Introductions

- City of Hartford
- United States Army Corps of Engineers (USACE)
- Riverfront Recapture
- Others
  - Fuss & O’Neill, Inc.
  - GEI Consultants, Inc.
Shared Responsibility

- Levee Accreditation
- Levee Inspection
- Flood Fighting
- Risk Assessments
- Operation and Maintenance
- Levee System Evaluations (Certifications)
- Mitigation Programs
- Insurance
- Floodplain Management
- Emergency Preparedness

Shared Responsibilities:
- FEMA & Local Community
- USACE & Local Community
- Local Community
Implementing the Risk Framework

Answer the Basic Questions
- National Levee Database
- Inspection Ratings And Eligibility

Context
- Risk Assessments
- Sponsor Meetings
- Public Dialogue

Action
- Plan IRRMs
- SJ Rs & FRMs
- SWIFs
- 408s

Today

Tell the Story
- Plan IRRMs
- SJ Rs & FRMs
- SWIFs
- 408s

Build Shared Solutions
- Advise
- Plan Path Forward

- Inventory
- Periodic Inspections
- Communication

- Risk Assessments
- Communication
- Public Dialogue
Background
Connecticut River Basin

(Source: USACE)
Flood of 1936

Looking North over Dutch Point Toward Bulkeley Bridge

(Source: Connecticut History Online)
Flood of 1936

Front Street Neighborhood with Bulkeley Bridge in the Distance

(Source: Connecticut History Online)
Flood of 1936

Soldiers’ and Sailors’ Memorial Arch and Capitol Building

(Source: Connecticut Historical Society)
Flood Control System Construction

- Authorized by the Emergency Relief Appropriations Acts of 1936, 1937, and 1938
- Constructed in several phases by the US Army Corps of Engineers from 1938 to 1981
- Construction of the dikes and floodwall, 3 pump stations, and Park River conduit began in 1938 and was completed in 1944
- The last portions (e.g., Folly Brook conduits, Park River conduit extension, 2 pumping stations, and the auxiliary conduit) were completed by 1981
Earthen levee construction south of Bulkeley Bridge (circa 1940)
Flood Control System Construction

Floodwall construction south of Bulkeley Bridge (circa 1940)
Hartford Flood Control System: Overview

- Provides protection against flooding for approximately 3,000 acres of developed urban area.
- Main components of the system include:
  - 6.4 miles of earthen dikes
  - 0.8 miles of concrete floodwalls
  - Six pumping stations
  - Two drainage basins
  - Three pressure conduits
  - An auxiliary conduit
Typical Earthen Dike Cross-Section

Composition Overview

- Drainage Ditch
- Rock Toe Drain
- Free Draining River Sand
- Vegetative Cover
- Lateral Drain
- Gravel Access Road
- Hand Placed Riprap
- Select Impervious Material Blanket
- Native Material
- Steel Sheet piling
- Native Material
- Composition Overview
Levee and Flood Elevation Comparison

- Top of Levee
- Probable Maximum (“Catastrophic”) flood
- 500-year flood
- 100-year flood
- ~10 feet freeboard for the 500-year flood
Flood of 1984

View looking north of South Meadows Dike and Brainard Airport
Recent Flood Events

Riverfront Plaza
Recent Flood Events

Riverfront Boat House
FEMA Flood Map
FEMA Accreditation

- Completed in July 2009 and in effect for 10 years
- Prevents owners within the levee protected area from having to obtain mandatory flood insurance
As part of the FEMA Accreditation process:
- Sent mailers to affected property owners
- Conducted a Public Information Meeting (televised on public access)

Note: Minimal response from the public
Used computer tools (ArcGIS & HEC-GeoRAS) to simulate a levee breach during a FEMA 100-year flood in each of four neighborhoods and developed maps showing possible timing and extents of flooding.
Emergency Operations Plan Annex

- Worked with Hartford Emergency Operations Center (EOC) to prepare a Flood Evacuation Plan
- Incorporated maps from levee breach analysis
- Hartford EOC receive input from various other city agencies
• Worked with FEMA and the USACE during the 2009 Accreditation process
• Received cost sharing assistance from the State of Connecticut to fund previous projects
  – Projects performed under CT DEEP oversight
• Developed outstanding working relationships with these agencies
### Political Outreach & Grant Funding

- Assisted Representative John Larsen and his staff during a March 2013 Levee tour and press event in an attempt to receive federal funding for Flood Control System improvements.

