

IMPLEMENTING A NATURE-BASED SOLUTION FOR CLIMATE ADAPTATION AND FLOOD RESILIENCE: A LARGE-SCALE LEVEE SETBACK ALONG THE MISSOURI RIVER

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Environmental Resources Specialist

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Strategy Manager: Floodplains & Nature-
Based Solutions

Water and the Watershed UACE PROSPECT
Course
March 30, 2022



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PRESENTATION OUTLINE

CHAPTER 1 – The Damage and the Solutions (Dave)

CHAPTER 2 – Community Overview and Partnerships (Barbara)

CHAPTER 3 – Interagency Partnerships (Barbara)

CHAPTER 4 – Secondary Environmental Benefits (Dave)



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CHAPTER 1 – THE DAMAGE AND THE SOLUTIONS

- Trailer Video
- Levee Flood Damages
- Repair Alternatives Analysis
- Design & Construction Innovation Highlights



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L536 TRAILER VIDEO
WWW.NATURE.ORG/MORIVERLEVEE



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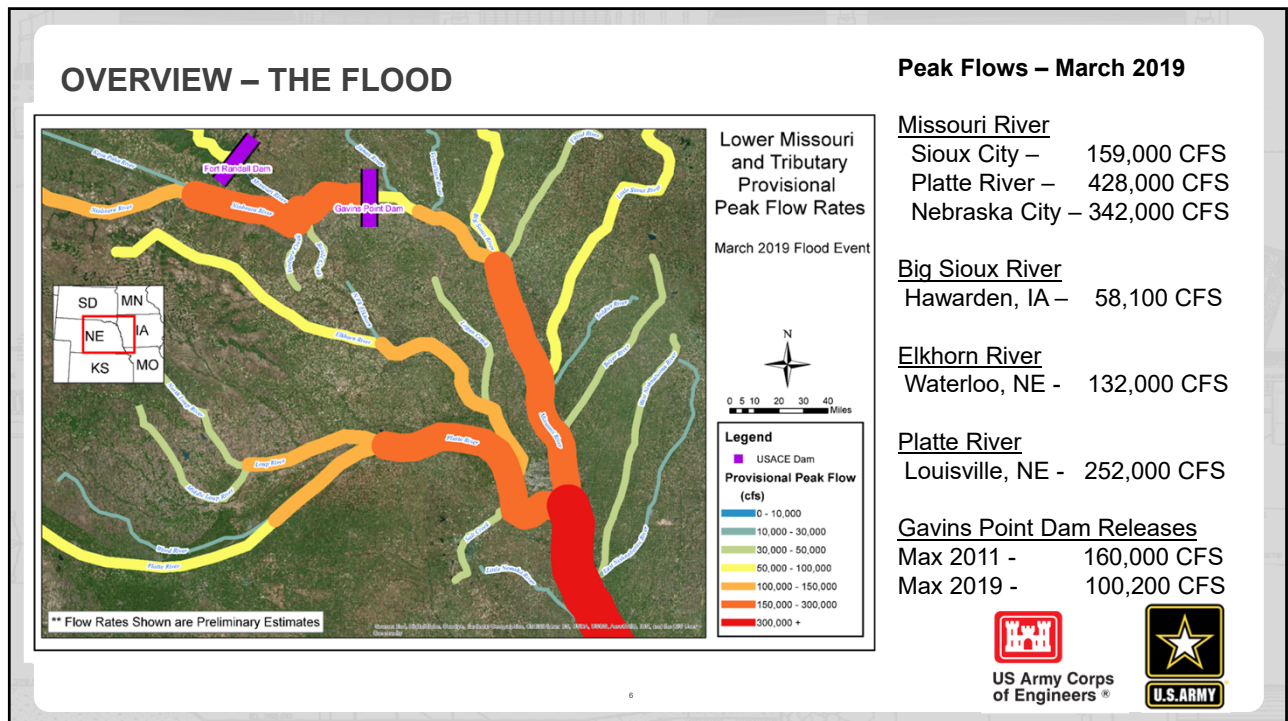


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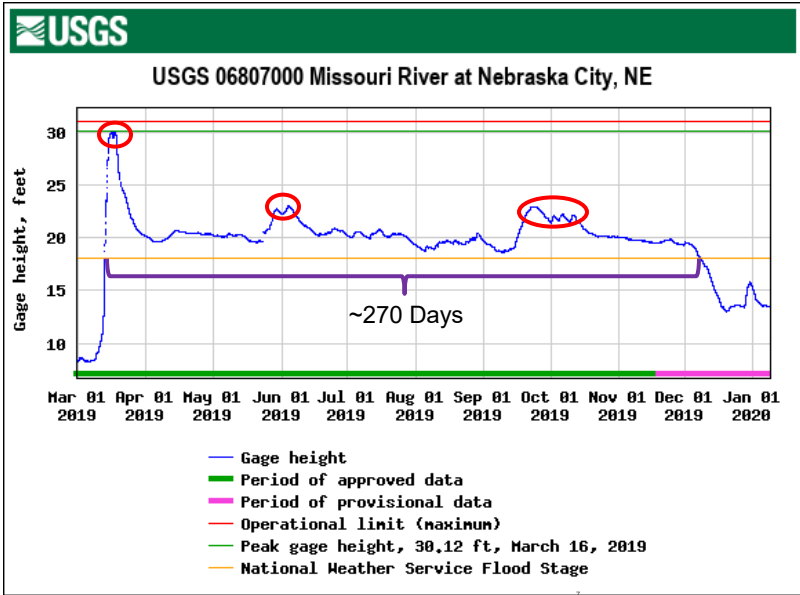


