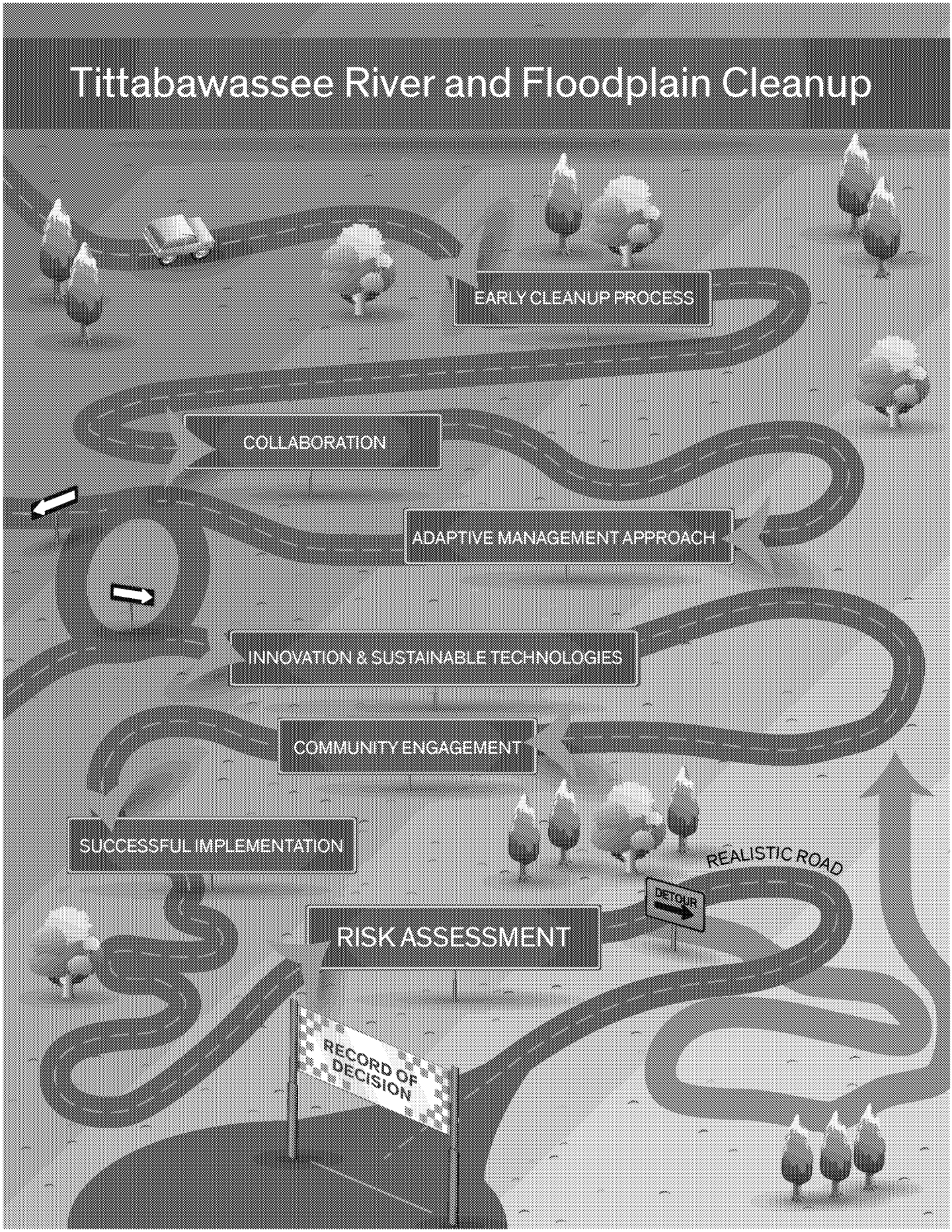
Tittabawassee River and Floodplain Cleanup:

A Model for Success

JUNE 15, 2017

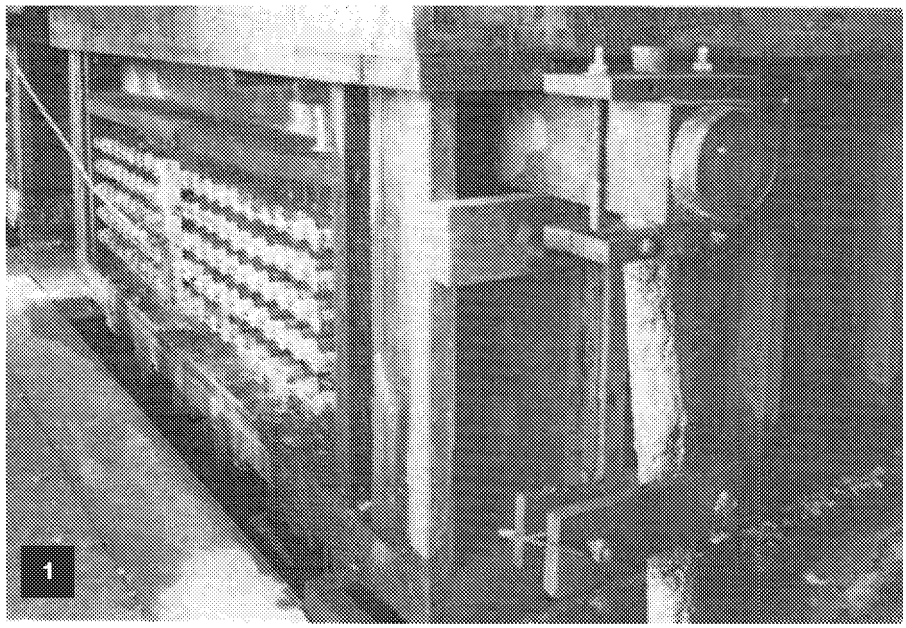
Tittabawassee River and Floodplain Cleanup

