

scarp. At the water's edge a 6-in. thick layer of CS was found to lie on top of coarse silt (CST).

The core sample showed historical deposits and a very poorly drained very late Holocene soil profile. The island surface appears to be a late to very late Holocene surface, much younger than the deposits observed across the channel at Site 6. Major historical vertical sediment accretion has occurred at the site along the eastern channel margin.

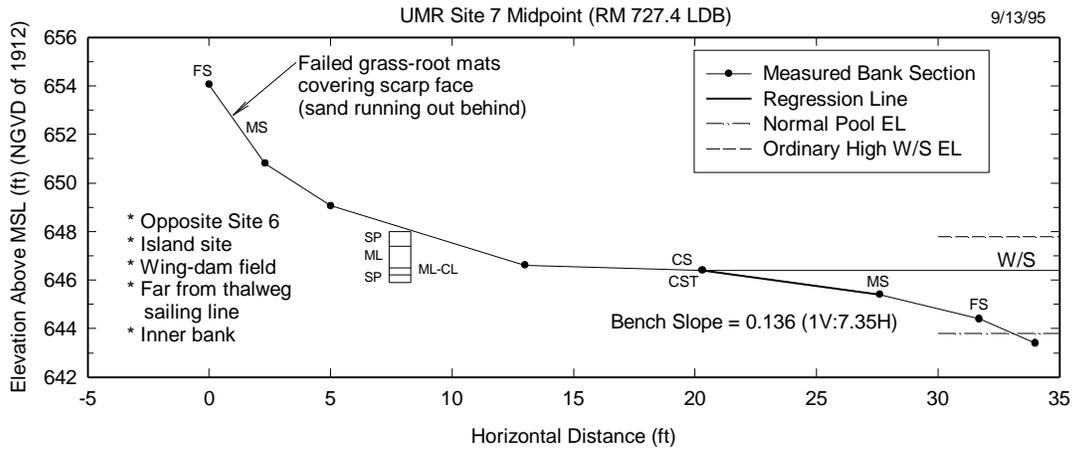
Primary causative factors for bank retreat at this site include flood erosion, wave and rework-transport within bench and berm areas, and minor piping. Because bench cover is primarily sand, erosion by traffic-induced waves was observed. This site is classified as bank Type E.



**Photo 7-22 An upstream view of Site 7 midpoint**



**Photo 7-23 A down stream view of Site 7 midpoint**



**Figure 7-28 Bank section measured at Site 7 midpoint**

**8. Site 8 at RM 677.5 RDB (Pool 9)**

This right-bank site on the outside of a slight bend, shown in figure 7-29, is located only about 1.7 miles downstream from Lock & Dam No. 8. A downstream view of the site is shown in Photo 7-24. Three bank sections obtained at this site are plotted in figures 7-30 through 7-32. The bank soils are predominantly coarse silt (CST defined in table 7-3), and piping features were observed within the entire bank face. The river cross

section shown in figure 7-31 is typical for a river bend. Bed level at this site drops off sharply, and the thalweg sailing line is very close to the site. As shown in figure 7-29,

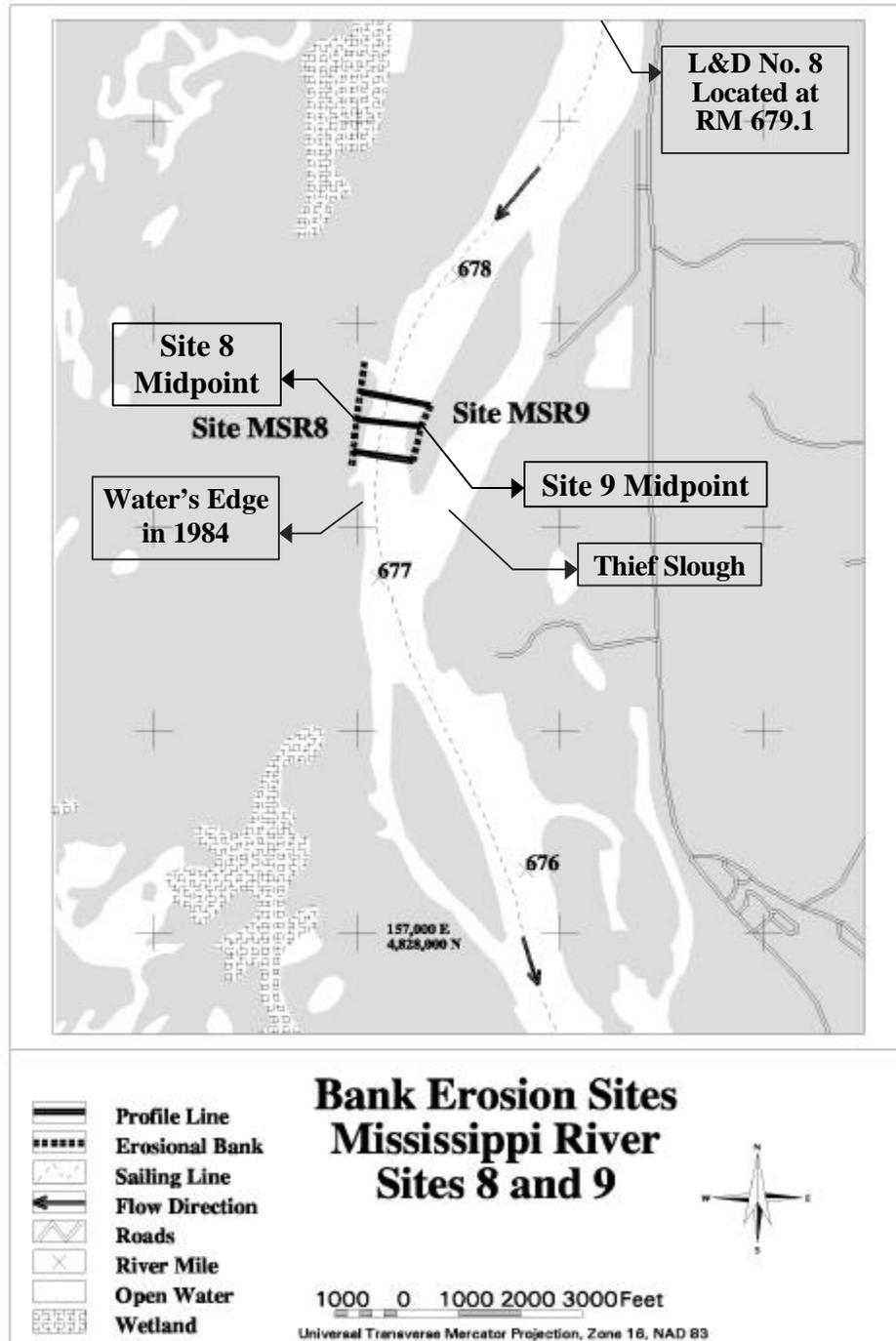
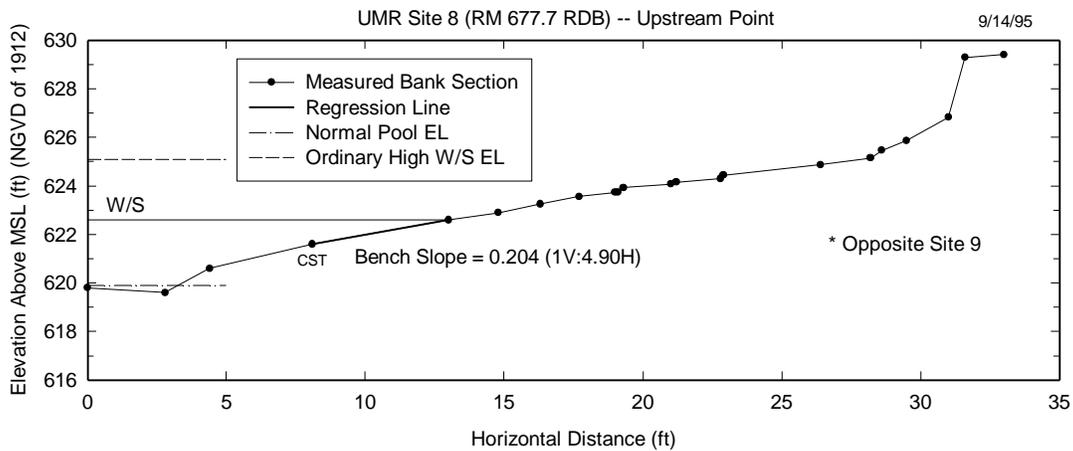