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FLOOD DURATION (~270 DAYS)

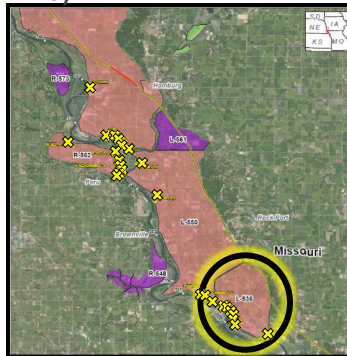
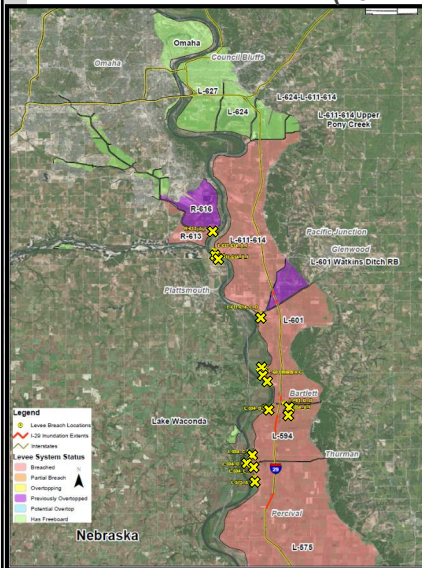


- 3 Events
 - March
 - May/June
 - September
- ~9 months above flood stage
 - 163 days in 2011
 - 25 days in 2003

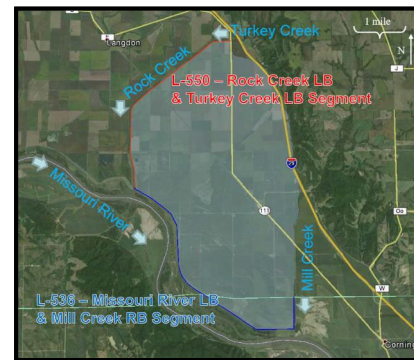


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LEVEE SYSTEMS ON THE MISSOURI RIVER RM 626 – 516 (15 APRIL 19)



