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GORDON

CASE STUDY 4

Rec'd from Dave 8/19/02

4.2.4 Morgan City/Berwick Bay (Case Study 6)

Portions of the following was taken from the following two documents:

- Gordon, D.C., Davinroy, R.D., "Sedimentation and Navigation Study of the Lower Atchafalaya River at Morgan City and Berwick, Louisiana, River Miles 124.0 to 118.5, Hydraulic Micro Model Investigation," U.S. Army Corps of Engineers, St. Louis District, 2001.

- Gordon, D.C., Davinroy, R.D., Austin, J.W., "Small Scale Physical Sediment Transport Modeling Approach Used to Solve a Chronic Dredging Problem on the Atchafalaya River at Morgan City, Louisiana," 7th Federal Interagency Sedimentation Conference Proceedings, 2001.

In 1999, the Hydrologic Engineering Section of the U.S. Army Corps of Engineers, New Orleans District initiated a sedimentation and navigation improvement study of the Lower Atchafalaya River at Morgan City and Berwick, Louisiana. The purpose of the study was to evaluate a number of structural design alternatives and/or modifications for channel improvement on the Atchafalaya River between Miles 124.0 and 118.5. Micro modeling methodology was used to evaluate the sediment transport and hydrodynamic response trends that could be expected to occur in the river from various channel improvement design alternatives. These alternatives were conceptualized and submitted by members of a study team representing the New Orleans District, the St. Louis District, and the Corps of Engineers Coastal and Hydraulics Laboratory. The primary goal was to qualitatively evaluate the impacts of these measures on the resultant bed configuration (sediment transport response) and hydrodynamic response (flow patterns) within the study reach.

4.2.4.1 Problem Description

The Atchafalaya River is the largest of all distributaries of the Mississippi River in which the Corps of Engineers maintains a 12-foot deep by 125-foot wide navigation channel. The Berwick Bay reach, shown in the aerial photo in Figure 1, is located between Morgan City and Berwick, Louisiana. The reach is comprised of several branches of the Gulf Intracoastal Waterway System (GIW) that converge through this reach. This intersection of waterways results in congestion for commercial navigation traffic.

This particular stretch of river has been one of the most troublesome reaches on the Atchafalaya River in terms of dredging cost, frequency, and volume. The New Orleans District must maintain navigable depths between river banks within Berwick Bay to ensure adequate depths for the ports, facilities, and boat docks that are located along the riverfronts of both cities. Although Berwick has sufficient depth to maintain navigation, Morgan City is faced with a large depositional area that accumulates enough sediment to halt navigation into the port facilities. The District currently dredges at this location approximately twice per year. Nearly one million cubic yards of material were removed from this site in 1999.

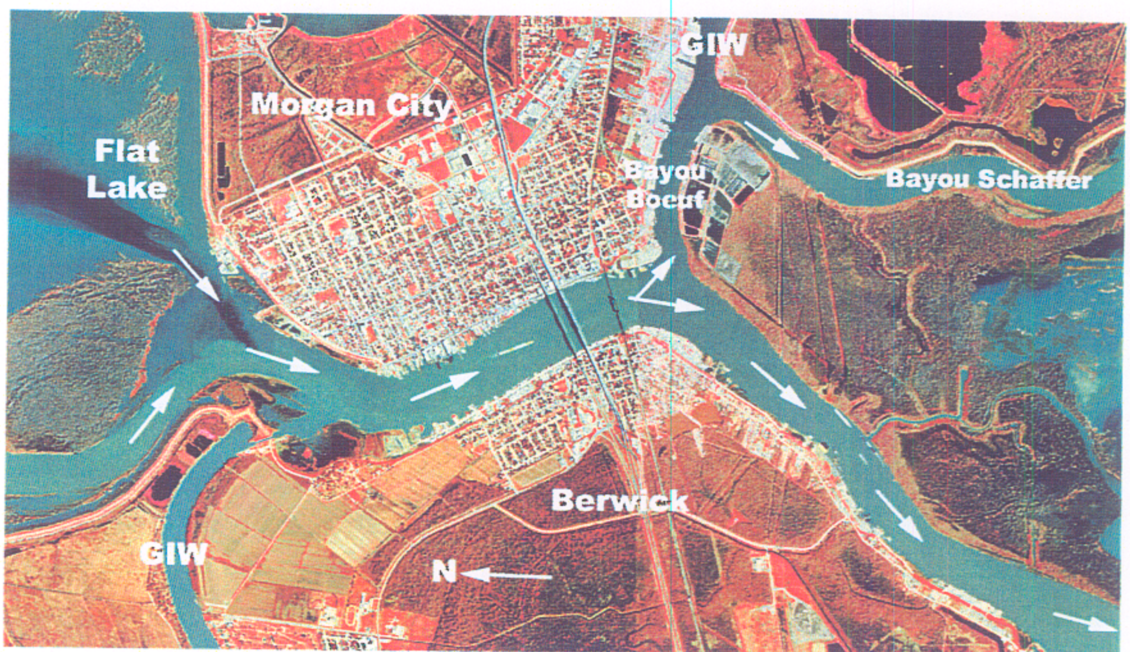

Figure 1: Aerial Photograph of the Atchafalaya River at Morgan City and Berwick, Louisiana.

