Mississippi River Navigation Book Gets an Updated Low Water Reference Plane

Craig Hunter
Sr. GIS Specialist
Software and Scanning Services

Purpose

- Inland river waterways form a vital transportation network for commerce throughout the United States and must be maintained for the navigation of ships and the goods that they carry.
- Natural flowing water ways are subject to constant change in channel morphology, especially in the Mississippi River, and the river channel must be maintained at minimum depth to ensure ship traffic does not run aground.
- Channel depths are maintained as measured from the Low Water Reference Plane (LWRP).
- Since river channels and capacities are so dynamic, it is necessary to calculate a new LWRP every five to ten years.
- Historically the LWRP was interpreted along the channel based on time-consuming manual processing of sparse river channel cross-sections.
- Utilizing LIDAR and Multi-Beam SONAR data, U.S. Army Corps of Engineers has developed a new process to quickly generate a more accurate and more detailed Low Water Reference Plane.

What is a Low Water Reference Plane?

- Hydraulic-based statistical datum reference plan represented by a zero foot low water elevation established from long-term observations of the river's stages, discharge rates, and flood duration periods
- For New Orleans District:
  - Ø River Mile 313.7 to 265.4 is based on a 97% discharge duration of 146,000 cfs at Tarbert Landing (1954-2005) and corresponding 10 year (1996-2005) mean stage of 14.8 ft. NAVD88 at Knox Landing, 13.5 ft. NAVD88 at Red River Landing, and 6.6 ft. NAVD88 at Bayou Sara.
  - Ø Below river mile 265.4, from Baton Rouge to Venice is based on a 97% stage exceedence of daily lows for the period of record at each site.
- Hydraulic output is an adjustment factor from the survey datum (NAVD88) to the LWRP datum by river mile at 0.1 mile interval

Survey Surface Grid

- LiDAR

Ø Every few years LiDAR is collected for analysis of the levee system from flood-side to the protected side toe

Ø The LiDAR collection occurs when the foilage is at a minimum (winter).

- Sonar

Ø Each year, a portion of the river channel is surveyed using side-scan sonar. After the 2011 High Water Event, nearly the entire channel was surveyed

Ø The Sonar collection occurs when the river is at it's lowest (winter)