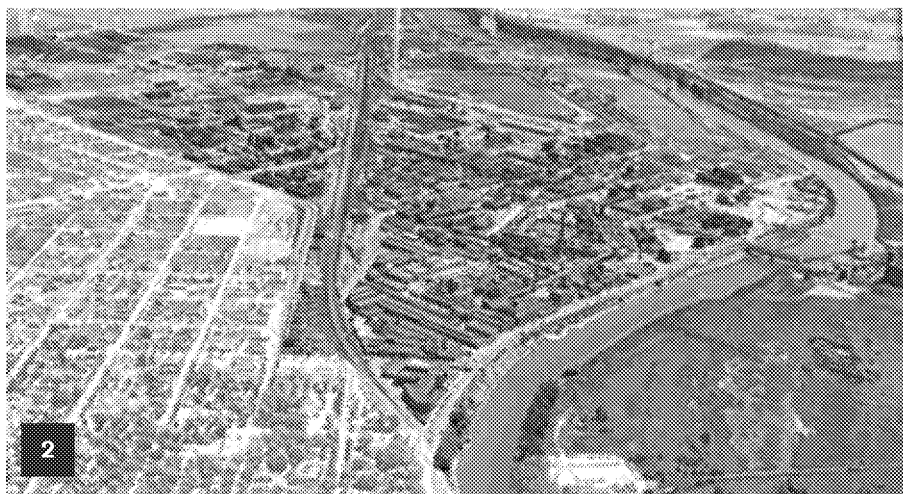


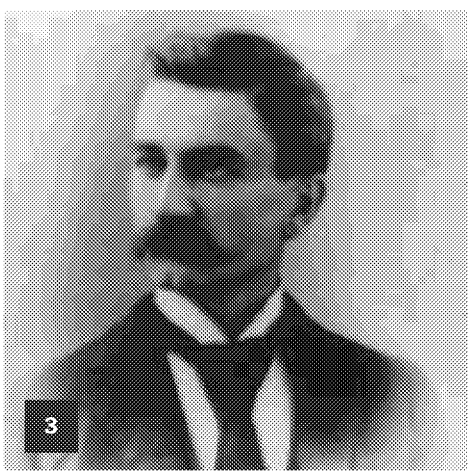
Introduction

Background

Dioxins and furans were formed in the early days of Dow's manufacturing processes. In the early 1900s, Dow used an electrolysis process to produce bleaching powders and bromides. Before waste management ponds were built around 1920, some solids were washed into the Tittabawassee River. Dioxin and furan compounds were not well understood until the 1960s.







1 **Dow electrolytic bromine cell, 1910-1916 period.**

2 **Historic photo of Michigan Operations showing early waste management ponds.**

3 **Herbert H. Dow founded The Dow Chemical Company in 1897.**

4 **Historic photo of Michigan Operations showing cell buildings used in the electrolysis process.**

Site Overview

The site is defined as the lower Tittabawassee River and its floodplain, the Saginaw River and its floodplain, and and portions of the Saginaw Bay.

- **Tittabawassee River and banks:** 24 miles
- **Tittabawassee River floodplain:** about 4,500 acres
- **Saginaw River:** 22 miles

Extensive Investigation Activities

Dow, in partnership with DEQ and EPA, has extensively studied floodplain and bank soils and in-channel sediments since 2006, gathering tens of thousands of samples. Since 2010 alone, Dow has collected more than 1,000 samples to help inform remedial design, cleanup and monitoring activities.

Field crews collecting floodplain and bank soil samples

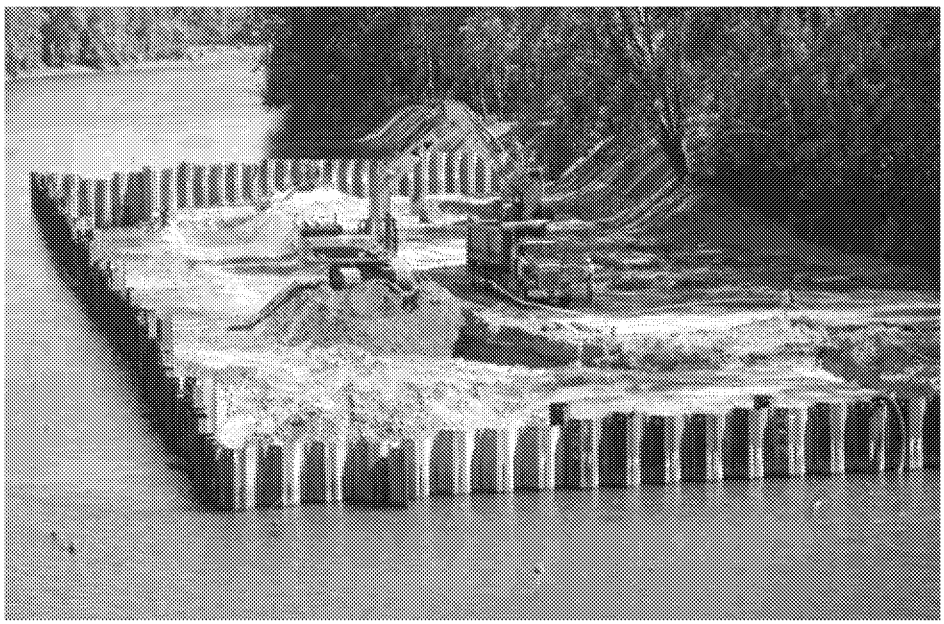
Sonic rig used to install sampling wells

