Withstanding Nature's Power: Engineering a Road at the Confluence of America's Mightiest Rivers

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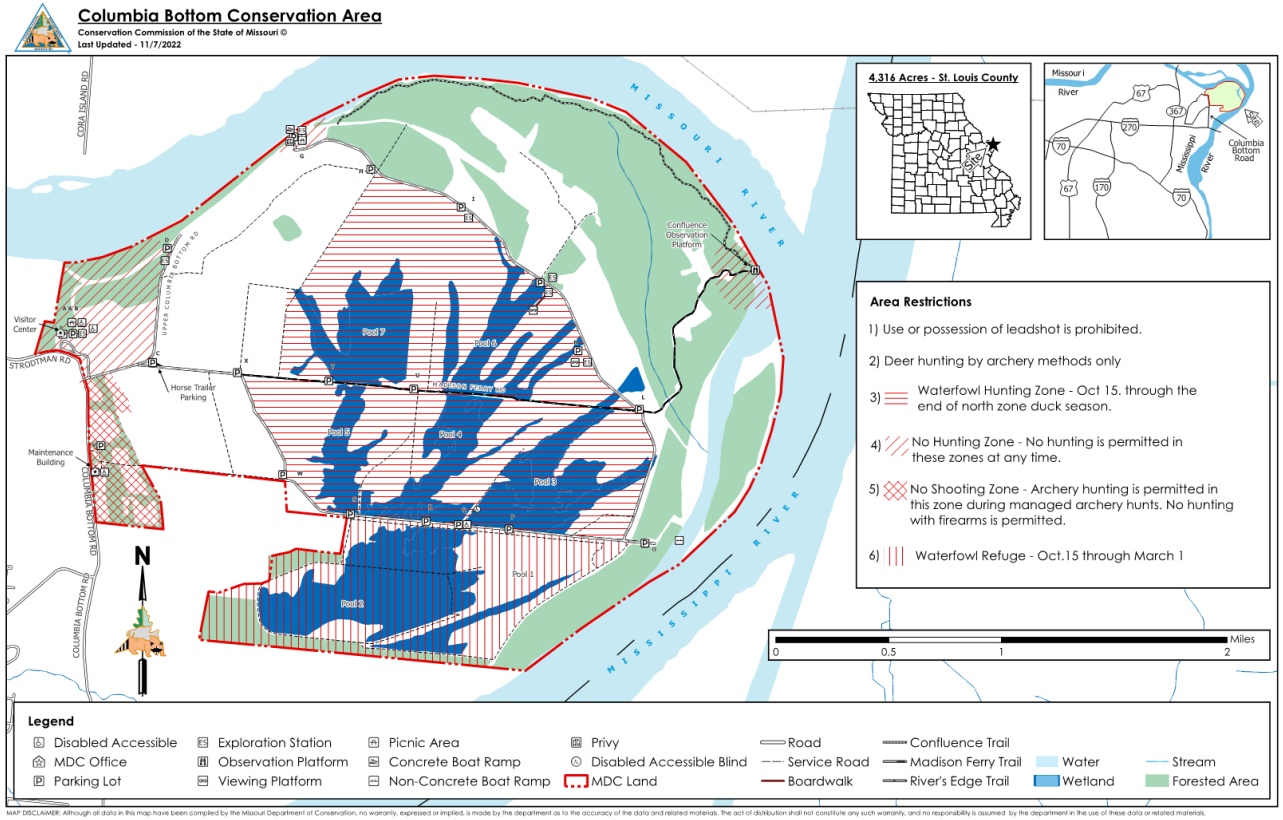
Withstanding Nature’s Power: Engineering a Road at the Confluence of America’s Mightiest Rivers

- Introduction
- Project Background
- Engineering Challenges
- Hydraulic Analysis
- Road Design Solutions
- Final Thoughts
- Q&A

