Nonstructural Plan Formulation

Buffalo District Planning Conference

6 August 2009
Project – Little Duck Creek
District - Louisville
Location – Cincinnati, Ohio
Authority – Section 205
Non-Structural Measures
-- Acquisition
Justification
- Flood Damage Reduction
- Ecosystem Restoration
BCR – 1.1
Status - On Hold
Project - *Tug Fork Basin*
District - Huntington
Location - McDowell County, W VA
Authority - General Investigation
Non-Structural Measures
- Elevation
- Dry Flood Proofing
- Acquisition
- Flood Warning
- Wet Flood Proofing
Economics - Flood Damage Reduction
BCR - n/a
Status - Implementing
Project - *Johnson Creek*
District - Ft. Worth
Location - Arlington, Texas
Authority
- General Investigation
Non-Structural Measures
  - Acquisition
Justification
  - Flood Damage Reduction
  - Recreation
BCR - 1.6
Status - Implemented
Project - Tehama
District - Sacramento
Location - Tehama, California

Authority
- Section 205

Non-Structural Measures
- Elevation
- Flood Warning/Evacuation

Justification
- Flood Damage Reduction

BCR - 1.1
Status - Implemented
Project - *Reclamation Districts 2099, 2100, 2192*

District - Sacramento

Location - Stanislaus County, California

Authority
- Section 202E of WRDA 1996
- Public Law 84-99

Non-Structural Measures
- Acquisition
- Flowage Easement
- Ring Levee

Justification
- Flood Damage Reduction

BCR - 1.0

Status - Complete
Project - *Louisa Levee District 11*

District - Rock Island

Location - Louisa County, Iowa

Authority

- Section 202E of WRDA 1996
- Public Law 84-99

Non-Structural Measures

- Easements?
- Flood Proofing?
- Acquisition?
- Natural and Beneficial Flood Plain Functions

Justification

- Flood Damage Reduction

BCR - 1.06

Status - Under Study
Project - **Mill Creek**
District - **Baltimore**
Location - **Montgomery County, PA**
Authority - **Section 205**
Non-Structural Measures - Acquisition
Economics - Flood Damage Reduction
BCR - 1.2
Status - Feasibility Complete, No Local Sponsor
Project - *Missouri River*
District - *Omaha*
Location - Pierre/Fort Pierre, SD
Authority - General Investigation
Non-Structural Measures
- Acquisition
- Relocation
- Elevation
- Wet Flood Proofing
Economics - Hydropower
BCR - 2.1
Status - Implemented
Project - *Paxton Creek*
District - Baltimore
Location - Harrisburg, PA
Authority - Section 205
Non-Structural Measures - Flood Warning System
Economics - Flood Damage Reduction
BCR - 7.4
Status - Implemented
Project: **Cypress Creek**
District: Galveston
Location: Harris County, TX
Authority: General Investigation
Non-Structural Measures:
- Acquisition

**Economics**
Flood Damage Reduction

**BCR**: 1.1

**Status**: Implemented
Project - Cold Brook
District - Omaha
Location - Hot Springs, SD
Authority - Section 205
Non-Structural Measures
- Acquisition
Economics
- Flood Damage Reduction
- Recreation
- Ecosystem Restoration
BCR - 2.6
Status
- Terminated
Project - MsCIP
District - Mobile
Location - Hancock, Harrison, and Jackson Counties, MS
Authority - General Investigation
Non-Structural Measures
- Relocation
- Buyout
- Elevation
- Flood Proofing
Justification
- Flood Damage Reduction
- Ecosystem Restoration
- Recreation
BCR - N/A
Authorized

www.sam.usace.army.mil
Project - **Onion Creek**
District - **Fort Worth**
Location - **City of Austin/Travis County**
Authority - **General Investigation**
Non-Structural Measures
- Buyout
Economics
Flood Damage Reduction
- Recreation
- Ecosystem Restoration
BCR - 1.6
Status
- Authorized
Project - *Yellowstone River*
District - Omaha
Location - Glendive, Montana
Authority - General Investigation
Non-Structural Measures
- Relocation
- Acquisition
Justification
- Flood Damage Reduction
- Recreation
- Ecosystem Restoration
BCR - 1.4
Status - Feasibility/On Hold
Paxton Creek
Flood Warning
Harrisburg, Pennsylvania
Baltimore District
Problem Identification

