PILOT TEST PROGRAM UTILIZING GLASS BEAD FILTER PACKS FOR RELIEF WELL CONSTRUCTION

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OUTLINE

Program Objectives
Study Length
Site Locus
Geologic Setting
Lock No. 27 Historical Performance & Remedial Improvements
RW Locations
RW Design
Sand Filter Issues
Benefits of Glass Bead Filter Media
Field Work
Anticipated Cost Savings
Levee Risk Assessment
Special Thanks
Questions
PILOT PROGRAM OBJECTIVES

Can a “better filter media” assist in reducing long term O&M costs

Lengthen O&M pump testing intervals

Reduce installation development times

Create a more durable “reliable well”
  – Reduce screen clogging
  – Allow for more flow and pressure relief
  – Assists in resiliency and reliability estimates for risk assessment of the remedial systems in place
LONG TERM STUDY OVER 5-10 YEARS

1. Yearly installation of additional wells
2. Compiling performance and O&M data for sand pack and glass bead pack wells
3. Optimization of glass filter pack design (FY17)
4. Side by side comparison of both well types in similar geologic strata
5. Observe performance during flooding events
6. Feed back to USACE Geotech and Geology COPs
REGIONAL LOCUS
SITE: CHAIN OF ROCKS LOCK NO. 27
GEOLOGIC SETTING

• American Bottoms – A large alluvial valley of the Mississippi River containing up to 125' of water laid clay, silt, sand, and gravel

• 8-9 miles wide located near the confluence of the Mississippi, Illinois, and Missouri Rivers

• The materials have changed from glacially deposited outwash sands to postglacial silty-clay deposits where the river evolved from a braided to a meandering river system

Lepley et al., 1957
1993 FLOOD OF RECORD AND REMEDIAL IMPROVEMENTS TO THE EAST LEVEE
# Geotechnical Sampling

## DRILLING LOG

**Boring Designation:** CHRX-52R-15

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Chain of Rocks Pilot Holes FY15 Lower River</td>
<td></td>
</tr>
<tr>
<td>Location Coordinates</td>
<td>N 748.527.9, E 2,297.463.3</td>
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<tr>
<td>Boring Agency</td>
<td>CHRX-52R-15</td>
</tr>
<tr>
<td>Driller</td>
<td></td>
</tr>
<tr>
<td>Name of Driller</td>
<td></td>
</tr>
<tr>
<td>Direction of Boring</td>
<td>Vertical</td>
</tr>
<tr>
<td>Total Number of Core Bore</td>
<td>0</td>
</tr>
<tr>
<td>Total Core Recovery for Bore</td>
<td>N/A</td>
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<tr>
<td>Total Depth of Bore</td>
<td>94.3 ft</td>
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</table>

## Grain Size Distribution

**Client:** FY15 Lower River

<table>
<thead>
<tr>
<th>Classification</th>
<th>Grain Size in Millimeters</th>
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</thead>
<tbody>
<tr>
<td>Cobble</td>
<td>Course, Fine</td>
</tr>
<tr>
<td>Gravel</td>
<td>Course, Fine</td>
</tr>
<tr>
<td>Sand</td>
<td>Medium, Fine</td>
</tr>
<tr>
<td>Silty Sand (SM)</td>
<td>Medium, Fine</td>
</tr>
<tr>
<td>Poorly Graded Sand (SP)</td>
<td>Medium, Fine</td>
</tr>
<tr>
<td>Silty Sand (SP)</td>
<td>Medium, Fine</td>
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</table>

*US Army Corps of Engineers.*
RELIEF WELL DESIGN

CHECK VALVE FOR 10" Ø WELLS

WELL SCREEN DETAIL FOR "D" TYPE WELLS

METAL WELL GUARD DETAIL FOR "D" TYPE WELLS

TYPICAL "D" TYPE RELIEF WELL

NOT TO SCALE
GLASS BEAD GRADATIONS

SB#40 Filter Pack

SB#30 Filter Pack

Percent Passing by Weight

Grain size (mm)

