

# R471-460 LEVEE RAISE (ST. JOE) ELWOOD/WATHENA

## UPDATE FOR RAC

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# AGENDA

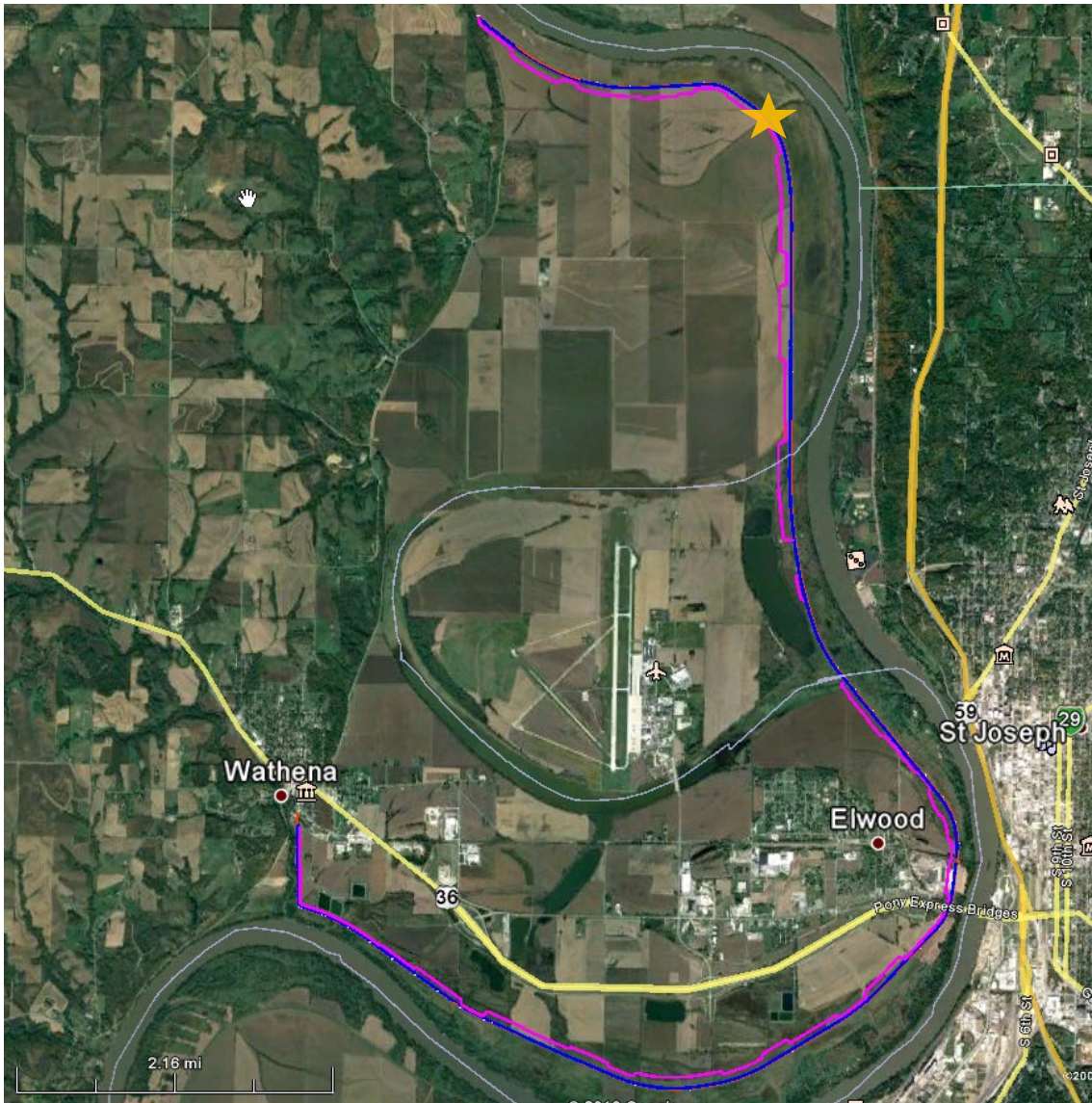
- Project Background
- Geotechnical Design Approach
- Failure Mechanisms
- 2019 Flood
- Borrow Areas
- Construction Video



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# BACKGROUND



## PROJECT PURPOSE

- Correct Hydraulic Deficiency
- Provide project that can be FEMA recertified

## HISTORY

- Originally built in 1968
- Overtopped in 1993 ★
- FEMA Decertified in 1999
- NWD deemed hydraulically inadequate
- 1999 Feasibility
- 2016 Prelim. Redesign
- 2016 Start Construction
- 2017 Full Federal portion of Funding obtained