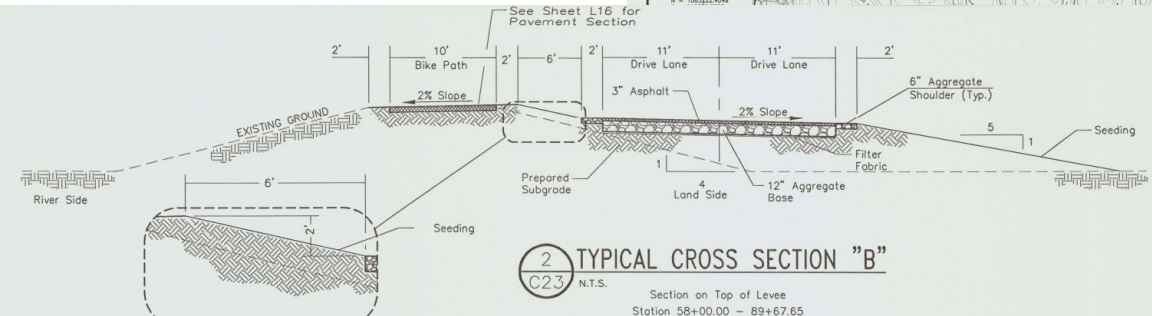
Introduction

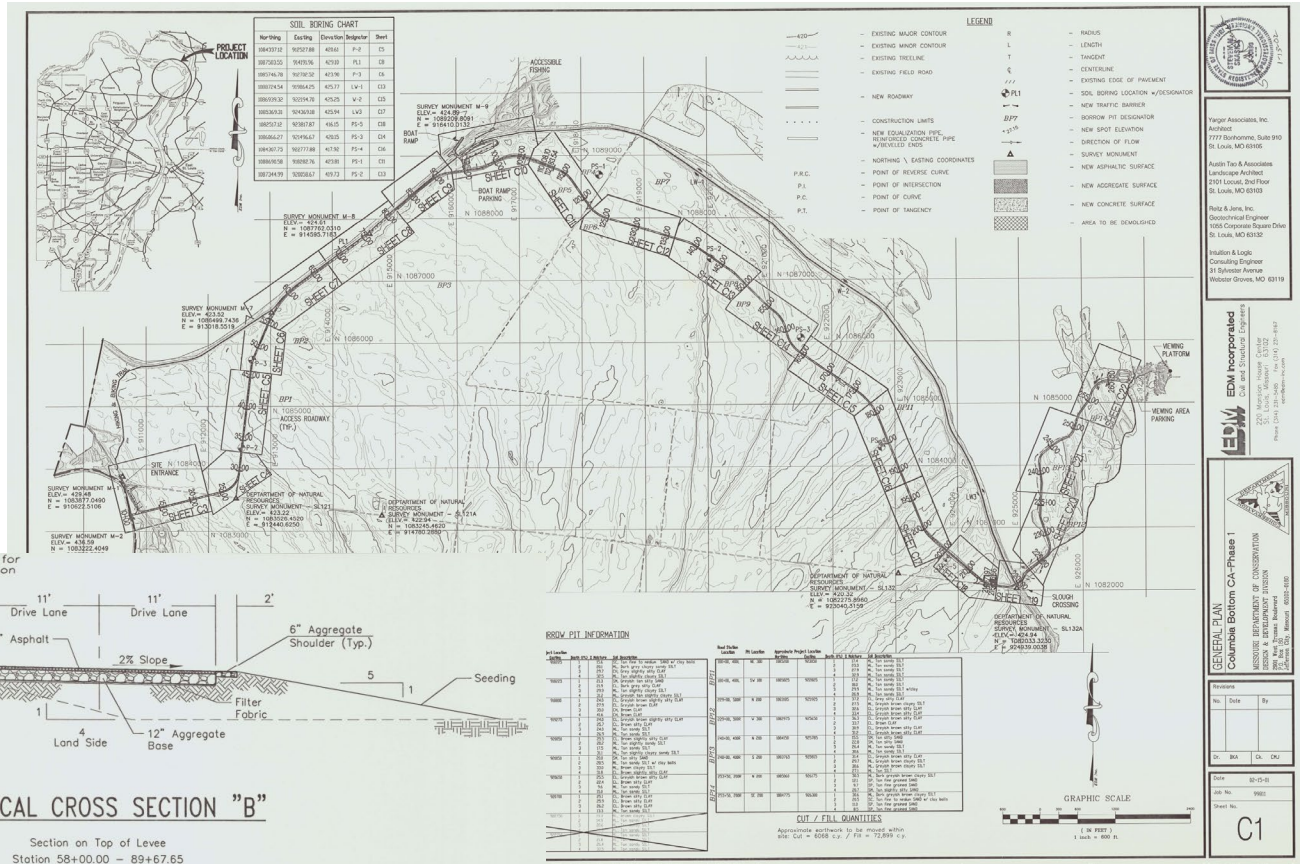
Columbia Bottom Conservation Area is located at the confluence of the Missouri and Mississippi rivers in the north St. Louis County. MDC purchased this 4,318-acre area in 1997 to create an urban conservation area. The area includes a view of the confluence of the Missouri and Mississippi rivers, more than 6.5 miles of river frontage, about 800 acres of bottomland forest and a 110-acre island. A small town once known as Columbia, and later St. Vrain, was located in this river bottom. It was shown on plat maps from the mid-1800s but was gone by 1870.



Project Background

- **Area Developed Early 2000's**
- **Levee Protected Area**
  - **Overtopped 6 times**
- **Historical Flooding Events:** Major floods in **2017** and **2019** heavily impacted infrastructure.
- **"infrastructure damage, siltation to wetlands, reduced ability to control invasive plants, and decreased access"**
- **Over 4 Mile Detour** to boat ramp.





Engineering Challenges

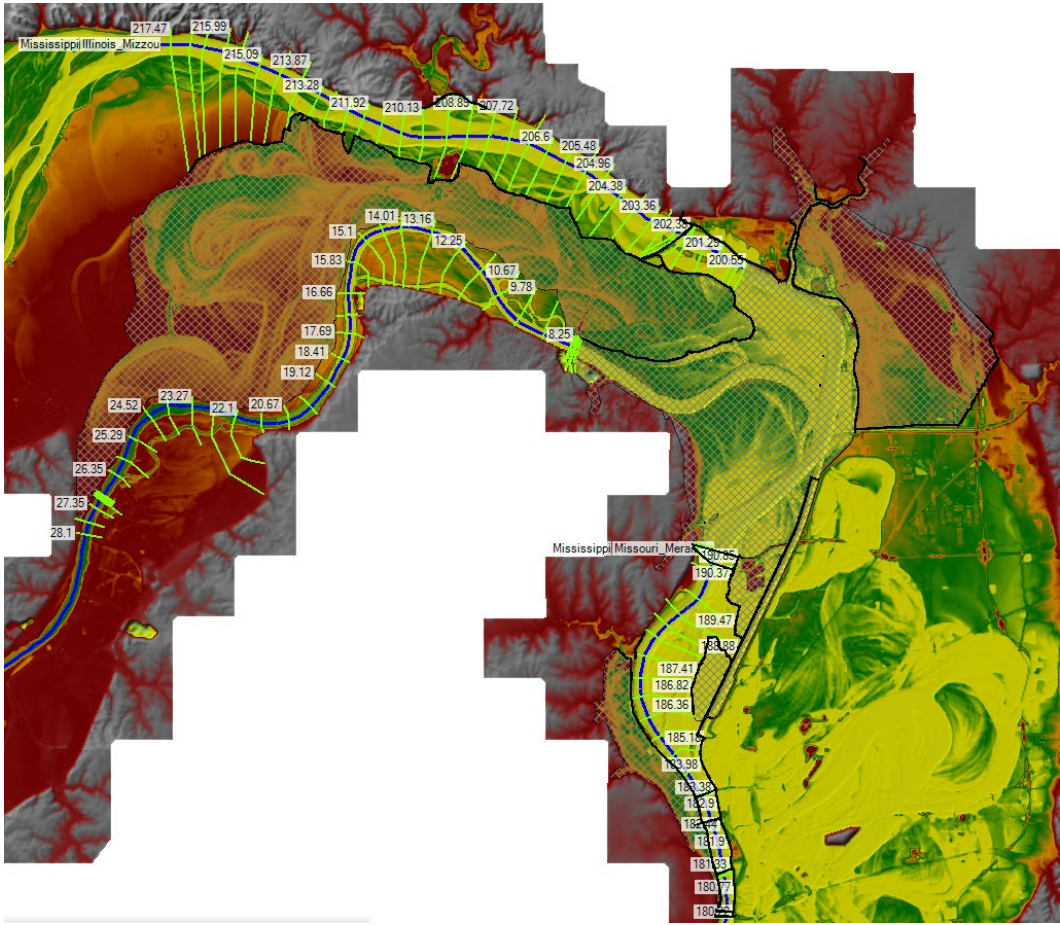
- **Hydrodynamic Forces:** Engineering designs must counteract flood-induced forces.
- **Sediment Transport:** Controlling sediment movement is essential to prevent deposition that can obstruct roadway function and stability.
- **Erosion Resistance:** Selecting materials and construction methods is critical for ensuring long-term durability against erosive flood conditions.