Figure 7-29 A map showing Mississippi River Sites 8 and 9



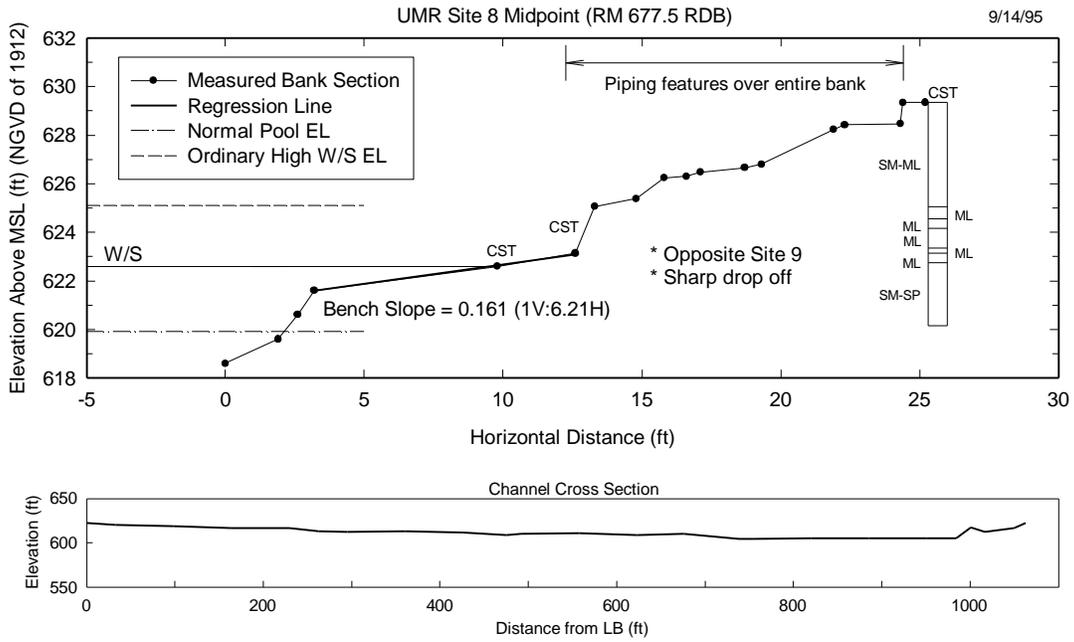
**Photo 7-24 A downstream view of Site 8 midpoint**



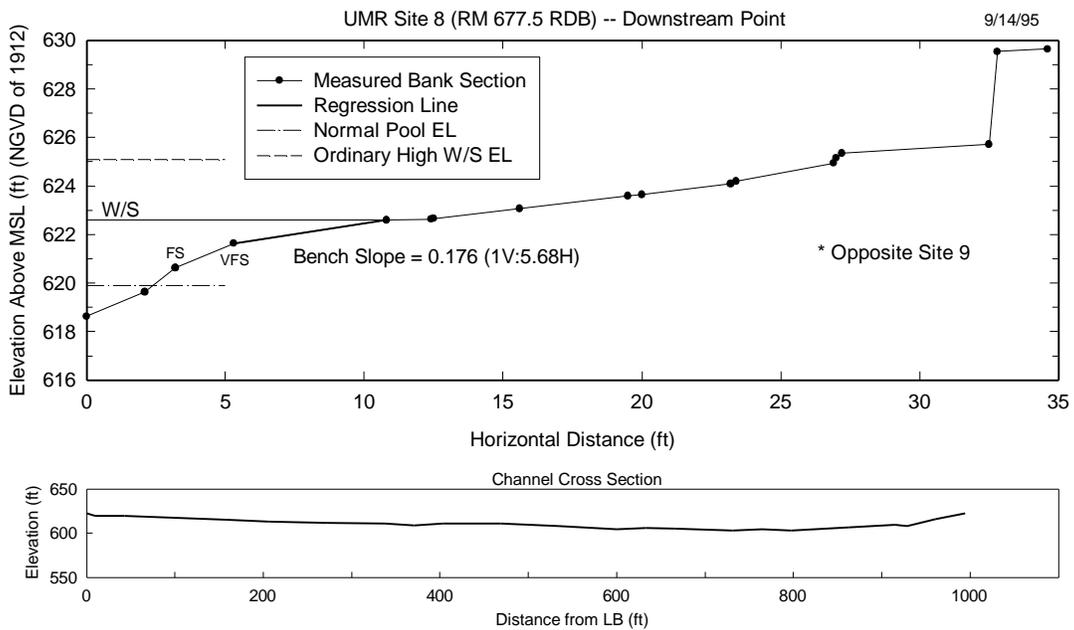
**Figure 7-30 Bank section measured at Site 8 upstream point**

the bank line at this site had retreated considerably in comparison with that in 1984.

Historical alluvium was encountered from the surface to a depth of 4.3 ft, as shown in figure 7-31. Below the alluvium are late Holocene levee deposits with two buried soils. Multiple-age Holocene surfaces are encountered in this part of Pool 9. The



**Figure 7-31 Bank section and channel cross section measured at Site 8 midpoint**



**Figure 7-32 Bank section and channel cross section measured at Site 8 downstream point**

Holocene surfaces have been buried by a variable thickness of historical alluvium. This site is located on a very late Holocene to historic surface.

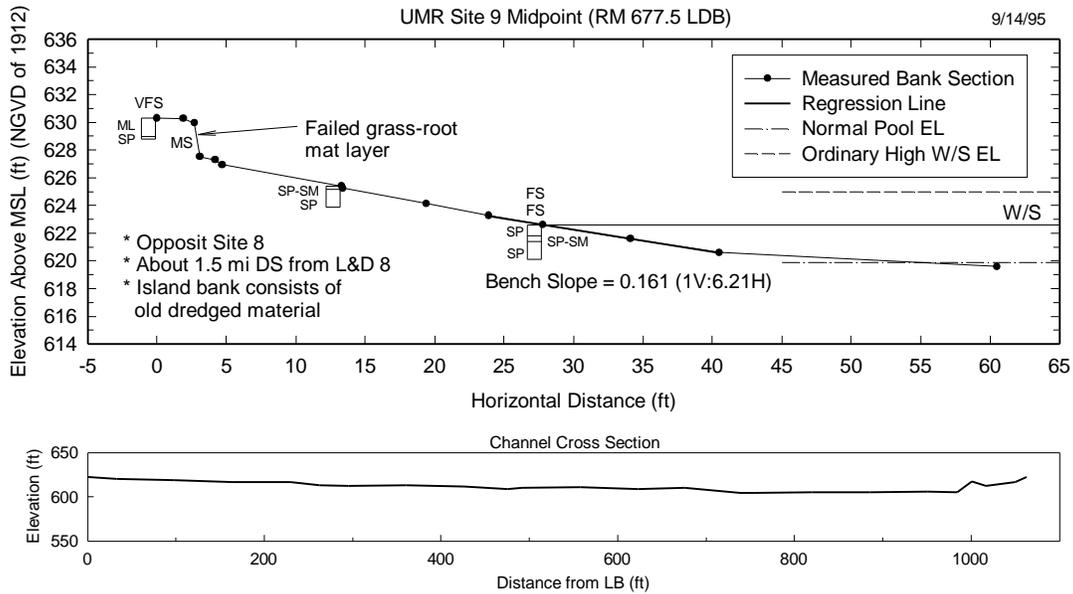
Causative factors for bank retreat at this site include flood-flow erosion, wave-flow related rework-transport of failed soils and recently deposited sediments, and piping. Potential for wave erosion of bench areas is significant. This site is classified as Type C.

**9. Site 9 at RM 677.5 LDB (Pool 9)**

This left-bank site on the inside of a slight bend, shown in figure 7-29, is located opposite Site 8. An upstream view of the site is shown in Photo 7-25. On the other side of this island is Thief Slough. Site 9 is located within a wing-dam field. Bank retreat at this site since 1984 is apparent in figure 7-29. The bank section is shown in figure 7-33, and the bank soils are old dredged material (VFS-MS). A small scarp was covered by a layer of failed grass-root mat.



**Photo 7-25 An upstream view of Site 9 midpoint**



**Figure 7-33 Bank section and channel cross section measured at Site 9 midpoint**

All three core samples showed dredged material. The deepest core was advanced to 2.5 ft. This island is probably of late to very late Holocene age. The older Holocene surfaces lie on the east and west sides of the island.

The site is far from the thalweg sailing line. Causative factors for bank retreat at this site include wave and rework-transport of failed soils and recently deposited sediments in berm and bench areas, and flood and secondary current erosion. Because of the nature of sandy bench cover, there is potential for wave erosion in bench areas. This site is characterized by a combination of bank Type E and Type F.