- Subject to flooding from two sources, Paxton Creek basin and backwater from Susquehanna River.
- Paxton Creek flooding, from intense localized rainfall, tends to be very flashy.
- Moderate to high flood stages on the Susquehanna River back up into the low area creating a ponding effect that can last several days.
- There is the potential for combined flooding as a result of intense localized rainfall in conjunction with a backwater from the Susquehanna River.
Several Deficiencies Were Identified in the Existing Flood Warning System

- Lack of Local Participation
- Lack of a Base Station
- Lack of a Back-up Base Station
- Lack of an Additional Rain Gauges
- Lack of Timely Warning Dissemination
- Lack of Stage Forecast Model
Plan Formulation

Develop plan to improve the existing flood warning system.
Flood Warning System Plan

Improvements

- Installation of a base station within the City of Harrisburg
- Implementation of an improved flood warning dissemination system
- Flood stage forecast model
Flood Warning System Improvements, Continued

- Integration of the flood warning system into the IFLOW network
- Installation of an additional rain gauge within the lower Paxton Creek basin
- Installation of solar panels on all existing and proposed gauges
Economics Analysis

- Two major damage categories:
  - Industrial and Commercial Buildings
    Contents
      - Estimated average annual damages of $2,487,000
  - Vehicles
    - Estimated average annual damages of $83,000
Owners and managers of commercial or individual property were asked what actions they would take to reduce flood damage if given 15, 30, 45 or 60 minutes of flood warning time.
## Warning Time-damage Reduction Relationship

### I. Commercial Contents

<table>
<thead>
<tr>
<th>Warning Time (minutes)</th>
<th>Percent Damage Reduction</th>
<th>Existing Average Annual Damages</th>
<th>Average Annual Damages Prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0</td>
<td>$2,487,000</td>
<td>$-</td>
</tr>
<tr>
<td>30</td>
<td>7</td>
<td>$2,487,000</td>
<td>$174,000</td>
</tr>
<tr>
<td>45</td>
<td>14</td>
<td>$2,487,000</td>
<td>$348,000</td>
</tr>
<tr>
<td>60</td>
<td>25</td>
<td>$2,487,000</td>
<td>$622,000</td>
</tr>
</tbody>
</table>

### II. Motor Vehicles

<table>
<thead>
<tr>
<th>Warning Time (minutes)</th>
<th>Percent Damage Reduction</th>
<th>Existing Average Annual Damages</th>
<th>Average Annual Damages Prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>32</td>
<td>$83,000</td>
<td>$27,000</td>
</tr>
<tr>
<td>30</td>
<td>35</td>
<td>$83,000</td>
<td>$29,000</td>
</tr>
<tr>
<td>45</td>
<td>42</td>
<td>$83,000</td>
<td>$35,000</td>
</tr>
<tr>
<td>60</td>
<td>47</td>
<td>$83,000</td>
<td>$39,000</td>
</tr>
</tbody>
</table>
Average Annual Benefits

- Benefits attributable to the improved flood warning system are an estimated increase in flood warning time between 25 to 55 minutes.

- Average annual benefits for commercial content between $116,000 and $531,000.