2019 Flood


STOP
AREA
CLOSED
WELCOME
COLUMBIA BOTTOM
CONSERVATION AREA
MISSOURI
CONSERVATION
DEPARTMENT

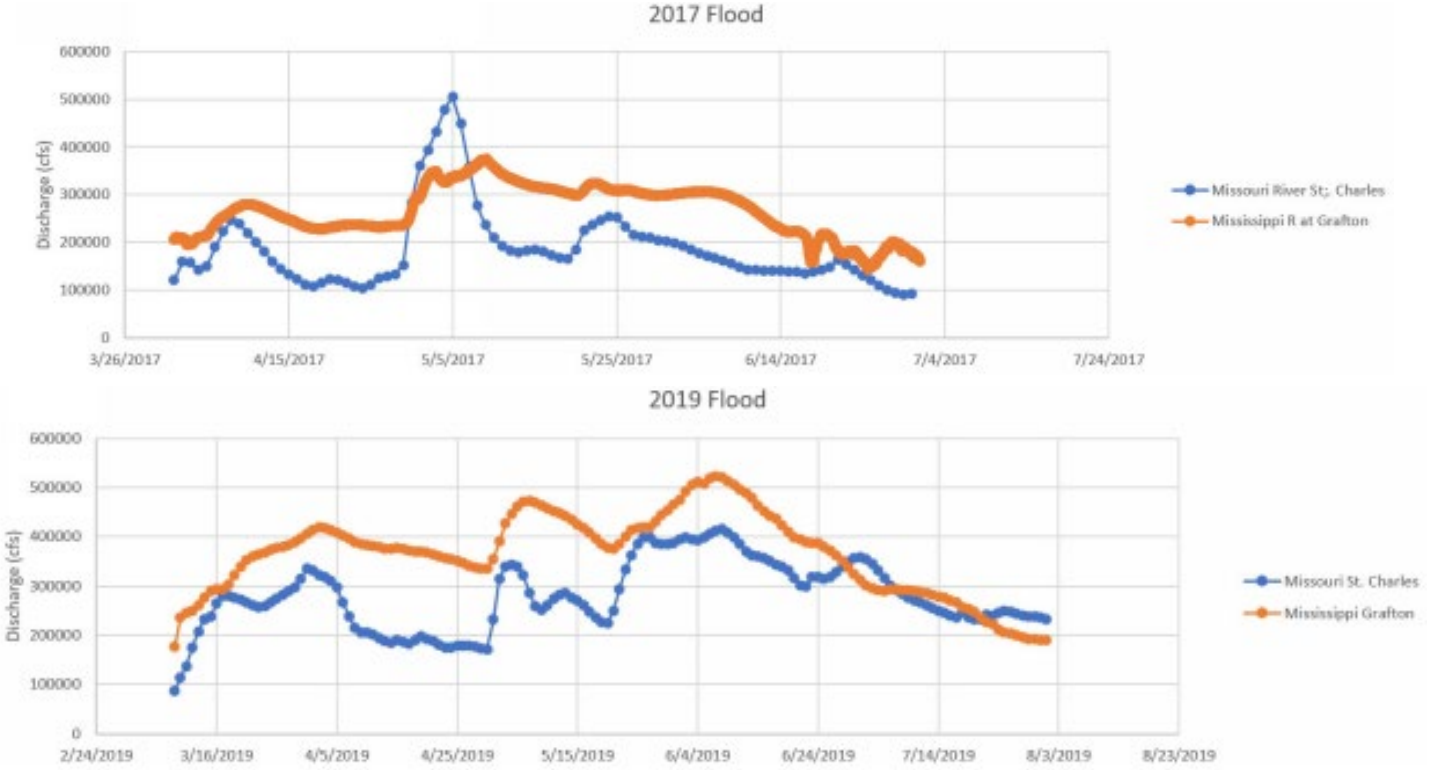
Hydraulic Analysis

- **HEC-RAS Model Overview:** A hydraulic model was developed using HEC-RAS to analyze flows during the 2017 and 2019 floods.
  - Truncated the Upper Mississippi River Flood Risk Management Existing Conditions Hydraulic Model that covers 320 river miles from Thebes, IL to Lock & Dam 19 at Keokuk, IA to a model from the Eads Bridge (RM 180) to Grafton, IL (RM 217) and St. Charles, MO on the Missouri River at RM 28.
  - Replaced the 1D model elements in the vicinity of the confluence with 2D elements from the I-270 Chain of Rocks Bridge to the Mel Price Locks and Dam and the US 67 Lewis Bridge.
  - Replaced cross-section data on the Missouri River with Bathymetry data.
- **Terrain:** Modeled five geometry scenarios.
  - Pre-2018 Terrain
  - 2022 Terrain
  - Proposed Terrain
  - Levee Modifications – Remove 1800’ of Levee along MO River
  - Levee Modifications - DS – Remove 1100’ of Levee along MS River