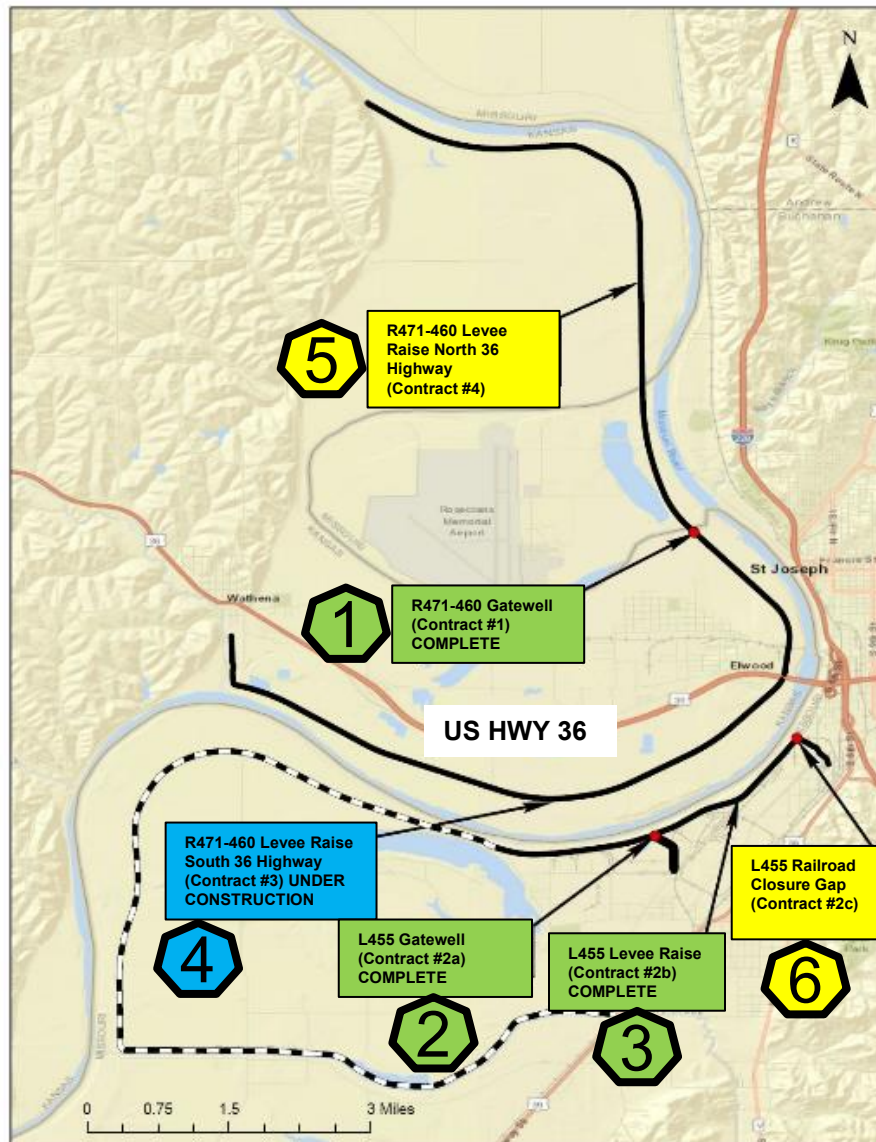


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# LOCATION MAP & CONSTRUCTION



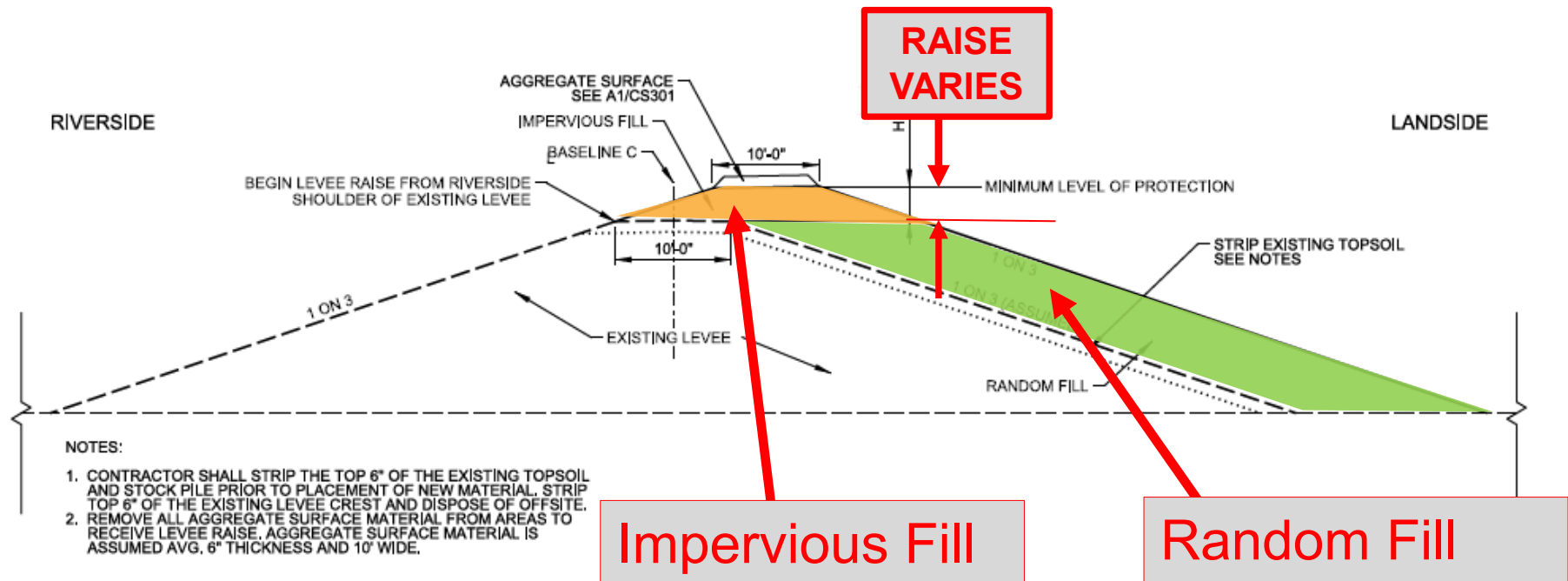
- ① Gatewell Complete 2017
- ② Gatewell Complete 2018
- ③ Levee Raise Complete 2020
- ④ Levee Raise S-36 In Construction Complete ~2022
- ⑤ Levee Raise N-36 Construction Start 2022
- ⑥ RR Closure Gap Construction Start 2022




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# LEVEE RAISE CROSS-SECTION



- Side of levee - Landside
  - Material proposed – Impervious and Random borrow
  - Top of Levee Raise – 831.6' to 817.3'  
South: .5' to 3' (2.5' average) North: 0.5' to 2.5' (1' average)
  - Levee Raise distance – 12.3 miles ( 65,300 feet)  
(North: 7+00 – 404+00, 405+00- 416+00,  
South: 416+00- 629+00, 696+00-728+00)
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# THROUGH LEVEE SEEPAGE

- Impervious fill material selected for riverside to reduce rate of water entering levee
- Random fill material selected for landside to allow the use of larger variety of material.
- Random fill material in berm can be beneficial to the stability of the levee slope.

(diverts water that would exit on the slope to the toe)



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# IMPERVIOUS FILL

- Really should be called “much less” pervious fill
- Composed of Clay (low plasticity), or Silt or combination of the two
- Rate of water flow through the material is several orders of magnitude less “Pervious material”, which is typically Sand
- Used to limit how much seepage enters levee



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# RANDOM FILL

- Will allow water to flow through it more rapidly than Impervious
- It is anticipated that it will be sandy material but can also be clay and silt
- Its placement allows a lot more types of material to be placed and its tendency to move water more rapidly can actually be more beneficial



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# Design Measures to Prevent Underseepage type Failures

- Option 1. Place Soil (berm) at toe of levee to add weight to soil on landside
- Option 2. Install relief well near landside toe to reduce water pressure.