Site map showing soil and sediment sample locations

Critical Elements for Success

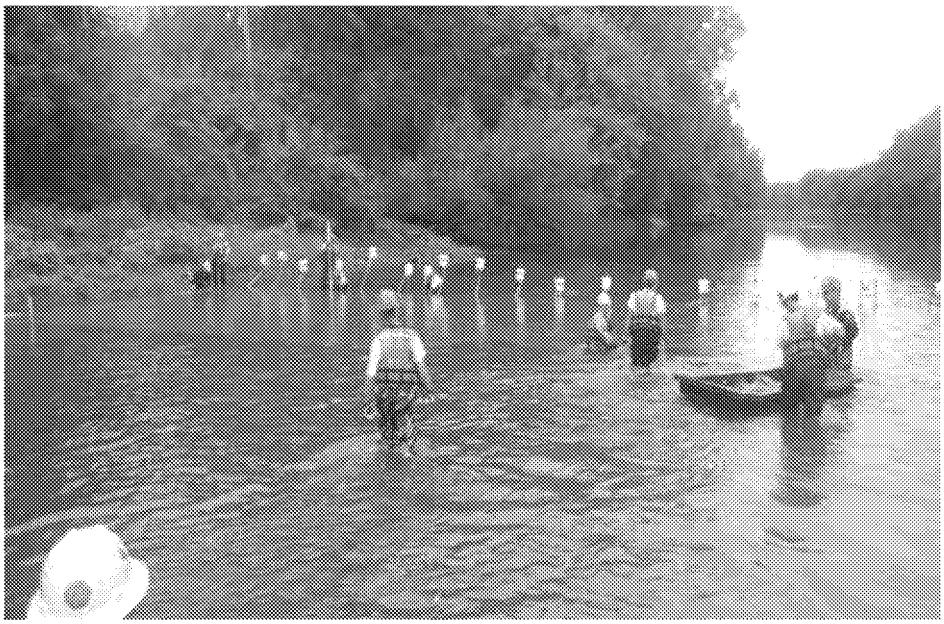
Early Cleanup

While following the Superfund Alternative Process under CERCLA, Dow's efforts have focused on rapid implementation, with residual risk assessment at a later time.

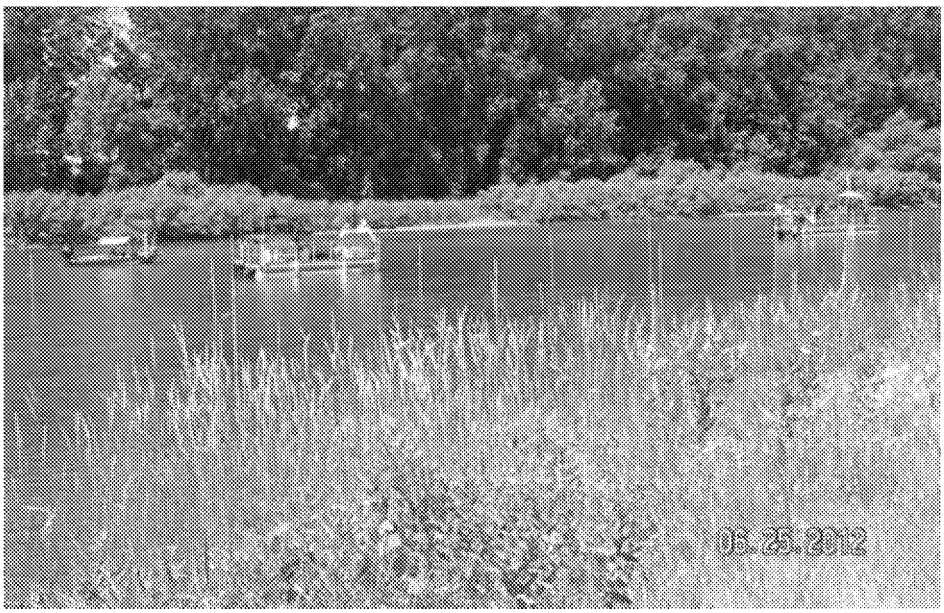


In-channel sediment removal

In-channel sediment removal



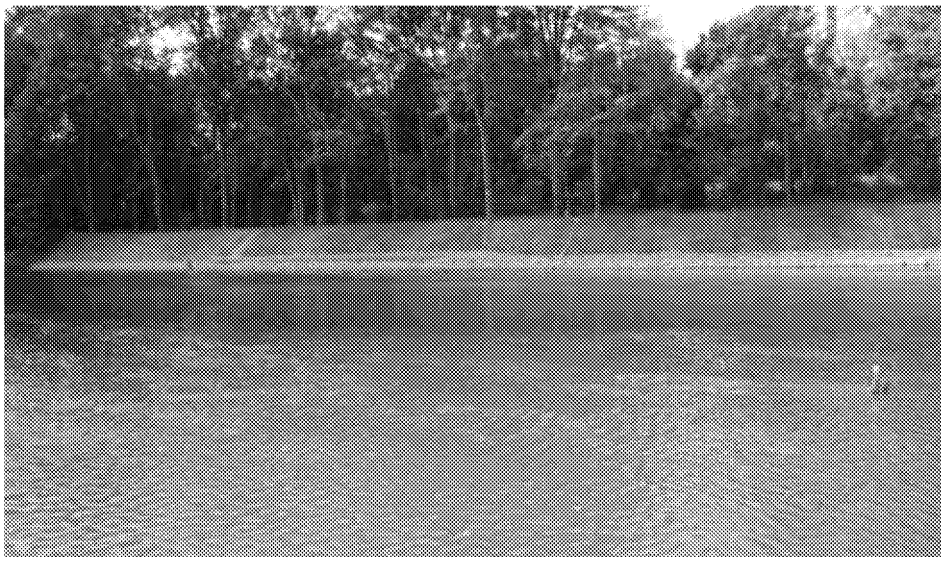
Installation of a Cellular Containment System (CCS)