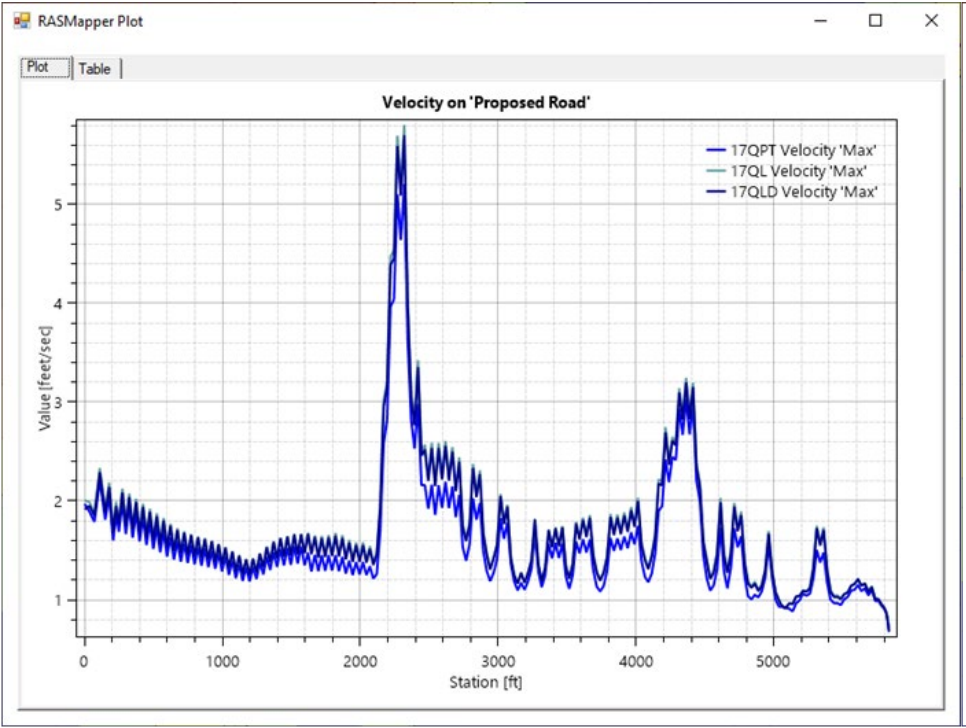
Hydraulic Analysis

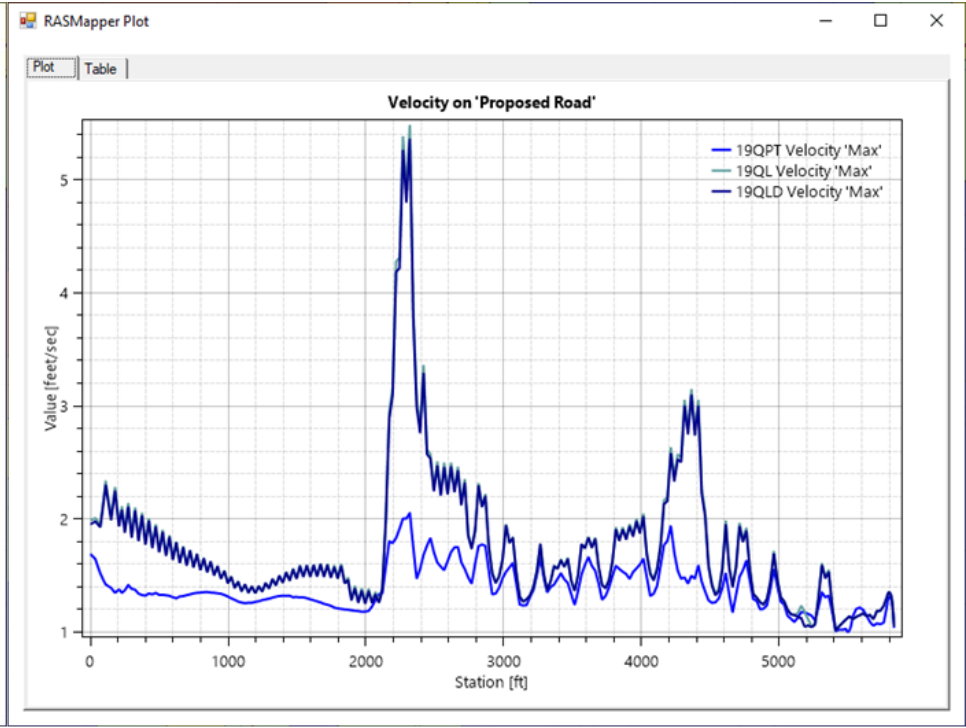
2017 & 2019 Flood Hydrographs



Hydraulic Analysis

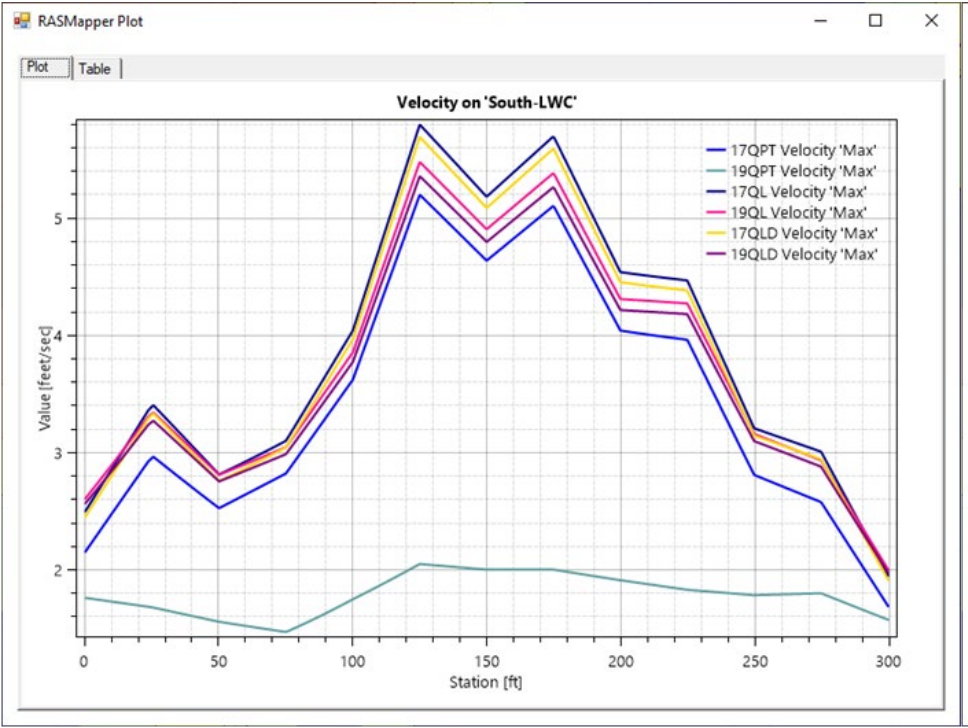
2017 & 2019 Max Velocities along Proposed Road