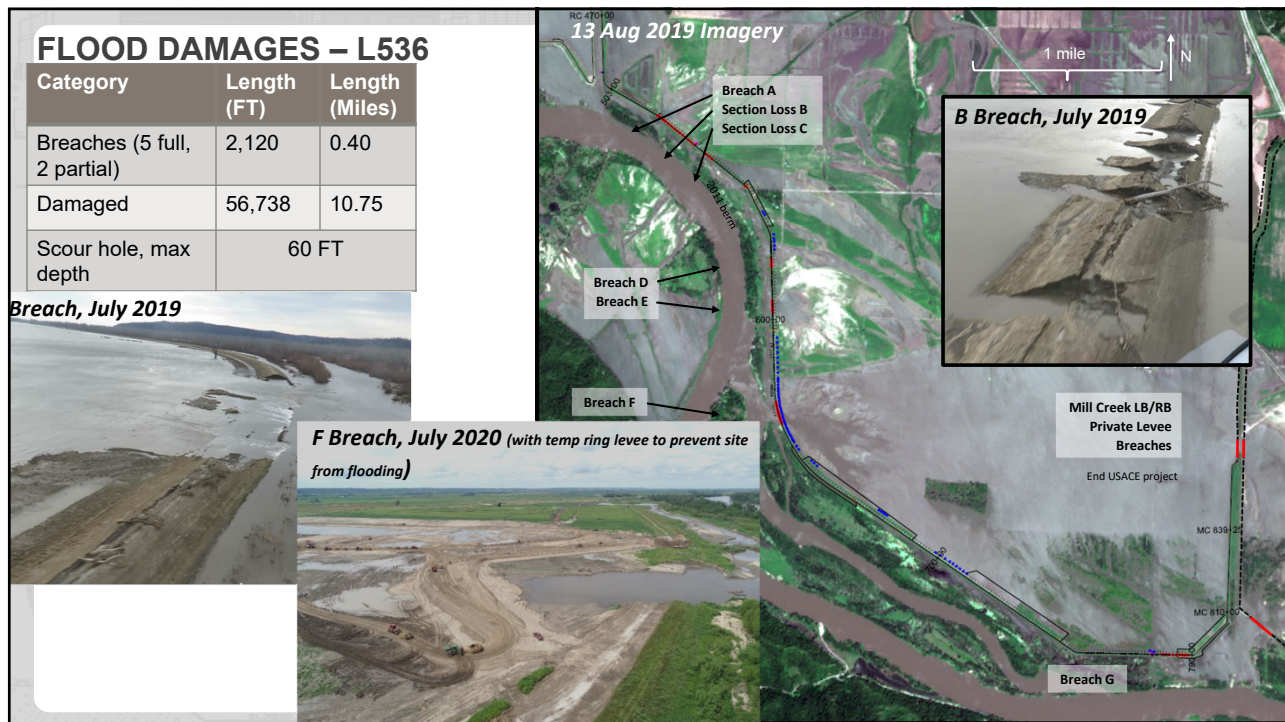
L536 LEVEE SYSTEM



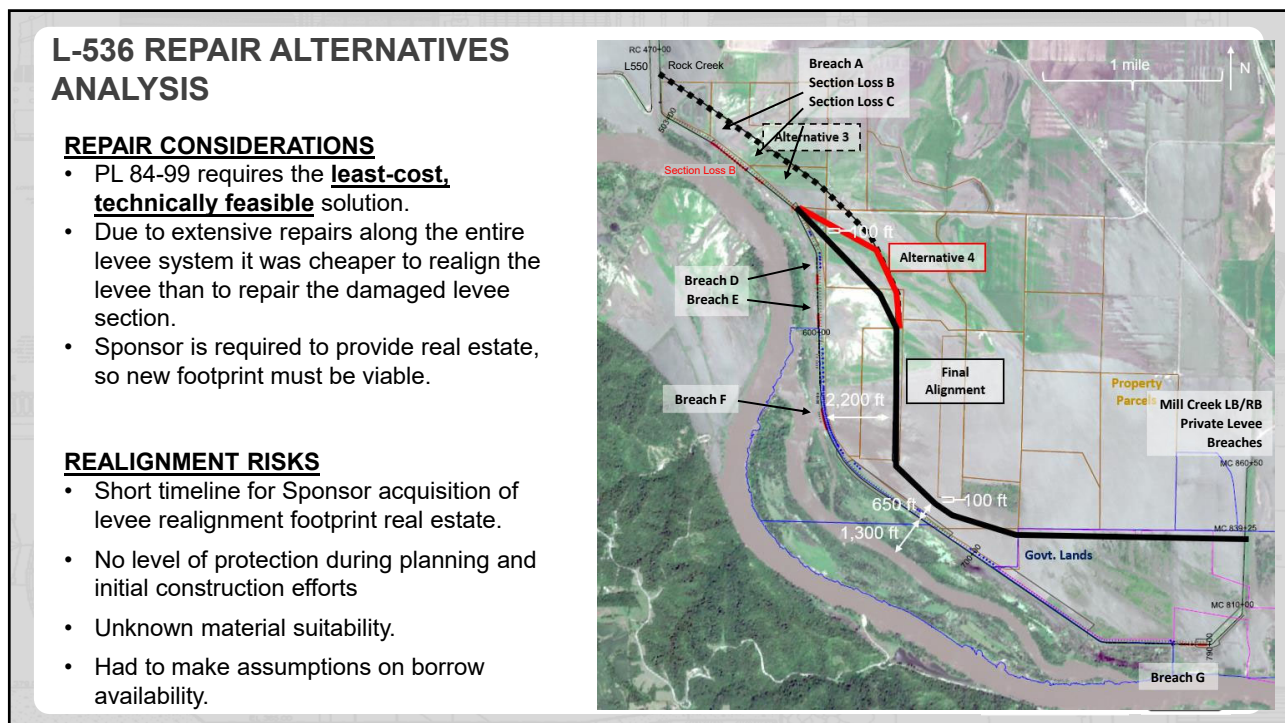
2019 OVERALL DAMAGE

- Over 50 Breaches (widespread, unprecedented damage)
 - 17 breaches on systems inactive in PL 84-99
- Failure mode primarily overtopping
 - Short duration events
 - Reloading of levees on Memorial Day
- Requests for assistance on levee systems active in PL 84-99
 - 60 levee and channel systems (60 completed Project Information Reports)
 - 352 miles of levees

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WHAT L-536 REPAIRS COULD HAVE LOOKED LIKE WITHOUT SETBACK



Mill Creek Levee, 2021



Rebuild levee through breach scour holes



L-575, 2021




Drive miles of concrete capped sheet pile in-line


Build 300' wide "super berm" on the landward side of levee

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INNOVATIVE CONSTRUCTION METHODS



Heated tents for winter construction and material processing



Conversion of borrow pits into wetlands

Dredge-discharged sand for sand seepage berm construction

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L536



Material Type Placed	QTY total*	% from MRRP/ NRCS land*
Sand (cubic yards)	810,000	24%
Random (CY)	430,000	50%
Cohesive (CY)	510,000	88%
Topsoil (CY)	200,000	55%
Levee surfacing (tons)	12,000	N/A
Rip Rap (TN)	8,000	N/A
ECB (square yards)	400,000	N/A
Seeding (acres)	170	30 native seeding
Sheet pile (linear feet)	400	N/A

*quantities represent preliminary estimates

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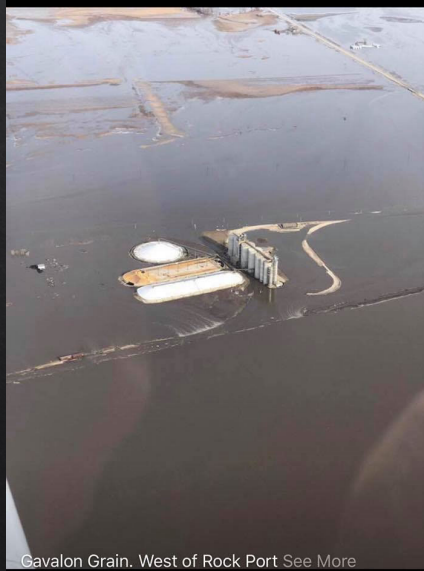
CHAPTER 2 – COMMUNITY OVERVIEW AND PARTNERSHIPS

