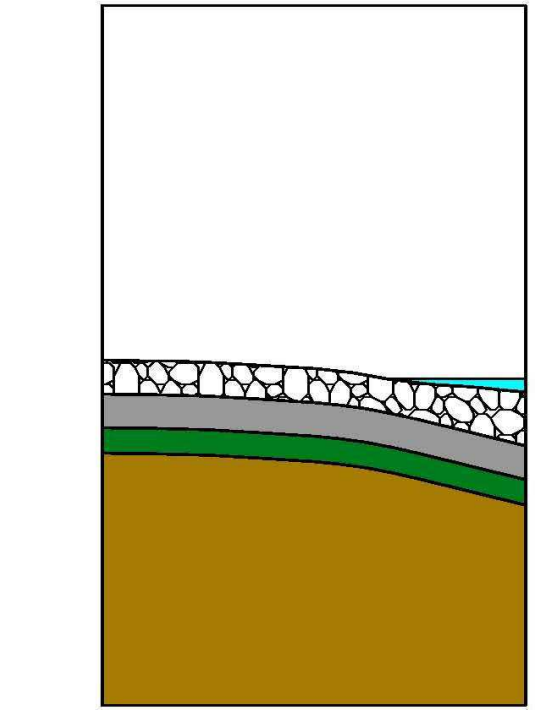
# Geotechnical Properties
## Overburden Scenarios – At Land

| AquaBlok Blend | 2080 | 3070 |
|---|---|---|
| AquaBlok Layer Thickness As-Delivered (in.) | 6 | 6 |
| Percent Swell from Initial Hydration (%)[2] | 5% | 8% |
| Thickness Post-Swelling (in.) | 6.3 | 6.5 |
| Swell Pressure Exhibited (psf) | 320 | 650 |
| Overburden Thickness (ft.) | 0.5 | 0.5 |
| Overburden Unit Weight (pcf)[3] | 130 | 130 |
| Overburden Pressure (psf) | 65 | 65 |
| Net Swell Pressure (Swell Pressure - Overburden Pressure) (psf) | 255 | 585 |
| % Primary Consolidation at Net Overburden Pressure (psf) | 0.0% | 0.0% |
| Thickness Post-Overburden Loading (in.) | 6.3 | 6.5 |
| Bearing Capacity | | |
| Underlying Sediment (psf) | 250 | 250 |
| AquaBlok (psf) | 200 | 300 |
| Final Bearing Capacity at Surface (psf)[1] | 450 | 675 |

1. Based on 2V:1H distribution from overburden material.
2. Percent Swell from Basic Geotech Properties - includes 30lb/SF Load during swell.
3. Based on 1-3' Rip Rap Overburden/Armor at 1.75 tons/CU Yard.

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