- Average annual benefits for motor vehicles between $28,500 and $37,500.
Only the benefits attributable to reduction in damages to commercial contents were used in the Beneficial-Cost Ratio Analysis.
**Project and Average Annual Cost**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lands</td>
<td>$500</td>
</tr>
<tr>
<td><strong>Project Components:</strong></td>
<td></td>
</tr>
<tr>
<td>Rain Gage</td>
<td>$7,400</td>
</tr>
<tr>
<td>Base Station</td>
<td>$25,600</td>
</tr>
<tr>
<td>Flood Warning</td>
<td></td>
</tr>
<tr>
<td>Dissemination Service</td>
<td>$53,600</td>
</tr>
<tr>
<td>Solar Panels</td>
<td>$2,000</td>
</tr>
<tr>
<td>IFLOWS Software</td>
<td>$0</td>
</tr>
<tr>
<td>Flood Forecast Model</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Subtotal Components</strong></td>
<td>$8,600</td>
</tr>
<tr>
<td>Planning, Engineering and Design</td>
<td>$21,500</td>
</tr>
<tr>
<td>Contract Activity</td>
<td>$5,000</td>
</tr>
<tr>
<td>Implementation Management</td>
<td>$5,000</td>
</tr>
<tr>
<td><strong>Total Project Cost</strong></td>
<td>$120,100</td>
</tr>
<tr>
<td>Interest and Amortization</td>
<td>$12,700</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>$2,200</td>
</tr>
<tr>
<td>Replacement</td>
<td>$800</td>
</tr>
<tr>
<td><strong>Total Average Annual Cost</strong></td>
<td>$15,700</td>
</tr>
</tbody>
</table>
### Benefit-Cost Ratio Analysis

<table>
<thead>
<tr>
<th>Average Annual Benefits</th>
<th>Average Annual Cost</th>
<th>Benefit Cost Ratio</th>
<th>Net Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$116,000</td>
<td>$15,700</td>
<td>7.4</td>
<td>$100,300</td>
</tr>
</tbody>
</table>

*Based on a Conservative Flood Warning Time of 25 Minutes*
Johnson Creek
Arlington, Texas
Fort Worth District
Problem Identification

- The study area is found along Johnson Creek in Central Arlington.
- A total of 474 structures were identified within the 100-year flood boundary.
- Expected annual flood loses were estimated at nearly $1.4 million.
Plan Formulation

- An extensive number of structural and nonstructural flood damage reduction plan were investigated.
- The structural plan that was investigated consisted of concrete and gabion lined channels.
### Economic Analysis of Investigated Structural Alternatives

<table>
<thead>
<tr>
<th></th>
<th>20' BW</th>
<th>30' BW</th>
<th>40' BW</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimated First Cost</strong></td>
<td>$9,262,300</td>
<td>$10,868,100</td>
<td>$12,534,500</td>
</tr>
<tr>
<td><strong>Annual Interest Rate</strong></td>
<td>0.0713</td>
<td>0.0713</td>
<td>0.0713</td>
</tr>
<tr>
<td><strong>Project Life (years)</strong></td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Construction Period (months)</strong></td>
<td>18</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td><strong>Compound Interest Factor</strong></td>
<td>18.93786</td>
<td>18.93786</td>
<td>18.93786</td>
</tr>
<tr>
<td><strong>Capital Recovery Factor</strong></td>
<td>0.0736071</td>
<td>0.0736071</td>
<td>0.0736071</td>
</tr>
<tr>
<td><strong>Interest During Construction</strong></td>
<td>$494,989</td>
<td>$580,806</td>
<td>$669,861</td>
</tr>
<tr>
<td><strong>Investment Cost</strong></td>
<td>$9,757,300</td>
<td>$11,448,900</td>
<td>$13,204,400</td>
</tr>
<tr>
<td><strong>Interest</strong></td>
<td>$695,205</td>
<td>$815,734</td>
<td>$940,810</td>
</tr>
<tr>
<td><strong>Amortization</strong></td>
<td>$22,999</td>
<td>$26,986</td>
<td>$31,124</td>
</tr>
<tr>
<td><strong>Operation/Maintenance ($/years)</strong></td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td><strong>Replacements</strong></td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>TOTAL ANNUAL CHARGES</strong></td>
<td>$758,200</td>
<td>$882,700</td>
<td>$1,011,900</td>
</tr>
<tr>
<td><strong>Flood Reduction Benefits</strong></td>
<td>$880,100</td>
<td>$1,013,100</td>
<td>$1,024,200</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td>$880,100</td>
<td>$1,013,100</td>
<td>$1,024,200</td>
</tr>
<tr>
<td><strong>NET BENEFITS</strong></td>
<td>$121,900</td>
<td>$130,400</td>
<td>$12,300</td>
</tr>
<tr>
<td><strong>BENEFIT TO COST RATIO</strong></td>
<td>1.16</td>
<td>1.15</td>
<td>1.01</td>
</tr>
</tbody>
</table>
Corps Investigation