DNAPL Recovery activities in Segment 1

Bank preparation for stabilization including canopy management

Early Cleanup – continued



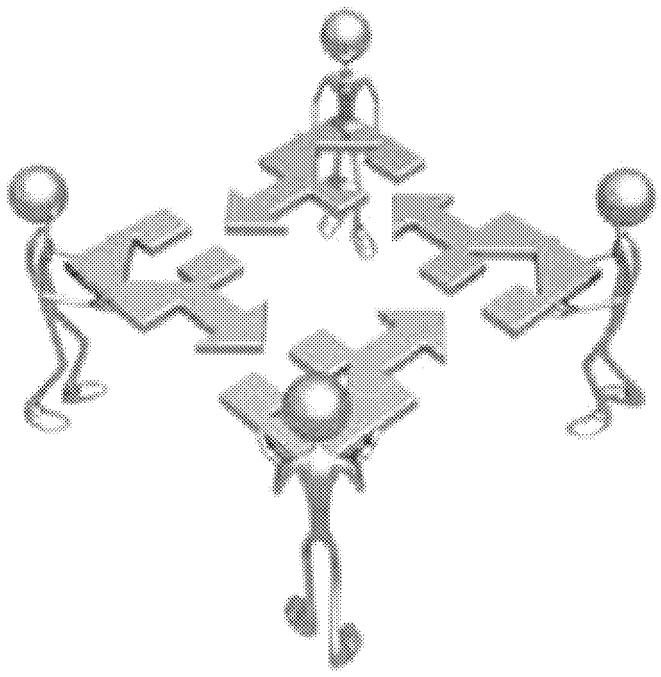
Bank management area after construction and early vegetation growth

Bank management area showing established vegetation

Floodplain removal area being seeded following the completion of removal activities

Collaboration with EPA and MDEQ

Working in partnership with EPA and MDEQ, Dow teams have taken a pragmatic yet flexible approach to project management. This involved monthly meetings, work in real-time and commitment to an aggressive timeline.



Adaptive Management Approach and Innovative, Sustainable Technologies

With the adaptive management approach, lessons learned in one phase of cleanup inform the next. Promoting continuous improvement and innovative technologies, this approach results in faster and more effective cleanups tailored to the specific characteristics of the Tittabawassee River.

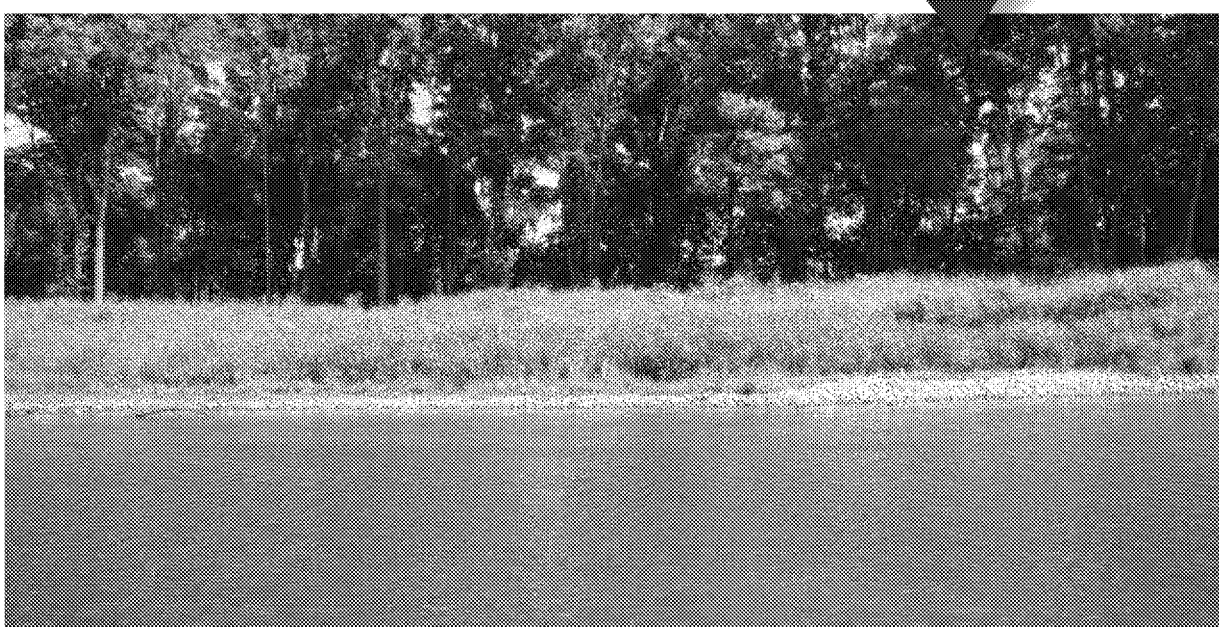
In-channel CCS cap pilot technology installed at Reach J in 2010. Information gained from the pilot about the implementablity and effectiveness of the cap was used to inform future cap projects.

What we learned

The piloted cap technology became a final remedy selected by the EPA. Picture of cap installed at Sediment Management Area 1-4.