We have used each of these options where appropriate

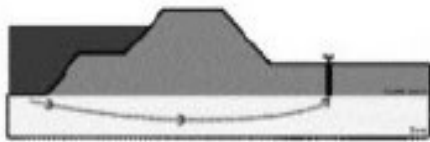


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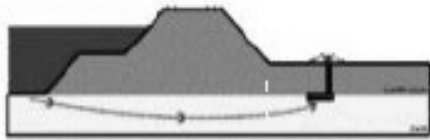


# Raising Levee – Impact on Seepage Failure Mechanisms

- Raising Levee under seepage pressures on landside of levee can lead to piping failure if not adequately addressed during design



Phase 1: seepage



Phase 2: backward erosion initiation



Phase 3: backward erosion progression



Phase 4: widening of pipe



Phase 5: failure of the levee



Phase 6: breakthrough



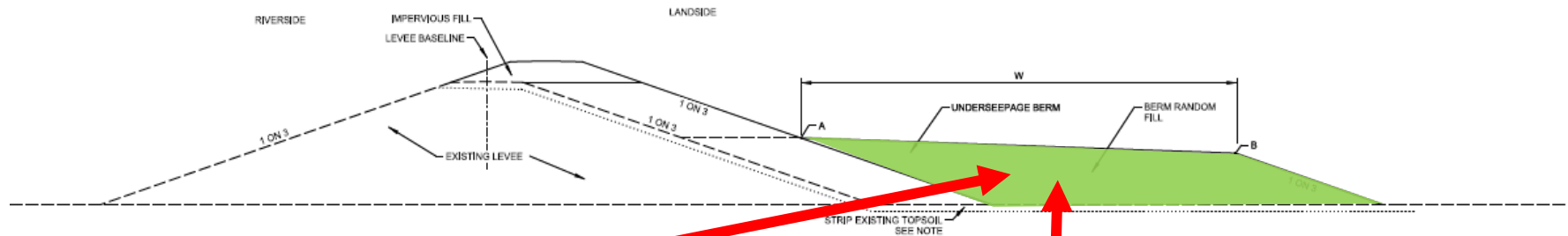
Sandbag ring around a sandboil



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# SEEPAGE BERM SECTION



Composed of: RANDOM FILL

UNDERSEEPAGE BERM

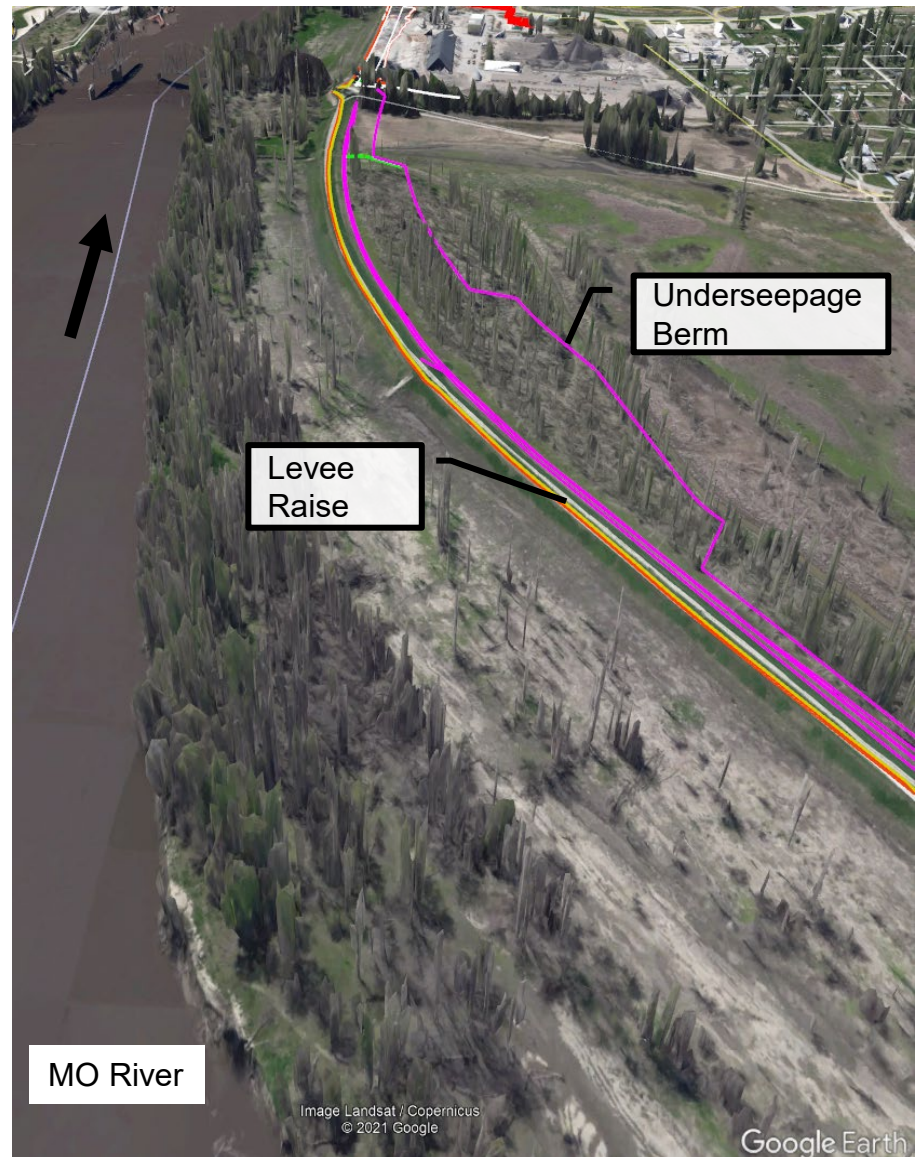
NOTE:  
1. CONTRACTOR SHALL STRIP THE TOP 6" OF THE EXISTING TOPSOIL AND STOCK PILE PRIOR TO PLACEMENT OF NEW MATERIAL. STRIP TOP 6" OF THE EXISTING LEVEE CREST AND DISPOSE OF OFFSITE.



