Keeping the Lights On:
Energy Facility Flood Mitigation Projects in New England –
Takeaways for Protecting Critical Assets and Infrastructure

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Topics

• Background

• Flood Resilience Options

• GZA’s Work
  • Permanent Flood Control Solutions
  • Temporary and Mobilized Solutions
  • Testing

• Conclusions/Takeaways
Background

- Climate change/sea level rise/larger events
- Super Storm Sandy
  - 8.1M homes without power in 17 states
  - 57k utility workers assist in returning power to NYC
- Post-Super Storm Sandy Lessons
  - Restoring power can be:
    - Time consuming
    - Costly
    - A public relations nightmare
Flood Risk Mitigation – Substation Specific Issues

- Security
- Safety
- Accessibility and Space Limitations
- Underground Penetrations

Plus typical issues:
- Cost
- Maintenance
- Schedule
- Compatibility with future projects
- Site constraints
- Permitting – comp. storage
- Risks/benefits
- Adaptability to climate change
Protecting Critical Infrastructure

Critical Infrastructure

- Water / Wastewater
- Chemical
- Commercial
- Communications
- Manufacturing
- Dams
- Defense Industrial Base
- Emergency Services
- Energy
- Nuclear
- IT
- Healthcare / Public Health
- Government
- Financial
- Food / Agriculture
Flood Resilience Options

- Physical Options
  - No Flooding
  - Controlled Flooding

- What gets protected?

- Longevity of Solution
  - Long-term
  - Interim
  - Mobilized

Photo Source: fema.gov

Floodwall protects Our Lady of Lourdes Hospital in Binghamton, NY along Susquehanna River in 2011 during Tropical Storm Lee
Flood Resilience - Option 1
No Flooding

- Re-Build above DFE
- Permanent Barrier
- Mobilized Barrier
- Interim Barrier
Flood Resilience - Option 2
Controlled Flooding

Raise Panels / Equipment

Dry Floodproofing
Permanent Flood Control Barriers

Steel Sheet Pile

Concrete

Vinyl Sheet Pile

Fiberglass Sheet Pile
Interim Flood Control Barriers

- Sand Bag (Big Bag)
- Reinforced Barrier (HESCO)
- Timber Wall
- Shaped Bag (Trap Bag)
Mobilized Flood Control Barriers

Aquafence
Invisible Wall
Floodstop
Sand Bag
Bladder Dam
Flood Control Barriers
Control of Water

Duck bill

Interior Sump & Pump

Exterior Sumps & Pumps

Flap gates

www.duckbillvalve.net  www.drainagesolutionsinc.com
Project Overview

• Permanent flood control concepts
  • 11 substations in New England
  • Design Flood Elevation (DFE)
    • Set based on ASCE-24
    • Base Flood Elevation (BFE) +2 (or +3)

• Interim flood control concepts
  • 22 substations in New England
  • Flood Contingency Plans (FCPs)
    • Temporary controls (2-3 years)
    • Mobilized controls
Permanent Flood Control Concept Plans

FEMA Flood Zone Boundaries

Protected Area

River
Permanent Concepts – Site Specific Realities

Aging seawall

Property constraints

Historical structures, tunnels/conduits
Flood Control Concept Selection Process

"The Matrix"
## “The Results”

<table>
<thead>
<tr>
<th>Engineering/Installation / Construction</th>
<th>Risk/Opportunity</th>
<th>Operations, Maintenance, &amp; Replacement Cost (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost (thousands)</td>
<td>Critical Path Duration (months)</td>
<td>Weighted Risk</td>
</tr>
<tr>
<td>---------------------------------</td>
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</tr>
<tr>
<td><strong>Alternative 1</strong> — Floodwall around Existing 23kV Yard and Building Housing 4kV yard, Flood-proofing north wall of building.</td>
<td>$3,824</td>
<td>40.0</td>
</tr>
<tr>
<td><strong>Alternative 2</strong> — Construct new raised 23kV yard, decommission existing 23kV yard, Allow building to flood</td>
<td>$3,379</td>
<td>51.5</td>
</tr>
<tr>
<td><strong>Alternative 3</strong> — Floodwall around 23kV yard ONLY, Allow building to flood</td>
<td>$2,503</td>
<td>36.5</td>
</tr>
</tbody>
</table>
PHASE 2: PROPOSED 200 GPM PUMP

PHASE 1: SEAL CONDUITS

PHASE 2: PROPOSED 100 GPM PUMP

PHASE 2: 36-INCH FLOODSTOP BARRIER SYSTEM MIN EL 101.5’
(SEE DETAIL)
COORDINATE FENCE AND EQUIPMENT CLEARANCES
Flood Contingency Plans/Mobilized Concepts Testing

- Geotextile between cells
- Geotextile not folded under

Mock-Up #1
HESCO Testing

End dumped fill
Mock-Up #1
HESCO Testing

Excessive Internal Seepage

Increasing Flow, Piping
Flood Contingency Plans/
Mobilized Concepts Testing

Mock-Up #1
HESCO Testing

Loss of Strength – Potential Failure of Multiple Cells

Loss of Fill – Imminent Failure of Cell
Mock-Up #2
HESCO Testing

Geotextile folded under this time

Geotextile damage due to compaction method
1. Need to listen and understand Client needs
   • Facility – past, present, and future
   • Operations and capabilities
   • What needs protection?

2. Thorough design development is key

3. Proper installation, training, and execution are essential
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