INTEGRATED PLANNING OF REGIONAL TRANSPORTATION AND STORMWATER MANAGEMENT TOGETHER AS A SYSTEM OF IMPROVEMENTS: PREVENTION VS. RESPONSE

Presenter: Edith Marvin, P.E., Director of Environment & Development, NCTCOG
Presenter: Jerry Cotter, P.E., Chief of Water Resources, USACE, Fort Worth District
Partner: Michael Morris, P.E., Director of Transportation, NCTCOG
Flooding continues to be a challenge in North Texas

**Threats:** Increased flooding and safety risks; cost of infrastructure, stormwater, environmental restoration

**Solution:** Innovative partnerships and integrated infrastructure
Flooding Fatalities and damages

Texas far outpaces other states in flood related fatalities & flood related damages

5 Year Tally of Flood Fatalities

(Source: Gregory Waller, Service Coordination Hydrologist, NWS – West Gulf River Forecast Center, http://www.nws.noaa.gov/om/hazstats.shtml, 11/18 TFMA)
1996 - 2016 FLOODING IN TEXAS

Map Legend
- 1 - 10 Events
- 10 - 20 Events
- 20 - 35 Events
- 35+ Events

Costs of Flooding
The National Flood Insurance Program (NFIP) provides flood insurance to homeowners, renters, and business owners. FEMA’s Individuals and Households Program (IHP) provides financial assistance and direct services to eligible individuals and households who have uninsured or underinsured necessary expenses and serious needs. See differences in NFIP claims paid to individuals from 1996-2016 and funding from IHP for flood-related damages from 2005-2016 for your state.

Average NFIP Claim Payment

Average IHP Payment

Source: www.fema.gov/data-visualization-floods-data-visualization
Perspective:
With only a few members reporting yet on Low Water Crossing Locations, 504 existing; 391 needed

This indicates a flaw in infrastructure design standards
Growth and Development Increases Flooding

- Floodplains are among the most valuable ecosystems on earth, they are also one of the most threatened
- Growth and development increases impervious cover and runoff
- Growth and development depletes storage
- Flooding increased
- Maintaining capacity over time

Kazemi, Hamidreza (Kayra, (2014). Evaluating the effectiveness and hydrological performance of green infrastructure stormwater control measures. 10.18297/edt/1744
Heavy Rains Lead to Sewage Spills in Multiple North Texas Cities
Published Oct 16, 2018 at 9:10 AM – NBC5 DFW

119 million gallons of sewage overflow in DFW, by the numbers
A closer look at sewage overflows here and across Texas.

In 2018, more than 119 million gallons of sewage overflowed onto the streets and lakes of Dallas-Fort Worth. That's 119,096,755 gallons, to be exact, over more than 1,700 overflow incidents.
Parts of North Texas see flooding overnight

CARROLLTON, Texas - Heavy rain flooded parts of Collin, Dallas, Denton and Tarrant counties Wednesday night.

There was a flash flood warning for those parts of the Metroplex until just after midnight. Those living in low-lying areas were encouraged to move to higher ground.

Several cars got stuck in high water in the Dallas suburb of Carrolton. Firefighters were called out to rescue people in the heavily-flooded intersections near North Denton Drive and Jeanette Way as well as Countyline Road and North Josey Lane.

The service road on Central Expressway in Allen in Collin County was closed by flooding south of Bethany Drive. High water and debris covered the road. Highway officials had to set up barricades to keep people away.

Rain flooded an apartment complex in suburban Coppell. Viewers submitted pictures of standing water in the parking lot of the Wellington Place Apartments on MacArthur Boulevard near Sandy Lake Road. The complex has flooded before, including twice in 2018.

Homes in a new development just off Highway 360 in Princeton, east of McKinney, also flooded. Video posted on Facebook showed one family sweeping fast-moving water out of their home. A creek behind the house filled with water and flooded at least five homes.

"Look at this. It's like a river right here in my brother's side of the house. The landscaping is ruined. The sprinkler system is going to have to be redone. They have brand new furniture in this house. It's ruined," said Monica Moncer, whose brother's home flooded.

The family just moved into the house in November. They're upset with the builder and the city of Princeton.