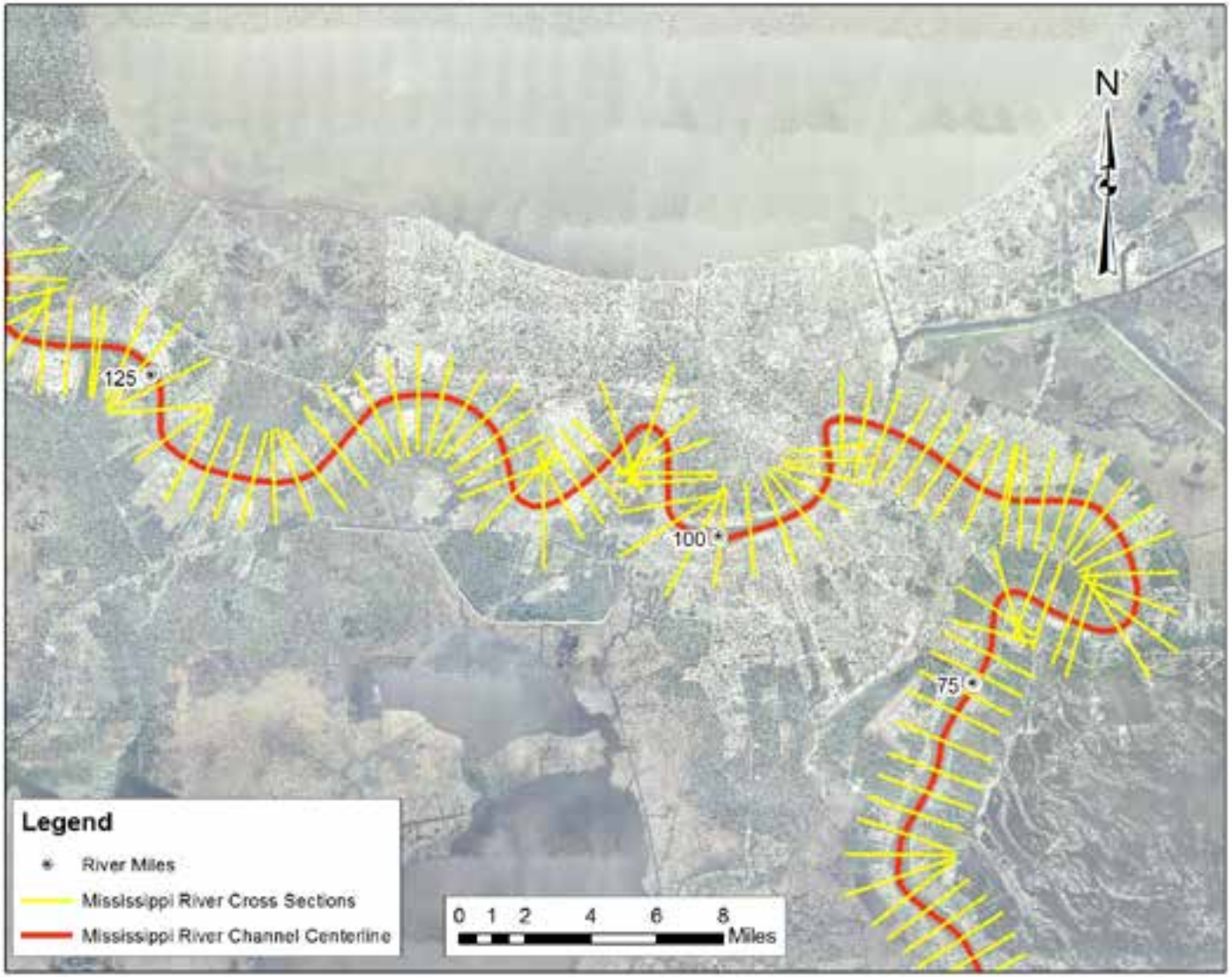
- Single Surface

Ø A new mosaic survey surface grid was generated with the latest SONAR data on top of the LIDAR data in order to provide a more comprehensive coverage area.

Generating the LWRP Adjustment Grid

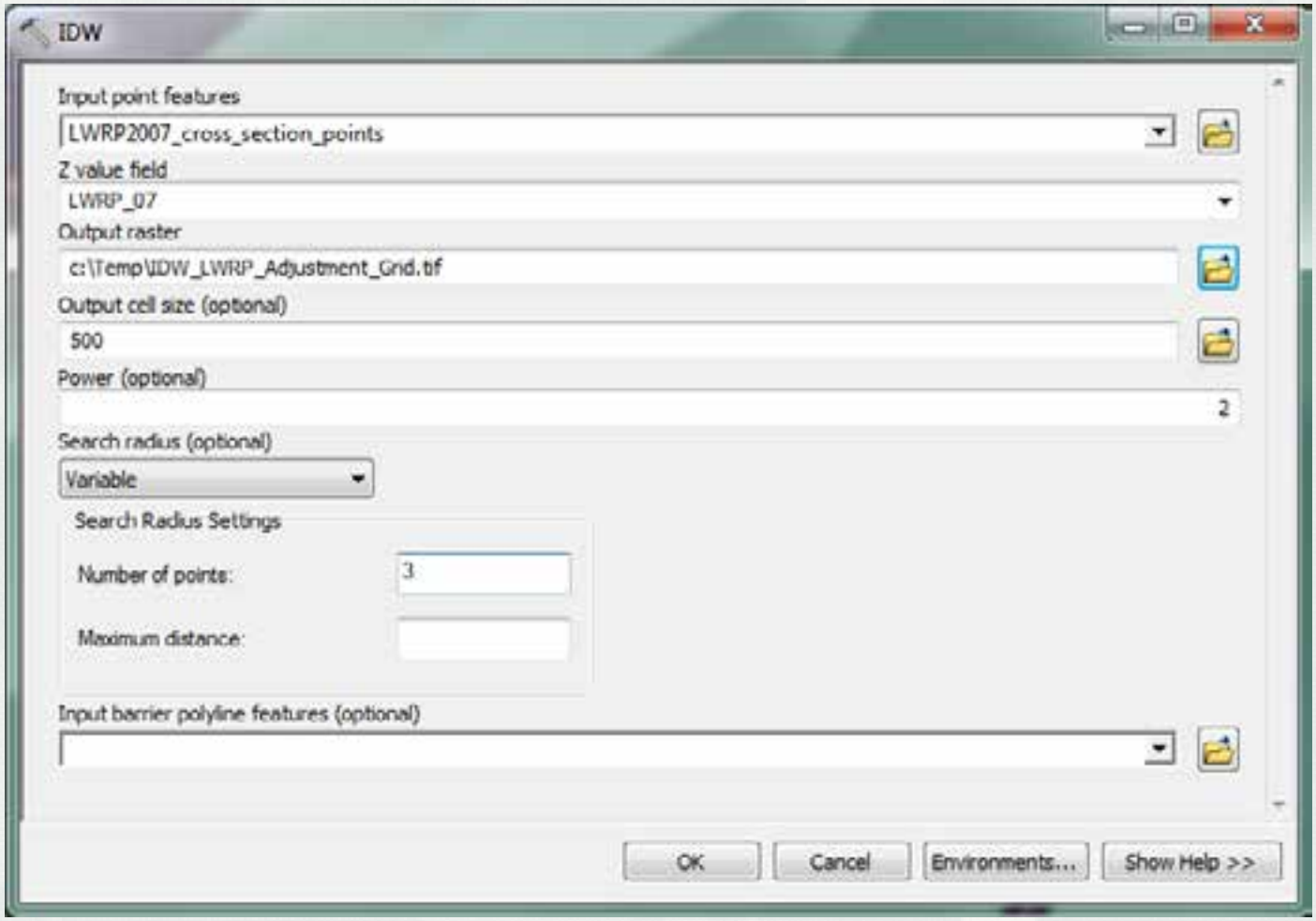
- Hydraulic output is an adjustment factor from the survey datum (NAVD88) to the LWRP datum by river mile at 0.1 mile interval
- Hydraulic cross-sections of the Mississippi River used for HECRAS modelling (extended the features over the levee system features) are assigned a river mile
- Assigned the adjustment factor to the linear cross-sections based on river mile
- Data Management Tools > Features > Feature Vertices To Points was used to make a point shapefile