Another concern in this reach of river is safety. Berwick Bay contains three bridges that span the river in close proximity to each other. The two U.S. Highway 90 bridges contain adequate navigation span widths of 580 feet and 520 feet. However, the Southern Pacific Railroad Bridge contains a lift-span with an extremely narrow navigation width of approximately 320 feet. Until the establishment of a stringent traffic control system by the U.S. Coast Guard in 1974, this bridge was listed as the "most hit" in the United States.

Historically, the flow and direction of currents in this area have not been conducive to safe navigation through these bridge spans. While the navigation spans of the bridge crossings are located in the center of the channel, the thalweg and main concentration of flow are located near the right descending bank along the Berwick side of the river. Therefore, the direction of river currents tends to divert downbound vessels attempting to navigate through the center bridge spans toward the right descending bank. The misalignment of currents with the navigation spans has forced tow pilots to make precise adjustments to the position of their vessels well upstream of the bridges. A slightly misguided tow could easily collide with the many bridge piers located in the channel.

4.2.4.2 Study Purpose and Goals

The purpose of this study was to empirically assess the present day sediment transport and flow response trends of the Atchafalaya River. The primary goals were to evaluate design alternatives that would reduce the deposition and dredging associated with the reach, and to provide improved flow conditions for navigation through the bridge crossings. Improving flow conditions included examining ways to reduce velocities and generally redistribute flow patterns in the Atchafalaya River channel by the use of underwater weirs. Qualitative assessments of each design alternative included the examination on the ultimate effects to sedimentation, flow patterns, and navigation within the main channel of the Atchafalaya River.

4.2.4.3 Morgan City/Berwick Bay Micro Model

The micro model encompassed the Atchafalaya River channel between Miles 116.5 and 126.0 and was constructed according to the high-resolution aerial photography of the study reach shown in Figure 1. Portions of Flat Lake, Bayou Boeuf and Bayou Schaffer were also included in the model. The scales of the model were 1 inch = 600 feet, or 1:7200 horizontal, and 1 inch = 100 feet, or 1:1200 vertical, for a 6 to 1 distortion ratio. The model was calibrated to the 1999 multi-beam bathymetric survey shown in Figure 2. The micro model base test is shown in Figure 3. A comparison of cross sectional area between the micro model and the prototype revealed an average 8.2% difference.

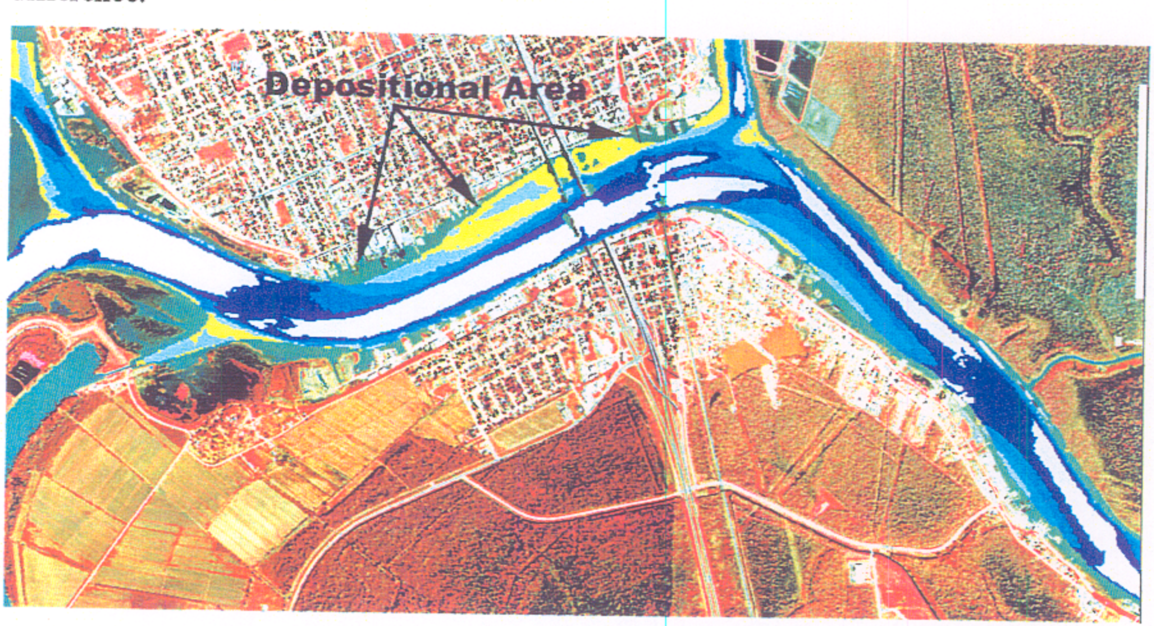

Figure 2: Multi-Beam Bathymetry from the Atchafalaya River used to Calibrate the Micro Model.

Figure 3: Bathymetry from the Micro Model Base Test.