- **Pursuing all available funding opportunities**
  - FEMA – No eligible projects this cycle
  - Connecticut Institute for Resilience and Climate Adaptation (CIRCA)
  - Water Resources Development Act (WRDA)
Construction Work Performed
Vegetation Clearing

Before

North Meadows Dike Near Police Firing Range

After
A portion of North Meadows Dike under repair (stakes show burrow locations)
Riprap Repair

Removal of disturbed riprap
Drainage Ditch Restoration

Drainage ditch North of Hartford Landfill

Before

After

Drainage ditch North of Hartford Landfill
Toe Drain Repair

Toe drain clogged with sediment being cleaned
Lateral Drain Pipe Repair

Lateral drain being repaired with HDPE sleeve
Concrete Floodwall Repair

Repaired floodwall keyway near MIRA Powerplant
Auxiliary Conduit Sediment Removal
North & South Meadows Pond Dredging
South Meadows Pumping Station Rehab

**Before**

Propellers

**After**
Stop Log Structure Repair

Sill Installation at Closure 2 near North Meadows Pumping Station
Maintenance & Monitoring
Maintenance & Preparedness

- **Earthen Levees**
  - Mowing of levees
  - Ditch clearing
  - Herbicide of riprap
  - Animal burrow repairs
  - Flood event cleanup

- **Closure Structures**
  - Trial erections

- **Pump Station**
  - Equipment testing
  - Routine maintenance
Flood Event Monitoring

- City Performs Monitoring Prescribed in:
  - Operation & Maintenance Manual
  - Emergency Operation Plan (Annex N)

**PHASE IB MONITORING (>16 FEET)**
- Patrol Levee System Daily

**PHASE II FLOOD MONITORING (>24 FT)**
- Establish Emergency Ops Center @ Public Safety Complex
  - Patrol Levee every 8 hours
  - Contact media if warranted

**LEVEE BREACH (>31.2 FT OR BREACH POTENTIAL)**
- DPW & City officials work together to inform residents

**PHASE IA MONITORING (>12 FEET)**
- Ensure availability of Staff and Materials
SWIF Program
Late 2014: “Unacceptable” rating by USACE based on USACE Routine Inspection June 2013

System temporarily placed on “Inactive” status – not eligible for federal funding if system is damaged

August 2015: “Active” status is restored to the system while under the SWIF Program
System-wide Improvement Framework (SWIF) Program

- City must develop a SWIF Plan that:
  - Outlines the cost and schedule to address system deficiencies
  - Is completed by August 2017

- In the Interim, the City must also:
  - Implement risk reduction measures until repairs are made
  - Implement a public outreach program (e.g., mailers, website)
  - Continue to perform flood event inspections
# System Deficiencies

- 37 Items in all deemed “Unacceptable” by USACE
  - Any one of the “Eligibility Criteria” deficiencies below places the entire system in “Inactive Status”

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>Status</th>
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<tbody>
<tr>
<td>Encroachment: Soil pile with heavy vegetation along landside toe</td>
<td>Completed</td>
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<tr>
<td>Closure Structures (General): Remove vegetation, Repair cracking, and perform trial closures</td>
<td>City to perform trials 2016; New aluminum panels installed for several crossings; Working with railroad for last crossing which required tracks to be cut for trials</td>
</tr>
<tr>
<td>MDC Sewer Crossing: video inspection required</td>
<td>Planned for 2016 Inspections, may have follow-up repairs</td>
</tr>
<tr>
<td>Toe Drainage Systems: visually or video inspect</td>
<td>Planned for 2016 Inspections, Expected to require toe drain replacement</td>
</tr>
<tr>
<td>Closure Structures - Corroded bulkhead door @ MIRA</td>
<td>Completed - CS Removed</td>
</tr>
<tr>
<td>Establish a floodwall tilting monitor program</td>
<td>Proposed for 2016</td>
</tr>
<tr>
<td>Visually or video inspect all culverts and discharge pipes</td>
<td>Planned for 2016 Inspections, may have follow-up repairs</td>
</tr>
<tr>
<td>Visual or video inspection of the Folly Brook Conduit, Gully Brook Conduit, Park River Conduit, and lateral sub drains</td>
<td>Planned for 2016 Inspections, may have follow-up repairs</td>
</tr>
<tr>
<td>Pope Park PS: Corrosion on the intake/discharge pipe flanged connections, Sand and repaint connections, Repair cracked flanges</td>
<td>Pope Park Pumping Station requires replacement of all suction and discharge piping</td>
</tr>
</tbody>
</table>
System Deficiencies

- The majority of deficiencies that lead to the system being placed on inactive status were related to not performing the required inspections.
- However, based on past work the need for additional repairs to the system are anticipated.
- Therefore, the overall SWIF Program will include a comprehensive assessment of known and potential improvements to the entire flood control system.
# Capital Improvement Projects