Traditional Structural Investigation

Concrete/Gabion lined channel

BCR – 1.16

Rejected by local sponsor as too environmentally damaging
Nonstructural plans considered include:

- Floodplain Management
- Flood Warning
- Floodproofing
- Permanent Evacuation
**Economic Analysis**

*Buyout*: Benefits from permanent relocation classified in five categories:

- Value from the new use of vacated land
- Reduction in damage to public property
- Reduction in emergency costs
- Reduction in the administration costs of disaster relief
- Reduction in flood insurance subsidy
Corps Investigation

Non-Structural Investigation

Removal of homes

Based on flood damage reduction only

BCR – 0.85
Opportunities/Innovation

New Uses of the Evacuated Flood Plain
Implemented Alternatives

- Acquire and remove 140 structures in the 25-year flood plain
- Acquire 155 acres of undeveloped areas in the corridor
- 11,404 feet of concrete rail
- 70 uncovered picnic sites
- 1 covered pavilion
- 4 footbridges
- 6 access points
- 60 parking spaces
- Information kiosk
- Plantings
Interim Feasibility Report, Upper Trinity River, TX

Johnson Creek, Arlington

Recommended Plan
Reaches 5 & 6
- **Structural**
  - BCR – 1.16

- **Non-Structural**
  - Flood damage reduction only
  - BCR – 0.85
  - Based on flood damage reduction and recreation in the evaluated flood plain and recreation in the ecosystem restoration area
  - BCR – 1.6
  - No credit taken for ecosystem restoration in the evacuated flood plain
Sacramento River
Tehama, California
Sacramento District
Project - *Sacramento River*
District - Sacramento
Location - Tehama, California

Authority
- Section 205

Non-Structural Measures
- Elevation
- Flood Warning/Evacuation

Justification
- Flood Damage Reduction

BCR - 1.1
Problem Identification

- Study area is along the right bank of the Sacramento River
- Flooding occurs at about the 4-year event
- Flooding occurs from a combination of snowmelt and rainfall
- Tehama population - 436
- Expected Annual Damages - $380,900
- Four flood sources
- 189 Structures/126 below 100 year flood
Problem Objectives

• Increased level of flood protection
• Reduce damages to structures
• Reduce requests for Federal disaster aid
• Reduce cost for flood insurance
• Low project O&M
Plan Formulation

• No Action
• Structural
  • Channel Improvements
  • Levees with Channel Improvements
  • Bypass Channel
  • Ring Levee
• Nonstructural
  • Relocation
  • Floodwalls
  • Structure Elevation
  • Flood Warning and Evacuation
  • Ring Levees
  • Dry Flood Proofing
Alternative Evaluation

• No Action
  • Not acceptable

• Channel Improvements
  • High Cost
  • Significant Environmental Damage
  • 10-year protection
  • O&M

• New Levees with Channel Improvements
  • High Cost
  • Significant Environmental Damages
  • 10-year Protection
  • O&M
Alternative Evaluation (cont.)

- Bypass Channel
  - Significant Environmental Damage
  - 9-Year Protection
  - High Cost
  - O&M

- Ring Levee
  - 100-Year Protection
  - O&M
  - Home Removal

- Relocation
  - Socio/Economic Impacts
  - High Cost
  - O&M

- Floodwalls - R
  - Protection Too Low
  - Not Cost Effective
  - O&M
Alternative Evaluation (cont.)

- Structure Elevation - R
  - 100-Year Protection Plus 2 feet
  - Maximizes Net Benefits
  - Maximizes BCR
  - Community Intact
  - O&M
- Flood Warning & Evacuation - R
  - Large Amount of Damage Remain
  - Included with Other Plans
- Ring Levee
  - Protection Too Low
  - Not Cost Effective
  - Land Requirement
  - O&M
Alternative Evaluation (cont.)