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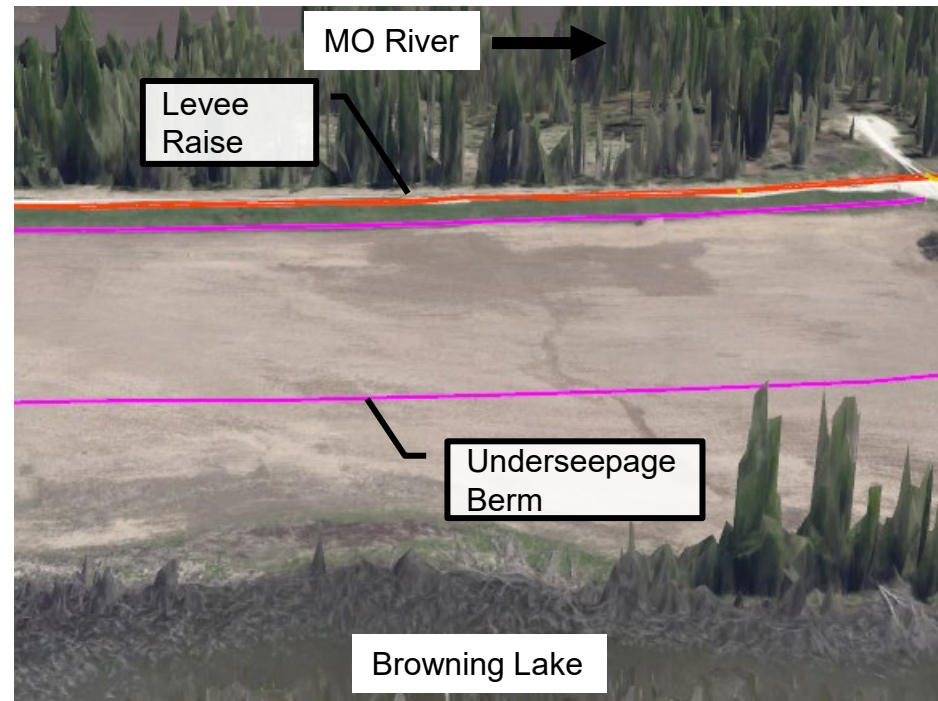
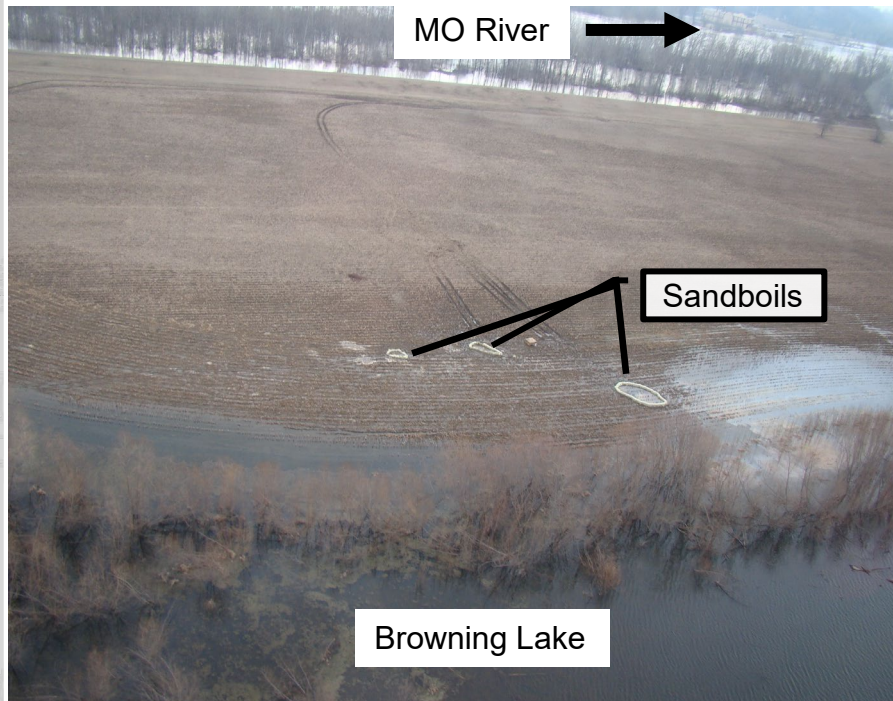


