Missouri River Levee Systems

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Hanson Professional Services Inc.
Outline of Presentation

- Missouri River Levee System Overview
- Missouri River Levee System Status
- Monarch Chesterfield Levee
- Riverport Levee
Missouri River Levee System Overview
(ref USACE STL District)
# Missouri River Levee System Status
*(ref USACE STL District)*

<table>
<thead>
<tr>
<th>Levee</th>
<th>Protection</th>
<th>Federal Levee</th>
<th>PL 84-99 Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutzow Bottom LA</td>
<td>10-year</td>
<td>Non-Fed</td>
<td>A</td>
<td>agriculture</td>
</tr>
<tr>
<td>Augusta Bottom LA</td>
<td>25-year</td>
<td>Non-Fed</td>
<td>A</td>
<td>agriculture</td>
</tr>
<tr>
<td>Darst Bottom LD (Sec 2)</td>
<td>100-year (cert.)</td>
<td>Non-Fed</td>
<td>M (trees)</td>
<td>agriculture</td>
</tr>
<tr>
<td>Missouri University L</td>
<td>10-year</td>
<td>Non-Fed</td>
<td>M (trees)</td>
<td>agriculture</td>
</tr>
<tr>
<td>Monarch-Chesterfield LD</td>
<td>100-year (cert., PAL, 500-year)</td>
<td>Fed (USACE design)</td>
<td>M (trees, encroachments)</td>
<td>commercial, retail</td>
</tr>
<tr>
<td>Greens Bottom LD (Sec 1&amp;2)</td>
<td>5-year</td>
<td>Non-Fed</td>
<td>M (trees)</td>
<td>agriculture</td>
</tr>
<tr>
<td>Howard Bend LD</td>
<td>500-year (cert., PAL)</td>
<td>Non-Fed</td>
<td>M (trees, encroachments, concrete)</td>
<td>agriculture, commercial</td>
</tr>
<tr>
<td>Riverport LD</td>
<td>500-year (cert., PAL)</td>
<td>Non-Fed</td>
<td>A</td>
<td>commercial</td>
</tr>
<tr>
<td>Earth City LD</td>
<td>500-year (cert., PAL)</td>
<td>Non-Fed</td>
<td>A</td>
<td>commercial</td>
</tr>
<tr>
<td>Missouri Bottoms LD</td>
<td>10-year</td>
<td>Non-Fed</td>
<td>M (trees, rutting)</td>
<td>agriculture</td>
</tr>
<tr>
<td>Columbia Bottoms LD</td>
<td>5-year</td>
<td>Non-Fed</td>
<td>M (trees)</td>
<td>agriculture</td>
</tr>
<tr>
<td>L – levee</td>
<td>(cert.) – requires certification</td>
<td>Non-Fed</td>
<td>A – acceptable</td>
<td></td>
</tr>
<tr>
<td>LA – levee association</td>
<td>PAL – Provisionally Accredited Levee</td>
<td>Non-Fed</td>
<td>M – min. acceptable</td>
<td></td>
</tr>
<tr>
<td>LD – levee district</td>
<td></td>
<td></td>
<td>U - unacceptable</td>
<td></td>
</tr>
</tbody>
</table>

*Notes:*
- **L** – levee
- **LA** – levee association
- **LD** – levee district
Monarch-Chesterfield Levee - Description

- Missouri River (RM 46.3 – 38.3) and Bonhomme Creek
- Federal Flood Control Project, authorized level of protection: 500-year
- Protects 4,250 acres commercial / retail, $660 million in economic value (Spirit of St. Louis Airport, I-64 / Hwy 40/61)
- 11.5 mile long earth levee, typically 15-20 feet high
- 3 roadway / railway closure structures / floodwalls
- 3 – 60,000 GPM Pump Stations
- Commercial / industrial development, agricultural land; City of Chesterfield / City of Wildwood, Flood Plain Managers
- Monarch-Chesterfield Levee District (est. 1947)
Monarch-Chesterfield Levee - Site
Chesterfield Valley < 1940's

