Visualizing Levee Failures and Performance through 2D Techniques
TFMA Spring Conference
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OVERVIEW
- Project Background
- Developing the Model
- Simulations Types and Results
- Integration with EAP

EMERGENCY ACTION PLAN
- EAP needed in case of a levee failure
- Modeling was used to support development of EAP
- Typical EAP may have as few as two flooding sources
- This case was not so clear cut in terms of flooding sources
CONTROL STRUCTURES

INTERNAL DRAINAGE

REASONS FOR ADVANCED MODELING

- Complex system; multiple interactions
- Multiple Scenarios:
  - Historic events
  - System response to various storms
  - Pump station failure
  - Levee breach
ADVANTAGES OF ADVANCED MODEL

• Comprehensive model of the system
  – Only one assumed boundary condition
  – Connectivity between all elements
  – 2D flow paths through mesh

• Ease of understanding output
  – 2D animation replays
  – Time-series data
  – Results points

• Analyze multiple different scenarios
  – Historic Events
  – Pump Station Failure
  – Breach Analysis

WHY INFOWORKS ICM?

• Large 2D area (5,000 acres)
• Variable element area mesh
• Breach analysis capabilities
• GPU Processing (Simulations are faster)

MODEL DEVELOPMENT

• Hyc
• Hys
PROBLEMS WITH EXISTING MODELS

- Assumed boundary conditions
- No connectivity
- No way to account for undefined flow paths

CONVERTING TO ICM

1D COMPONENTS COMBINED
2D COMPONENTS

• Road buffered from TNRIS Centerline
  – Roads as Mesh Zone
  – Finer mesh triangles
• Roughness Zones determined from Aerial Photos
• Elevation data from LIDAR

1D/2D COMPONENTS COMBINED

CHALLENGES BUILDING/RUNNING THE MODEL

• Size of the study area
  – ±5,000 acres
• Mass balance (junctions, voids)
• Meshing Errors
• Initialization
• Operating Procedures
• Elevation datum
Simulation Types and Results

**Determining Exterior Level of Protection**

**Historic Events**

- Mother’s Day Flood 2012 (Internal)
  - 5-8 inches of precipitation in area in 12 hours
  - Calibrated rainfall
  - Validated the model
- Christmas Flood 1991 (Brazos River)
REGIONAL EVENT

- Not in design criteria, but good to understand

- System response to regional 100-year event including:
  - Tailwater elevations
  - Gravity outfalls
  - Pump operations

REGIONAL EVENT EXAMPLE

- Worst-case scenario
- No way to evacuate water

PUMP STATION FAILURE (BEYOND DESIGN CRITERIA)
PUMP STATION FAILURE (BEYOND DESIGN CRITERIA)

LEVEE BREACH ANALYSIS

- Breaches modeled in two different ways, based on location
  - River Bank Elevation
    - Control individual bank stations
  - Variable Width Weir + 2D Outfall to mesh
    - Control width of weir
- Controlled with Real-Time Control (RTC)
  - Breach geometry defined in FEMA document
  - Breach timing defined by FNI

MODELED BREACH LOCATIONS

- Breach locations not indicative of potential failure
- Concept of “Representative Levee Reach”
**Representative Levee Reach**

**Breach Location B03**
- Largest inundation extents of the 6 locations
- Assumes other levees have been compromised
- Flows recirculated by standard pump operations

**100-Year Breach B03 (Beyond Design Criteria)**
Levee breach analysis was critical for the EAP
Advanced modeling needed in this case
Value added by using the model for other analyses
Client now has a modeling framework that can be modified
  - CIP project planning
    - Channel modification
    - Levee improvements
    - Pump improvements
  - Add storm sewer lines
  - Water quality modeling – sediment
  - Evaluate benefit from stormwater BMPs
  - Economic assessment

Questions??