Low Water Crossings in Urbanized Areas
Flood Mitigation Planning, Design, & Construction

Reem Zoun, PE, CFM, City of Austin
Jorge Morales, PE, CFM, City of Austin
Laura Cassett, PE, CFM, CPESC, HDR Engineering, Inc.
Overview

- Flood Mitigation Planning
  - Travis County Drainage Basin Master Plan
  - City of Austin Prioritization Process
- Low Water Crossing Replacement
  - Preliminary Engineering Report
  - Project Challenges
  - Design
  - Construction
- Lessons Learned & Project Successes

Constructed Flood Mitigation Solution
Flood Mitigation Planning
Travis County Drainage Basin Master Plan

1. Problem Area Identification
2. Data Collection
3. Preliminary Problem Area Ranking
4. Drainage Analysis
5. Final Problem Area Ranking
Flood Mitigation Planning
Travis County Drainage Basin Master Plan

Identify the Problem Areas

County Staff Interviews  Public Meetings  Emergency Call Log

Over 100 Problem Areas Identified
Flood Mitigation Planning
Travis County Drainage Basin Master Plan
Data Collection
Flood Mitigation Planning
Travis County Drainage Basin Master Plan
Preliminary Problem Area Ranking

<table>
<thead>
<tr>
<th>Preliminary Problem Area Ranking Criteria</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impacts to <em>Emergency Access</em></td>
<td>1</td>
</tr>
<tr>
<td>Flooding of <em>Habitable Structures</em></td>
<td>2</td>
</tr>
<tr>
<td>Frequency of Reported <em>Road Closures</em></td>
<td>3</td>
</tr>
<tr>
<td>Existing Facility Condition</td>
<td>4</td>
</tr>
<tr>
<td>Ratio of Structure Opening Area to Drainage Area</td>
<td>5</td>
</tr>
<tr>
<td>Severity of Existing <em>Erosion</em> Condition</td>
<td>6</td>
</tr>
<tr>
<td><em>Combined Project</em> - Drainage and Roadway Improvements</td>
<td>7</td>
</tr>
<tr>
<td>Observation - Severity of Existing Debris Condition</td>
<td>8</td>
</tr>
<tr>
<td>Observation - Severity of Existing Sediment Condition</td>
<td>9</td>
</tr>
<tr>
<td>Contributing Watershed Area</td>
<td>10</td>
</tr>
</tbody>
</table>
Flood Mitigation Planning
Travis County Drainage Basin
Master Plan

Drainage Analysis

Field Survey

Hydrologic & Hydraulic Analysis

Define Extents of Flooding
Final Problem Area Ranking

**Ranking Criteria**

- Depth of Overtopping
- Impact to Emergency Access Routes
- Flooding of Habitable Structures
- Severity of Flooding

34 Low Water Crossings
6 Subdivision Areas
City of Austin Creek Flooding Mitigation Master Planning

Flood Scores for Roadway Crossings
How does flood scoring fit into Master Planning process?

- Master Plan Objectives for Creek Flood Mitigation
  - Project Prioritization and planning
    - Roadway crossing improvement
    - Regional flooding/structure flooding
  - Funding Allocation

- Capital Improvement Projects: Identifying Priorities
  - Flood scores
  - Feasibility Assessments
  - Access, traffic count
  - Constructability
  - Cost
  - Multi-mission objectives
Roadway Crossing Scoring

\[ FT_{crossing} = RV \times \left( \frac{1}{2} D_2 \times V_2 + \frac{1}{10} D_{10} \times V_{10} + \frac{1}{25} D_{25} \times V_{25} + \frac{1}{100} D_{100} \times V_{100} \right) \]

Where:

RV = Resource Value*

D_2 = flood inundation depth for the COA fully developed 2 - year storm event

V_2 = channel velocity for the COA fully developed 2 - year storm event

*Resource Values:

- Differentiates between type and use of street crossings and structures
- Reflects potential structural damage and risk to public safety due to flooding
- Resource values based on “impact” value, not monetary damages
Calculating Flood Scores

- Identify structures in the 100yr floodplain (point file)
- Identify roadway class and assign resource value
- Get minimum weir elevation from HEC-RAS
- Get WSE and velocity information for 2, 10, 25 and 100yr storm evens
- Calculate depth of flooding
- Calculate score
Low Water Crossings in COA Full Purpose Jurisdiction