- Dry Flood Proofing
  - Protection Too Low
  - Not Cost Effective
  - O&M
- Recommended and Implemented Plan
  - Elevate 126 Home to 100-year plus 2 feet
Nonstructural Measures for Flood Risk Management

Lecture 4.2
MsCIP NS Formulation

30 March – 3 April 2009
Mississippi Coastal Improvements Program

Studies related to the consequences of the 2005 hurricanes

* All efforts fully coordinated with the Louisiana Coastal Protection and Restoration Project (LACPR) team

- $10 Million Emergency Supplemental Appropriations
  (P.L. 109-359) 30 December 2005

- Cost Effective Projects in lieu of NED benefits
- No Incremental Benefit-Cost Analysis
- 6 month interim and 24 month comprehensive report requirements

- Hurricane and Storm Damage Reduction
- Salt Water Intrusion
- Shoreline Erosion
- Fish and Wildlife Preservation
- Other Water Related Resource Projects
MsCIP Non-Structural Formulation
MsCIP Non-Structural Formulation
MsCIP Non-Structural Formulation
MsCIP Non-Structural Formulation

Katrina August 29, 2005
MsCIP Non-Structural Formulation
**MsCIP Non-Structural Formulation**

**AGENCY INITIATIVES:**
- Elevation
- Protection of Critical Facilities
- Evacuation (aka buyouts or acquisitions)
- Environmental Restoration
- Relocation of defined areas
- Relocation of Public facilities
- Flood Proofing
- Storm Warning & Emergency Evacuation

**LOCAL INITIATIVES:**
- National Flood Insurance Program
- Property Taxation and Growth Redirection
- TDR or PDR
- Building Codes
- Storm Warning & Emergency Evacuation
- Land Use Regulations (zoning)
MsCIP Non-Structural Formulation
Damages to Elevated Structures in V-zone vs non V-zone areas

- Total loss of structure in V-zone despite being elevated above the BFE in accordance with NFIP

Inundation damages but structure survived Katrina surge outside of the V-zone
Formulated Nonstructural Plans

- **Single measure plans**
  - NS-PAHHZ – Nonstructural Permanent Acquisition in the high-hazard zones only.
  - NS-PA100 – Nonstructural permanent acquisition in the identified BFE (high-hazard zones and areas where water at the ABFE-2 exceeds 13 feet deep).

- **Combined measures plans**
  - NSC-1 Federal Agencies Plan (Acquisition, FP, Relocations, FWEE)
  - NSC-2 Floodproofing and FWEE (Federal Plan)
  - NSC-3 Local Agencies Plan (NFIP, IBC, LU Zoning, TDR/PDR, etc.)
  - NSC-3 Combined Agencies Plan (NSC-1 and NSC-3 combined)
  - NSC-4 Loss of Life Reduction Plan (Acquisition, Relocations, FWEE)
  - Combined Structural/Nonstructural Plans (at ABFE-2, 20 ft, 30 ft, & 40ft of surge inundation)
    - Ringwall/ring-levee plans and associated NS outside line of protection (buffer zones).
    - NS alternatives to and with the LOD4 (coastal levee) structural measure in place
Mississippi Coastal Improvements Program (MsCIP)

COMPREHENSIVE PLANNING ELEMENTS

• Education, Evacuation, Planning, and Flood Plain Management
• Barrier Island Restoration
• High Hazard Area Risk Reduction Program (HARP)
  • Near Term – 2000 parcels / 5 year window
  • Long Term – Out year acquisition coordination
• Moss Point Municipal Relocation Project
• Waveland Floodproofing Pilot
• Forrest Heights Levee Rehab
• Coastal Forest and Wetland Restoration
• Coast-wide Beach/Dune Restoration
• Submerged Aquatic Vegetation Restoration
• Freshwater Diversion
• Other
Mississippi Coastal Improvements Program (MsCIP)

EDUCATION, EVACUATION, PLANNING AND FLOOD PLAIN MANAGEMENT

Critical components of Comprehensive Plan
  - Hurricane Risk Reduction Education
  - Hurricane and Storm Warning System
  - Hurricane Evacuation Planning
  - Flood Plain Management
  - Building Codes
  - Zoning Codes
  - Long-term Critical Infrastructure / Facility Relocation