#### **10. Site 10 at RM 669.5 RDB (Pool 9)**

This right-bank site on the outside of a mild bend, shown in figure 7-34, is located only about 1.5 miles downstream from the mouth of the Upper Iowa River. The bank is covered by fine silt (FST) and sand (VFS-MS), and subaqueous soil is silt (FST-CST). A downstream view of the site is shown in Photo 7-26, and a close-up view of the scarp is shown in Photo 7-27. Three bank sections are shown in figures 7-35 through 7-37. Numerous fresh, fallen silty soil blocks, 6 in. to 2 ft high, were found along the sand

bench, which indicates that Site 10 is an active bank failure and erosion location. At the upstream section, a rocky bottom was observed about 30 ft from the water's edge (see figure 7-35).

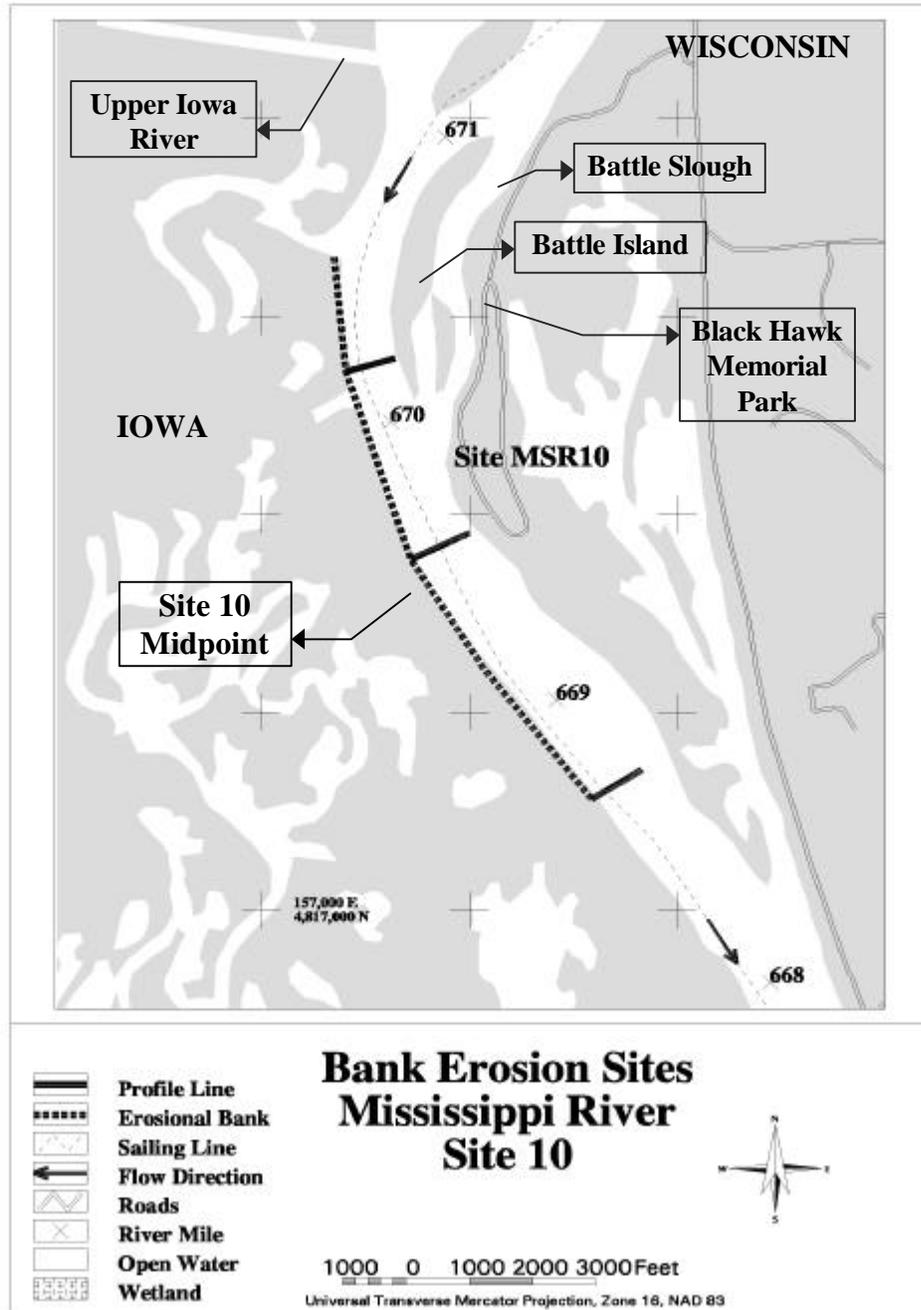


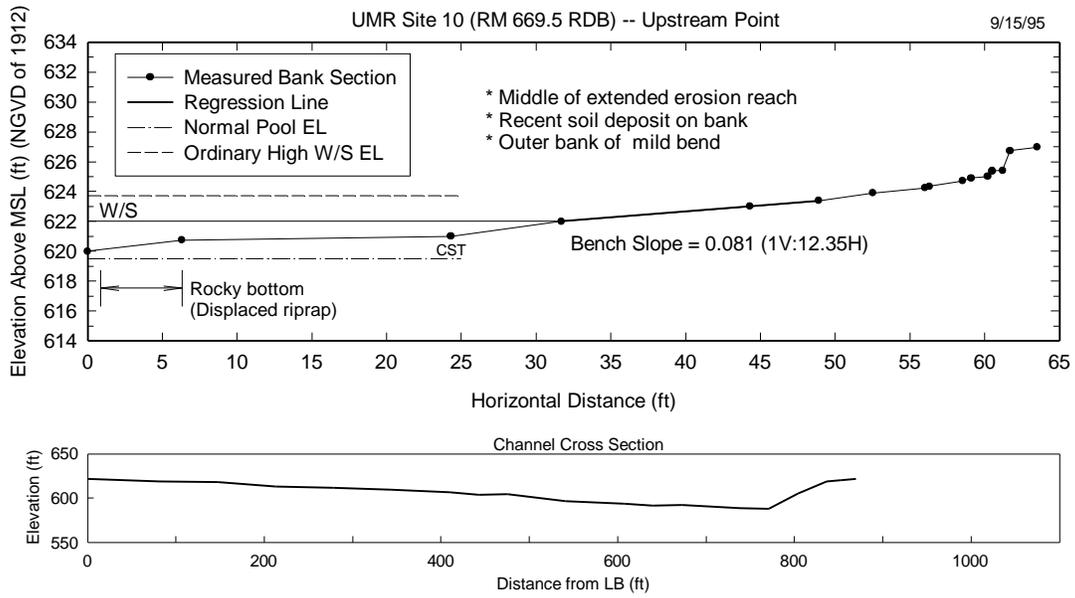
Figure 7-34 A site map showing Mississippi River Site 10



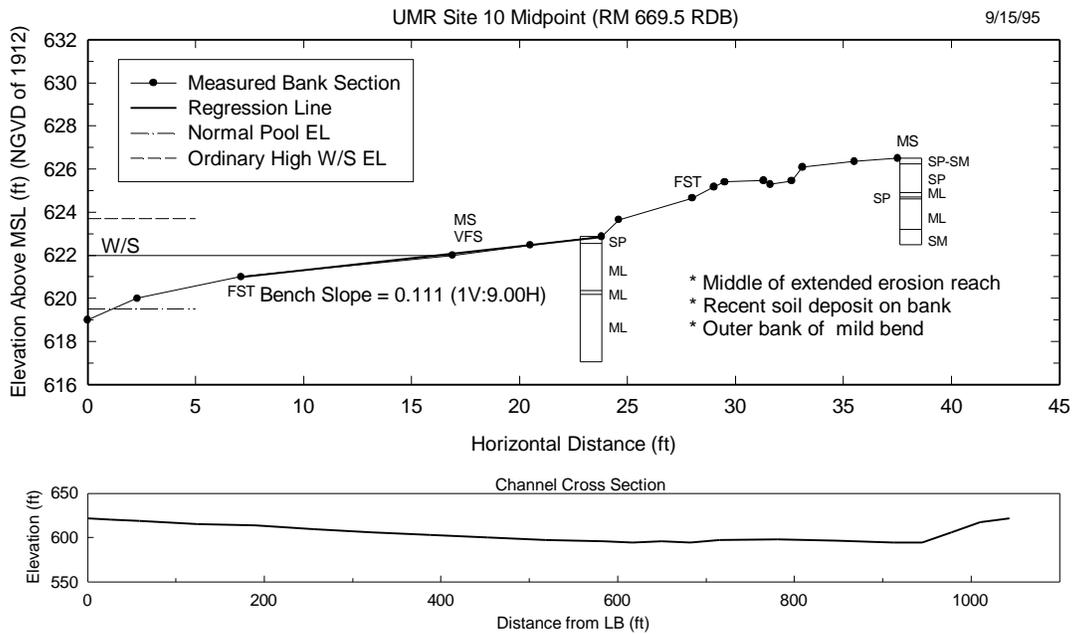
**Photo 7-26 A downstream view of Site 10 midpoint**