# RESULTS FROM 2019 FLOOD





# RESULTS FROM 2019 FLOOD



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# SEEPAGE BERM PARAMETERS

Station	Berm Width (ft)	Proposed TOL Elev (ft)	Pre-Raise TOL (ft)	Landside Ground El. (ft)	L <sub>2</sub>	L <sub>2</sub> addition	Proposed L <sub>2</sub>	Min. Tie in Elev. (ft)	X <sub>berm</sub>	Berm Crown Elev. (ft)	Berm Slope (1/S)	Berm toe Slope (1/S)
0+00 to 18+00	140	831.64	831.64	818.0	70.0	0.0	70.0	821.0	175	819.0	70	6
18+00 to 37+00	340	831.38	831.25	817.0	80.0	0.4	80.4	821.0	380	818.0	113	6
37+00 to 44+00	140	831.12	830.75	818.0	80.0	1.1	81.1	821.0	181	819.0	70	6
44+00 to 52+00	290	831.03	830.9	816.5	80.0	0.4	80.4	820.0	330	817.5	116	6
52+00 to 66+00	290	830.93	830.86	816.0	70.0	0.2	70.2	819.0	325	817.0	145	6
66+00 to 70+00	390	830.75	830.56	816.0	90.0	0.6	90.6	819.5	436	817.0	156	6
70+00 to 79+00	265	830.39	830.39	817.0	85.0	0.0	85.0	820.0	308	818.0	133	6
79+00 to 85+00	290	830.58	830.39	815.0	75.0	0.6	75.6	818.5	328	816.0	116	6
85+00 to 99+45	240	830.52	830.23	816.0	100.0	0.9	100.9	819.0	291	817.0	120	6
99+46 to 114+50	215	830.30	829.55	815.0	100.0	2.3	102.3	819.0	267	816.0	72	6
114+51 to 131+00	140	830.02	828.61	816.0	90.0	4.2	94.2	819.0	189	817.0	70	6
131+00 to 152+00	340	829.69	828.31	815.0	85.0	4.1	89.1	819.5	387	816.0	97	6
152+00 to 166+00	390	829.36	827.16	815.0	85.0	6.6	91.6	820.0	439	816.0	98	6
166+00 to 179+00	140	829.18	828.67	815.0	90.0	7.5	97.5	818.0	193	816.0	70	6
179+00 to 205+00	390	828.95	826.65	815.0	85.0	6.9	91.9	820.0	439	816.0	98	6
205+00 to 228+00	175	828.50	825.89	815.0	80.0	7.8	87.8	818.5	223	816.0	70	6
228+00 to 236+00	125	828.05	825.56	810.0	110.0	7.5	117.5	813.0	187	811.0	63	6
236+00 to 256+00	390	827.89	825.54	807.0	90.0	7.1	97.1	813.0	442	808.0	78	6
256+00 to 270+00	365	827.72	824.89	810.0	60.0	8.5	68.5	815.0	403	811.0	91	6
270+00 to 284+00												
284+00 to 293+00	140	827.20	824.31	810.0	80.0	8.7	88.7	813.0	189	811.0	70	6
326+00 to 331+00	215	826.46	825.01	807.0	130.0	4.4	134.4	810.5	284	808.0	86	6
331+00 to 342+00	240	826.27	824	808.0	115.0	6.8	121.8	811.5	304	809.0	96	6
342+00 to 349+00	265	826.01	823.85	807.0	130.0	7.1	137.1	811.0	337	808.0	88	6
349+00 to 367+00	140	825.87	823.65	806.0	145.0	6.7	151.7	809.0	219	807.0	70	6
367+00 to 376+00	50	825.40	823.74	807.5	135.0	5.0	140.0	810.5	122	808.5	25	6
376+00 to 386+00	365	825.01	822.34	806.0	150.0	8.0	158.0	811.0	448	807.0	91	6
386+00 to 397+00	255	824.89	822.08	807.0	130.0	8.4	138.4	811.0	328	808.0	85	6
397+00 to 404+00	140	824.49	821.61	807.0	100.0	8.6	108.6	810.5	199	808.0	56	6
405+00 to 417+00	200	823.75	821.88	815.0	65.0	5.6	70.6	818.0	238	816.0	100	6
417+00 to 448+00	50	823.6	821.5	809.0	70.0	6.3	76.3	812.0	91	810.0	25	6
448+00 to 466+00	275	822.7	821.3	806.0	75.0	4.2	79.2	809.5	317	807.0	110	6
466+00 to 480+00	100	822.3	820.9	804.0	70.0	4.2	74.2	807.0	139	805.0	50	6
480+00 to 500+00	215	821.8	820.1	805.0	80.0	5.1	85.1	808.5	260	806.0	86	6
500+00 to 510+00	400	821.1	819.8	805.0	70.0	3.9	73.9	809.5	439	806.0	114	6
510+00 to 528+00	270	820.9	820.4	804.0	70.0	1.5	71.5	808.0	307	805.0	90	6
528+00 to 551+00	400	820.6	819.6	802.0	70.0	3.0	73.0	807.5	438	803.0	89	6
551+00 to 561+00	400	820.1	819.2	802.0	70.0	2.7	72.7	806.0	438	803.0	133	6
561+00 to 573+00	230	819.6	819.2	802.0	75.0	1.2	76.2	806.0	269	803.0	77	6
573+00 to 587+00	350	819.2	819.2	802.0	75.0	0.0	75.0	805.0	388	803.0	175	6
587+00 to 606+00	250	818.7	818.7	803.0	75.0	0.0	75.0	806.0	288	804.0	125	6
606+00 to 620+00	50	818.3	818.3	803.0	80.0	0.0	80.0	807.0	90	804.0	17	6
620+00 to 631+00	50	818.2	818.2	801.0	85.0	0.0	85.0	804.0	93	802.0	25	6
631+00 to 651+00	190	818.4	818.4	802.0	85.0	0.0	85.0	805.5	233	803.0	76	6
651+00 to 666+00	105	817.9	817.9	802.0	85.0	0.0	85.0	805.0	148	803.0	53	6
666+00 to 681+00	50	817.6	817.6	802.0	85.0	0.0	85.0	805.0	93	803.0	25	6
681+00 to 690+00	50	817.4	817.4	801.0	90.0	0.0	90.0	804.0	95	802.0	25	6
690+00 to 702+00	150	817.3	817.3	802.0	90.0	0.0	90.0	806.0	195	803.0	50	6
702+00 to 715+00	50	817.3	816.6	804.0	70.0	2.1	72.1	807.0	87	805.0	25	6
715+00 to 728+00	50	817.3	816.8	810.0	70.0	1.5	71.5	813.0	87	811.0	25	6

## Summary

- 13.14 miles of berms (69,400 feet)
- 50' to 400' in width
- Avg. Width =220 feet
- 3' – 5' thickness



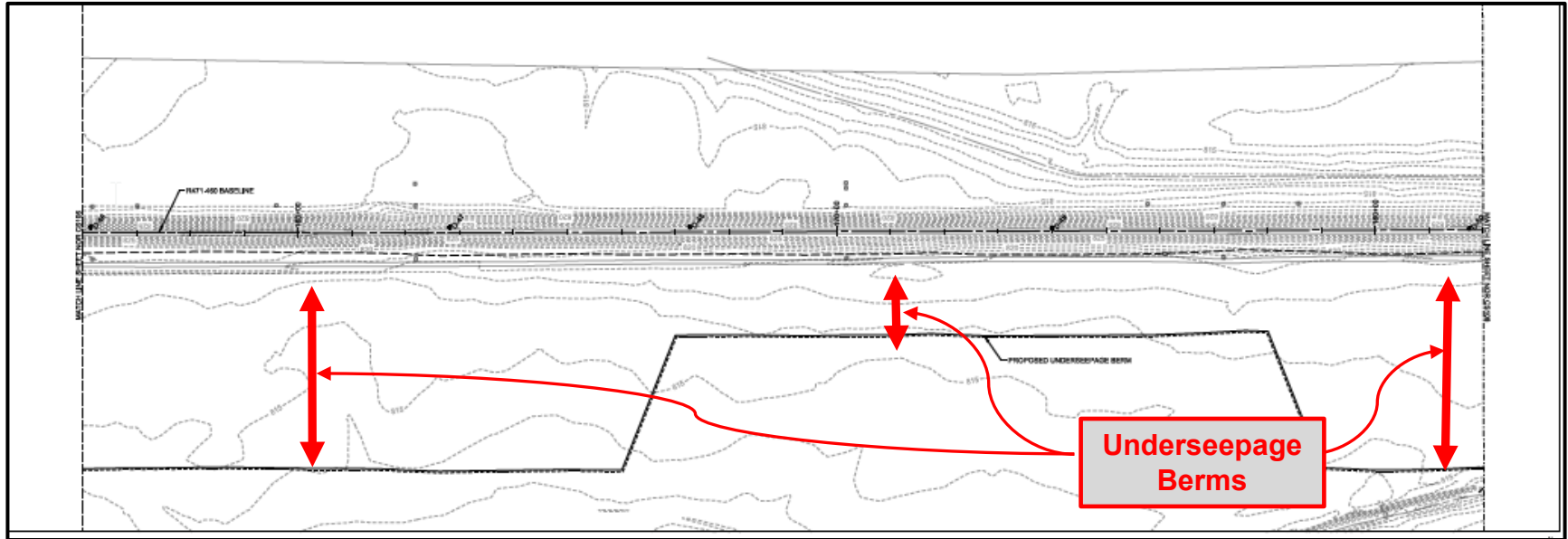
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<sup>1</sup>Use 100 ft to transition between different berm widths.