Coordination required among all parties – Federal, State, Local, Academic, NGOs
Mississippi Coastal Improvements Program (MsCIP)

HIGH HAZARD AREA RISK REDUCTION PROGRAM

- **Near Term**
  - Willing sellers, approximately 2000 parcels, 100-yr floodplain. Coordinated with local municipalities
- **Long Term**
  - Possible future effort coordinated with FEMA, HUD, State
Mississippi Coastal Improvements Program (MsCIP)

MOSS POINT MUNICIPAL COMPLEX

- Moss Point Municipal Complex
  - Relocate municipal buildings outside high hazard zone
  - Restore flood buffer potential to current location
  - Reduce interruption of public services
  - Fully coordinated with local municipality
  - Required coordination – FEMA, HUD, MDA
Mississippi Coastal Improvements Program (MsCIP)

WAVELAND FLOODPROOFING

• Waveland Floodproofing Project (25 structures)
  • Contiguous area, acceptable for floodproofing, structures still present
  • Apply new standards
  • Evaluate FEMA 550 design guidelines
  • Demonstrate techniques to stakeholders
  • Required coordination – FEMA, HUD, MEMA, MDA
# Mississippi Coastal Improvements Program (MsCIP)

## Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Feb 2009</td>
<td>Federal Register Notice of Availability of EIS</td>
</tr>
<tr>
<td>16 Mar 2009</td>
<td>Jackson County Workshop / Public Hearing</td>
</tr>
<tr>
<td>17 Mar 2009</td>
<td>Hancock County Workshop / Public Hearing</td>
</tr>
<tr>
<td>19 Mar 2009</td>
<td>Harrison County Workshop / Public Hearing</td>
</tr>
<tr>
<td>26 Mar 2009</td>
<td>Federal Principals Meeting</td>
</tr>
<tr>
<td>31 Mar 2009</td>
<td>Comment Period Closes</td>
</tr>
<tr>
<td>20 Apr 2009</td>
<td>Transmit Final Report to SAD/HQ</td>
</tr>
<tr>
<td>21 May 2009</td>
<td>Civil Works Review Board</td>
</tr>
<tr>
<td>6 Jun 2009</td>
<td>State and Agency Review</td>
</tr>
<tr>
<td>6 Jul 2009</td>
<td>State and Agency Review Closes</td>
</tr>
<tr>
<td>20 Jul 2009</td>
<td>Sign Final Chief’s Report and Transmit Final Recommendations/Report to ASA(CW)</td>
</tr>
<tr>
<td>20 Jul - 20 Nov 2009</td>
<td>ASA/Administration Review and Transmittal to Congress</td>
</tr>
</tbody>
</table>
FROM THE PEOPLE OF WAVELAND

In appreciation and gratitude to all who gave of their time, energy, and money to help us recover from Hurricane Camille. On August 17, 1969 our city was devastated, but those who cared came to her rescue.
Presentation on the
Lower Colorado River Basin Phase I, Texas
Interim Feasibility Study
(Onion Creek)
Project Location
Local Project Support

- Lower Colorado River Authority (Official Sponsor)
- LCRA executed interlocal agreements with:
  - Onion Creek
    - City of Austin
    - City of Sunset Valley
    - Travis County
- Texas Water Development Board provided grant funding to Austin for approximately 50% of the local cost share.
2001 Flood was higher than most citizens thought possible.

2001 Flood relocated homes without asking.

Over 400+ homes flooded
Existing Conditions

- Rapid urbanization is occurring.
  - Stringent drainage ordinances has resulted in reduced impacts.

- Significant damages occur in six areas.

- Average Annual Flood damages = $7.4 million.


- Experiencing ecosystem degradation along the major streams, and restoration opportunities exist.