- 2019 flood impacts on Atchison County
- Levee Sponsor’s role in PL 84-99
- Atchison County Levee District response to 2019 flood

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2019 Flood Impact on Atchison County



Cavalon Grain, West of Rock Port See More

- ◆ 56,000 acres under water
- ◆ 121 miles of road destroyed in the county
- ◆ 14 commercial businesses underwater
- ◆ 166 homes flooded
- ◆ 278 citizens forced to evacuate
- ◆ 1,295 agricultural buildings flooded
- ◆ Estimated \$25 million in lost agricultural revenue



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Atchison County Levee District #1



- ◆ 1952, 1984, 1993, 2010, 2011, and 2019
- ◆ General Approach: fix breaches in place, if possible, as the least cost alternative.
- ◆ Levee realignment and benefits:
 - Relieve known pinch points.
 - Adjust alignment based on more recent hydraulic data from the Corps.
 - Update 67-year-old levees that have experienced several high-water events.
 - Change landside slope from 3H to 1V to 5H to 1V.



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Levee Sponsor's role in PL84-99

- ◆ Land acquisition for levee footprint.
 - ◆ Often will also need to acquire land that is put on riverside of levee setback/realignment (Not a PL 84-99 requirement).
- ◆ Also includes the need to provide material (borrow) to be used to construct the new levee construction.
 - ◆ Landowners in L-536 have played a huge part in helping with this.



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ACLD Response to 2019 Flood

- ◆ Initial focus was realignment of L-550.
- ◆ TNC setup meeting in August of 2019 with government agencies to discuss realignment of L-550 with L-536 briefly mentioned.
 - ◆ Soon after we were informed by the Corps that L-550 would not meet least cost alternative for realignment.
- ◆ L-536 was a good candidate for realignment given the extensive damage to the entire levee system and no initial work had taken place to fix it.
- ◆ In November ACLD held meeting with key L-536 landowners to present options and gauge interest
- ◆ Critical issue we faced was how to cover the roughly \$3.2m for footprint (120 acres) and riverside ground (450 acres)



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CHAPTER 3 – INTERAGENCY PARTNERSHIPS

- The Nature Conservancy
- Project Partners
- Resources



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THE NATURE CONSERVANCY L-536 ROLE

CO-LEAD: BARBARA CHARRY
PROGRAM MANAGEMENT, FUNDING, MARKETING

CO-LEAD: VIV BENNETT
STRATEGY, REAL ESTATE, CROSS-BOUNDARY/CROSS-PROJECT

Convene Partners

Assist with Real Estate



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Project Partners

Atchison County Levee District #1

Missouri Dept Natural Resources

Missouri Dept of Conservation

Missouri Dept of Economic Development

Missouri River Recovery Program

Missouri State Emergency Management Agency

Northwest Missouri Regional Council of Governments

The Nature Conservancy

US Army Corp of Engineers

USDA Natural Resource Conservation Service



The Nature
Conservancy 

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MDNR, SEMA, MDC State Agency Response & Recovery

- State Funding Has Provided Assistance to Secure Necessary Real Estate for the Project
- Funding for New Levee Footprint, Riverward Land, and Associated Actions
- Innovative Project Providing an Example and Lessons- Learned that will Make Future Similar Projects More Successful



 MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

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USDA
United States Department of Agriculture

Emergency Watershed Protection Program – Floodplain Easements

Purpose of EWPP-FPE:
Provides NRCS the opportunity to purchase floodplain easements when the current condition of the land or watershed impairment poses a threat to health, life, or property.

This is a voluntary program where the landowner gets to choose whether he/she wants to participate or not.

FARM PRODUCTION AND CONSERVATION FSA | NRCS | RMA | Business Center

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USDA
United States Department of Agriculture

NRCS and USACE Collaboration

- Memorandum of Understanding (MOU)
 - Emergency Clause
- Compatible Use Authorization (CUA)
 - Existing WRP easement
- Policy Waivers
 - Early Restoration

FARM PRODUCTION AND CONSERVATION FSA | NRCS | RMA | Business Center

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Learn More: www.nature.org/moriverlevee



STORIES IN MISSOURI

Reconnecting the Missouri River Floodplain

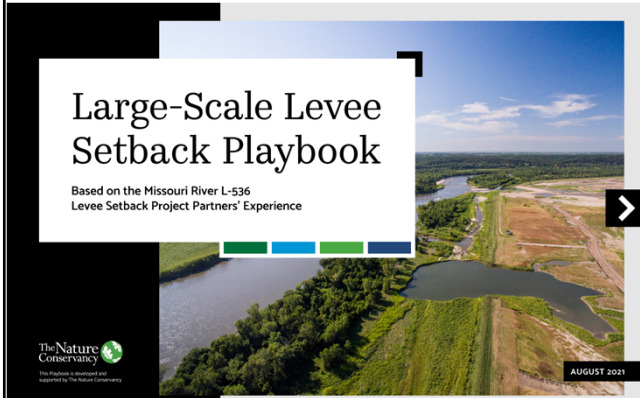
The construction of a levee setback will reduce flooding impacts on the community and restore a more natural floodplain.