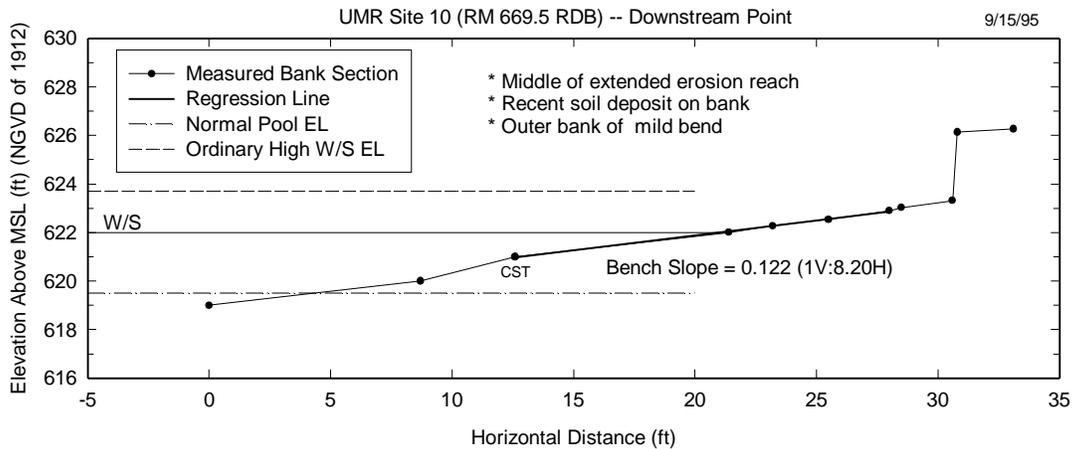
**Photo 7-27 A close-up view of scarp at Site 10 midpoint**



**Figure 7-35 Bank section and channel cross section measured at Site 10 upstream point**



**Figure 7-36 Bank section and channel cross section measured at Site 10 midpoint**



**Figure 7-37 Bank section measured at Site 10 downstream point**

Five sampling tube cores and an excavated soil pit were examined at four locations across Site 10. The cores showed a highly variable thickness of historical alluvium and dredged material, ranging from about 0.3 ft to 4.0 ft thick. Below the historical deposit is a fine-grained, poorly drained, very late Holocene wetland soil. Older Holocene surfaces are expected to lie west of the site and away from the channel. The Upper Iowa River alluvial fan enters the Mississippi River Valley immediately upstream from the site.

Causative factors for bank retreat at this site include flood-flow erosion, secondary currents, overland flow, wave and rework-transport of failed soils and recently deposited sediments, and piping. There is potential for wave erosion in bench areas. The bank section at this site is classified as a combination of bank Type D and Type E.

### **11. Site 11 at RM 620.5 LDB (Pool 10)**

This island site, shown in figure 7-38, is located within a relatively narrow section of the valley, about 5.5 miles upstream from Lock & Dam No. 10, in the crossover reach between two mild bends. Upstream and downstream views of this site are shown by Photos 7-28 (see undercutting) and 7-29, respectively. Three bank sections are shown in figures 7-39 through 41. There are two wing dams, the upstream wing dam extends about 700 ft, and the downstream wing dam extends approximately 1,000 ft from the island. The midpoint section is just upstream from the longer downstream wing dam. The river

cross section in figure 7-40 seems to indicate that the thalweg developed along this left bank. It appears that the shorter upstream wing dam is not able to direct river flow

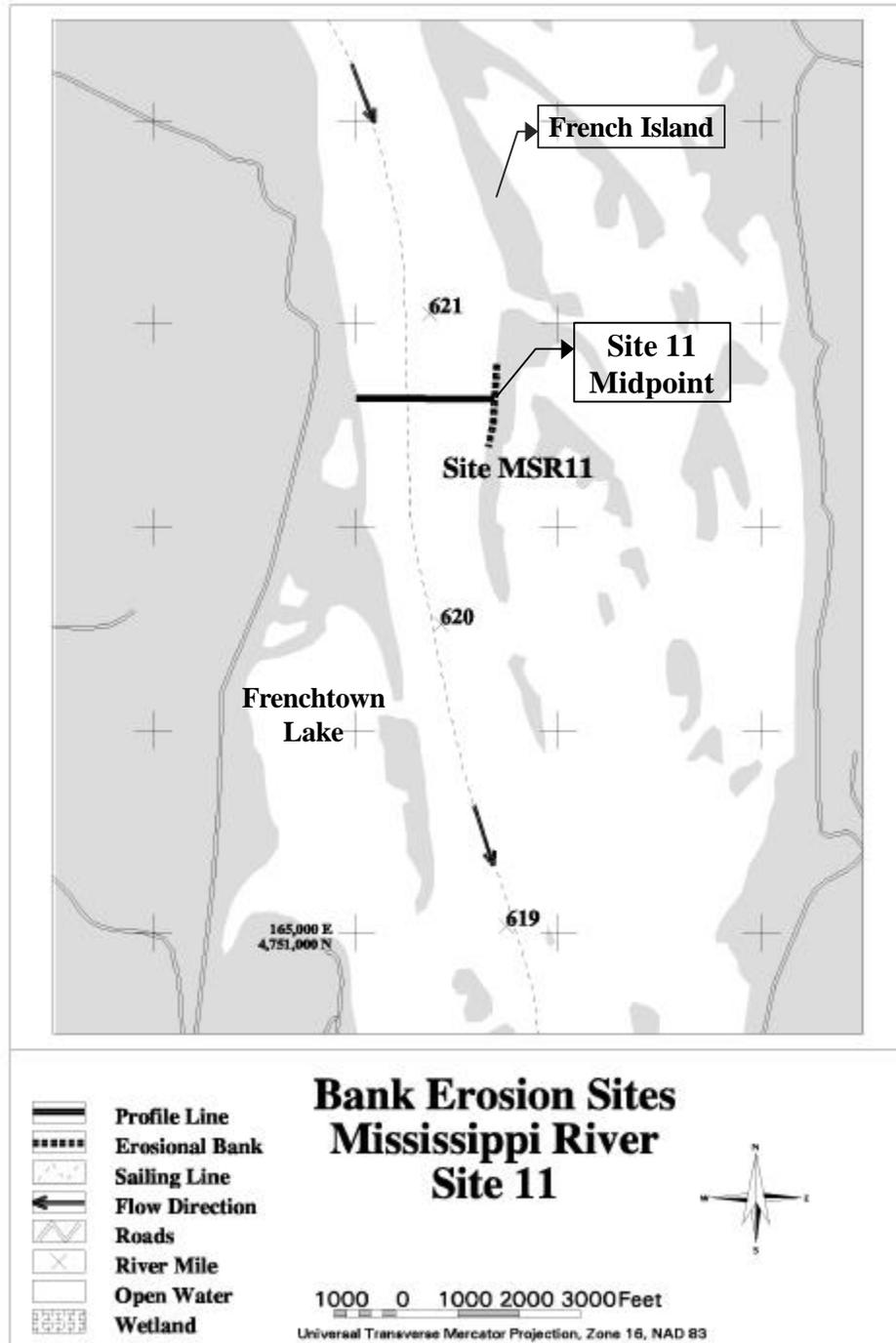


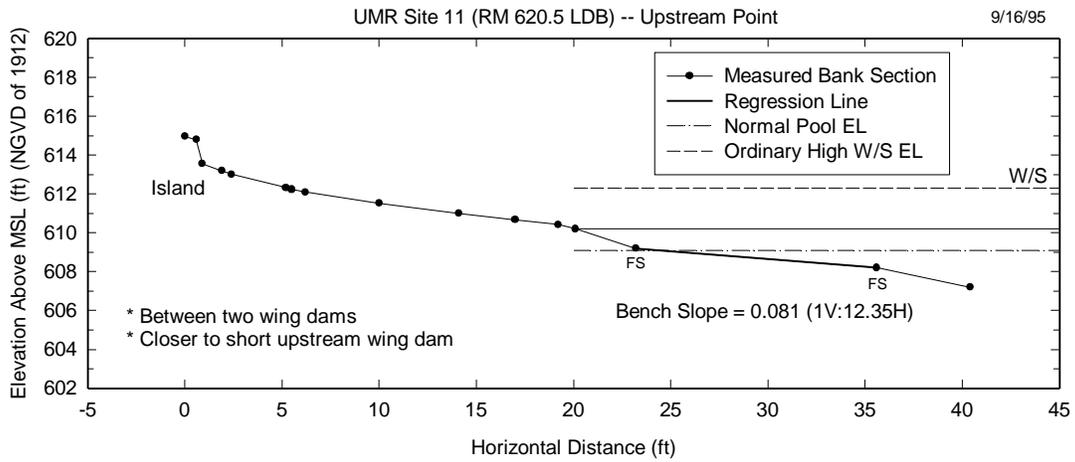
Figure 7-38 A site map showing Mississippi River Site 11