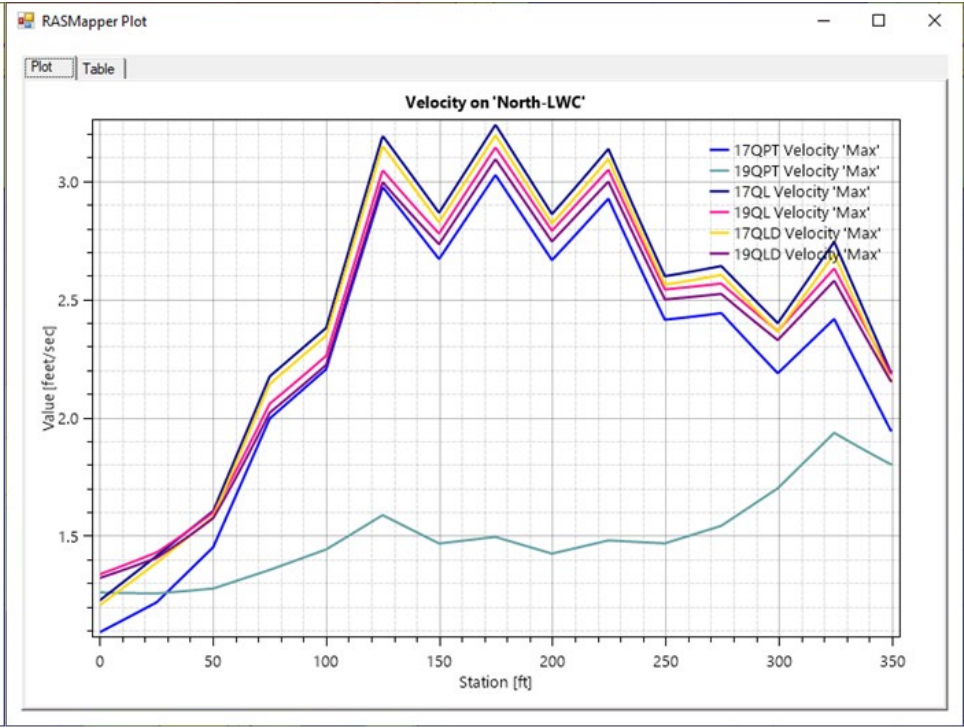




Hydraulic Analysis

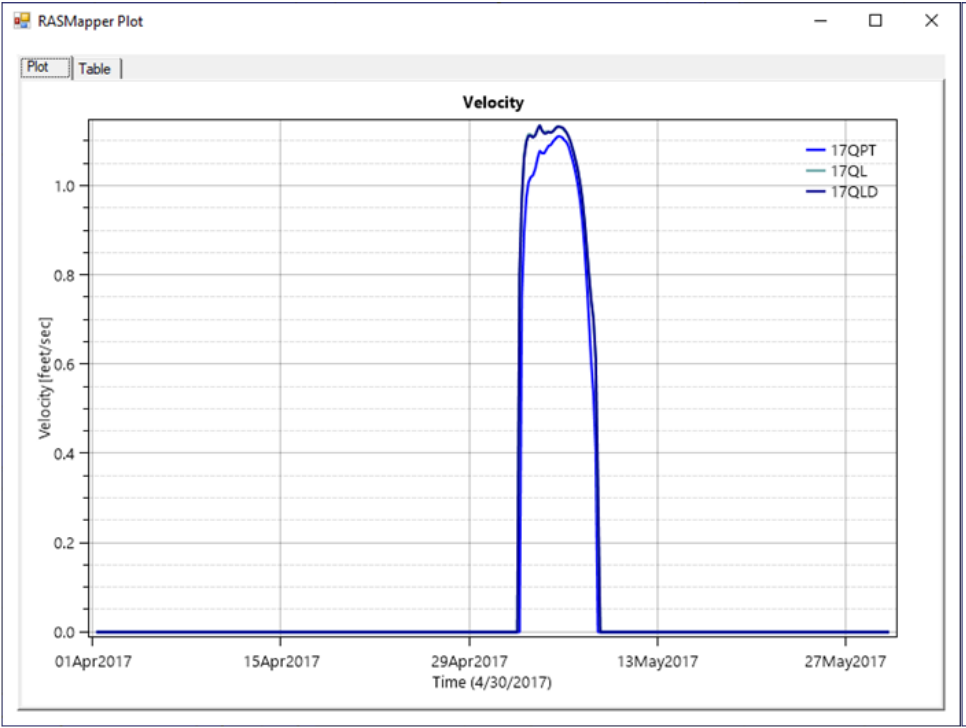
2017 & 2019 Max Velocities at Low Water Crossings