November 02, 2020



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Large-Scale Levee Setback Playbook



Large-Scale Levee Setback Playbook

Based on the Missouri River L-536 Levee Setback Project Partners' Experience

AUGUST 2021





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 - Real Estate Requirements
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 - Design
 - Permitting
 - Construction
- 03** Recommended Modifications to Existing Legislation, Regulation, Policy, and Practices
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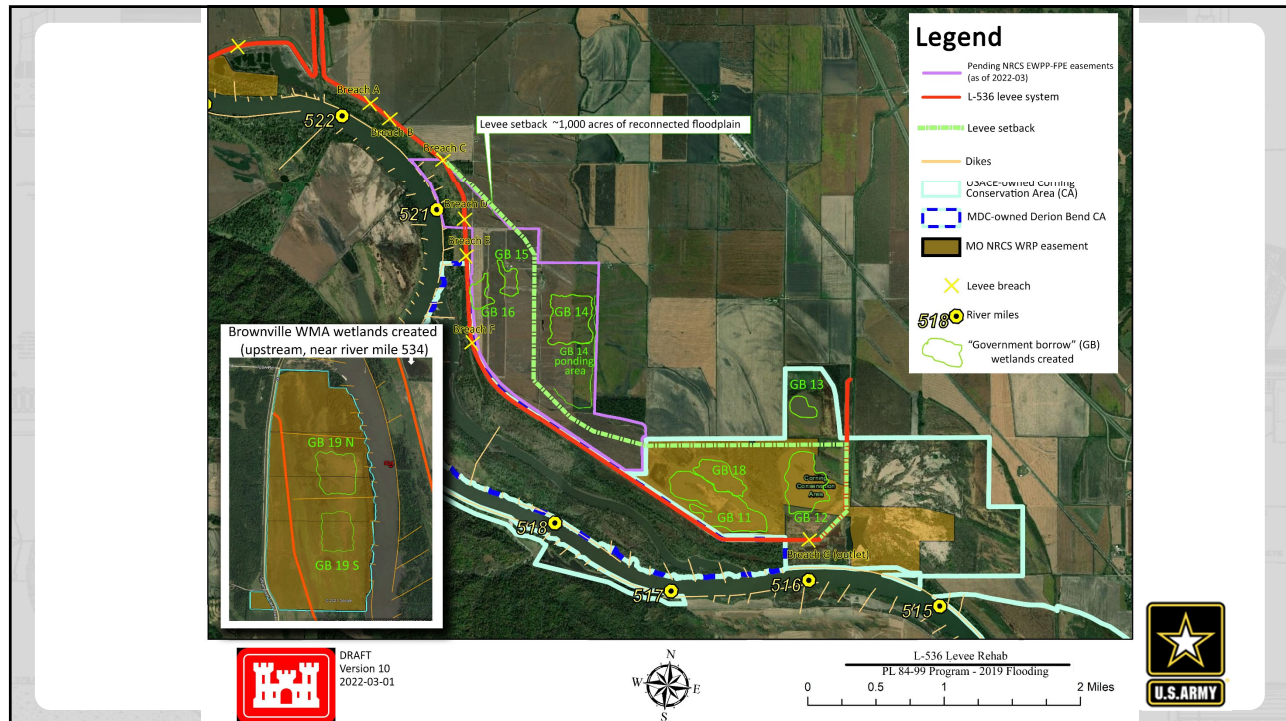
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- Federal and State Conservation Agency Coordination
- Incidental Hydraulic and Environmental Benefits