In 100yr Floodplain = 581 Structures

Roadway Flood Risk:
- Very High
- High
- Moderate
- Low
- Very Low

Watershed
Limited Purpose and ETJ
COA Fully Developed 25-Year Floodplain
COA Fully Developed 100-Year Floodplain
Low Water Crossings in COA Full Purpose Jurisdiction

In 100yr Floodplain = 581 structures
100 yr depth > 0 = 394 structures

Roadway Flood Risk; 100yr D > 0; 394
- Red: Very High
- Orange: High
- Yellow: Moderate
- Green: Low
- Very Low

Watershed
Limited Purpose and ETJ
COA Fully Developed 25-Year Floodplain
COA Fully Developed 100-Year Floodplain

City of Austin WATERSHED PROTECTION

This product is for informational purposes only and is not intended for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.

This product has been produced by the Watershed Protection Department for the sole purpose of geographic reference. No warranty is made by the City of Austin regarding specific accuracy or completeness.
Low Water Crossings in COA Full Purpose Jurisdiction

In 100yr Floodplain = 581 structures
100 yr depth > 0 = 394 structures

Top 10 Roadway Flooding Priorities

Roadway Flood Risk; 100yr D > 0; 394
- Very High
- High
- Moderate
- Low
- Very Low

Watershed
Limited Purpose and ETJ
COA Fully Developed 25-Year Floodplain
COA Fully Developed 100-Year Floodplain

City of Austin WATERSHED PROTECTION

This product is for informational purposes and may not have been prepared for or suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries.

This product has been produced by the Watershed Protection Department for the sole purpose of geographic reference. No warranty is made by the City of Austin regarding specificity of completeness.
Preliminary Engineering Report

- Low water crossing
- Lower part of Slaughter Creek
- Current Conditions
  - 3-24” CMP
  - 24’ Asphalt roadway
  - Overtops during 2-yr storm
  - 4.5’ depth during 100-yr storm
  - 5,080 cfs during 100-yr storm
  - On routine emergency closure list
- Drainage Criteria
  - < 6” overtopping allowed during 100-yr storm
  - Fully convey 25-yr
  - No adverse impact allowed
- Mission Integration Prioritization (MIP)
  - Flood
  - Erosion
  - Water Quality
Preliminary Engineering Report

- Subdivisions bounded by floodplain
  - Extra territorial jurisdiction (ETJ)
  - City of Austin full purpose limits
- Bilbrook DR only entrance during 2-yr storm
- Travis County coordination
  - Slaughter Creek Drive high priority low water crossing (#8 for Travis Co.)
  - Alternative access via Chappell LN
Preliminary Engineering Report

- Modeling and Mapping
  - HEC-RAS
  - GIS – ESRI

- Alternatives (cost)
  - 1 - Box Culverts ($1M)
  - 2 - Clear-Span Bridge ($2M)
  - 3 – Two CONSPAN ($1.5M)
  - 4 - CONSPAN and Box Culverts ($1.2M)
PER Recommendation
PER Recommendation

- Escarpment Blvd in Austin, TX
Project Coordination and Considerations

- Neighborhood
- School
- Church

- Neighborhood Connectivity
Project Coordination and Considerations

- Emergency Access
Project Coordination and Considerations

- Easements

FACTS:
1. Property not zoned for development.
2. No existing drainage easement.
3. Low water crossing improvements will increase the water surface elevation (WSCE) upstream and downstream of property without existing DE.

QUESTIONS ON DRAINAGE EASEMENT REQUIREMENTS:
1. Will a DE be required for only the areas of impact in WSEL or will a DE be required on the entire property where there is an existing floodplain?
2. If DE is required for entire lot, will a DE be required on adjacent property where the flood plain is upstream of the impacted area, but next to the DE that would be created?

Legend:
- Lot Lines
- Streets
- WSEL Increase

<table>
<thead>
<tr>
<th>FLD_ZONE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>AE</td>
</tr>
<tr>
<td>AE</td>
<td>COA FD 100-Year Floodplain</td>
</tr>
<tr>
<td>COA FD 25-Year Floodplain</td>
<td></td>
</tr>
<tr>
<td>WWMain</td>
<td>WWManhole</td>
</tr>
<tr>
<td>Easements</td>
<td>Creeks</td>
</tr>
<tr>
<td>2003 Contours</td>
<td>Impacted Lot</td>
</tr>
<tr>
<td>WSEL Increase</td>
<td>- 400 Feet</td>
</tr>
</tbody>
</table>
Project Team
David Moore Drive - Low Water Crossing Replacement Project
David Moore Drive Low Water Crossing Replacement Design