# TYPICAL SEEPAGE BERM



Plan View (example): Station 156+00 to 162+00



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# RELIEF WELLS TO CONTROL UNDERSEEPAGE

- Browning lake and Drainage at station 325+00 necessitated Relief Wells rather than seepage berm
- Needed Relief Wells from Station 292+00 to 325+00
- 27 relief wells
- Spacing 90 to 100-feet
- Will Extend to Bedrock ~90-feet
- Flows to discharge to Browning lake or adjacent ditch

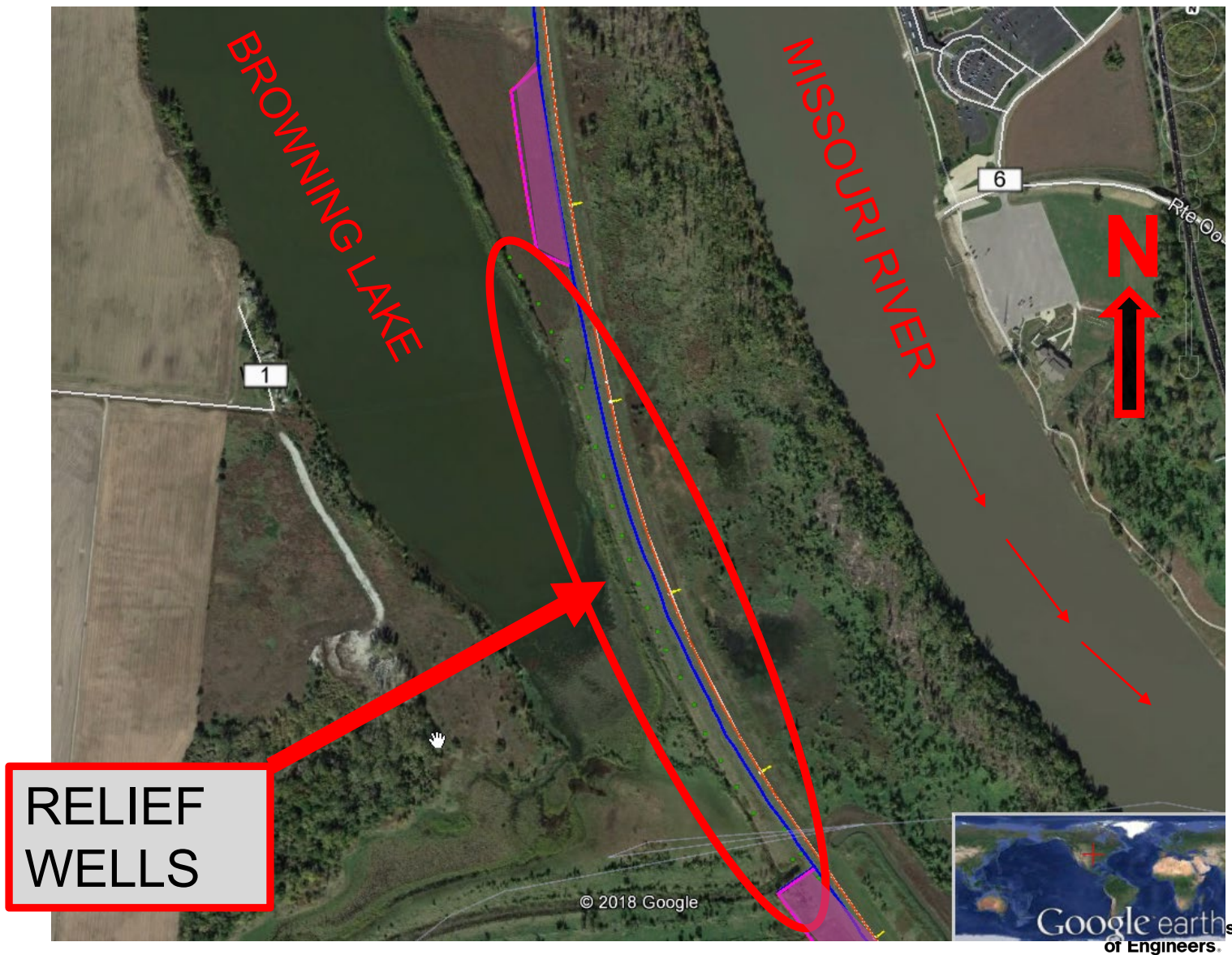


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# RELIEF WELL - PROPOSED LOCATIONS



# STABILITY – MODE OF FAILURE WE DESIGN TO PREVENT



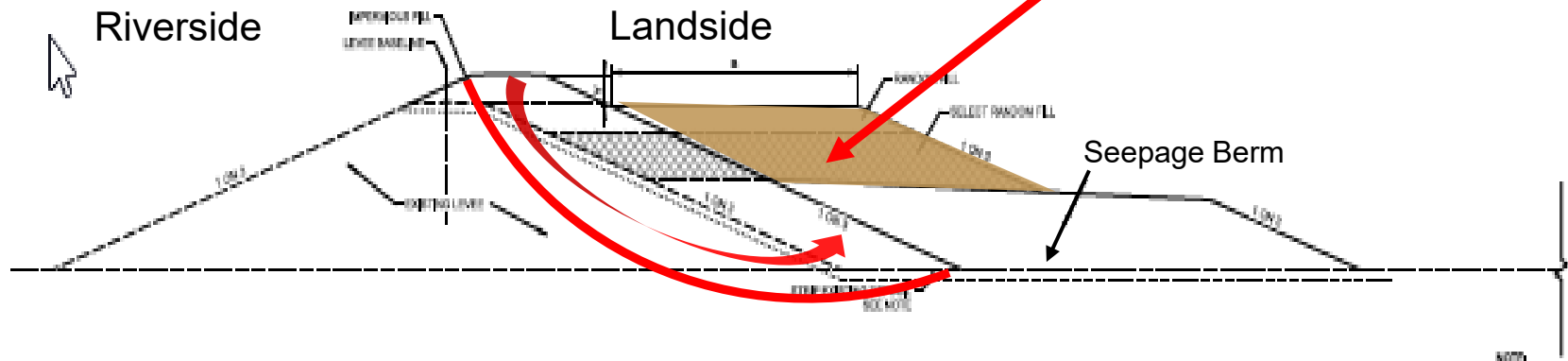
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# STABILITY BERM