Flow visualization photographs were examined at both low flow and high flow to better assess the general surface current patterns associated with each design alternative. It was determined that the flow trends of the model base test, shown in Figure 4, were very similar to the prototype velocity vectors established from ADCP data. These photos then served as the comparative flow patterns for all design alternative tests. At both flow rates, the model demonstrated that most of the flow was concentrated along the right descending bank and to the right of the navigation spans which are located in the center of the channel.

Eleven design alternative plans were model tested to examine methods of modifying the sediment response trends that would minimize dredging and improve the flow patterns through the Berwick Bay reach. The impacts induced by each alternative design were assessed by qualitatively examining both the flow and sediment response of the model. The effectiveness of each design was evaluated by comparing the resultant bed configuration and flow patterns to those of the base test condition.

4.2.4.4. Recommended Solution

Careful examination of the model results indicated that the most effective design consisted of 10 bendway weirs located within a one-mile reach of river and at a depth of –20 feet below the low water stage. The resultant flow patterns and bathymetry developed by this design in the model are shown in Figures 5 and 6. The model results demonstrated that the design proved very effective at reducing the elevations in a substantial portion of the depositional area along the left descending bank. The design also shifted the thalweg towards the center of the channel at the upstream portion of the reach. The weir field effectively created a smooth transition of the thalweg from the bend towards the middle of the channel and into the straight reach upstream of the bridges. The length, angle, position, and elevation of each weir were critical to achieve the desired bed forms and flow patterns.

Flow visualization demonstrated a significant redistribution of current patterns across the channel width. The design indicated that the flow patterns were more evenly distributed across the entire channel width and were no longer concentrated along the right descending bank. This change in flow patterns may decrease the dangerous currents that effect downbound tows navigating through the bridge openings.

Figure 4: Micro Model Base Test Flow Visualization.

Figure 5: General Flow Patterns Developed by Bendway Weirs of the Recommended Design Alternative.

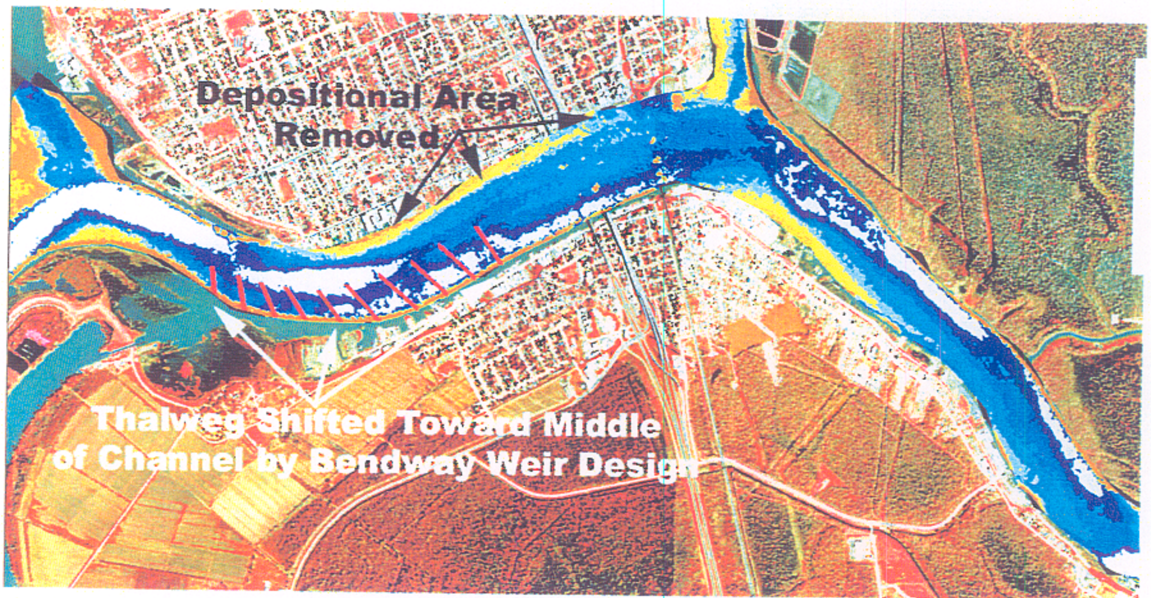

Figure 6: Bathymetry Trends Developed by Bendway Weirs of the Selected Design Alternative.

4.2.4.5. Results

The historically ~~precarious~~ complex nature of this reach of river has caused river engineers to use extreme caution when studying designs that significantly modify the flow patterns in this dangerous and busy reach of river. Therefore, the results of the micro model are being utilized in a three-dimensional numerical flow model at the University of Iowa to quantitatively evaluate the flow conditions induced by the bendway weir design. The results from this model will then be applied to a computer navigation simulator at the Corps of Engineer's Coastal and Hydraulics Laboratory in Vicksburg, Mississippi to study the effects of ~~these~~ modeled flow conditions on tows navigating this reach of river. Construction of the design may begin only after these models are completed and approvals are obtained from the towing industry and the U.S. Coast Guard.