- St. Louis County
- Wetlands
- Katy Trail
- Missouri River Channel
- St. Charles County
Chesterfield Valley < 1940's
Typical Flood Condition

St. Louis County

Wetlands

Katy Trail

Missouri River Channel

St. Charles County
Chesterfield Valley 1947 - 1980

St. Louis County

Agriculture Levee (10 year)

Wetlands

Katy Trail

Missouri River Channel

St. Charles County
Chesterfield Valley 1947 - 1980
Typical Flood Condition
Chesterfield Valley 1980 - 1993

St. Louis County

Monarch-Chesterfield Levee (100 year)

Farmland

Katy Trail

Missouri River Channel

St. Charles County
Chesterfield Valley 1980 - 1993

100 year flood

St. Louis County

Monarch-Chesterfield Levee (100 year)

Farmland

Katy Trail

Missouri River Channel

St. Charles County
Chesterfield Valley July 1993
Approx. 250 year flood

St. Louis County

Monarch-Chesterfield Levee
(100 year)

Farmland

Katy Trail

Missouri River Channel

St. Charles County
Chesterfield Valley > 2000

- St. Louis County
- Monarch-Chesterfield Levee (500 year)
- Wetlands
- Katy Trail
- Missouri River Channel
- St. Charles County
Chesterfield Valley > 2000
500 year flood

St. Louis County

Monarch-Chesterfield Levee
(500 year)

Wetlands

Katy Trail

Missouri River Channel

St. Charles County
Monarch-Chesterfield Levee <1993

- Agricultural Levee
- 1947-1948 Survey, MCLD established
- High Water events (’86, ’73, ’51, etc.)
- 1980’s Improvements
- 1983 FEMA 100-Year Certification
- Spirit of St. Louis Airport Improvements, FAA Grants
- I-64 / Hwy 40/61 Improvements
- Commercial Development
Chesterfield Valley - 1993

- Over 240 businesses
- Employment for over 4,400 persons
- Spirit of St. Louis Airport (2\textsuperscript{nd} busiest in FAA’s Central Region)
- I-64 / Hwy 40/61 (Missouri Hi-Tech Corridor)
- 3.1 million square feet of development
- $25 million in assessed valuation
- $4.65 million in local tax revenues
1993 Flood

Stages for St. Charles Gage on the Missouri River, Flood Stage: 25.0 ft

(1) 36.7 ft on 07/18/1993

(2) 38.7 ft on 07/30/1993 (forecast 38.5 ft)

Monarch-Chesterfield Levee breach 07/30/1993 10 p.m.

(3) 40.0 ft on 08/02/1993

(4) 35.3 ft on 10/02/1993
1993 Flood

Historic Crests for St. Charles Gage on the Missouri River, Flood Stage 25.0 ft

(1) 40.11 ft on 6/24/1884
(2) 40.04 ft on 8/2/1993 (forecast 39.0 ft)
(3) 37.5 ft on 10/07/1986
(4) 37.3 ft on 7/20/1951
(5) 36.5 ft on 5/21/1995 (forecast 38.0 ft)
(6) 36.4 ft on 4/26/1973
(7) 35.4 ft on 04/15/1994 (forecast 36.5 ft)
1993 Flood

- Water level estimated in excess of 250-year flood (8-10 feet of water throughout Chesterfield Valley)
- 139 days over flood stage (59 consecutive days)
- Flash flooding and high water in Sept. and Oct. 1993
- Property damage in excess of $200 million
- Total economic losses in excess of $500 million
Chesterfield Valley – 1993 Flood

- 80 Businesses left
- Chesterfield Valley
- Loss of employment for 1,500 persons
- Assessed valuation dropped to $18.5 million (25% decrease)
Post 1993

- Levee repair under PL 84-99 by USACE-KC and MCLD (8/93 – 4/94)
- FEMA request for Levee Re-certification (8/25/93)
- Engineering evaluation and analyses (Part 65.10 of 44 CFR)
- Re-certification Report (3/31/94)
- Levee Improvements necessary for re-certification (construction 10/94 – 5/96)
- Levee (100-year) Re-certification (8/18/97)
- FEMA LOMR (1/6/98)
FEMA Re-Certification (100-yr)