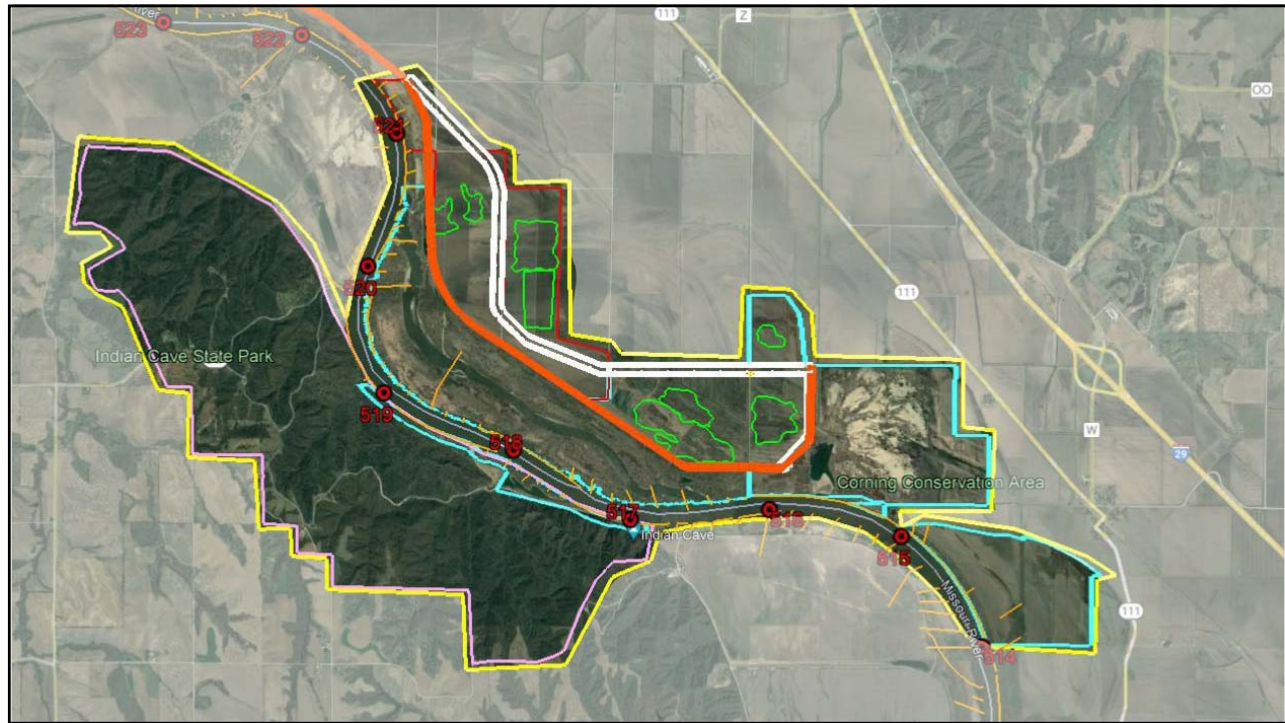


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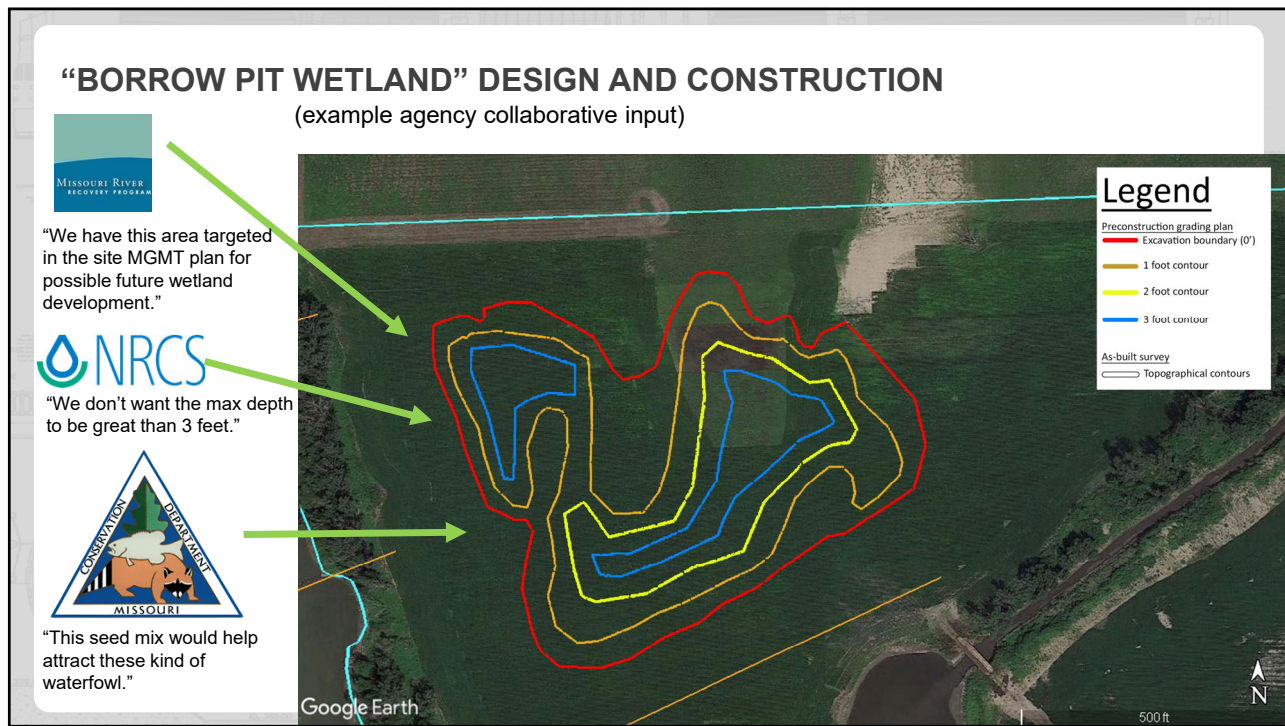
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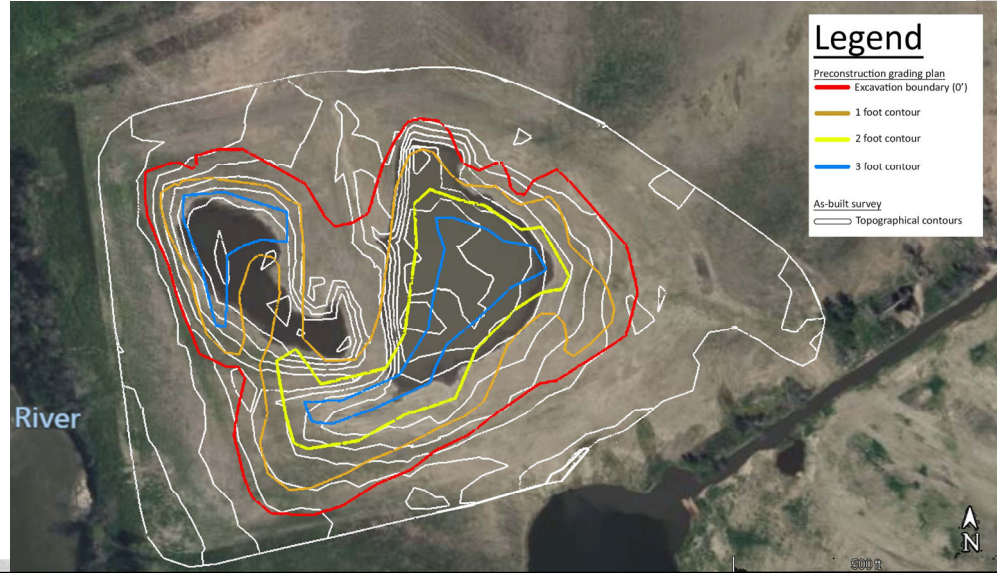