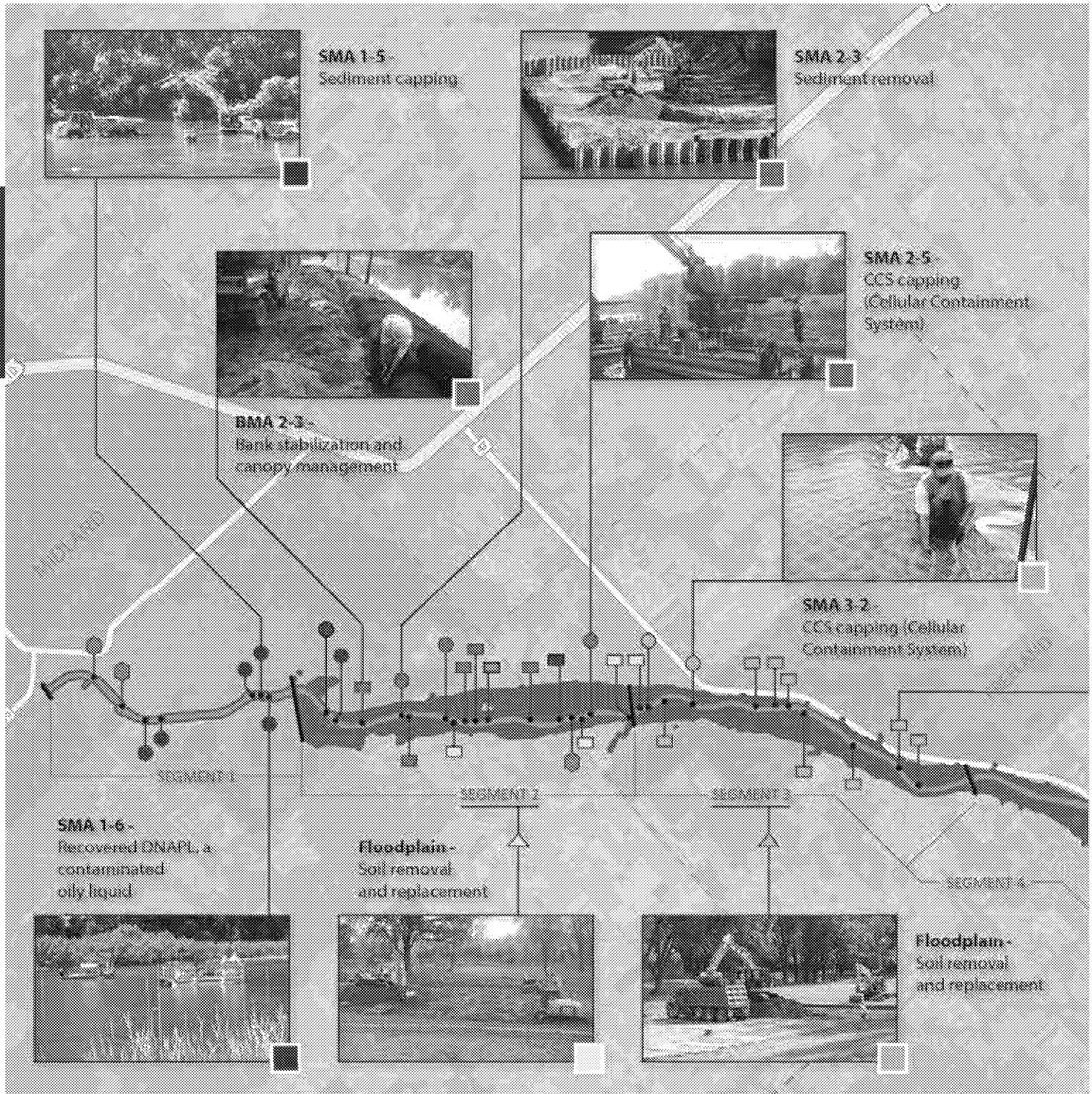
What we learned

Pilot bank stabilization technologies were installed in 2008 through 2011 along the Tittabawassee River. The pilots provided EPA and Dow information to select and design effective, bioengineered and sustainable technologies for banks.



The piloted bank technologies that performed well became final cleanup technologies at bank management areas. Pictures depicts stabilized bank at Bank Management Area 2-4.

Aggressive Timeline



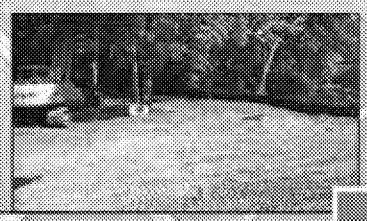
LEGEND: Cleanups completed within the Tittabawassee River and its floodplain from Midland to the confluence of the Shiawassee River.

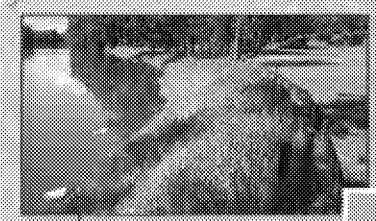
Early Actions Pre 2010	2010 & 2011	2012	2013	2014	2015	2016

Sediment Cleanup Areas | Bank Cleanup Areas | Tittabawassee River | Floodplain Area