Continue North Texas rain causing problems for some

North Texas neighborhoods are flooding more than ever before. Why?

BY BILL HANNA AND LUKE RANKER

OCTOBER 12, 2018 06:00 AM, UPDATED OCTOBER 12, 2018 05:07 PM

Community Impacts
Tropical Storm Hermine – Arlington, Texas September 2010

- Extreme drought
- 2010 Tropical Storm Hermine
- Extensive flooding
- No fatalities
- Buy-outs for 150 residences
- $17+ M
## REGIONALLY RECOMMENDED STANDARDS IN WATERSHED MANAGEMENT*

### For New Development Within County Regulated Areas

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Design infrastructure to fully developed conditions with approved land-use maps if data is available</td>
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<tr>
<td>2</td>
<td>Begin protection at the most upstream end of the watershed above Federal Emergency Management Agency Limit of Detail Study</td>
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<tr>
<td>3</td>
<td>Maintain unfilled valley storage areas</td>
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<tr>
<td>4</td>
<td>Protect against and reduce erosive velocities</td>
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<tr>
<td>5</td>
<td>Match pre-developed site runoffs</td>
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<tr>
<td>6</td>
<td>Verify/require adequate downstream conveyance</td>
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<tr>
<td>7</td>
<td>Require freeboard from fully developed (if data is available) and changing watershed conditions</td>
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<tr>
<td>8</td>
<td>Define written operation and maintenance responsibilities</td>
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<tr>
<td>9</td>
<td>Size conveyance of street and storm systems adequately to safely convey traffic</td>
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<tr>
<td>10</td>
<td>Create stream buffers and preserve open space; limit clearing and grading</td>
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<tr>
<td>11</td>
<td>Consider regional (on or off stream) detention incentives</td>
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<tr>
<td>12</td>
<td>Implement Conservation and/or Cluster Development incentives</td>
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<tr>
<td>13</td>
<td>Encouraging low impact development techniques and/or green infrastructure</td>
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</tbody>
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*Developed by the North Central Texas Countywide Watershed Management Roundtable, March 14, 2017*
### Benefits to Local Government

| Development Community Avoids Costs | Communities Don’t Lose Revenues |

### Local Government Flood Reduction Challenges

| Limited Resources | Limited Staff Expertise | Competing Priorities | Piecemeal Modeling and Reviews |

### Local Government Flood Reduction Needed Resources

| Development of Tools that Define Waterways | Stormwater Features (e.g. detention storage) |

### EXISTING CHALLENGES WITH FLOOD REDUCTION EFFORTS

- Limited Resources
- Limited Staff Expertise
- Competing Priorities
- Piecemeal Modeling and Reviews
State Recommendation:
The January 2019 Interim Report to the 86th Texas Legislature from the House Committee on County Affairs contains a recommendation that the Texas Legislature should explore a regional approach to floodplain regulation, allowing counties that share watersheds to adopt similar regulations, as allowed by the Texas State Water Code.

EXISTING TRINITY RIVER CORRIDOR PROGRAM

Partners:
- Arlington
- Carrollton
- Coppell
- Dallas
- Farmers Branch
- Fort Worth
- Grand Prairie
- Irving
- Lewisville
- Dallas County
- Tarrant County
- Denton County
- TRWD
- TRA
- NCTCOG
- USACE
- FEMA
- TWDB

(Source: Jerry Cotter, Chief Water Resources, USACE Ft. Worth District, 11/18)
USACE Dallas-Fort Worth - Flood Reduction and Water Supply System

- Devastating floods, 1908, 1942, 1949
- 6 multi-purpose reservoirs (1952-1987)
- 2 federal levee systems
- DFW Flood Control System
  - 7.4 million people
  - $100+ billion in damages prevented
  - $2 - $3 billion annually
- Water supply system
- Total cost $2.5 billion
- **Must be operated as a system**
Typical Master Plans:
* Thoroughfare/Roadway (freeway, highway, arterial, collector)
* Wastewater (treatment system and major trunks)
* Water system (provider, major trunks, pressure zones, elevated and ground tanks)
* Parks (trail systems and green space connections)
* Solid Waste (landfill capacity, trash disposal contracts)
* Fire and police stations/protections
* Other – but typically not stormwater by watershed – “drainage as-you-build”
Key points

