Elimination of Urban Flooding with Innovative Mitigation

CASE STUDY - WESTBURY DRAINAGE

Roopa Metla, PE, CFM
Agenda

- Westbury Drainage Overview
- Phase I Sub-Project 1 (SP1) “Inline Detention” / COH Technical Committee Review Action Items
- Phase II Expanded Area H&H Modeling with “Reduced Inline Detention”
- Findings / Road Blocks
Westbury Drainage Overview
Westbury Drainage Mitigation – Willow Waterhole Bayou Greenway Complex
### Sub-Project Areas

**Phase 1 SP1 Study in 2017 without Atlas 14**

<table>
<thead>
<tr>
<th>Drainage System</th>
<th>Drainage Area (acres)</th>
<th>100-year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1 w/o Atlas 14</td>
<td>155</td>
<td>540</td>
</tr>
<tr>
<td>Additional Study Area w/ Atlas 14</td>
<td>1,070</td>
<td>4,220</td>
</tr>
</tbody>
</table>
Phase I SP1 – Storm Sewers with Inline Detention
Phase I SP1 100-Year Inundation

Existing

Recommended Inline Detention Alt

**Ponding Depth (ft)**

- 0.0 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 5.0
- 5.0 - 10.0
- Study Limits
Action Item:
COH Technical Review Committee (TRC) requested a new drainage option that would include the feasibility of constructing a surface detention pond within the area of the lots that have been subjected to repetitive flooding and are proposed to be bought out by HCFCD. This could reduce the size of the in-line detention incorporated into the proposed underground storm sewer system within the project area.

Resolution:
KIT will obtain additional data related to the total volume available for the detention pond from buy-outs and the feasibility of constructing a small detention basin. If feasible, the detention basin will be incorporated into the proposed condition drainage model during the Phase 2 Final Design to determine the possible reduction of proposed storm sewer sizes within the project area.
Westbury Additional H&H Study Area
H&H Model Development

XPSWMM Model

Surveyed D12-00-00 XS & Sub-Project I
LiDAR 2018

2017 D12-00-00 Tailwater Condition

HEC-RAS 2D
Overland Drainage

HEC-HMS
Hydrographs
Atlas 14 Inlets

Tailwater
Channel cross sections
West offsite flows
East offsite flows
Multilink for dual drainage
Roadway cross section
D112-00-00 – Greenway Detention Basin Complex Integration

Tailwater condition from Revised D112-00-00 Model that includes:

- Six Detention basins with ~1850 ac-ft of storage volume
- Side-flow weirs from D112-00-00 to detention basins
- Willow Waterhole channel modifications
Onsite Drainage Systems

<table>
<thead>
<tr>
<th>Drainage System</th>
<th>Area (acre)</th>
<th>100-Year Atlas 14 Flows (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North D112-00-00</td>
<td>280</td>
<td>1,120</td>
</tr>
<tr>
<td>South D112-00-00</td>
<td>470</td>
<td>1,880</td>
</tr>
<tr>
<td>D140-05-01</td>
<td>100</td>
<td>370</td>
</tr>
<tr>
<td>D140-05-02</td>
<td>60</td>
<td>215</td>
</tr>
<tr>
<td>D139-04-00</td>
<td>110</td>
<td>430</td>
</tr>
<tr>
<td>D139-04-01</td>
<td>50</td>
<td>205</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,070</strong></td>
<td><strong>4,220</strong></td>
</tr>
</tbody>
</table>
Overland Drainage Flows

West Overflows (1,750 cfs)

East Overflows (290 cfs)
Existing Storm Sewer Layout
Existing WSEL along WWB (D112-00-00)
Existing 100-year Inundation and Structural Impacts
Reduced Inline Detention Storm Sewer Sizes
Proposed Alternatives

Base

Alt 1
- Reduced Inline Detention
- Utilizing LOC 1
- No Improvements to WWB

Alt 2
- Reduced Inline Detention
- Utilizing LOC 1
- Utilizing LOC 2
- Utilizing LOC 3
- No Improvements to WWB

Alt 3
- Reduced Inline Detention
- Utilizing LOC 1
- Utilizing LOC 2
- Utilizing LOC 3
- Improvements to WWB

Alt 2
With Total West side overflows

Alt 2A
With Partial West side overflows

Alt 3
With Total West side overflows

Alt 3A
With Partial West side overflows
Exist and Alt 1 WSEL along WWB
Alternative 1 Findings

100-Year

Structures Saved in 100-Year
~ 170 out of 1,260 (13%)

Structures Saved in 10-Year
~ 100 out of 685 (15%)

Storage Required:
LOC 1 ~ 25 ac-ft
Alt 2 includes parcel acquisitions as part of storage and conveyance

- Alt 2 includes total 1,750 cfs overflows from west side
- Alt 2A reduced overflows from west side to 1,000 cfs
Exist, Alt 2 and Alt 2A WSEL along WWB

- Alt2A 100-yr WSEL
- Alt 2 100-yr WSEL
- Exist 100-yr WSEL
- Top of Bank
- Bottom of Channel

Elevation (ft)