Floodplain Cleanup Areas | Early Actions

Riverside Boulevard -
Removed and replaced soil





BMA 3-9 -
Bank stabilization

Wickes Park -
Sediment dredging

SEGMENT 5 SEGMENT 6 SEGMENT 7

MM Island -
Soil removal and sediment capping

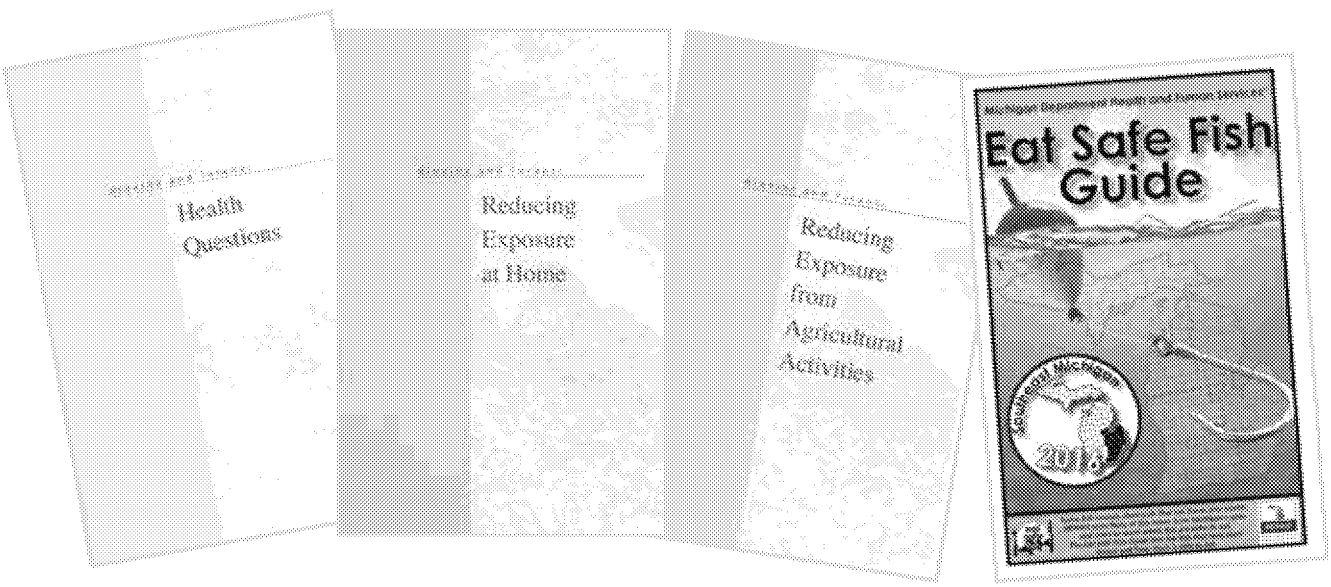
West Michigan Park -
Removed soil

SCALE:

www.epa.gov/superfund/tittabawassee-river

Community Engagement

Dow and EPA continue to partner on extensive outreach to affected property owners and the community at large. The robust community involvement program includes EPA Information Sessions, public meetings and a Community Advisory Group (CAG), as well as frequent communications to keep property owners updated on project stages and activities.



Educational brochures

TITTABAWASSEE RIVER CONSERVATION PROGRAM

Dow created this voluntary program to preserve the natural features of the river and floodplain and ensure the long-term effectiveness of the cleanup. The Tittabawassee River Conservation program is available to qualifying land owners who have property within the eight-year floodplain and whose land will be evaluated for cleanup. The current use of the floodplain consists of 5% residential maintained, 18% active agriculture, and 76% forest, wetland, meadows or ponds.

FIGURE: Eight-Year Floodplain Along the Tittabawassee River

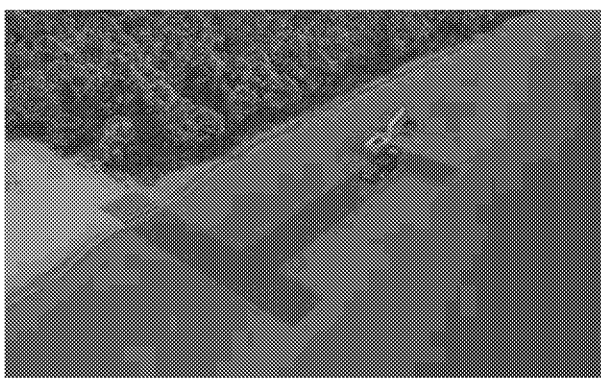
Fast Facts
Preserves the natural features of the river and floodplain.
Provides access to the property for sampling and implementing the cleanup, and for periodic monitoring, if needed.
Allows property owners to continue using the property as they do today (unless they currently raise poultry or livestock on the floodplain, which the Covenant prohibits).
Signing the Conservation Covenant means the owner is confirming property ownership, and agrees to the conditions of the Covenant.

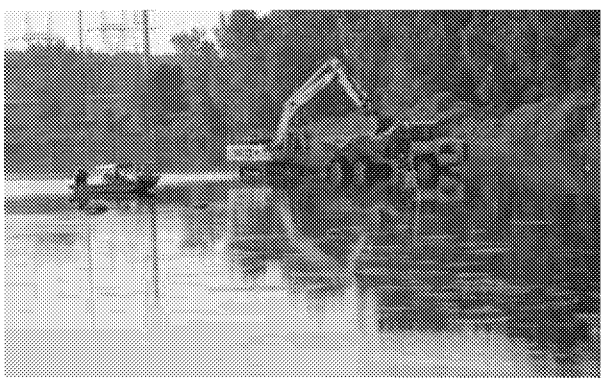
Successful Implementation

The adaptive management approach and use of innovative sustainable technologies – along with collaboration and early cleanup actions – resulted in faster and more effective cleanups. Remedy options were tailored to the specific characteristics of the Tittabwassee River.

Armor Stone Cap

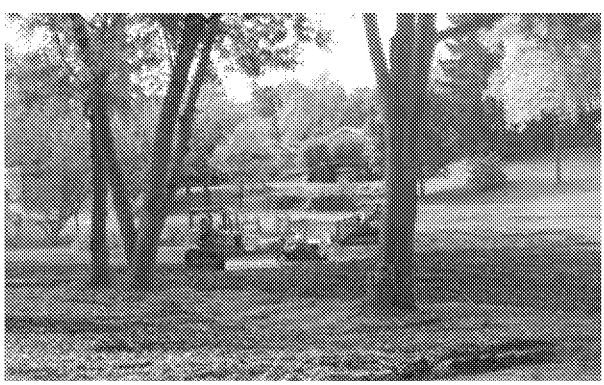
Site access for equipment into the sediment management area at SMA 1-5.