▪ Project should complement, leverage and build upon existing resources and systems
  ► iSWM
  ► Common vision
  ► DFW USACE/Communities regional flood control system (does not protect against all threats)
▪ Should be a collaboration between local, state and federal partners
▪ We are not currently comprehensively planning stormwater infrastructure
▪ Should provide a formal definition of the project and project area for areas where highest potential for cost effective efforts are and where best practices are not yet in place
▪ Comprehensive stormwater infrastructure planning should be evaluated through a range of hydrologic loading utilizing latest technologies… not just 100-year
**WHAT/WHY:** Comprehensive, collaborative planning will dissolve silos and improve delivery of consolidated, adaptive infrastructure *before* expected population growth makes addressing these issues more difficult and costly.
WHERE: Proposed Study Area
HOW: Integrate regional transportation planning, regional stormwater management planning, and environmental planning to develop consolidated, adaptive infrastructure.
WHO: Project Team Members

A working group of partners and stakeholders to carry out a comprehensive planning effort in Wise County and portions of Dallas, Denton, Ellis, Johnson, Parker, and Tarrant counties.
Additional Transportation Interests: PREVENTION VS. RESPONSE

Transportation Infrastructure
- Structure Elevation / Culverts / Model Growth
- Mechanical Culverts?
- Transportation “LEED” Certified (Ray Roberts / Lewisville)
- Green Parkway Widths / Detention

Safety
- Technology / Routing
- Prioritization / Low Lying Facilities

Stormwater
- Minimize / Reduce Downstream
- Detention
- Tools, Data, Experts
Additional Transportation Interests: PREVENTION VS. RESPONSE CON’T.

Environmental Features
  Tree Farms / Intentional Saturation
  Filtration / Recharge

Wetland and Stream Bed Mitigation Banking

Environmental Stewardship as a Revenue Element
  Mitigation Banking
  Horse Farms
  Eco-Tourism
CONTRIBUTIONS: Partners are critical to making this possible

<table>
<thead>
<tr>
<th>Texas General Land Office (GLO)</th>
<th>US Housing and Urban Development (HUD)</th>
<th>US Army Corps of Engineers (USACE)</th>
<th>Federal Emergency Management Agency (FEMA)</th>
<th>Texas Department of Transportation (TxDOT)</th>
<th>Texas Water Development Board (TWDB)</th>
<th>Regional Transportation Council (RTC)</th>
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Project Funding Goal: $10 Million

*Project Has Begun With Getting the Money*
2017 “Natural Hazard Mitigation Saves” report by: National Institute of Building Sciences Institute, Multi-hazard Mitigation Council (MMC), at the direction of the U.S. Congress

Riverine flooding – for $1 invested in mitigation strategies and higher standards (versus recovery from flooding actions), communities save $5-7

Storms Exceeding Infrastructure and NFIP Standards

- 2015 Tropical Storm Patricia – 24.2”
  90 miles south of DFW

- 1981 Tropical Storm Norma – 18.7”
  90 miles west of DFW

- 1978 Tropical Storm Amelia – 27.2”
  75 miles west of DFW
Storms Exceeding Infrastructure and NFIP Standards

- Regional observed storms
  - USACE extreme storm database
- 24-hour rainfall for 10 mi²
- Plotted in descending order
- Grey band is current design standard (100-year) for all of TX
- Blue X’s points are 2010-2017 storms that exceed 100-year
- 18 events exceeded the 100-yr design standard

### 24-Hour Precipitation for 10 Square Miles

- **100-Year 24-hour Average**
- **24-hour 10 sq. mi. Rainfall (1904 - 2009)**
- **24-hour 10 sq. mi. Rainfall (2010-2017)**

- **24-Hour 10 Sq. Mi. Rainfall Depth (in)**
  - 0, 5, 10, 15, 20, 25, 30, 35, 40
Storms Exceeding Infrastructure and NFIP Standards
Uncertainty In Determination of 100 Year BFE

- Many techniques to estimate flood and rainfall frequencies rely on observations.
- Need record length 3-4 times estimated return interval.
- Short Observation Periods - On average TX has 50 years of stream record and 70 years of precipitation records.
- Significant variability and/or non-stationarity observed in flood flow and rainfall frequency estimates.