- Part 65.10 of 44 CFR, Mapping of Areas Protected by Levee Systems, NFIP (rev. 10/1/92)
- FEMA Form 81-89, Levee / Floodwall System Analyses Form 8 (8/93)
  - Freeboard
  - Closures
  - Embankment protection
  - Embankment and foundation stability
  - Settlement
  - Interior drainage
  - Operation and maintenance plan
Levee Improvements (100-Yr) (re-certification)

- Increase freeboard
- Repair and protect against scour and erosion damage
- Widen / flatten slopes to increase factors of safety against slope failure / instability
- Mitigate burrowing animal damage
- Further interior drainage analyses
- Consolidate and update operation and maintenance plan
Levee Improvements (100-Yr)
(re-certification)

- Phases 1, 2, and 3 construction
  10/94 – 5/96
- April 1994 Flood Event
- May 1995 Emergency Flood Fight
- Post 1995 Flood Fight construction
- Total costs through re-certification $9 million
Levee Improvements (500-Yr)
Typical Levee Cross Section
Typical Levee Cross Section

Clay Levee

Pervious Sand Stratum

Top Stratum

Berm

Bedrock

Seepage Control w/Berm
### Levee Improvements (500-Yr)

#### Slope Stability

<table>
<thead>
<tr>
<th>Design Case</th>
<th>Shear Strength</th>
<th>Original Factor of Safety</th>
<th>Current USACE</th>
<th>Current FEMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of Construction</td>
<td>Q or S</td>
<td>riverside: 3.1</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>landside: 4.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudden Drawdown</td>
<td>R, S</td>
<td>riverside: 1.0</td>
<td>short term pool: 1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>long term pool: 1.2</td>
<td></td>
</tr>
<tr>
<td>Steady State Seepage</td>
<td>(R&lt;S): (R+S)/2</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>(R&gt;S): S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthquake</td>
<td>R, S</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Note: Q – UU test; R – CU test; S – CD test
# Levee Improvements (500-Yr)

## Seepage Control

<table>
<thead>
<tr>
<th>Element</th>
<th>Original Seepage Exit Gradient</th>
<th>Current USACE Seepage Exit Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seepage Berm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>levee toe: &lt;0.5</td>
<td>levee toe: &lt;0.3</td>
<td></td>
</tr>
<tr>
<td>berm toe: &lt;0.85</td>
<td>berm toe: &lt;0.8</td>
<td></td>
</tr>
<tr>
<td>(nominal 50 foot berm)</td>
<td>(minimum 150 foot berm 5 feet to 2 feet thick)</td>
<td></td>
</tr>
<tr>
<td>Drainage Channel</td>
<td>none</td>
<td>levee / channel toe &lt;0.3</td>
</tr>
<tr>
<td>Relief Wells</td>
<td>none</td>
<td>between wells &lt;0.5</td>
</tr>
</tbody>
</table>

Note: Original design assumed water level at design flood profile. Current USACE requires design water level at top of levee.
Levee Improvements (500-Yr)

Key factors
- Floodway boundary
- Wetland avoidance / impacts
- Cultural resources
- Borrow material
Levee Improvements (500-Yr)

- Phases 1A, 1B/C, 2B, 3A construction 10/97– 5/00 ($12 million)
- Chesterfield Valley Wetlands Mitigation construction 2/99-9/04 ($1.1 million)
- Phases 3B West & East construction 3/01– 9/02 ($14.5 million)
- USACE-STL (design in process)
  - Wetland mitigation sites
  - Centaur Road raise
  - Railroad closure structures (2)
  - Baxter Road closure structure / floodwall
  - Walnut Grove floodwall / realignment
  - Phase 2B seepage berms / Earthen Road relocation (in constr.)
USACE-STL / MCLD Partnership