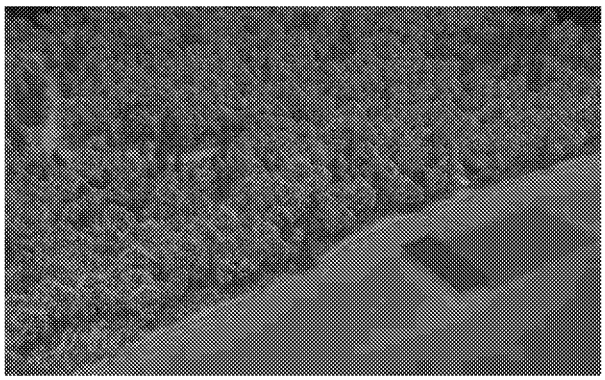
Installing armor stone over the sediment managment area in SMA 1-5.

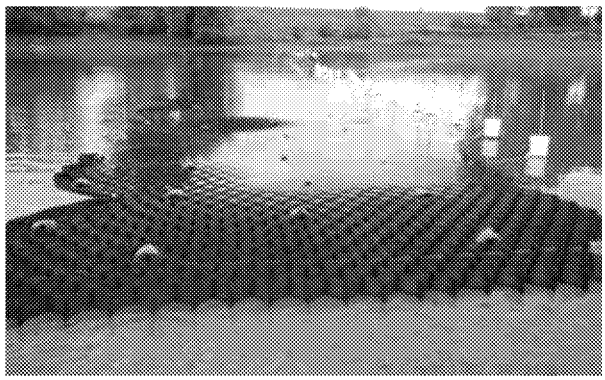
Floodplain Removal Activities



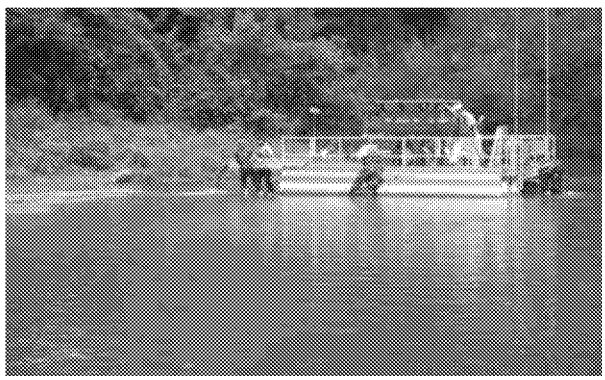
Floodplain removal activities along the Tittabawassee River.

CCS Cap

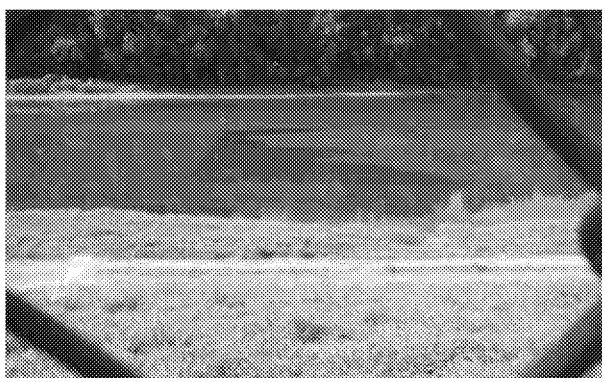




After establishing access, installation of cellular containment system (CCS) cap.

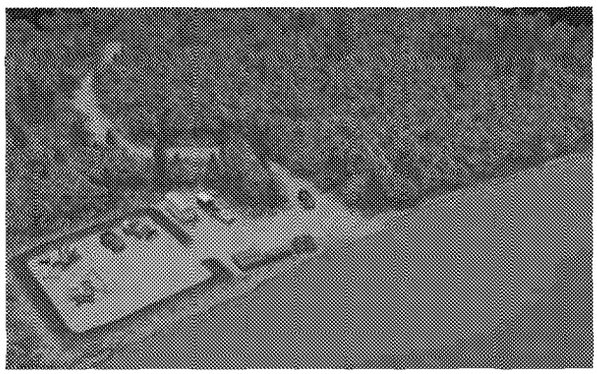


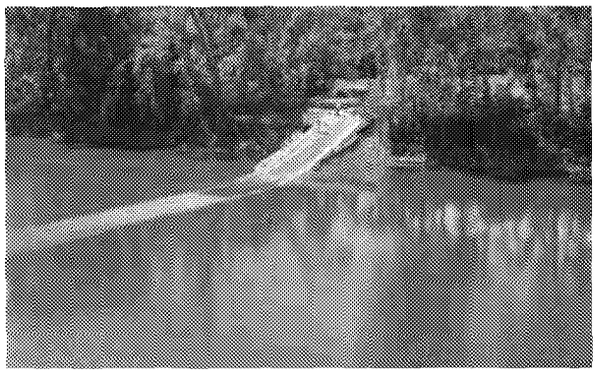
Installation of armor stone around the outer edge of the CCS cap using a pontoon boat with a conveyor system.



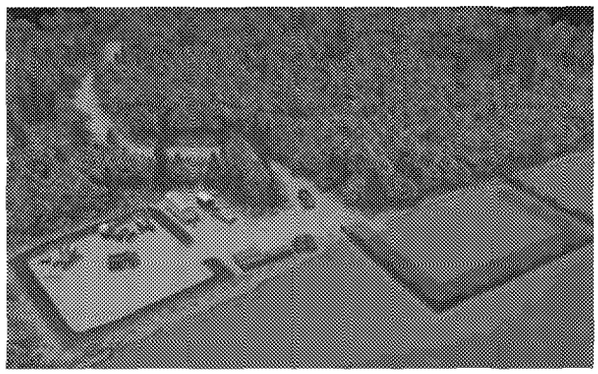
CCS cap filling with clean river sediment which naturally moved down the river system.