Trinity River at Rosser  Guadalupe River at Victoria
Interagency Flood Risk Management (InFRM)

- Established 2014
- Integrated Water Resources Science and Services (IWRSS) program
- Regional (FEMA Region 6)/Statewide/Basin-wide approaches & support
- Supports common missions
- Collaboration
- Leveraging resources and information
- Limit duplication of effort
- www.InFRM.US

InFRM Academic Council
Components of Flood Impact Determinations

Meteorology
- How much rain

Watershed Hydrology
- How much runoff

River Hydraulics
- How deep will the water get

Consequences
- Critical infrastructure
  - Homes, Businesses, Hospitals

Emergency Response/Recovery
- Observed & Future Rainfall
- Real-time Runoff
- Real-time Inundations
- Real-time Impacts

Emergency Preparedness
- Historical Events W/in Region
- What-if Runoff Scenarios
- What-if Inundations
- Preparedness Impacts

Infrastructure Planning
- Design Standard “100yr Rainfall”
- 100-year Runoff
- 100-year Inundations
- Planning Infrastructure

Meteorology
- How much rain

Watershed Hydrology
- How much runoff

River Hydraulics
- How deep will the water get

Consequences
- Critical infrastructure
  - Homes, Businesses, Hospitals
NOAA Atlas 14, Precipitation Frequency Estimates (Planning and Mitigation)
InFRM – NOAA Atlas 14, Are We Done?

- Should you be concerned about?
  - Climate variability, extreme weather, drought and climate change?
  - How will we manage these phenomena?
- Do we understand what is happening with the weather and climate change?
- Do we need additional studies? ($3 - $4 M)
  - Other methods to estimate precipitation frequency (check)
  - Trend analysis
  - Storm studies
- Trend and storm studies underway (NOAA/USACE)
- Responsibility?
- Cost?
Changes in weather and climate

• USACE policy – USACE will adapt projects and operations to climate change
• NOAA Atlas 14 => 30% change in precipitation
• This translates directly to an increase in flood risk, e.g. 500-yr is now 100-yr
• Climate change, what do we know?
  • Water supply
    o Petroleum production H2O dependent
    o 30%-50% of nations needs
Watershed Hydrology Assessments
What is the 100-Year Flow (Planning and Mitigation)
InFRM Watershed Hydrology Assessments

sponsored by FEMA Region 6

- Watershed level vs. community level
- Current Basins
  - Guadalupe
  - Trinity
  - Neches
  - Colorado
- Provides
  - Frequency Flows for Design & NFIP 2-yr, 5-yr, 10-r, 25-yr, 50-yr, 100-yr, 250-yr, 500-yr
  - Existing, future and climate change conditions
- Benefits
  - FEMA NFIP
  - Supports all infrastructure groups
  - Independent non-political science based result using multiple methods

What is the 100-year flood?
Flood Flow Frequency Curve, Blanco River at Wimberley, TX
InFRM – Why WHA’s, Non-Stationary Trends In Flood Flow Frequency Estimates, Guadalupe River, TX

- Additional non-stationarities Guadalupe River system
100-Year Flow Estimates - Statistical - Wimberley

- 100-Year Estimate

Flow (CFS)

Time (Years)

1940 1960 1980 2000 2020

1972, 139,073
100-Year Flow Estimates - Statistical - Wimberley

- **Flow (CFS)**
  - 350,000
  - 200,000
  - 150,000
  - 50,000
- **Time (Years)**
  - 1940
  - 1960
  - 1980
  - 2000
  - 2020

- **100-Year Estimate**

  - 1992: 95,285

**Graph Details:**
- The graph shows the historical flow estimates from 1940 to 2020 for Wimberley.
- The flow estimates are represented in cubic feet per second (CFS).
- The year 1992 is highlighted with a value of 95,285 CFS.
100-Year Flow Estimates - Statistical - Wimberley

Flow (CFS) vs. Time (Years)

- 100-Year Estimate

- 2000, 104,660
100-Year Flow Estimates - Statistical - Wimberley

Flow (CFS)

