The Challenge of Urban Flooding

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Urban Flooding Awareness Bill

- Introduced into Congress in 2014 & 2015
- Based on Illinois law passed in 2014
- Study urban flooding, with “primary focus ... on urban areas outside of special flood hazard areas”
- Still in assigned committees
Urban Flooding Awareness Bill

• Adequacy of federal flood risk information

• Investigate causes:
  – global climate change;
  – increasing urbanization
  – undersized, deteriorating stormwater infrastructure

• Evaluate funding mechanisms

• Relevance of NFIP & CRS to urban flooding areas outside traditional floodplains
The Challenge

• Long-term chronic or nuisance flooding
• Typically older parts of town
• No affordable solutions available
• Happens fast: gone in an hour
• Often only brief public attention
The Challenge

• Generally not addressed by NFIP
• Considered local problem only
• Low grant priority
• Flood risk not mapped
• “Not floodplain”
WHAT IS URBAN FLOODING?
Typical urban drainage patterns
Typical urban drainage patterns
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Typical urban drainage patterns
Main Causes of Urban Flooding

• Pre-1970, small creeks often enclosed in storm drains, usually severely undersized

• Street grid often ignored drainage patterns, leading to mid-block sumps

• Homes and buildings constructed over these creeks and storm drains, with overflow path running through them
Typical Older Neighborhood
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TRADITIONAL SOLUTIONS ARE NOT FEASIBLE
7800’ of pipe from worst flooding to the outfall, then across a rail yard.
The only place for 3 6’x10’ box culverts in this street is... where the houses are!
Tunneling preserves neighborhood $30-50 million!
Larger pipesheds likely requires several ponds occupying 150+ homes
Deep Detention with Pumps

3.5 ACRES

DETENTION STORAGE: 320 ACRE-FEET = 104 MILLION GALLONS
Buyouts and Neighborhood Integrity

• Empty lots destroy neighborhood integrity

• Are linear parks, greenways and pocket parks acceptable?
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DOWNSTREAM CONSIDERATIONS
Unit Hydrograph

Discharge rises quickly due to rapid surface run-off and reaches its peak just 10 hours after peak rainfall.

Precipitation causes the discharge in the river to rise.

Discharge falls at a slower rate due to base flow increasing. Base flow is the normal flow of water in the river derived from throughflow and groundwater flow.

Base flow slowly declines as throughflow declines.
Volume Issues

Valley Storage: Undersized pipes cause floodwater to be stored in neighborhoods, decreasing the peak flows downstream.
Timing Issues

SUB-BASIN 7a 100-YR HYDROGRAPH COMPARISON

Upward Arrow:
- **PEAK FLOW IF 100-YEAR FLOW COULD FIT IN PIPE**
- **ACTUAL PEAK FLOW DUE TO UNDERSIZED PIPE**
- **PEAK FLOW IF 100-YEAR FLOW ALL OVERLAND**

**Conveyance improvements would increase peak at outfall by over 60%!**
Increased Flooding Downstream
Texas Water Code §11.086

a) No person may divert or impound the natural flow of surface waters in this state, or permit a diversion or impounding by him to continue, in a manner that damages the property of another by the overflow of the water diverted or impounded.

b) A person whose property is injured by an overflow of water caused by an unlawful diversion or impounding has remedies at law and in equity and may recover damages occasioned by the overflow.
No Adverse Impact

• “No Adverse Impact floodplain management takes place when the actions of one property owner are not allowed to adversely affect the rights of other property owners.” (ASFPM, 2008)

• Consistent with Texas Water Code §11.086 and similar laws in other states.
Downstream Impacts Summary

• Flooding upstream caused by undersized pipes reduces flooding downstream.

• Increased conveyance (larger pipes) is likely to move flooding downstream.

• “Managing flooding in place”
  – Detention and related solutions.
  – Downstream impacts are beneficial.
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A DIFFERENT PARADIGM
Understanding Risk

• Usually public safety not a major threat
• Zone X: nothing hinders rebuilding
• Chronic flooding vs. periodic flooding
• Manage flooding like other risks in life
• Flood risk management:
  – Avoidance: move out
  – Coping: minor prevention and repair
  – Insurance: limit economic losses
The Challenge

• More than just a technical challenge!
• In most situations we must find a bit of compromise in all three elements.
Buy out the Traditional Buyouts in solutions i.e. neighborhood.

ACCEPTABILITY

AFFORDABILITY

EFFECTIVENESS
Let’s think about a rain gage

1- hour Storm Duration

System Capacity

- 100-yr (92) (properties damaged)
- 50-yr (85)
- 25-yr (70)
- 10-yr (55)
- 5-yr (42)
- 2-yr (29)
- 1-yr (18)
What if it rains more than 1”?

Single-Event Damages

System Capacity

1 hour
Damage X Annual Probability

- 4" 100-yr (92)
- 3" 50-yr (85)
- 3" 25-yr (70)
- 2" 10-yr (55)
- 2" 5-yr (42)
- 2" 2-yr (29)
- 1" 1-yr (18)

System Capacity

1 hour

Damage X Annual Probability

- $1M
- $500 K
- $250 K
- $0 K
Expected Annual Damage

- Area under the curve equals the expected annual damages ($2.6M)
- Present value of expected annual damages can be computed (Using 50-year cash flow, i=7%)

Net Present Value = $36.5 million
Expected Annual Damage

Net Present Value = $36.5 million

System Capacity

What if we increase capacity to 2 in/hr???
Expected Annual Damages

Existing Damages = $36.5 million
Residual Damages = $7.5 million
Benefit = $29 million
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MANAGING FLOODING IN PLACE
NOT THIS!

- Historically, detention viewed as fenced-off drainage facility
- Ends up as eyesores and wasted land
Multi-Use Detention

Detention areas can be used for aesthetics and water quality
Multi-Use Detention

Detention areas can be used for recreation and open space
Detention Basin—Neighborhood Park
Integrated with Urban Redevelopment
Daylighting Streams
Linear Parks and Greenways
URBAN FLOODING

• Solutions must be EFFECTIVE, AFFORDABLE & ACCEPTABLE

• NO ADVERSE IMPACT principles require evaluating downstream effects

• INCREMENTAL improvements may be the only cost-effective option

• MANAGING FLOODING IN PLACE is likely to be most feasible solution
URBAN FLOODING

• It is receiving more attention.
• Handled differently than riverine flooding.
• Hydrodynamic modeling and citizen videos provide a better understanding.
• Major issues:
  – How to map it
  – How to enforce it
  – Who should regulate it
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QUESTIONS?