Stability Berms are design to add weight and prevent stability failure

Stability Berm  
(Typical proposed)

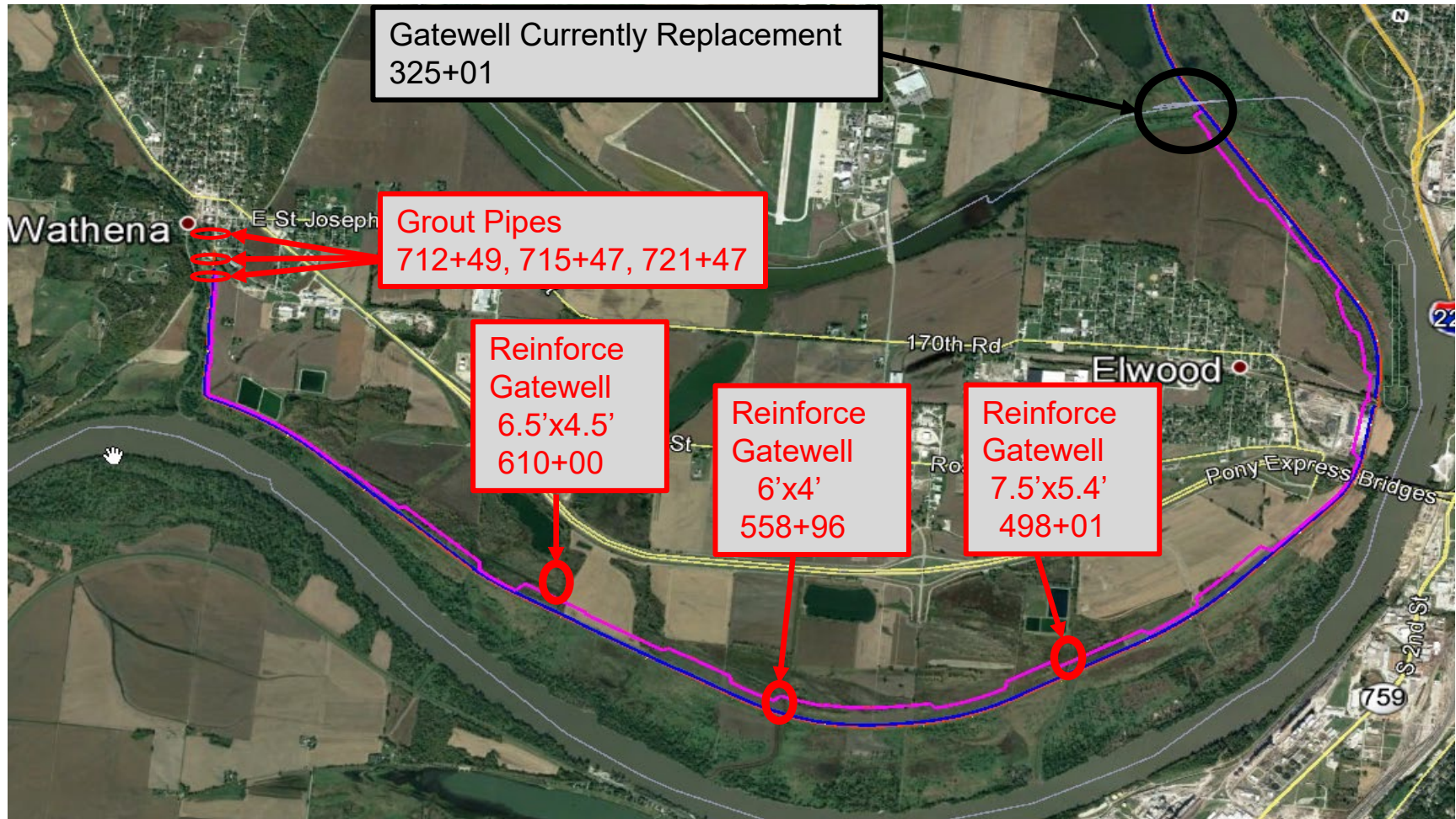


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# OTHER PROJECT FEATURES

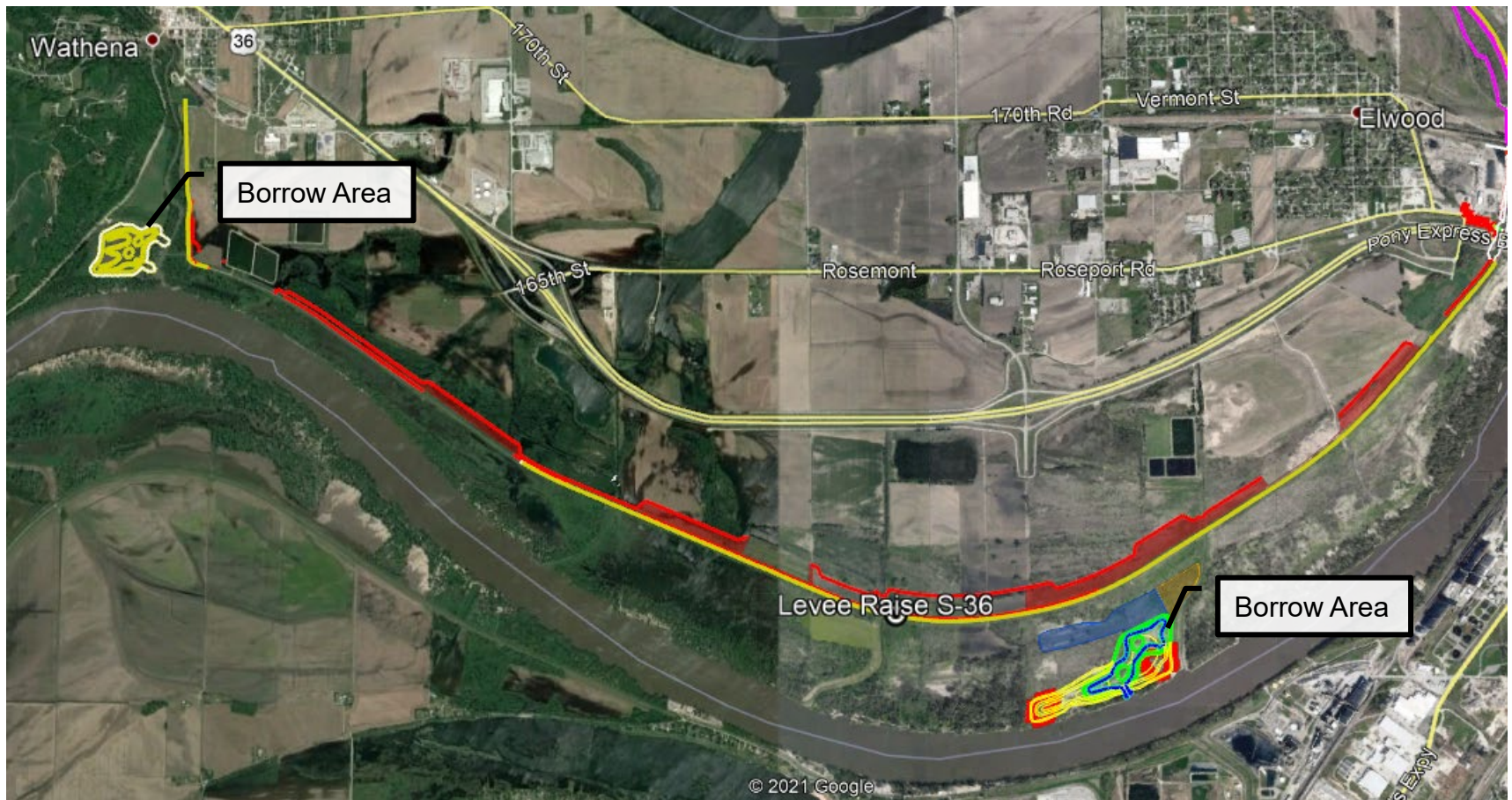


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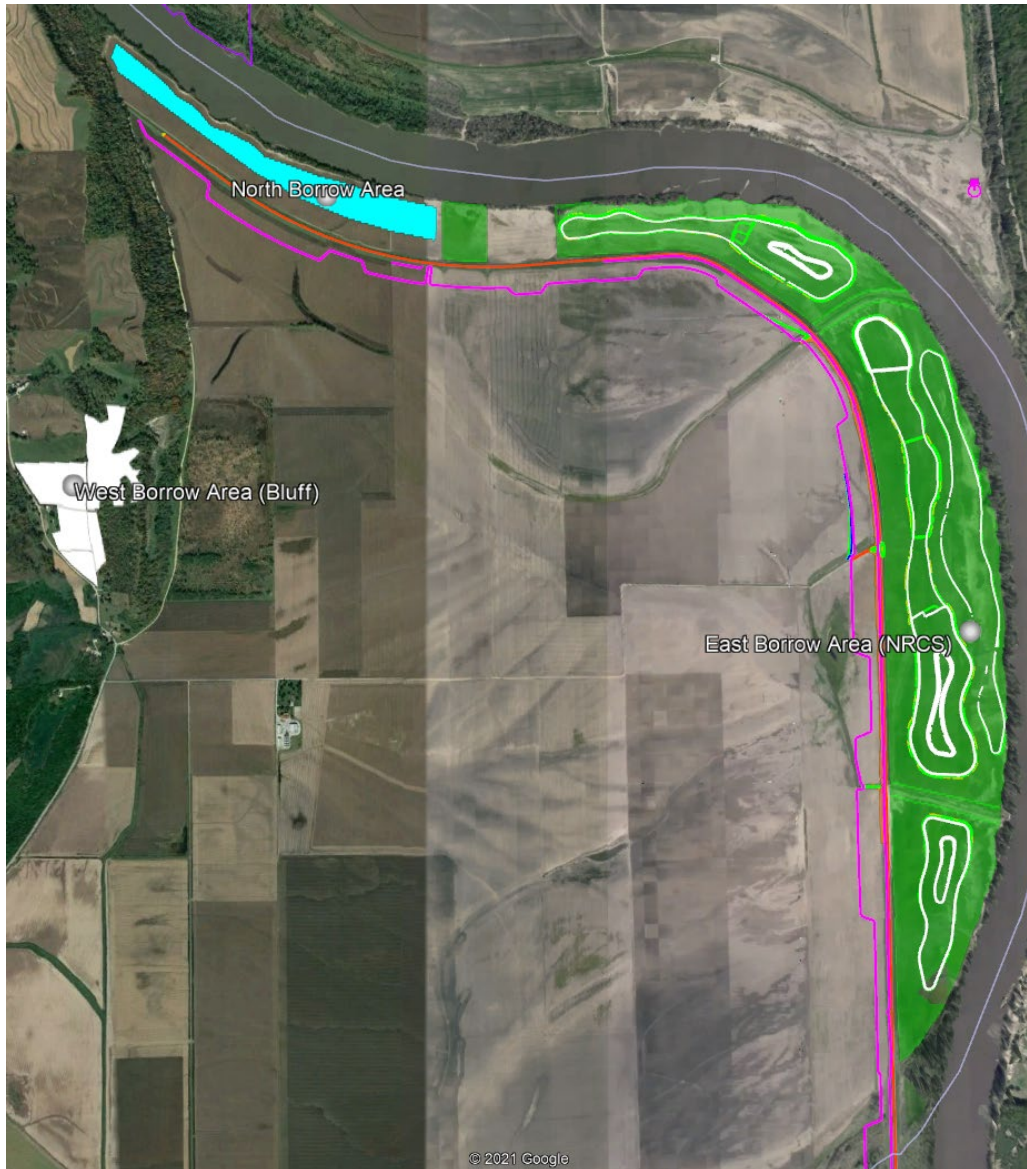
# BORROW SOUTH OF 36



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# BORROW NORTH OF 36



 West Borrow Area

 North Borrow Area

 East Borrow Area



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# CONSTRUCTION VIDEO FROM MCON



<https://www.facebook.com/mconunderground/videos/1735419773329687/>



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