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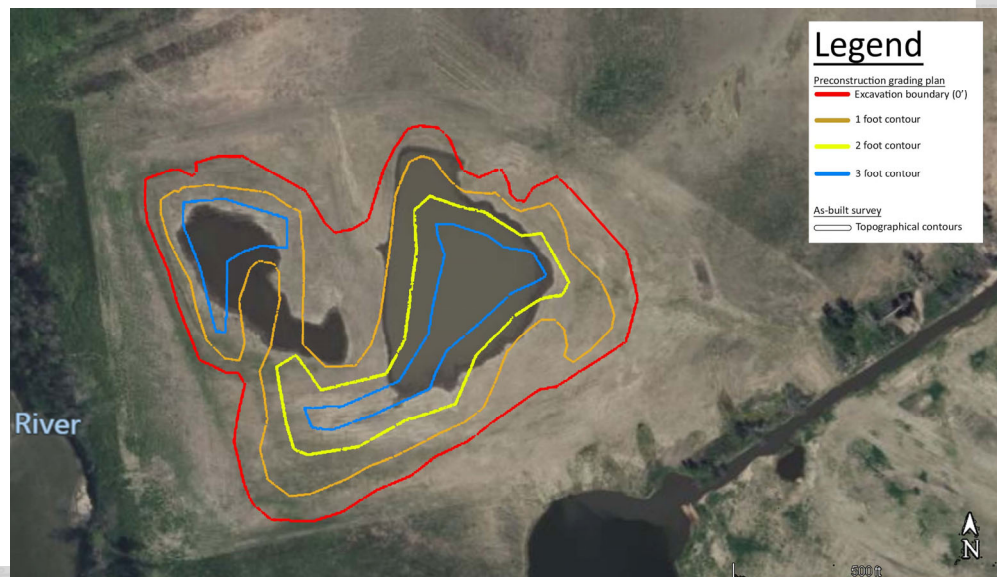
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“BORROW PIT WETLAND” DESIGN AND CONSTRUCTION



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“BORROW PIT WETLAND” DESIGN AND CONSTRUCTION



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“BORROW PIT WETLAND” DESIGN AND CONSTRUCTION



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PL 84-99 AND CONSERVATION PROGRAM MUTUAL BENEFITS

MISSOURI RIVER RECOVERY PROGRAM (MRRP) BORROW UTILIZATION COST SAVINGS* 2019 – 2022, Missouri River river miles 585 – 516 - DRAFT, version 1, 2022-03-11					
Levee system	MRRP Site	Quantity (CY) of Clay, Sand, and Topsoil	Total USACE Construction Contract Cost Savings(\$)**	Total Per Unit Cubic Yards Cost Saving to Levee Sponsors (\$)***	New Habitat Created (acres of “borrow pit wetlands”)
L-601	Noddleman Island	43,000	\$1,935,000	\$129,000	6.1
L-575	Civil Bend	145,000	\$2,575,000	\$435,000	17.4
L-575	Lower Hamburg (dredge)	800,000	-	\$2,400,000	35.4
L-575	Upper Nishnabotna	750,000	\$45,000,000	\$2,250,000	148.0
L-575	Copeland Bend	650,000	\$32,500,000	\$1,950,000	169.0
L-550	Aspinwall Bend	35,000	\$175,000	\$105,000	15.0
L-536	Brownville	125,000	\$5,625,000	\$375,000	54.1
L-536	Corning	473,900	\$38,518,500	\$1,421,700	360.2
TOTAL		3,021,900 ‡	\$126,328,500	\$9,065,700	805.2

NOTE: without question there were mutual benefits here, this is a reasonable order of magnitude estimation of cost savings. The material quantity and acre figures are real word quantities and have a high degree of accuracy. A LOT of qualitative assumptions went into the construction savings estimate. There is great unresolvable uncertainty on those sponsor-provided borrow areas (e.g., quality of material, date and weather conditions during attempted transportation, processing requirements compared to MRRP site material, etc.), questions we'll likely never know the answer to and would likely not spend the money to conduct the highly detailed geotechnical investigation required to actually quantify this. See additional caveats/ explanations below.
 *33 CFR, Part 203.82a. Allows USACE to assume responsibility for LERRD's when it is deemed advantageous to the government, like when it results in creation of habitat on USACE conservation land
 **based on an average round trip of 31 miles to alternative levee sponsor ID'ed borrow source, calculated during 2019 and 2020 borrow mining operations
 ***based on an average of \$3/CY of sand/ clay, or topsoil material, calculated during 2019 flooding based on information from levee sponsors
 ‡ the amount and types of material excavated were equivalent to the amount of clay that would have gone into the construction of 4 levee miles and the amount of sand that would have gone in 14 levee miles. This also would have fill over 800 Olympic-sized swimming pools.