SB#40 Coarse  SB#40 Fine

SB#30 Coarse  SB#30 Fine
INHERENT ISSUES WITH STANDARD SAND PACKS

Problems with decreasing functionality over time

- Wide variety of physical properties due to origin
- If mechanically processed could have wide gradation and fines
- Sphericity
- Crushing during transport, installation, development, and rehabilitation
- Clogging due to disintegration during installation
- Bridging during installation
- Subsidence and compaction after development and rehab
- Clogging due to fines (reduced performance)
BENEFITS OF GLASS BEAD MEDIA

- Improved physical, chemical, and hydraulic properties
- Consistency of physical, chemical, and hydraulic properties
- Reduced long term operational costs due to overall strength and sphericity
- Reduced surface area for less biota growth
- Enhanced lifetime cycle for the RW
OPTIMIZED FILTER PACK DESIGN

- Stable filter pack
- Keeps foundation materials at boundary of filter media or it passes through
- Highest possible effective pore space
- Increased hydraulic permeability from borehole to well screen

[Graph showing permeability vs. sphericity]

Glass  Sand
Filter pack is a hydrologic barrier to strata or natural formation.
Initial well designs identical for sand and glass bead filter packs.
Optimization of glass bead filter packs will be performed during the FY17-18 field seasons.
This should reduce the bead quantities by roughly half (initial calculations) while not changing the overall performance of the RW.
LONG TERM COST REDUCTIONS

Initial installation costs higher due to glass bead costs.

This is recovered by reduced development times and longer intervals between O&M maintenance (examples in water well industry).

Long term durability of well pack so well replacement may not have to occur or there is a much longer intervals between relief well replacement.

Current projection is 15-20% reduction in O&M costs.
### WELL DEVELOPMENT TIME REDUCTIONS IN GLACIAL DEPOSITIONAL ENVIRONMENTS IN NEW ENGLAND

<table>
<thead>
<tr>
<th>Town/City</th>
<th>State</th>
<th>Customer</th>
<th>Well Dimension</th>
<th>Well Depth (ft)</th>
<th>Screen Length</th>
<th>Screen Opening</th>
<th>SiLi Bead Size (MM)</th>
<th>Well Yield (GPM)</th>
<th>Dev. Hours</th>
<th>Budgeted Dev. Hours</th>
<th>Well Efficiency</th>
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</thead>
<tbody>
<tr>
<td>Seekonk</td>
<td>MA</td>
<td>Seekonk Water</td>
<td>24&quot; x 18&quot;</td>
<td>56</td>
<td>10</td>
<td>0.300</td>
<td>18.0</td>
<td>750</td>
<td>30</td>
<td>80</td>
<td>95</td>
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<tr>
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<td>MA</td>
<td>Bourne Water</td>
<td>22&quot; x 16&quot;</td>
<td>227</td>
<td>20</td>
<td>0.035</td>
<td>1.25 - 1.65</td>
<td>824</td>
<td>20</td>
<td>80</td>
<td>93</td>
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<tr>
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<td>Bridgewater Water</td>
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<td>53.5</td>
<td>10</td>
<td>0.280</td>
<td>12.0</td>
<td>300</td>
<td>29</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Harrisville</td>
<td>RI</td>
<td>Harrisville Water</td>
<td>24&quot; x 18&quot;</td>
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<td>5</td>
<td>0.140</td>
<td>5.0 - 6.0</td>
<td>305</td>
<td>16</td>
<td>40</td>
<td>92</td>
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</tbody>
</table>

**Well 8 - Bourne Water District**

- **Design:** 22"x16"
- **Depth:** 226 feet.
- **Pack:** SiLi Bead 1.25 mm - 1.65 mm over 3.8 mm - 4.40 mm
- **Screen:** 20 feet of 0.035" slot over 7 feet of 0.100" slot
- **Capacity:** 825 GPM.
- **Efficiency:** 93% at 825 GPM
REVERSE ROTARY DRILLING-INSTALLATION
LEVEE RISK ASSESSMENT

Assists in resiliency and reliability estimates for risk assessment of the remedial systems in place

Uncertainty, and Confidence Levels

Durable well materials = resilient relief well
SPECIAL THANKS

USACE MVS District employees who worked tirelessly to get this pilot program started (Chris Redell, Jose Lopez, Cathy Fox et al.)

USACE Risk Management Center

USACE Geologic and Geotechnical COPs
QUESTIONS?