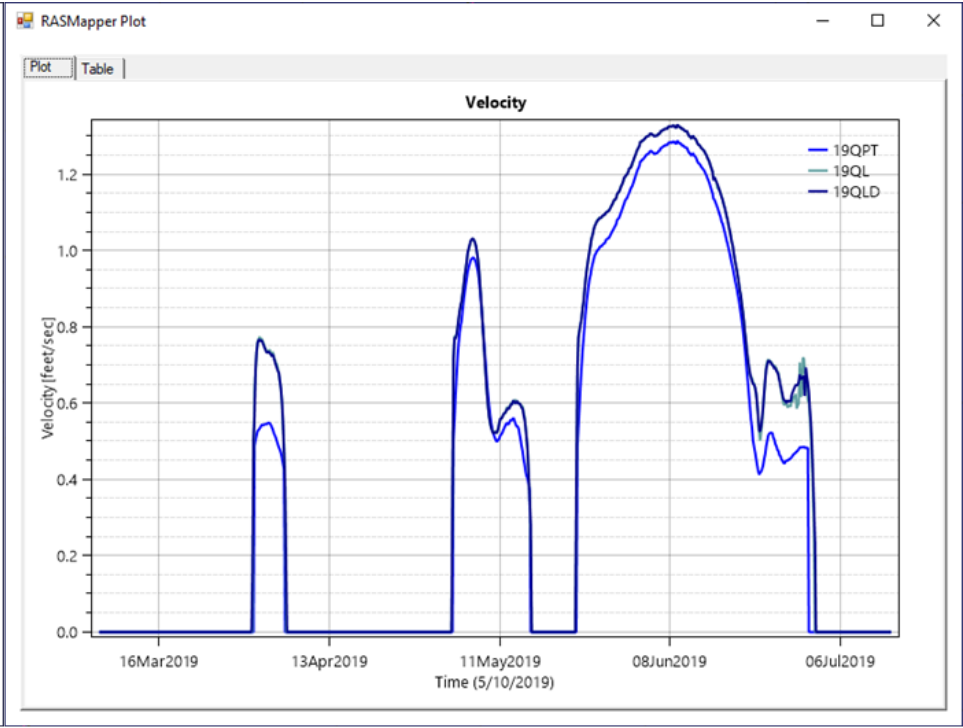




Hydraulic Analysis

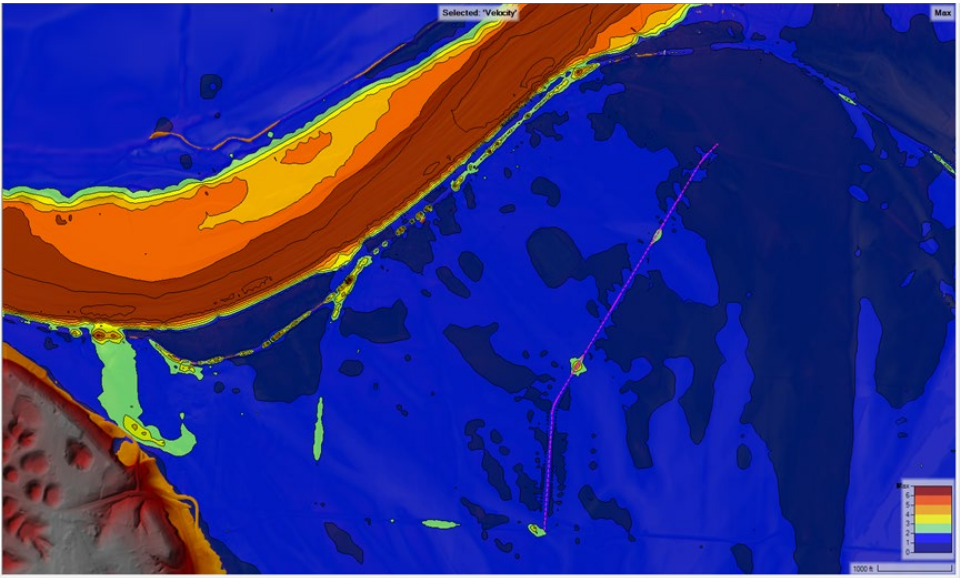
2017 & 2019 Velocity Hydrographs On Proposed Road – Middle Segment