- USACE-STL St. Louis Region Flood Damage Reduction Reconnaissance Study (11/93-12/95)
- USACE-STL / MCLD Feasibility Cost Sharing Agreement (4/97)
- USACE-STL Feasibility Study Report with Integrated Environmental Impact Statement (10/00)
- USACE-STL Value Engineering Study (9/01)
- USACE-STL / MCLD Preliminary Engineering and Design & PEDA (1/01 – present)
Permitting

- Re-certification improvements - Erosion Protection under nationwide Permit (NWP No. 13) (10/94)
- City of Chesterfield Floodplain Development / Grading Permits (numerous 10/97 through 4/03)
- U.S. Department of the Army – Permit No. P-2314 (3/27/02)
- Section 401 Permit Modification, MDNR (10/1/02)
- NPDES, MDNR (10/9/02)
Financing

- 1994 Chesterfield Valley Tax Increment Financing District (TIF)
  - $26.7 million of levee improvements
  - $14.8 million of road and highway improvements
  - $9.4 million of stormwater drainage improvements
  - $783 thousand of utility improvements
- Excess TIF revenues began to pass through to underlying tax districts in 2002
- TIF to expire in 2017, early payoff 2009
- Total Project Costs: $58 million
Wetlands Mitigation

- Valley Wide Wetlands Mitigation
- Two sites providing 159.3 acres
- Wetlands / Wildlife Habitat
- Education / Recreation / Park
- Levee Wetlands Mitigation
Chesterfield Valley - 2008

- Over 500 businesses
- Employment for over 8,000 persons
- 7.0 million square feet of development
- $100+ million in assessed valuation
BIKE / WALKING TRAIL

10' Wide Trail
Asphalt Pavement Surface

Grass Lined 3:1 Slope

LEVEE

Grass Lined 3:1 Slope
Riverport Levee (500-year)
Riverport Levee - Description

- Missouri River (RM 30.0 - 28.8)
- Non-Federal Flood Control Project (private); level of protection: 500-year
- Protects 440 acres commercial / retail, $50 million in economic value (I-70)
- 1.1 mile long earth levee, typically 20-25 feet high
- 1 – 45,000 GPM Pump Station
- Commercial development; City of Maryland Heights, Flood Plain Manager
- Riverport Levee District (est. 2004)
Riverport – Site

- Levee Construction 1986-87
Riverport – 1993 Flood

- 24-hr Flood Monitoring and Inspection
- Flood Response / Flood Fight
- Landside toe / drainage channel stabilization
- Rock Protection
Riverport – Post 1993 Flood

- Pump Station approach reconstruction
- Relief Wells (new/rehab)
- Erosion / Rock Protection
- Landside toe / drainage channel stabilization
Levee Cross Section

Seepage Control w/Relief Wells, Channel and Liner

- Clay Levee
- Top Stratum
- Pervious Sand Stratum
- Relief Well
- Detention/Drainage Channel
- Liner
- Bedrock
- Detention/Drainage

RL
Riverport Levee

- Plan of Reclamation
- Riverport Levee District Formed
- Levee System Evaluation
- Supplemental Plan of Reclamation
- PL 84-99 Program
- FEMA Recertification
Acknowledgments

- USACE – St. Louis District
- USACE – Kansas City District
- Monarch-Chesterfield Levee District
- Riverport Levee District
- St. Louis County, Missouri
- City of Chesterfield, Missouri
- City of Wildwood, Missouri
- City of Maryland Heights, Missouri
- Surdex Corporation
- Jacobs Civil, Inc. (Sverdrup Civil, Inc.)
- Husch Blackwell Sanders, LLC (Husch & Eppenberger, LLC)
- Stantec (Fuller, Mossbarger, Scott & May Engineers, Inc.)
- Hanson Professional Services Inc.
Hanson Professional Services Inc.

- Engineering, architecture & program mgt.
- 10th largest private employer in Springfield
- More than 370 employees nationwide
- Headquartered in Springfield, 180+ employees
- 15 regional offices
- $60 million of revenue for 2007