Time (Years)

1940 1960 1980 2000 2020

350,000

250,000

200,000

150,000

100,000

50,000

2016, 153,700

100-Year Estimate
100-Year Flow Estimates - Statistical - Wimberley

- 100-Year Estimate
- 95% Confidence Limits
- Annual Peak Flows

Flow (CFS)

Time (Years)

1940  1960  1980  2000  2020
Limitations and Uncertainty Associated with Statistical Hydrology

- Average record length for TX is around 60 years
- Supports estimation of a 20-yr return interval
- Variation in stages at Wimberley is 20’
- Need 300-400 years of record to adequately estimate the 100-yr using this technique
- Should not be used alone
- Highly impacted by development and regulation (dams)
InFRM – Why WHA’s, Non-Stationary Trends in Flood Flow Frequency Estimates, Trinity River, TX

- Additional non-stationarities
  Trinity River system

Trinity River at Rosser
Trinity River at Oakwood
W. Fork Trinity at Grand Prairie
Denton Creek at Justin
E. Fork Trinity River at Crandall
### Junction "SanMarcos_at_Luling" Results for Alternative "Calib_1998"

- **For:** Calib_1998  
  - **Element:** SanMarcos_at_Luling  
  - **Result:** Observed Flow

- **For:** Calib_1998  
  - **Element:** SanMarcos_at_Luling  
  - **Result:** Outflow

- **For:** Calib_1998  
  - **Element:** SanMarcos_R030  
  - **Result:** Outflow

- **For:** Calib_1998  
  - **Element:** SanMarcos_S030  
  - **Result:** Outflow

### Junction "Blanco+CypressCr" Results for Run "Calib_Oct1998"

- **Run:** Calib_Oct1998  
  - **Element:** Blanco+CypressCr  
  - **Result:** Observed Flow

- **Run:** Calib_Oct1998  
  - **Element:** Blanco_abv_Cypress  
  - **Result:** Outflow

- **Run:** Calib_Oct1998  
  - **Element:** CypressCr_abv_Blanco  
  - **Result:** Outflow
### October 2015 Hydrographs

#### Junction "Blanco+CypressCr" Results for Run "Calib_Oct2015"

- **Run:** Calib_Oct2015  
  - **Element:** Blanco+CypressCr  
  - **Result:** Observed Flow
  - **Result:** Outflow

#### Junction "SanMarcos_at_Luling" Results for Alternative "Calib_2015_Oct"

- **For:** Calib_2015_Oct  
  - **Element:** SanMarcos_at_Luling  
  - **Result:** Observed Flow
  - **Result:** Outflow
  - **Result:** SanMarcos_R030
  - **Result:** SanMarcos_S030

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**Map of Wimberley and Luling with hydrograph data**
Design Storms

- Represents extreme events
- Reflects intense rainfalls
- Utilizes NOAA and Dr. Asquith precipitation frequency estimates
- Gage density much higher than stream network
- Less variability with increasing record length
How?: Realistic Meteorological and Hydrologic Loading

- Existing conditions 100-yr
- Future conditions 100-yr
- Alternative meteorological and hydrologic loading
  - Leverage regional storm catalog
  - Storm transpositions using HEC-MetVue
- Realistic indication of flooding potential
- 1:100 probability changes for blocks of years
- > 1:4 chance of being flooded over a 30 year mortgage
- > 1:2 chance of flooding over life of the structure (80 years)
Current 100 year water surface - 1-2 feet
• Destroy property (homes, automobiles, belongings)
• Take lives
• Destroy Infrastructure, transportation, waste water, water, human services
• Disconnect people - friends, schools, work, and familiar places
• Ruin family photos and heirlooms
• Alter relationships

Future 100 year water surface with increased imperviousness cover, storm drains and channels
- Permanent harm to culture and way of life
- Impact the most socially and financially marginal people
- Long-term consequences to the health (mental) and collective well-being of those effected
- Loss of pets
- Destroy natural ecosystems that are integral parts of communities
- Disrupt populations in ways that are difficult to articulate, let alone assign monetary worth

Water surface resulting from regional storms exceeding infrastructure design standards with future impervious cover, etc.
What are Our Storm Water Infrastructure Goals?