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000

D140-05-01/D140-05-02
Hillcroft
Landsdowne
Chimney Rock Rd.
U/S of Overflow Weir

- Alt 2A 100-yr WSEL
- Alt2 100-yr WSEL
- Exist 100-yr WSEL
- Top of Bank
- Bottom of Channel

(1,000 cfs Overflows)
(1,750 cfs overflows)
100-year Alternative 2A Findings

100-Year

Structures Saved in 100-Year
~ 220 out of 1,260 (17%)

Structures Saved in 10-Year
~ 210 out of 685 (31%)

Storage Required:
• LOC 1 ~ None
• LOC 2 ~ 33 ac-ft
• LOC 3 ~ 57 ac-ft

Improved
Structures in Alt 2A

Impacted
Structures in Alt 2A

Preliminary
Alternative 3

Alt 3 and 3A includes:

- Improvements to Willow Waterhole Bayou from D140-05-01 to overflow weir structure including concrete-lining
- Alt 3 includes total of 1,750 cfs overflows from west side
- Alt 3A reduced overflows from west side to 1,000 cfs
Alternative 3 and 3A Findings

Preliminary
100- year Existing vs. Alternative 3A

Structures Saved in 100-Year
~ 615 out of 1,260 (49%)

Structures Saved in 10-Year
~ 590 out of 685 (86%)

Storage Required:
- LOC 1 ~ 127 ac-ft
- LOC 2 ~ 33 ac-ft
- LOC 3 ~ 57 ac-ft

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Improved Structures in Alt 3A
Impacted Structures in Alt 3A

Preliminary
## Westbury H&H Analysis Findings

<table>
<thead>
<tr>
<th>Model Scenario Conditions</th>
<th>~ 100-Year WSEL Reduction in D112-00-00</th>
<th>% of Structures Saved in 100-year Event</th>
<th>% of Structures Saved in 10-year Event</th>
<th>~Storage Needed at LOC 1 (ac-ft)</th>
<th>~ Storage Needed at LOC 2 (ac-ft)</th>
<th>~ Storage Needed at LOC 3 (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALT 1</td>
<td>-</td>
<td>15%</td>
<td>15%</td>
<td>25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ALT 2</td>
<td>-</td>
<td>17%</td>
<td>30%</td>
<td>20</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>ALT 2A</td>
<td>0.6</td>
<td>23%</td>
<td>60%</td>
<td>-</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>ALT 3</td>
<td>2.3</td>
<td>40%</td>
<td>86%</td>
<td>216</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>ALT 3A</td>
<td>3.0</td>
<td>50%</td>
<td>86%</td>
<td>127</td>
<td>33</td>
<td>57</td>
</tr>
</tbody>
</table>
Alternative 2A saves 290 structures (23%) out of the current estimate of 1,260 structures impacted in a 100-year storm event and 390 structures (57%) out of 685 current impacted structures in a 10-year storm event.

Alternative 2A incorporates reduced overflows from the west and requires less storage volume detention to mitigate the impacts at WWB Detention Basin Complex. Also, it does not include any WWB channel improvements.

Alternative 3A saves 615 structures (49%) out of the current estimate of 1,260 structures impacted in a 100-year storm event and about 590 structures (86%) out of 685 current impacted structures in a 10-year storm event.

Alternative 3A also incorporates reduced overflows from the west, but includes WWB channel improvements such as concrete lining and shows the best reduction of the 100-year WSEL along WWB.
Existing vs. Alt 2A 100-Year Inundation

Exist 100-Year

Alt 2A 100-Year

Preliminary
Existing vs. Alt 3A 100-Year Inundation

Exist 100-Year

Alt 3A 100-Year

Ponding Depth (ft)
- 0.0 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3
- 3.0 - 5
- 5.0 - 10.0
- Study Limits

Preliminary
Existing vs. Alt 2A 10-Year Inundation

Exist 10-Year

Alt 2A 10-Year

Ponding Depth (ft)
- 0.0 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3
- 3.0 - 5
- 5.0 - 10.0

Study Limits

Preliminary
Existing vs. Alt 3A 10-Year Inundation

- **Exist 10-Year**
- **Alt 3A 10-Year**

### Preliminary

**Ponding Depth (ft)**
- 0.0 - 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3
- 3.0 - 5
- 5.0 - 10.0
- Study Limits
Because WWB is classified as a “natural” channel, any proposed improvements has to be submitted to and approved by the USACE. This is a lengthy time consuming process due to the many environmental studies and permits required to obtain approval to concrete line the channel.

The Greenway basin complex was implemented as a federal project using federal funds. Therefore any expansion of the existing detention basin on at South Post Oak will have to be done in accordance with Federal rules & guidelines which is also a lengthy and time consuming process.

Westbury SP1 final design will be based on Atlas 14 drainage criteria and will utilize a combination of storm sewers with in-line detention and the detention basin at Location 3.
Q & A / Wrap-up

Sreekanth Punukula, P.E.  
Vice President

Michael D. Lacy, P.E.  
Project Manager

Roopa Metla, P.E., CFM  
Senior H&H Modeler

Sora Ahn, PhD  
GIS Specialist / Modeler

Thank you