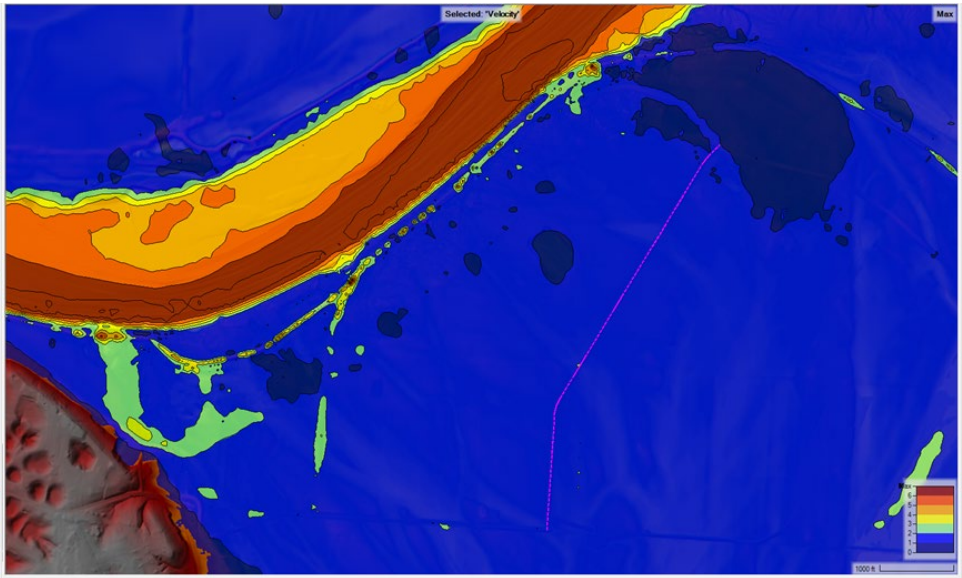




Hydraulic Analysis

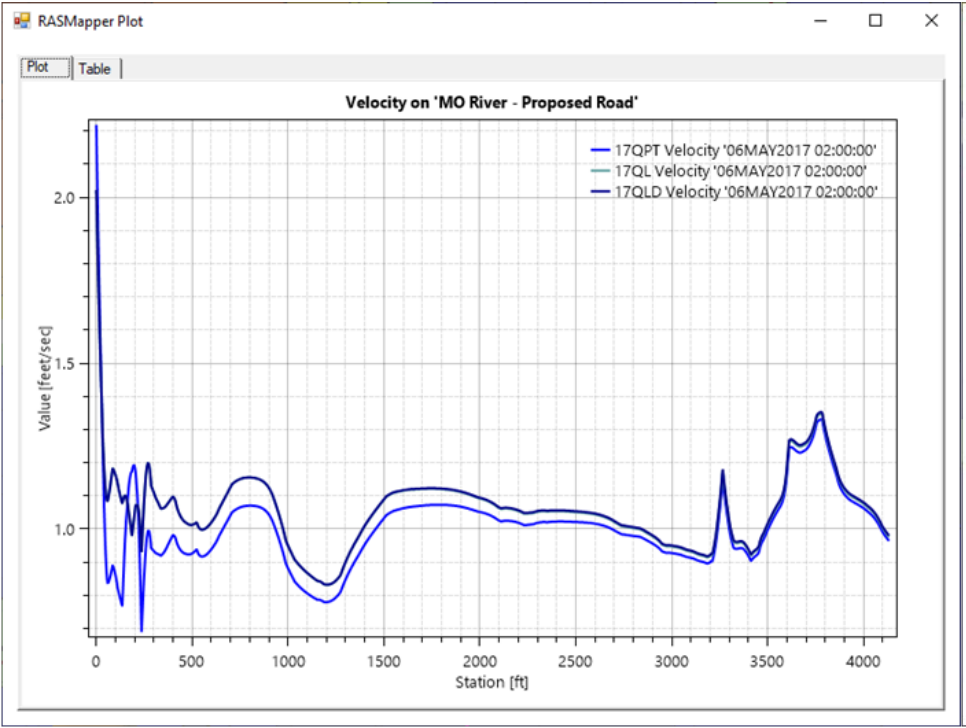
2017 & 2019 Max Velocity

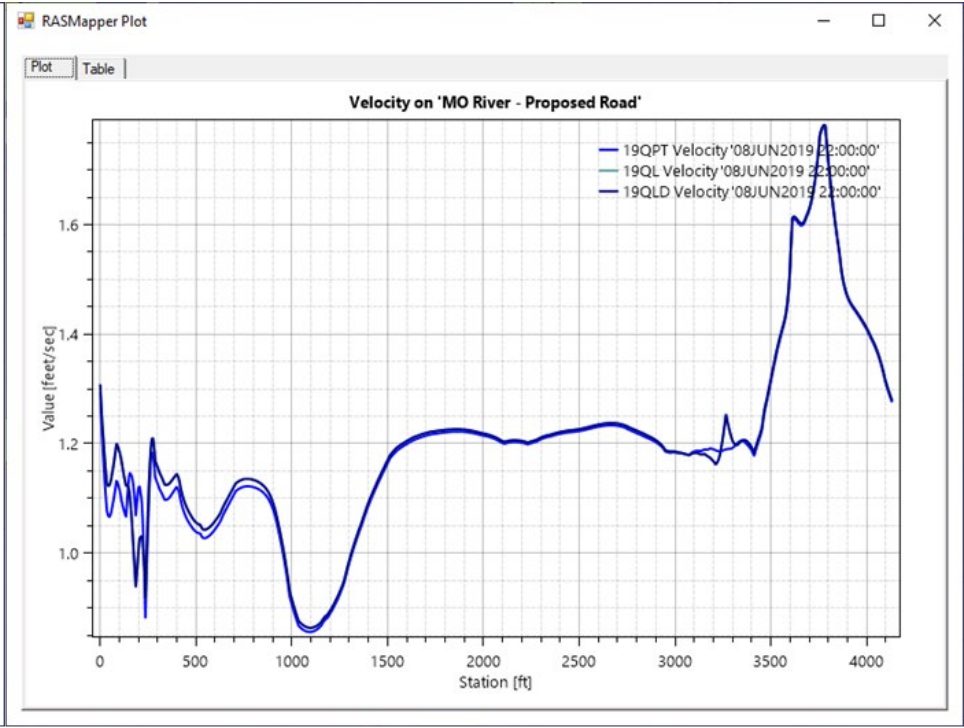




Hydraulic Analysis

2017 & 2019 Velocity Profile from MO River to Proposed Road



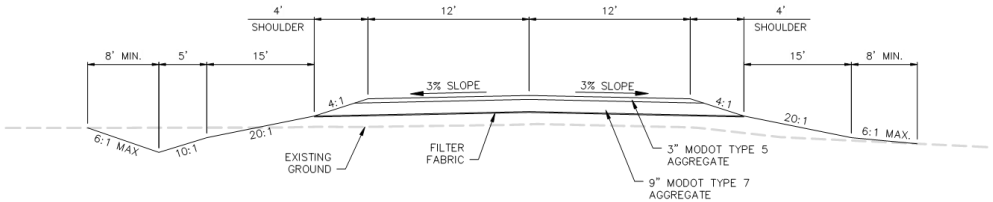


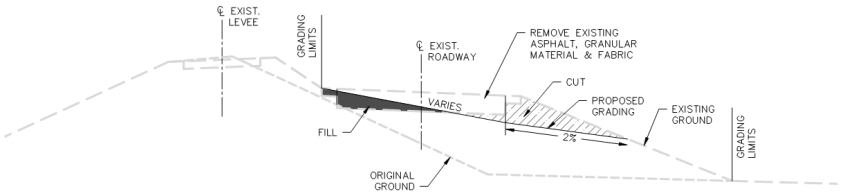
Hydraulic Analysis Findings & Recommendations

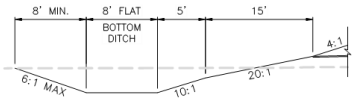
- Water velocities above 1 ft/sec will prevent deposition of the silt-clay fraction of sediment with velocities of 1.5 ft/sec required to keep the sand sizes less than 0.5 mm in suspension.
- A maximum velocity of 2.6 ft/s is allowed on the roadbed to prevent erosion.
- A maximum velocity of 1.5 ft/s is allowed on any unvegetated and unarmored road fill to prevent erosion.
- A maximum velocity of 3 ft/s is allowed on any vegetated unarmored road fill to prevent erosion.
- The estimated maximum deposition depth of silt/clay sediments on the relocated roadway for these 2017 and 2019 flow hydrographs is 0.02 feet (<0.25 inch).
- The tree corridor should be kept at least 100 feet away from the relocated roadway so as not to cause deposition of sand as windrows extending on to the roadway.
- The borders of the roadway extending at least 100 feet up valley and 100 feet down valley should be kept mowed and free of any woody vegetation.
- The previously identified problem of deposition in the boat ramp parking lot and existing roadway approaching the parking lot will remain unless additional mitigation strategies are implemented.