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Priority</th>
<th>Total Est. Cost</th>
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<tbody>
<tr>
<td><strong>EMBANKMENTS/FLOODWALLS</strong></td>
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<tr>
<td>1. Bulkeley Bridge Underseepage Mitigation</td>
<td>High</td>
<td>$12,500,000</td>
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<tr>
<td>2. North and South Meadows Dike Toe Drain Installation</td>
<td>High</td>
<td>$650,000</td>
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<tr>
<td>3. South Meadows Dike Underseepage and Impervious Blanket</td>
<td>Medium</td>
<td>$5,500,000</td>
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<tr>
<td>4. Floodwall Inspection and Tilting Portion Monitoring</td>
<td>Medium</td>
<td>$10,000</td>
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<tr>
<td>5. Closure Structure Upgrades</td>
<td>High</td>
<td>$1,369,000</td>
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<tr>
<td>6. Concrete Flood Wall Upgrades (Joint Repairs)</td>
<td>Low</td>
<td>$500,000</td>
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<tr>
<td>7. Utility Penetration Abandonment &amp; Modification</td>
<td>Low</td>
<td>$500,000</td>
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<tr>
<td><strong>PUMPING STATIONS</strong></td>
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<tr>
<td>8. Pump Station Inspections</td>
<td>High</td>
<td>$130,000</td>
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<tr>
<td>9. North and South Meadows Pump Station Trash Rack Replacement</td>
<td>High</td>
<td>$2,000,000</td>
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<tr>
<td>10. Repairs to intake and discharge pipelines at Pope Park, Bushnell Pump, and Amory Pump Stations</td>
<td>High</td>
<td>$6,000,000</td>
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<tr>
<td>11. South Meadows Pumping Station Valve Improvements</td>
<td>High</td>
<td>$3,870,000</td>
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<tr>
<td>12. North Meadows Pumping Station Improvements</td>
<td>High</td>
<td>$4,200,000</td>
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<tr>
<td>13. Bushnell Park Pumping Station Improvements</td>
<td>High</td>
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<tr>
<td>14. Keney Lane Pumping Station Improvements</td>
<td>Medium</td>
<td>$2,800,000</td>
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<tr>
<td>15. Pumping Station Training Program</td>
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<td>16. South Meadows Pumping Station Additional Improvements</td>
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<tr>
<td>17. Amory Pumping Station Improvements</td>
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<tr>
<td>18. Pope Park Pumping Station Improvements</td>
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<tr>
<td>19. Pumping Station Automation Improvements</td>
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<td>$3,750,000</td>
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<tr>
<td><strong>INTERIOR DRAINAGE &amp; CONDUITS</strong></td>
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<tr>
<td>20. Weston Street Drainage (Phase 1B)</td>
<td>High</td>
<td>$300,000</td>
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<tr>
<td>21. North Branch Park River Channel Improvements</td>
<td>Low</td>
<td>$3,500,000</td>
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<tr>
<td>22. Park River Conduit Upgrades</td>
<td>Low</td>
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<tr>
<td>23. Folly Brook Conduit Replacement</td>
<td>Low</td>
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<td>24. Cemetery Brook Conduit Upgrades</td>
<td>Low</td>
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<td><strong>TOTAL</strong></td>
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<td><strong>$42,200,000</strong></td>
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*Note: The map in the image shows the planned capital improvements, including flood control system enhancements and pump station developments.*
CIP Plan

<table>
<thead>
<tr>
<th>Project</th>
<th>ALREADY FUNDED</th>
<th>FY17</th>
<th>FY18</th>
<th>FY19</th>
<th>FY20</th>
<th>FY21</th>
<th>BEYOND 5 YEAR CIP</th>
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**Amount Bonded = $10M**
Underseepage Concerns
Cutoff Embedded into Underlying Clay

- Concrete Floodwall
- Landside Ground Surface
- Waterside Ground Surface
- Connecticut River Flood Level
- Connecticut River
- Steel Sheetpile Cutoff
- Seepage Flow
- Relatively Previous Sandy Soil
- Relatively Impervious Clay or Glacial Till
Short Cut-off Wall

Ground Surface
Before I-84/I-91
CTDOT Upgrades

Concrete Floodwall

Waterside Ground Surface

Connecticut River

Connecticut River Flood Level

Steel Sheetpile Cutoff

Seepage Flow

Relatively Previous Sandy Soil

Relatively Impervious Clay or Glacial Till
Following the construction of the levee system in the early 1940s, the area was largely unchanged until the construction of the I-91 & I-84 Interchange.

Connecticut Boulevard (future I-91) shown here to ramp up gradually to meet the grade of Morgan Street and the Bulkeley Bridge.

Overview of Area of Concern

View of Bulkeley Bridge, looking North
Overview of Area of Concern

View of Grove Street On Ramp, looking North
Seepage Monitoring
Seepage Monitoring

- Conditions w/ Sheet Piles (North Meadows Dike)
Seepage Monitoring

• Conditions without Sheet Piles (Bulkeley Bridge)
Conclusions

1. Flood Control System is FEMA-Accredited to the 100-year flood elevation
2. Flood Control System is currently “Active” per the USACE and the City is eligible for Federal funding if damage occurs to the system
3. SWIF Plan deadline is August 2017; Risk Reduction Measures and Public Outreach must be conducted in the interim
4. The City’s CIP outlines the strategy to address expected repairs and upgrades to the system
5. DPW staff is capable of maintaining and inspecting the system moving forward
Questions?