GIS as an Engineering Tool in Citywide Stormwater Planning
Agenda

- Background
- Need for change in thinking
- GIS Development
- 2D Hydraulic Model Incorporation
- Questions
Background

- Where does it flood?
How do we deal with this?

- Flood Insurance Rate Maps only map rivers and major streams
- Many urban areas subject to local flooding which is not mapped
- Reactive: where did it flood this time?
- Need to identify other flood prone areas
  - To be proactive
  - For better prioritization
  - To define need and benefit
Need for a Planning Tool

• Detailed inundation mapping of urban basins can be beneficial for individual projects, but too costly for citywide planning

• Are there products that can be developed to provide a broad overview of flooding?

• As a matter of fact…
Fort Worth’s “Screening Tool”

- First part is pipe grading and system rankings:
  - Calculates pipe capacity and compares to flow coming to that pipe.
  - Ranks systems based on additional factors

- Second part is inundation mapping:
  - InfoWorks ICM models for major stream basins
  - Applies rainfall on to digital terrain
  - Overland flow getting to the Creek
GIS Tool Development

- **Use Model Builder to create a tool for City to use**
- Using City’s existing data
  - Terrain
  - Asset Inventory
  - Other
- Repeatable process
- Updateable Results
- Combines engineering math with spatial relationships
- End up with all the components of a master plan much faster and cheaper than traditional approach
  - Maps showing the problem
  - System capacity calculations
  - Recommended prioritized improvements
Pipe Grading Tool

- Asset Inventory
- GIS-based flow accumulation grid
- Compared to pipe hydraulic capacity
- Graded A to F
- Identifies most deficient pipes
Watershed Grading

- Uses Pipe Grades
- Factors in
  - Resident complaints
  - Development
- Identifies basins with greatest need
GIS Tool Development

• Combined to provide context/meaning
  – Spatial relationships
    • Terrain
    • Pipe Location
    • Drainage Area
    • Complaint locations
  – Tabular relationships
    • Pipe Attributes
    • Engineering calculations
  – Compare drainage area to capacity
  – Complaint Density and Building Density to add “urgency”
  – Assign grades
    • A-F, easy to understand
Part 2: Citywide Inundation Mapping
Citywide Inundation Mapping

Need more “Benefits”
- Pipe Grades Identified Problems
- LIDAR only 2D Surface Flow Model
- Shows the low spots or “at risk” areas
- What are the benefits?
  - Flooded Structures
  - Inundation
  - Flood Hazard
  - Others…
- If we do a Stormwater capital project, what do we fix and who do we help?
Citywide Inundation Mapping

- Apply to multiple basins
- Analyzes quickly
- No pipes
- LIDAR-only 2D Model
- Use rainfall on mesh
- Shows overland flow accumulation
- Can add detail to refine
- Defer to FEMA for stream flooding (PINK)
Building a Citywide Terrain and 2D Mesh

Individual 2d elements in model
2D Mesh in model
TIN Points
ESRI Terrain
LIDAR Data
Ground Surface
• Useful, high-level planning tool.
• Both need and benefit
• Used to prioritize by benefit/unit fix.
• Output is ranked list to accompany maps

739 Structures At Risk
Or 1 per every 41 LF of Storm Drain

81 Structures At Risk
Or 1 per every 105 LF of Storm Drain
Other Uses for the Tools
Other Uses for the Tools

- Incremental flood depths for increasing storm severity
- Locate hazardous depths & high velocities
- Emergency access challenges
- Identify fugitive overland flows
- Identifying and scoping local studies and small projects
- Infrastructure Project design reviews
- Resiliency Planning
- Communicating with City Departments, Council, & Public
Incremental Depths
Incremental Depths
Hazardous Depths
High Velocities

Velocity:
- 2-4 fps
- 4-6 fps
- 6-8 fps
- > 8 fps
Emergency Vehicle Access

Legend:
- Green: Limited Access
- Yellow: No Resident Access
- Red: No Emergency Vehicle Access
Fugitive Overflow between Systems
Study Scoping
Small Project Planning
Small Project Planning
Small Project Planning
Vacant Land Availability (Detention)
Vacant Land Availability (Detention)
Pipe Grades
Probability of Failure
Business Risk Exposure
Communicating with City Departments/Council

- Road projects
- Water projects
- Flooding is not just inside FEMA floodplain!
- Development Reviews
- Resiliency Planning
- Parks
Planning Charettes
Available to the Public
Conclusions

- Citywide inundation mapping and pipe grading are worth the investment if you have multiple problem areas.
- They can “prove up” what you know and tell you new things that you didn’t know.
- Great for planning, but detailed models are needed for engineering design.