Mississippi River Channel Cross-Sections

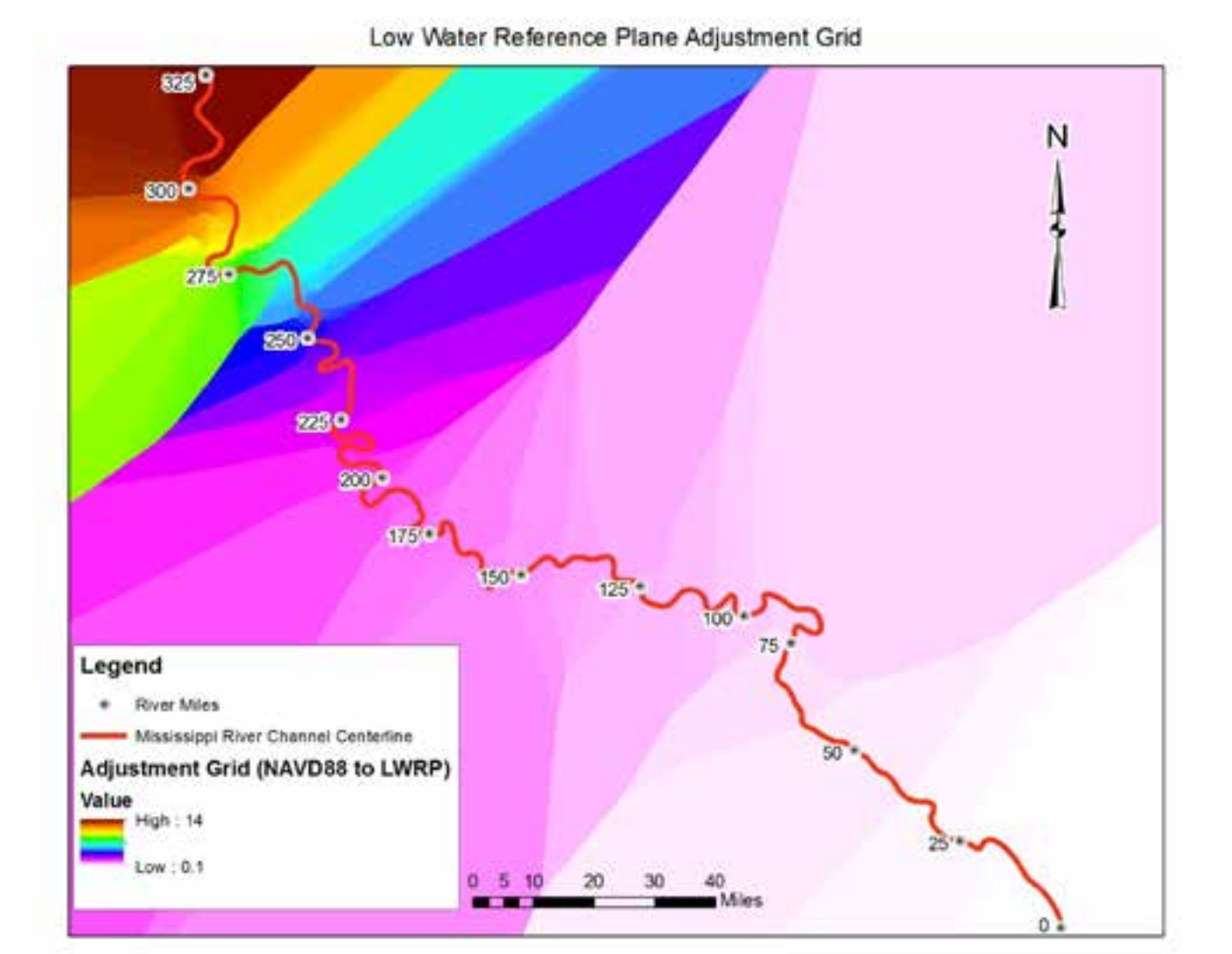


Adjustment Grid Parameters

- Spatial Analyst Tools > Interpolation > IDW was used to generate the LWRP Adjustment Grid



LWRP Adjustment Grid



Raster Processing

- Spatial Analyst Tools > Math > Minus

Ø Used to subtract the LWRP Adjustment Grid from the sonar and lidar mosaic survey suface grid to produce the LWRP surface grid as heights

- Spatial Analyst Tools > Math > Negate

Ø Used to turn the LWRP surface grid into depths (as positive numbers)

- Spatial Analyst Tools > Map Algebra > Raster Calculator

Ø Used the con function to assign 0 for values below zero and 1 for values equal to or greater than zero (which represent the zero-ft LWRP)

- Conversion Tools > Raster to Polygon

Ø Used to generate polygon shapefile

LWRP Polygon Processing

- Select Features with a value of 1 and export to new shapefile
- Delete the features not within the Mississippi River Channel
- You now have a new Mississippi River Low Water Reference Plane

Data Gaps


Barge Fleeting Areas/Dock Facilities
N
S
0
250
500
1,000
1,500
2,000
Feet
Legend
Zero Foot LWRP

LWRP Additional Polygon Processing

- The LWRP Polygon was reviewed for data gaps and adjusted accordingly. This generally involved deleting the holes in the polygon where barges, docks or other facility infrastructure interfered with SONAR data collection.

- The LWRP Polygon was compared against the available linear cross-sections in the lower Mississippi River channel approaching the area of tidal influence.

Results

- Utilizes existing data sources collected by other programs/offices
- Processing time reduced to a fraction of the previous method
- Accuracy of resulting polygon increased as it is data driven (reduces the need for interpretation by analysts.
- Replicable workflow for future epochs of the Low Water Reference Plane

Recommendations For the Future

- LIDAR surveys of the levee system as a hole are flown on a more frequent schedule but are focused on the levee system and captures the area between the protected-side toe and the flood-side toe.

Ø Recommend extension of the LIDAR survey area from the flood-side toe to the flood-side water's edge would improve data coverage for the generation of future Low Water Reference Plane epochs.

- SONAR surveys are collected during low water for the purpose of identifying changes in the river bottom that could threaten navigation or stability of the levee system

Ø Recommend changing the time of data collection to occur prior to low-water

Ø Overlap between LIDAR and SONAR data coverage would increase accuracy of future Low Water Reference Plane epochs.

Questions?