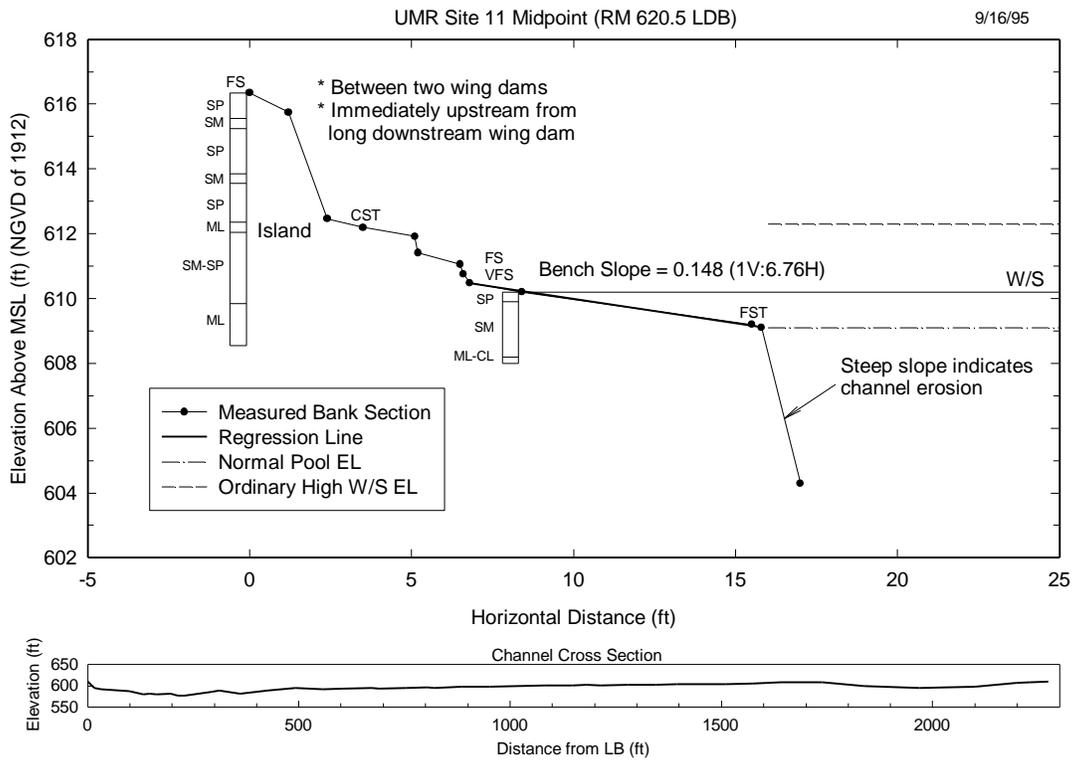
**Photo 7-28 An upstream view of Site 11 midpoint**



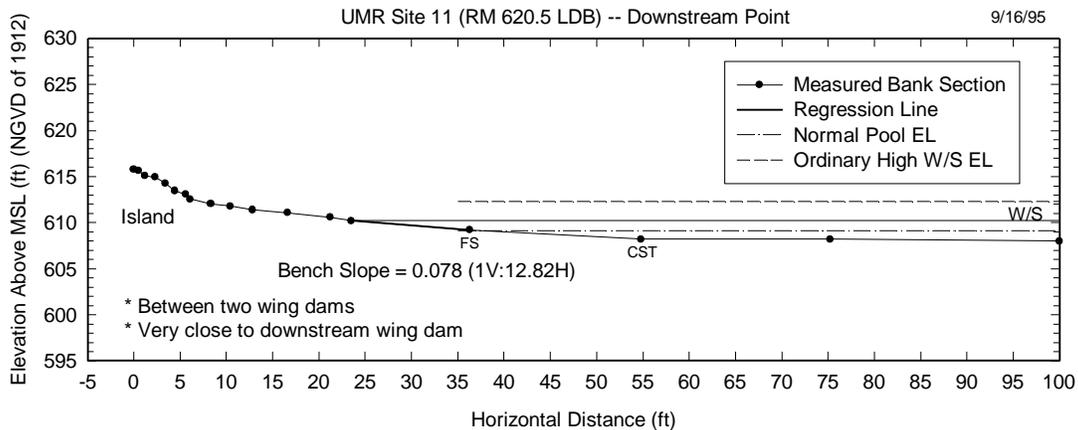
**Photo 7-29 A downstream view of Site 11 midpoint**



**Figure 7-39 Bank section measured at Site 11 upstream point**



**Figure 7-40 Bank section and channel cross section measured at Site 11 midpoint**



**Figure 7-41 Bank section measured at Site 11 downstream point**

toward the main channel, which resulted in strong currents impinging on the longer downstream wing dam, eroding the subaqueous bank at the midpoint section. The bank section in figure 7-40 shows a sharp drop of the bed near the bank. At both the upstream and downstream sections, near-bank water depth was small. The bank soils consist primarily of coarse silt (CST) and sand (VFS-FS).

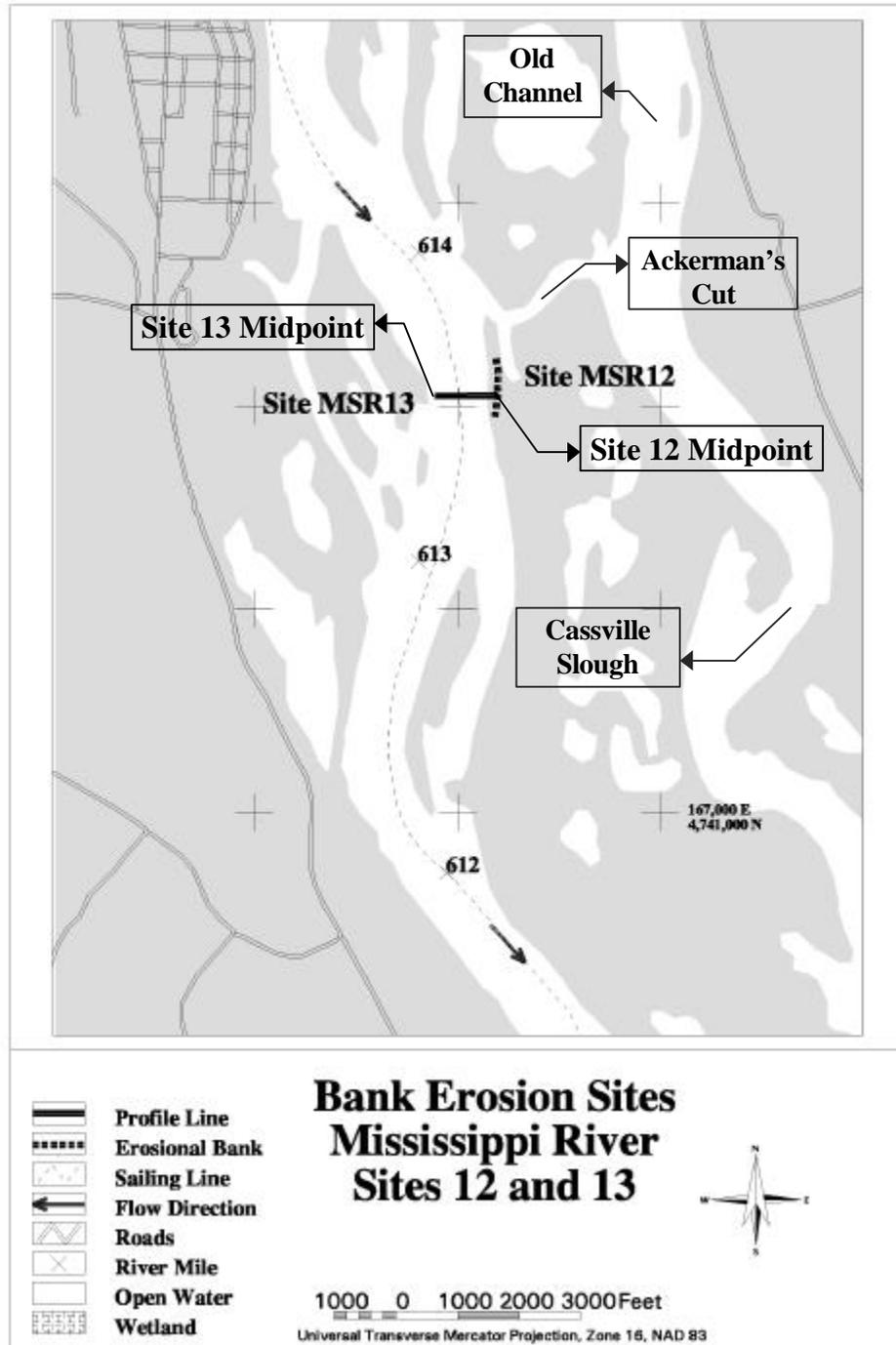
Two sampling tube cores were advanced on the very late Holocene island. The cores generally showed thick historical alluvium overlying a very poorly drained very late Holocene soil. At another island just upstream, a soil core showed a very late Holocene soil below thick historical alluvium. It is estimated that the historical alluvium near the main channel ranges from about 5 ft to 7 ft thick in this portion of Pool 10.