In-channel Removal

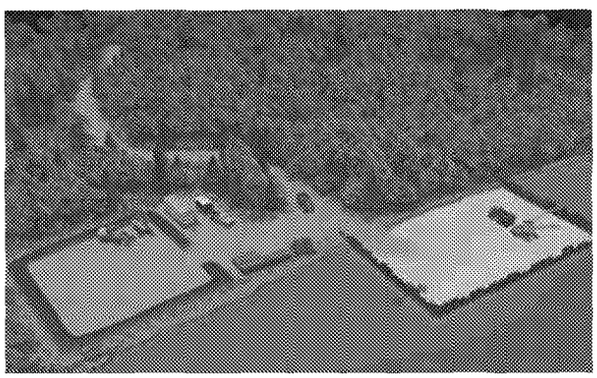


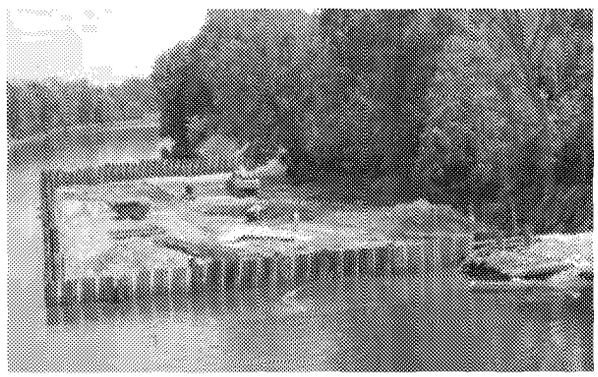


Establishing access into the sediment management area.



Installation of sheetpile walls around the sediment management area to allow the area to be dewatered, removal of sediment in the dry.





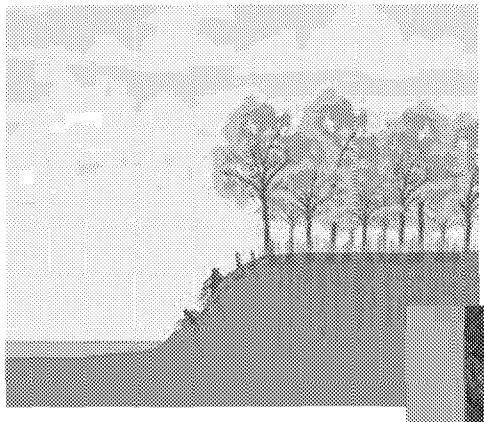
Removal of river sediment with direct loading into trucks for transportation and disposal.

Bank Stabilization

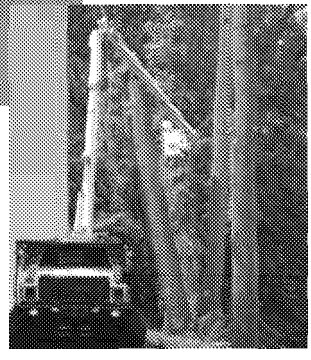
Before

Banks that are unstable and contain contaminated soil are being stabilized to stop bank erosion.

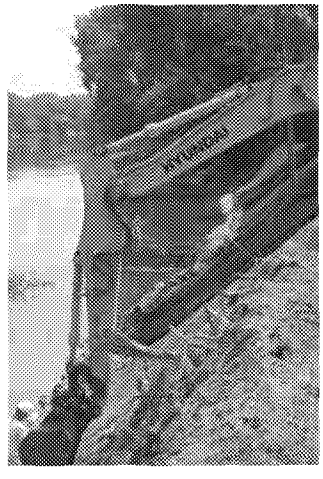
During



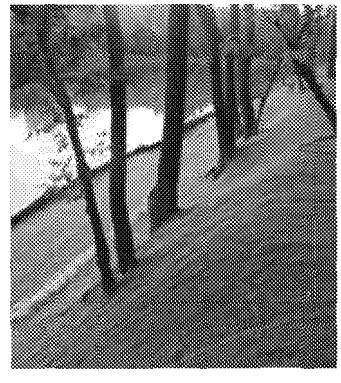
Step 1: Trees are trimmed *or removed* to allow sun light to the bank so deep rooting vegetation can stabilize the banks.



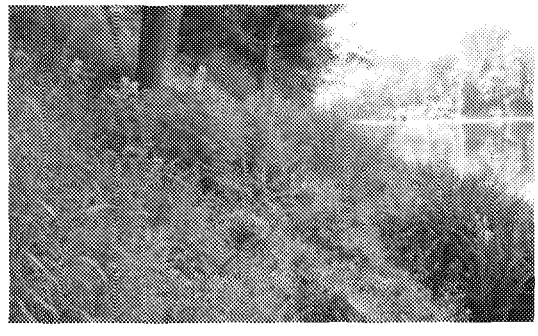
Step 2: In some cases the bank *angle is reduced* to help create stable conditions.



Step 3: Special materials are *often used* to help stabilize the banks and allow the native vegetation to be established.



After



Monitoring and maintenance *activities will ensure* that the remedy continues to maintain bank stability over time.

Risk Assessment

Extensive site-specific human exposure and ecological risk studies funded by unrestricted grants from Dow, along with other scientific studies, will be factored into final risk assessment.

University of Michigan Dioxin Exposure Study (UMDES)

"The Study found no direct exposure pathway by which dioxins in soils and sediments have accumulated in bodies of residents inhabiting Midland and Saginaw."

- Principal Investigator
Dr. David Garabrant

The University of Michigan
Dioxin Exposure Study

Michigan State University Wildlife Study

"Despite more than 20,000 person-hours in the field and the conscription of more than 6,350 animals, we were unable to identify the presence of any adverse effects associated with exposure to the contaminants of concern."

- Principal Investigator
Dr. Matt Zwiernik

The final step of a risk assessment will be a collaborative effort between Dow, EPA, and MDEQ, and will require a realistic, pragmatic approach in order for this project to be successful.