- More recreation needed
Flood Damage Reduction Evaluated in Detail

Recommended:

- **Timber Creek**
  - Floodplain Evacuation

- **OC Forest/Yarrabbee Bend**
  - Diversion
  - Levees
  - Floodplain Evacuation

- **Williamson Creek**
  - Channel Modification
  - Floodplain Evacuation

- **Bear/Onion Confluence**
  - Floodplain Evacuation
  - Floodwall
Mitigation Issue Identified

Existence of Ongoing FEMA buyout program as predecessor to Corps project within Onion Creek

- 40 properties purchased in Timber Creek
  - FEMA funds: $1,597,498
  - County/local funds: $750,006

- Federal Assistance for Buyouts:
  - Hazard Mitigation Grant Program
  - Flood Mitigation Project Grant
  - Pre-Disaster Mitigation Grant

- No duplication between FEMA and COE Projects
Onion Creek - Timber Creek Segment
Parcels to Be Acquired

- County owns parcels scattered within the area.
- No current beneficial land use.
- Difficult to maintain
Onion Creek - Timber Creek Segment
Recommended Plan

- Buyout of 81 residential structures within 4% ACE floodplain
- Recreational Facilities
  - 40 Ac. Recreation
  - 20 picnic shelters
  - 8 group shelters
  - 5100 ft unpaved trails
  - 1200 ft paved trails
  - Parking, restrooms, etc.
- 16 Ac. Ecosystem Restoration
- Estimated cost: $10.8 Mil
- Fed: $6.7 Mil, NF: $4.1 Mil
- Benefit-to-Cost Ratio: 1.7
- Ann Rec and FC cost: $510,000
- Ann Rec and FC benefit: $870,000
- Net Annual Benefits: $360,000
- ER Costs: $330,000
Onion Creek Forest / Yarrabee Bend Segment
Structures to be Acquired

410 residential structures within 4% ACE (25-year) floodplain
Onion Creek  Forest / Yarrabee Bend Segment
Recommended Plan

• Remove 410 residential structures

• Recreational Facilities
  – 100 Ac. Recreation
  – 32 picnic shelters
  – 33 group shelters
  – 7860 ft unpaved trails
  – 9680 ft paved pedestrian trails
  – 7400 ft multi-use trails
  – 25 sports courts (100% local costs)
  – Parking, restrooms, etc.

• 190 Ac. ecosystem restoration

• Estimated cost: $72.4 Mil
• Fed: $46.2 Mil, NF: $26.2 Mil
• Ann Rec and FC Cost: $3.41 Mil
• Ann Rec and FC Ben: $5.27 Mil
• Benefit-to-Cost Ratio: 1.5
• Net Annual Benefits: $1.86 Mil
Project Facts

Floodplain evacuation of two subdivisions totaling 490 homes in Austin/Travis County area, together with construction of recreation facilities and ecosystem restoration on the vacated lands.

Total Cost: $83.2 Million

BCR: 1.5

Without "new uses of the evacuated flood plain"

BCR less than 1.0
Buffalo District
Planning Conference

Case Study - Glendive, Montana

6 August 2009
• Risk
• Opportunities
• Impacts
• Innovation
• Challenges
• Excitement
Aerial Photo of Glendive, Montana
The Problem
Existing West Glendive Levee

• Constructed by the Corps of Engineers - Garrison District in 1959
  – average height approximately 9 feet
  – provided 100-year flood protection for non-ice affected conditions
  – protects approximately 180 structures
  – cutoff entire left bank flood plain from Yellowstone River
  – degraded ecosystem
Interstate 94 Bridge

- Constructed by Montana Department of Transportation (DOT) in 1968-69
  - cut-off the entire left bank flood plain including a chute that was about 200-feet wide and 2.5-miles long
    - raised ice affected flood stages as much as 4 feet for the 100-year event
    - degraded the ecosystem
Original Flood Insurance Study (FIS)

• Published by Federal Emergency Management Agency (FEMA) in 1980
• Included ice jam modeling
• Results of the FIS
  – the existing levee does not provide 100-year protection
  – property behind the levee was included in the flood plain
  – Glendive refused to adopt National Flood Insurance Program (NFIP) regulations and was subsequently suspended from participation by FEMA in 1980
  – development continued resulting in construction of 13 structures that are not in compliance with the NFIP
Results of the NFIP Suspension