Causative factors for bank retreat at this site include flood-flow erosion, rework-transport of failed soils and recently deposited sediments within bench areas, undercutting, and piping. Because this site is located away from the sailing line along the right bank, impacts of traffic-induced waves on erosion of bench areas is minor. This eroded bank is classified as a combination of bank Type D and Type E.

**12. Site 12 at RM 613.6 LDB (Pool 11)**

This left-bank island site on the outside of a slight bend, shown in figure 7-42, is located only 1.5 miles downstream from Lock & Dam No. 10, and 0.25 mile downstream

from Ackerman's Cut. Upstream and downstream views of the site are shown in Photos 7-30 and 7-31, respectively. Three bank sections obtained at this site are shown in figures



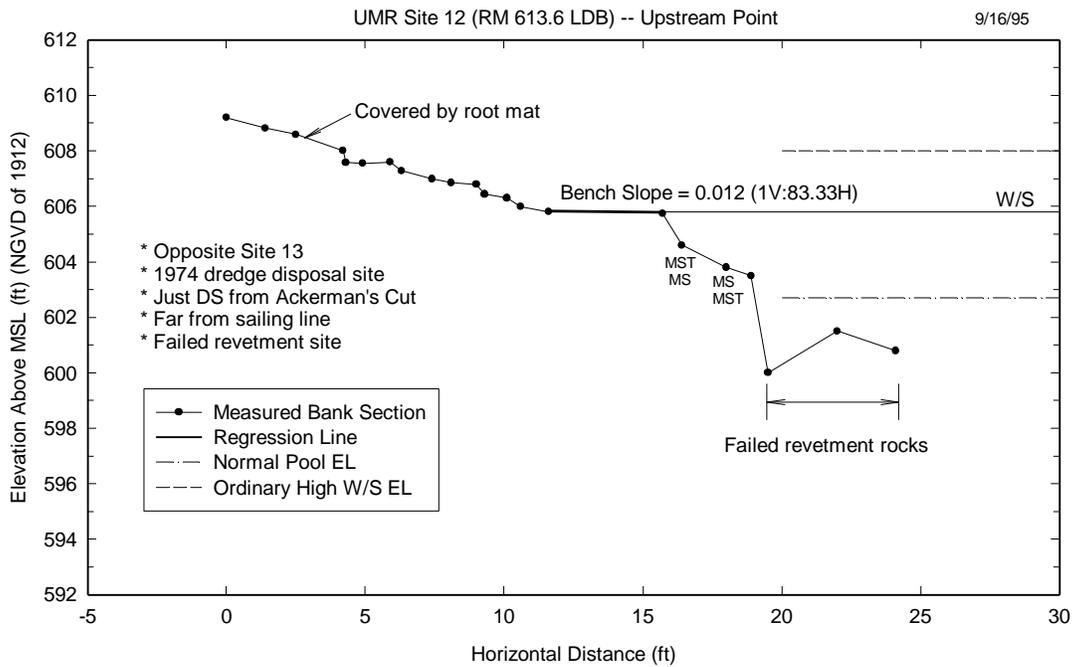
**Figure 7-42** A map showing Mississippi River Sites 12 and 13



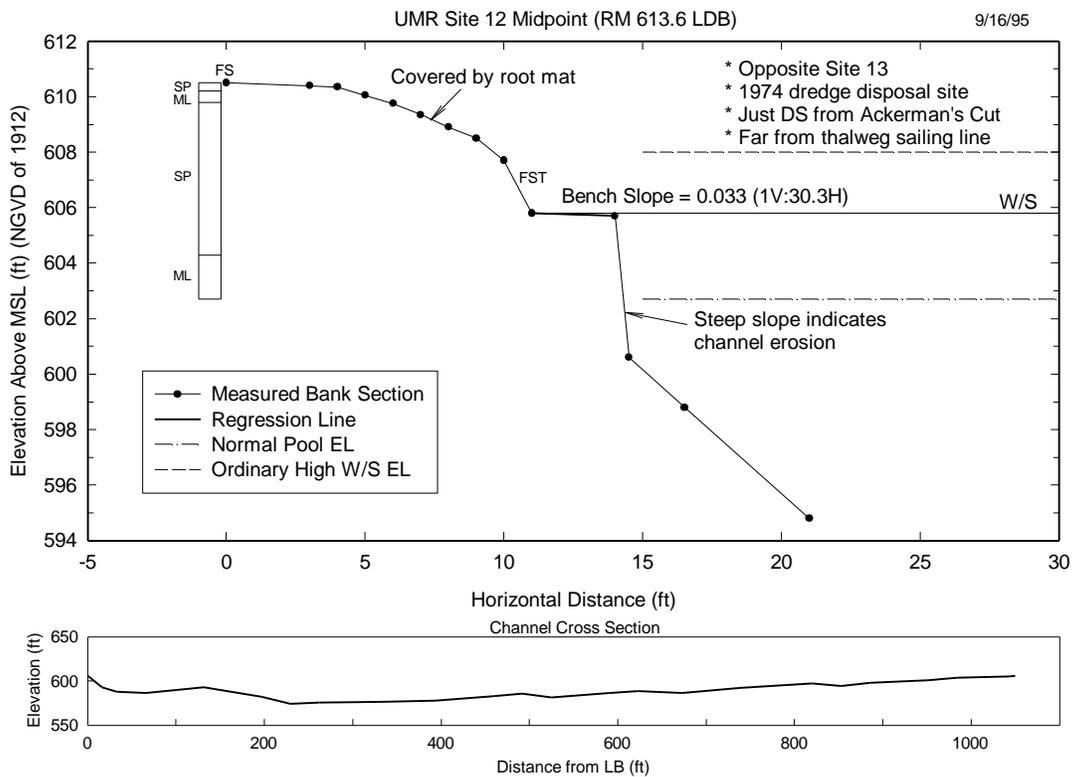
**Photo 7-30 An upstream view of Site 12 midpoint**