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INCIDENTAL HYDRAULIC AND ENVIRONMENTAL BENEFITS

L-536 Hydraulic Benefits:

- Increased Conveyance:
 - Reduction in water surface elevation in excess of **0.8 feet for 100-yr flood stage.**
 - Reduction in velocities within the immediate vicinity of the levee.
- Overtopping protection: State-of-the-practice design for **landward levee slope of 5V:1H** reduces overtopping velocities and erosion damage.

L-536 Environmental Benefits:

- **1,040 acres of reconnected floodplain.**
- **420 acres of wetlands** from converted borrow pits.
- Expanded floodplain can be **“hot spots” for age-0 native fish.**
- **Rare, declining, and species of conservation concern** have been observed after past levee setback construction.



Flathead chub (state listed in MO)
(MU Payne WMA setback floodplain- Hass, et al., 2020)



Blanchard's Cricket Frog (declining across much of range)
(Copeland Bend and MU Payne WMA setback floodplain- Murphy et al., 2014)



Wilson's Phalarope (lost prairie wetlands)
(Copeland Bend setback floodplain- Crane observation 2012, Murphy et al., 2014)

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MU Payne WMA Levee Setback

Summer of 2019, Nebraska Game and Parks survey (Hass, et al., 2020):

- Single year record number of age-0 sturgeon
 - Total: 1,530 individuals
 - High number of individuals over 80mm, indicating higher rate of survival and site retention compared to previous years' main channel surveys
- One juvenile hatchery-origin Pallid Sturgeon was collected
- Relatively high number of many age-0 native species
 - Blue Sucker
 - Blue Catfish
 - Channel Catfish
 - Sturgeon Chub
 - Sicklefins Chub
 - Shoal Chub
 - Silver Chub
 - 36 MO state endangered Flathead Chubs (was one of the most common fish in the historic Missouri River, now rarely sampled in the modified river)



Flathead chub



ArcGIS Maps of push trawl deployments (white lines) and age-0 sturgeon captures (blue dots) on the floodplain at Frazer Bend WMA in 2019.

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MU Payne WMA Levee Setback

Do we know if these Missouri River levee setbacks are benefitting aquatic species?:

- Gosch et al., (2014) indicate that macroinvertebrate richness, evenness, diversity, density, and water quality (DO) can decrease if long-term inundation coincides with more lentic inundation conditions.
- Gosch, et al., (2021) did not observe increased prey consumption by or condition of age-0 sturgeon on the reconnected floodplain during 2019 flooding at this site.

QUESTIONS:

- What research is needed to determine benefits?
- What features need to be incorporated into future Missouri River levee setbacks to ensure aquatic species benefits?
- How to optimize levee setback benefits to aquatic species under extreme real estate limited conditions like these (where benefit cannot be maximized)?

MoR Setback Similarities:

- Large floodplain reconnection
- HIGHLY real estate-limited
- More research needed
- Future flooding = future setbacks?



ArcGIS Maps of push trawl deployments (white lines) and age-0 sturgeon captures (blue dots) on the floodplain at Frazer Bend WMA in 2019.



VS



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QUESTIONS?

Sentinel Explorer imagery,
L-536 project area
18 February 2022

Citations;

Gosch, N.J.C., Miller, M.L., Dzialowski, A.R., Morris, D.M., Gemeinhardt, T.R., and Bonneau, J.L., 2014. Assessment of Missouri River Floodplain Invertebrates During Historic Inundation: Implications for River Restoration. Knowledge and Management of Aquatic Ecosystems (2014) 412, 05.

Murphy, K.T., Kinkead, K.E., Dinsmore, S.J., Frese, and P., 2014 Missouri River Multiple Species Inventory & Monitoring Project Annual Report—2014. Iowa State University and Iowa Department of Natural Resources.

Murphy, K.T., Kinkead, K.E., Dinsmore, S.J., Frese, and P., 2015 Missouri River Multiple Species Inventory & Monitoring Project Annual Report—2015. Iowa State University and Iowa Department of Natural Resources.

Hass, J., et al., 2020. 2019 Annual Report Pallid Sturgeon Population Assessment and Monitoring Program v2.0 and Habitat Assessment and Monitoring Program. Prepared for the U.S. Army Corps of Engineers – Missouri River Recovery Program, by the Nebraska Game and Parks Commission. January 27, 2020.

Gosch, N.J.C. Hall, J., Civiello, A., Haas, J., Gemeinhardt, T., and Bonneau, J., 2021. Floodplain Connectivity and Age-0 Sturgeon Prey Consumption in the Lower Missouri River. River Research and Applications. Publication Pending.

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