- Glendive has been trying to get back into the NFIP since the late 1980’s
- FEMA granted conditional re-instatement contingent on mitigation of property not in compliance and adoption of required flood plain regulations
- Glendive has asked the Omaha District to conduct studies under Section 205 and Flood Plain Management Services (FPMS) Authorities to evaluate mitigation measures allowing the city to be fully re-instated into the NFIP
100-Year Water Surface Profiles

Existing Conditions Water Surface Profiles

River Station (ft)

Elevation (ft)

Channel Bed
100-yr Open Water
100-yr Ice Jam (levee overtopping)
BNSF Railroad Profile
Existing Levee Crest Profile
100-yr Ice Jam (levee not overtopping)
Plan Formulation
Planning Objectives
(Section 205)

• Federal Objectives
  – maximize net annual benefit to contribute to national economic development (NED) consistent with socio-economic and environmental objectives

• City of Glendive Objectives
  – mitigate the structures not in compliance with FEMA regulations to achieve full re-instatement into the NFIP
  – provide 100-yr protection to the West Glendive area
Planning Constraints (Section 205)

- State of Montana floodway criteria
- Executive Order 11988
- National Flood Insurance Program
Section 205 Alternatives

- **Alternative 1 – No Action**
  - risk for loss of life and high flood damages from catastrophic flood depths remains the same
  - NFIP non-compliance structures are still non-compliant
  - no induced damage mitigation required
  - City’s participation in NFIP suspended
  - recreation remains the same
  - degraded ecosystem remains

- **Estimated Project Cost** - $0
Existing Conditions Flood Boundary
Section 205 Alternatives (cont.)

• Alternative 3 – West Glendive Levee Raise
  – Raise levee 2 to 5 feet over entire length
  – Construct channel training dikes upstream from BNSF Railroad Bridge
  – West Glendive area protected from 100-yr flood
  – NFIP non-compliance structures are mitigated
  – Significant induced damage mitigation (~$5.34M)
  – Significant environmental mitigation for channel training dikes (Value not determined)
  – City’s participation in NFIP fully re-instated
Section 205 Alternatives (cont.)

• **Alternative 3 - West Glendive Levee Raise**
  – Recreation remains the same
  – Degraded ecosystem remains and is further degraded

• **Estimated Project Cost**  -  $12,171,100
• **Net annual benefits**  -  $-177,700
• **BCR**  -  .76
Alternative 3
Planning Objectives
(FPMS)

• Federal Objectives
  – maximize net annual benefit to contribute to national economic develop (NED) consistent with socio-economic and environmental objectives
  – use all opportunities
  – maximize environmental sustainability
    • flood drainage reduction
    • recreation
    • ecosystem restoration

• City of Glendive Objectives
  – mitigate the structures not in compliance with FEMA
  – regulations to achieve full reinstatement into the NFIP
  – provide 100-yr protection to the West Glendive area
Planning Constraints (FPMS)

- State of Montana floodway criteria
- Executive Order 11988
- National Flood Insurance
- Ecosystem sensitivity of the Yellowstone River
FPMS Alternatives

- **Alternative 4 – Bypass Chute & Flood Plain Buyout**
  - restore historic chute 200-feet wide and 2.5 miles long
  - remove downstream 2/3 of existing West Glendive Levee
  - relocate 150 residential and commercial structures
  - use evacuated flood plain for environmental restoration and recreation
  - majority of flood prone West Glendive structures removed from 100-yr flood plain
  - NFIP non-compliance structures are mitigated
  - no environmental or induced damage mitigation required
FPMS Alternatives (cont)

• **Alternative 4 – Bypass Chute & Flood Plain Buyout**
  – ecosystem vastly improved through restored chute and ability of river to interact with its flood plains
  – recreation facilities improved with 5.5 miles of new trails, canoe launches, picnic, and playground areas, . . . Etc.
  – City’s participation in NFIP fully reinstated

• **Estimated Project Cost**  -  $16,676,500
• **Net Annual Benefits**  -  $+315,900
• **BCR**  -  1.31
Alternative 1
Alternative 3
Recommended Plan and With-Project Flood Boundary Map
• Risk
• Opportunities
• Impacts
• Innovation
• Challenges
• Excitement
Sustainable Flood Risk Reduction within the Corps of Engineers