Future 100 year water surface with increased imperviousness cover, storm drains and channels.
Regional storms exceeding infrastructure and/or future 100 year water surface with increased imperviousness cover, storm drains and channels.

Storm Water Infrastructure Goals

“Balance Stormwater Infrastructure and Freeboard”
Flood Risk Management Modeling

- Meteorology (what precipitation should we expect)
  - NOAA Atlas 14 (what is the 100-year rainfall)
  - WHA design storms
  - Regional USACE storm database (storm transpositions)

- Hydrology (how will the watersheds respond)
  - Watershed Hydrology Assessments (WHA) (what is the 100-year flow)
  - Detailed Mary’s Creek study
  - CDC or Common Vision studies
  - Storm transposition results

- Hydraulics (how deep)
  - Enhancements to FEMA Base Level Engineering (BLE) products
  - Other hydraulic studies
  - New hydraulic studies

- Stormwater infrastructure plans (range of hydrologic loading)
  - Distributed smaller
  - Large regional
  - Combinations
  - To collector level

- Mitigation areas (banks)

- WE CAN DO THIS TOGETHER! - Multi-discipline team
  - Federal, state and local partners
  - A/E’s, environmental firms
  - University researchers

InFRM Partnership

Components of Flood Impact Determinations

- Meteorology
- Watershed Hydrology
- River Hydraulics
- Consequences
- Real-time Impacts
- Emergency Preparedness
- Infrastructure Planning
Flood Risk Products and Uses

- Numerical models (meteorology, hydrology, hydraulics)
  - Existing conditions
  - Future conditions for impervious cover and hydraulic efficiency
  - Planning/preparedness/response
- Regulatory
  - Update technical basis for NFIP mapping (100-yr flood)
- Stormwater infrastructure plans
- Emergency preparedness
  - What-if scenarios
- Emergency response
  - Basis for real-time inundation mapping
- Environmental mitigation plans
- Groundwater recharge
- Open space connectivity opportunities
- Other infrastructure needs
Project Scope of Work Elements:

- Secure funding and agreements
- Inventory available regional data
- Generate 2055 storm runoff estimations
- Analyze areas where reductions are needed
- Evaluate locations for stormwater management structures
- Lead project management and organization:
  - coordinate with stakeholders
  - identify and manage contracts
  - continued communication with stakeholders
  - data and resource dissemination
  - encourage implementation of plans/use of tools developed
- Combined master planning for transportation infrastructure and safety, with future conditions
  stormwater runoff, with meaningful environmental features
- Ensure products result in reduced channel erosion and stream sediment transport
- Provide regulatory tools and example policies for more resiliency
- Follow through with Implementation (products and technical tools): address challenges faced by implementing entities, who have limited resources, including staff, expertise, and funding.
BIPARTISAN FLOODING NORTH TEXAS ROUNDTABLE AGENDA

DATE: MONDAY, JULY 8, 2019
TIME: 8:30 – 10:00 AM (CDT)
LOCATION: DALLAS REGIONAL CHAMBERS - TOYOTA BOARD ROOM

- Agenda by speaker: Michael Morris, Director of Transportation

North Central Texas Council of Governments

- Welcome to Dallas Regional Chamber (DRC)
- Introduction of Today’s Topic
- Introduction of Attendees
- Responding to Flooding vs. Prevention
- Project from North Central Texas on Prevention
- Project Funding Proposal: $10 Million (Non-Legislative)
- Opportunity for a National Shift in Policy
- Next Steps for Congressional Delegation, if Any
- Next Steps for Project Team

Definitions:
- NCTCOG (North Central Texas Council of Governments)
- USACE (United States Army Corps of Engineers)

Chief Executive Officer of DRC
Hon. Congresswoman Johnson

All
All
NCTCOG/USACE
NCTCOG/USACE
Congressional Delegation
Congressional Delegation
NCTCOG/USACE
INTEGRATED PLANNING OF REGIONAL TRANSPORTATION AND STORMWATER MANAGEMENT TOGETHER AS A SYSTEM OF IMPROVEMENTS: PREVENTION VS. RESPONSE

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