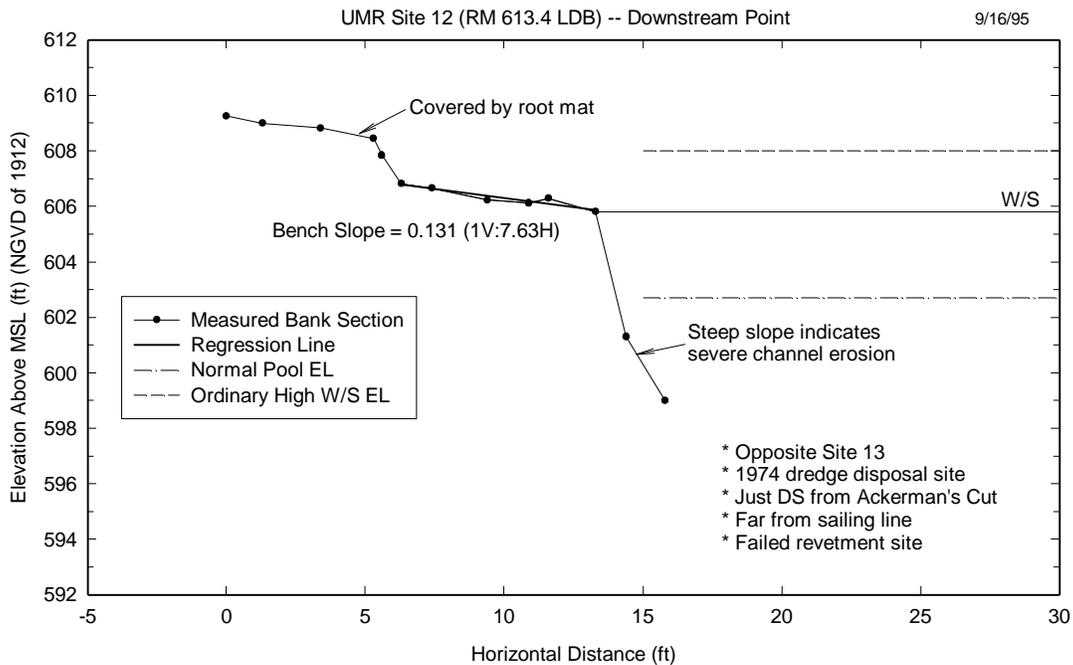
**Photo 7-31 A downstream view of Site 12 midpoint**



**Figure 7-43 Bank section measured at Site 12 upstream point**



**Figure 7-44 Bank section and channel cross section measured at Site 12 midpoint**



**Figure 7-45 Bank section measured at Site 12 downstream point**

7-43 through 7-45. Bank retreat at Site 12 since 1984 is apparent in figure 7-42. As can be seen in figure 7-44, the thalweg is very close to this left bank, and evidence of severe channel erosion was observed at the site. This site was a dredged material disposal site. At the upstream section, failed revetment rocks were found adjacent to the water's edge (see figure 7-43). Since the upper end of Cassville Slough (eastern limb of the MR) was closed when Lock & Dam No. 10 was completed in 1938, the new MR channel flow, downstream from the dam spillways located on the west side of the river, had a tendency to return to the old channel slough, resulting in Ackerman's Cut. According to Nakato (1983), as much as 28 percent of the river flow was passing through Ackerman's Cut, causing reduction of sediment-transport capacity of the main channel and transport of sediment into the slough. In order to protect the fishery resources of Cassville Slough and to reduce dredging requirements in the downstream navigation channel, the COE-RID constructed partial closure structures in Ackerman's Cut in 1985. A post-construction study was conducted in 1986 and it was found that the flow diversion rate was reduced to 18 percent from the previous 28 percent (Toda and Nakato 1987). The bank was covered

by a root mat. The top of the bank consists of old dredged spoil material (FS) and the scarp material is silt (FST). Subaqueous soil consists of silt (MST) and sand (MS).

The sampling tube core advanced at the midpoint section showed historical alluvium throughout the 7.8 ft deep profile. The early to mid-Holocene surface probably lies further inland (east) from this near-channel location. Earlier work conducted near Ackerman's Cut in 1984 identified buried late Holocene soils and Woodland pottery in a bank exposure. However, no archaeological site number has been assigned.

Causative factors for bank retreat at this site include flood damage which includes erosional oversteepening and rapid recessional loading and failure, wave and rework-transport of failed soils and recently deposited sediments within berm and bench areas, cleft pressures and block displacement, and minor piping. There is potential for traffic-generated wave erosion at this site. This bank section is classified as a combination of bank Type E and Type F.

### ***13. Site 13 at RM 613.6 RDB (Pool 11)***

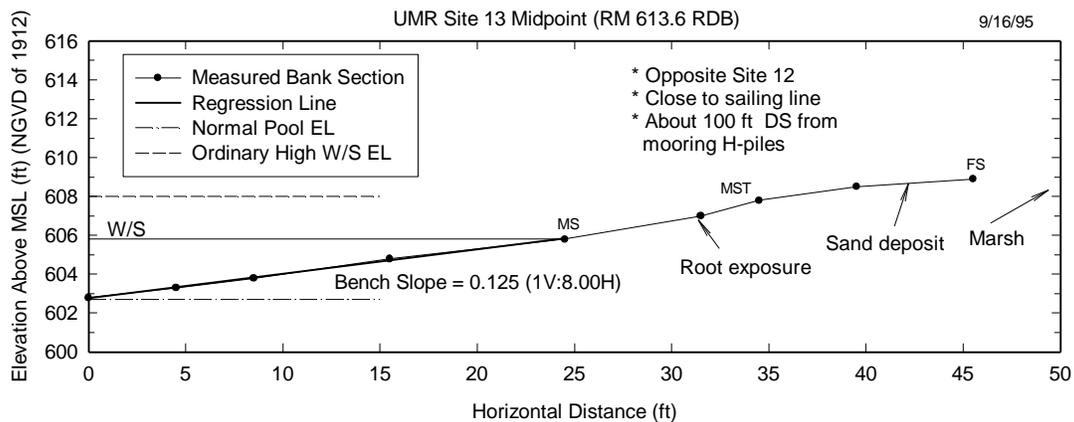
This right-bank island site is located on the inside of the bend opposite Site 12, as shown in figure 42. Upstream and downstream views of the site are shown in Photos 7-



**Photo 7-32 An upstream view of Site 13 midpoint**



**Photo 7-33 A downstream view of Site 13 midpoint**



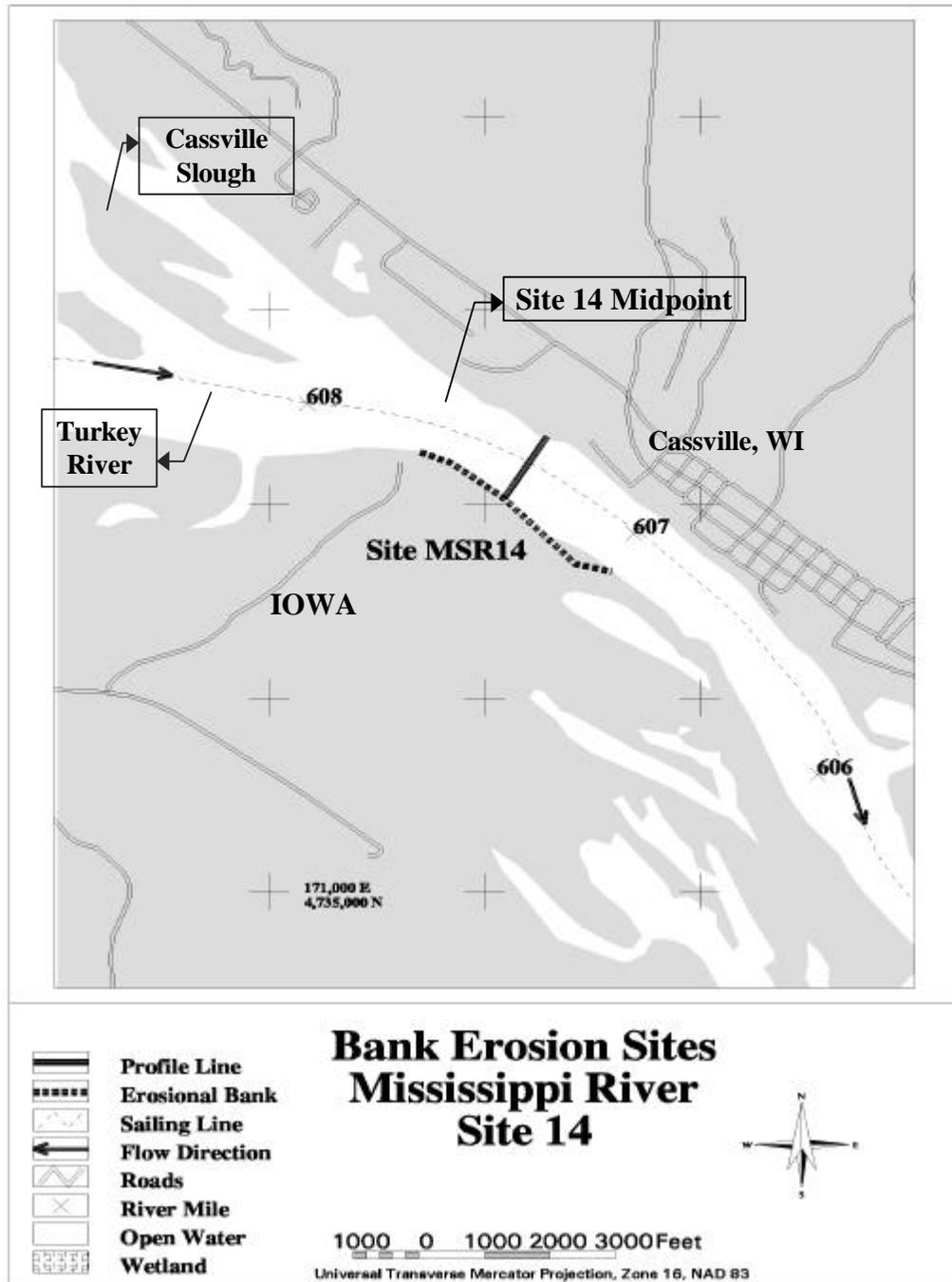
**Figure 7-46 Bank section measured at Site 13 midpoint**

32 and 7-33, respectively. The bank section is shown in figure 7-46. The site is located within a wing-dam field and the low-lying island is connected to a marsh area. There is a barge-mooring facility located about 100 ft upstream from this site. The bank bench and berm area cover consists of recent silt (MST) and sand (FS-MS) deposits left by floods.