- Precast Bridge Unit (31° Skew) and 4-10’x5’ Box Culverts
- City of Austin Hydraulic Criteria: Pass 25-year Storm; no more than 6” overtopping during the 100-year Storm
- Geomorphologic Considerations: Urban vs. Rural Crossings
  - Significant Development → Dynamic Streams
- Drainage Easement Acquisition
- Design Included 150 LF of Storm Sewer
David Moore Drive
Low Water Crossing Replacement

Construction Challenges

- David Moore Drive Road Closure limited to the AISD summer break; **79 days** between June 6, 2014 and August 24, 2014; excluding weekends and public holidays this is 54 days
- Limited lay down area adjacent to floodplain
- Slaughter Creek tributary classified as Waters of the U.S., as defined by Section 404 of the Clean Water Act. Construction of the proposed project is required to follow the terms and conditions outlined in the USACE Nationwide Permit 13 for Bank Stabilization
- Special attention to keep all activity inside the limits of construction to avoid impacts to adjacent wetland

Engineer’s Estimate - $900K
4 Bids Received within 3% of Engineer’s Estimate
Project Awarded to –
Smith Contracting Company
Bid $850K
Weekly Progress Update:

- **WEEK 11 – 7/2/2014**
- **WEEK 13 – 7/17/2014**
- **WEEK 15 – 7/30/2014**

David Moore Drive Construction Overview

Precon Held 4/15/2014

Road Closure 6/6/2014 to 8/24/2014
Lessons Learned

- Memo of Understanding (MOU) for critical project decisions during project development
  - Roadway Width Variance
  - Water Quality Variance

- Casting time for crown span on a skew – 8 week lead time

- Limited Construction Window ➡️ Quality contractor is key to success
Lessons Learned - Construction Phase

- Communication is Key
  - Calls made to adjacent school and church

- Manage Expectations
  - Communication with adjacent parcel owners is critical during construction

- Contingency Time for Ambitious Schedules
  - Unforeseen issues arise which can derail a construction project from successfully meeting schedule & budget
  - Rain
  - Ground condition
David Moore Drive Low Water Crossing Replacement

Project Successes

- The David Moore Drive Roadway Crossing currently meets COA DCM
- Improved public safety and reduced roadway closure
- Cost savings in the form of saved staff time for roadway closure and emergency response
- Project completed within contracted time and on budget
- Flood gauge salvaged and utilized at another LWC
- Design expects to restore natural creek condition
PROJECT PHOTOGRAPHS
Newly Completed Project Successfully Weathers Storm

Over the years, the low water crossing on David Moore Drive closed due to flooding in even minor storms. However, we completed an upgrade to the crossing recently. The crossing was opened to traffic just days before September 18, when four inches of rain fell in six hours and almost six inches in 48 hours — nearly a 10-year storm. During the rains, the David Moore Road low water crossing remained open, and a nearby school was able to have its buses roll in safely thanks to the improvements.

The upgrade for the low water crossing was designed to meet the City’s Drainage Criteria Manual, so the road would not flood in a 25-year storm, and there would be less than six inches of water overtopping it during a 100-year storm. The crown span built in the middle is intended to return the creek to its natural state, and the four culverts on each side will engage during larger storm events, which they did on September 18.

When Reem Zoun, the project sponsor in Watershed Engineering, checked the crossing on the morning of September 18, a school bus was crossing the roadway, and a local resident stopped his vehicle and said, “Thank you!”

This project makes one more road much safer during flooding in Austin’s Flash Flood Alley where any road can flood during storms. Always remember to check for water over any road, and Save Yourself! Turn Around—Don’t Drown.
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization</th>
<th>Email</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jorge Morales</td>
<td>PE, CFM</td>
<td>City of Austin</td>
<td><a href="mailto:Jorge.Morales@austintexas.gov">Jorge.Morales@austintexas.gov</a></td>
<td>512-947-000</td>
</tr>
<tr>
<td>Reem Zoun</td>
<td>PE, CFM</td>
<td>City of Austin</td>
<td><a href="mailto:Reem.Zoun@austintexas.gov">Reem.Zoun@austintexas.gov</a></td>
<td>512-947-000</td>
</tr>
<tr>
<td>Laura Casset</td>
<td>PE, CFM, CPESC</td>
<td>HDR Engineering, Inc.</td>
<td><a href="mailto:Laura.Casset@hdrinc.com">Laura.Casset@hdrinc.com</a></td>
<td>512-912-5198</td>
</tr>
</tbody>
</table>