Road Design Solutions

- **Road Section:**
  - 3” MODOT Type 5 aggregate
  - 9” MODOT Type 7 aggregate
  - Reclaimed asphalt and based material from damaged road used for fill material beneath road base





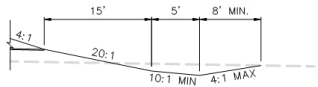


STA 27+25.00 TO STA 41+79.00
STA 44+78.00 TO STA 53+50.00

1 C201 TYPICAL SECTION
NOT TO SCALE

DESTRAHAN RD
STA 0+69.62 TO STA 14+38.95
STA 25+29.00 TO STA 40+79.00
STA 45+79.00 TO STA 53+73.84
STA 56+63.16 TO STA 57+12.72

MADISON FERRY RD
STA 30+25.00 TO STA 36+44.78

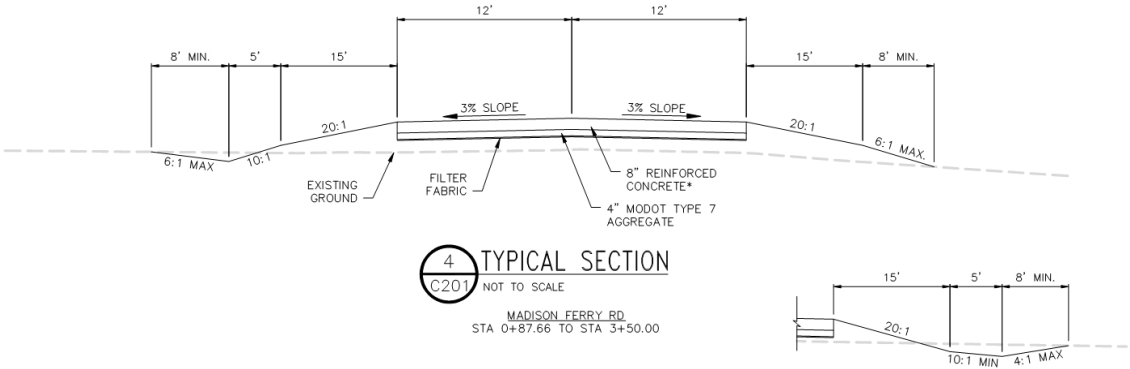


3 C202 LEVEE/ROAD SECTION
NOT TO SCALE

NOTES:
1) REMOVE EXISTING ROAD MATERIALS
2) GRADE REMAINING RIDGE ON SOUTH SIDE OF ROAD TO DRAIN AREA
3) BALANCE CUT AND FILL AND BLEND EXISTING ROAD BED WITH THE ADJACENT GRADES TO PROVIDE A PLEASING APPEARANCE
4) FOR SCOUR AREA GRADING SEE SHEETS C-114 & C-115

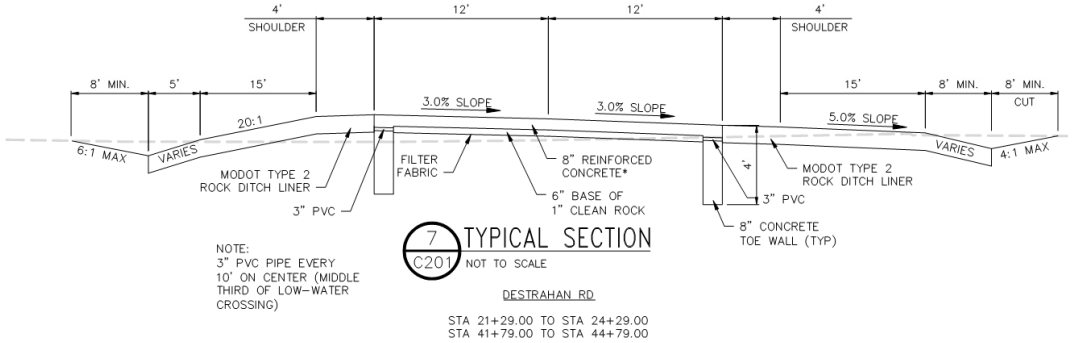
Road Design Solutions

- **Concrete Aprons @ Intersections:**
  - 8” Reinforced Concrete
  - 9” MODOT Type 7 aggregate



Road Design Solutions

- **Low Water Crossings:**
  - 8” Reinforced Concrete
  - 4’ Toe Wall All Sides



7 C201 TYPICAL SECTION
NOT TO SCALE

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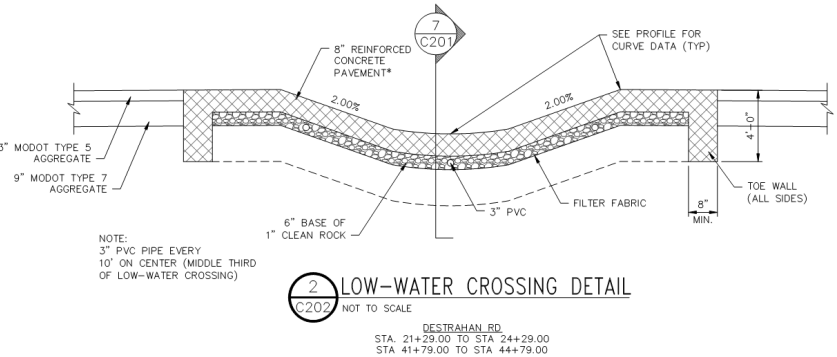
STA 41+79.00 TO STA 44+79.00



2 C202 LOW-WATER CROSSING DETAIL
NOT TO SCALE

DESTRAHAN RD
STA. 21+29.00 TO STA 24+29.00
STA 41+79.00 TO STA 44+79.00

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