Causative factors for bank retreat at this site include piping failure, and wave and flow rework-transport of recently deposited sediments in bench areas. This site is classified as bank Type E.

**14. Site 14 at RM 607.5 RDB (Pool 11)**

This right-bank, barge-fleeting site, shown in figure 7-47, is inside of a slight bend, and about 7.5 miles downstream from Lock & Dam No. 10 and 1 mile upstream from



**Figure 7-47 A site map showing Mississippi River Site 14**



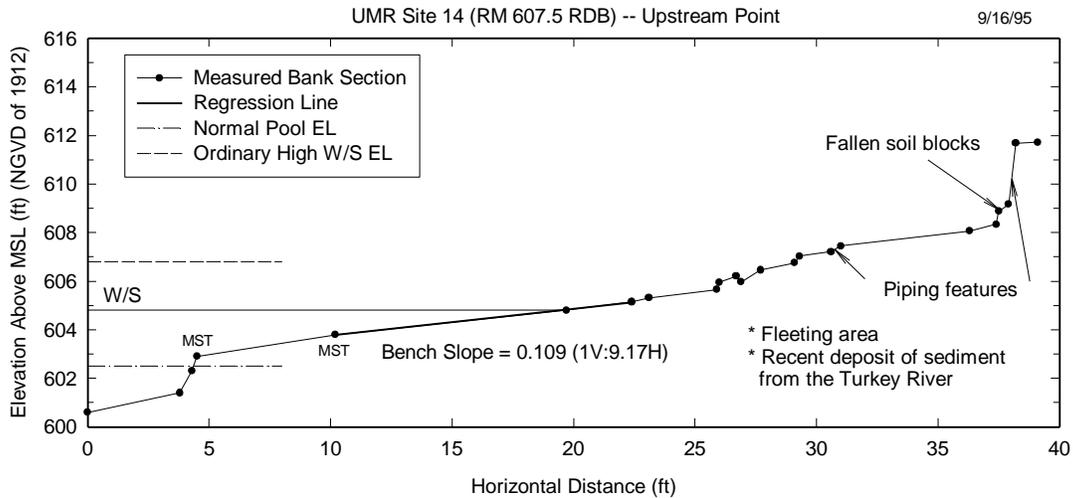
**Photo 7-34 An upstream view of Site 14 midpoint**



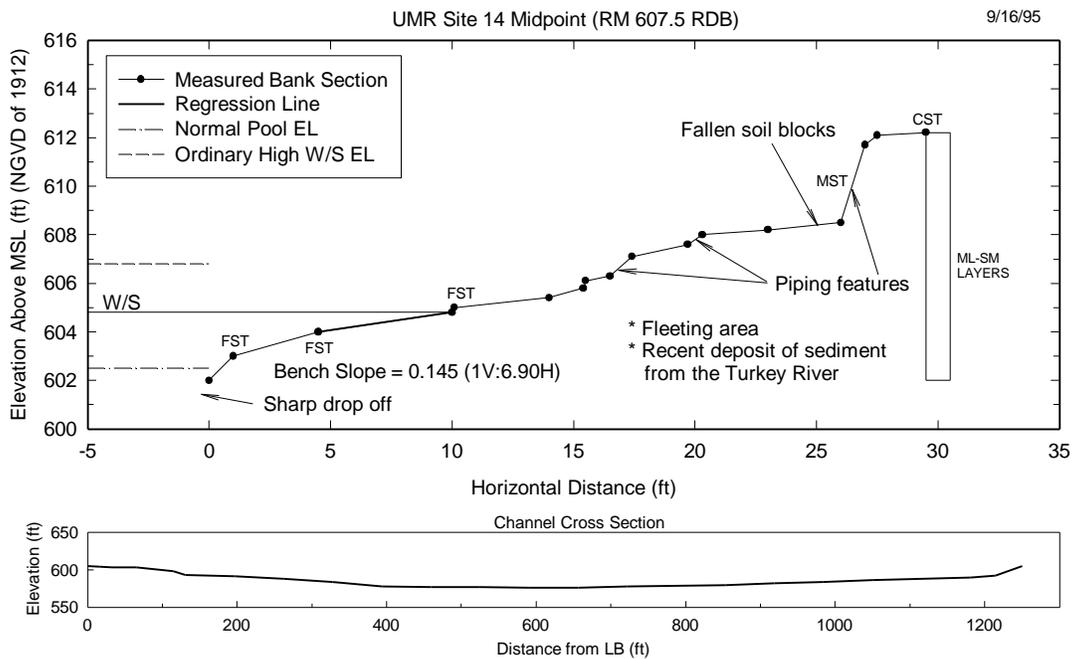
**Photo 7-35 A downstream view of Site 14 midpoint**

Cassville, Wisconsin. The Turkey River confluence is only 0.5 mile upstream from the site. Upstream and downstream views of the site are shown in Photos 7-34 and 7-35, respectively. Three bank sections taken at this site are plotted in figures 7-48 through 7-

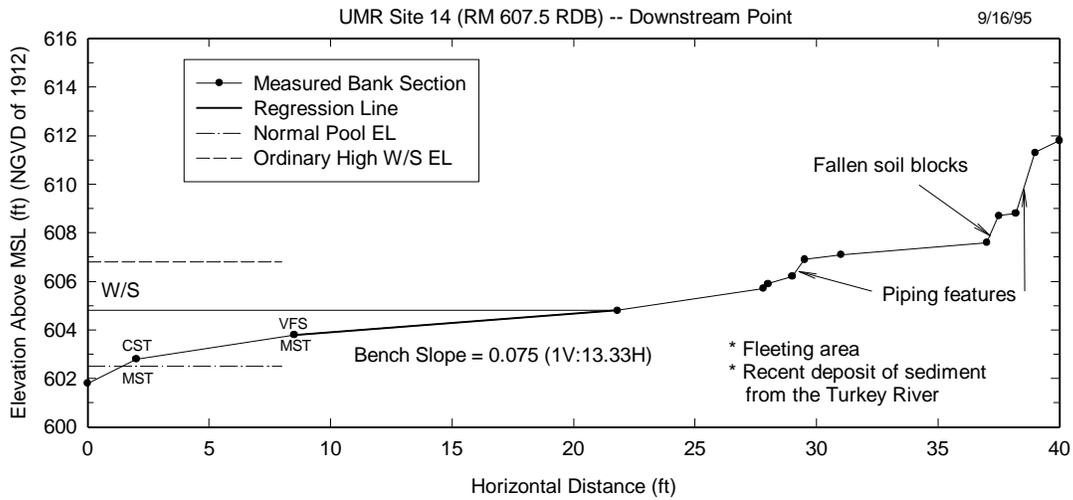
50. The bank soils consist of fine silt (FST) to coarse silt (CST). Fallen soil blocks were observed at the base of the scarp, and piping features were observed within the bank scarp as well as at minor scarps within the berm and bench rework-transport zones. As can be seen in figure 7-49, the surveyed river cross section is atypical for a river bend because the site is located near the upstream end of the bend.



**Figure 7-48 Bank section measured at Site 14 upstream point**



**Figure 7-49 Bank section and channel cross section measured at Site 14 midpoint**



**Figure 7-50 Bank section measured at Site 14 downstream point**

Thick historical (ML-SM) deposits were observed in the sampling tube core throughout the entire 10.2 ft profile. Scarp exposures further confirm the thick deposits which represent historical alluvium from both the MR and the Turkey River. The Turkey River fan is progressing into the main valley. Landform and depositional contacts near



**Photo 7-36 Piping feature of Site 14 midpoint**