Buttahatchie River River Bank Stabilization Project

Brad Maurer, The Nature Conservancy
Andrew Peck, The Nature Conservancy

The Buttahatchie River watershed is recognized by local and regional scientists, conservationists, and outdoors people for its ecological significance, especially the unique biological diversity found and documented in this system (Mississippi Museum of Natural Science, 2005). Mussel surveys, conducted by O'Neil et al (2004; 69 FR 40084), and the Mississippi Department of Wildlife Fisheries and Parks (2004) have documented viable communities of rare mussel species along several reaches of the Buttahatchie River and some of its major tributaries. In addition, rare and unique fish communities and species have been reported from the Buttahatchie River system (Mississippi Museum of Natural Science, 2005). In an unpublished survey (Hicks 2004) of 23 biological experts in Mississippi, the Buttahatchie River ranked second behind the Pascagoula River out of 14 rivers in Mississippi in terms of priority for conservation and ecological significance (Mississippi Museum of Natural Science, 2005).

However, the lower reaches of the river have undergone wholesale channel adjustments in recent years, including widening, rapid erosion, quarry capture, and excess sediment. Erosion and excess sediment continue to be a problem in this area. The Stability Analysis of the Buttahatchie River by USDA National Sedimentation Laboratory (2005) cites disturbances including meander cutoffs, construction of the Tennessee-Tombigbee Waterway (including the impoundment of the Columbus pool), and gravel-mine capture.

The Buttahatchie River Stabilization Project was completed by The Nature Conservancy and partners in October, 2010 , to demonstrate techniques to reduce non-point source (NPS) pollution within the Buttahatchie River Watershed, specifically NPS resulting from eroding river banks. The project was supported by a Section 319 Grant, and used several Best Management Practices (BMPs) designed to show habitat-oriented options to riverbank stabilization. Located in Lowndes County, Mississippi, the project met several important goals. Most immediately, it stabilized a rapidly eroding river bank and prevented thousands of cubic yards of soil from washing into the river. In the long term it is expected that the river bed in this area will also become more stable, and this will allow for improved habitat for fish, aquatic invertebrates, mussels, and other benthic organisms.

It also created an open-air educational site that demonstrates several useful stabilization BMPs and sets of techniques. This unique setting allows for the comparison of various techniques in one location.

The presentation will describe the individual BMPs, their installation process, and the resulting improvements to the river bank.

Introduction

The Buttahatchie River originates in northwestern Alabama and flows southwest into northeastern Mississippi where it joins the Tennessee-Tombigbee Waterway north of Columbus, Mississippi. The watershed encompasses approximately 556,750 acres. This total acreage is divided between Mississippi with approximately 128,459 acres and Alabama with approximately 428,291 acres. Counties within the watershed include Itawamba, Lowndes and Monroe Counties in Mississippi and Franklin, Lamar, Marion and Winston Counties in Alabama. The Buttahatchie River was listed as an important site for conservation of freshwater biodiversity in North America by the World Wildlife Fund, United States in 2000. It has also been classified as a Freshwater Conservation Area by the Nature Conservancy (Smith, et al 2002). In an unpublished survey (Hicks 2004) of 23 biological experts in Mississippi, the Buttahatchie River ranked second behind the Pascagoula River out of 14 rivers in Mississippi in terms of priority for conservation and ecological significance (Mississippi Museum of Natural Science, 2005).

The Buttahatchie River watershed is a Conservation Priority Area for The Nature Conservancy (TNC). Local and regional scientists, conservationists, and outdoors people have long recognized the ecological significance of the Buttahatchie River, especially the unique biological diversity found and documented in this system (Mississippi Museum of Natural Science, 2005). Mussel surveys, conducted by O'Neil et al(2004; 69 FR 40084), and the Mississippi Department of Wildlife Fisheries and Parks (2004) have documented viable communities of rare mussel species along several reaches of the Buttahatchie River and some of its major tributaries. In addition, rare and unique fish communities and species have been reported from the Buttahatchie River system (Mississippi Museum of Natural Science, 2005). However, the lower reaches of the river have undergone wholesale channel adjustments in recent years, including widening, rapid erosion, quarry capture, and excess sediment. Erosion and excess sediment continue to be a problem in this area. The Stability Analysis of the Buttahatchie River by USDA National Sedimentation Laboratory (2005) cites disturbances including meander cutoffs, construction of the Tennessee-Tombigbee Waterway (including the impoundment of the Columbus pool), and gravel-mine capture.

Sediment

Erosion and sedimentation are natural and necessary processes in streams and rivers, and the movement of sediment in a stable system occurs at steady rates when averaged over fairly long time periods (such as years or decades). However, changes in conditions can cause perturbations to the amount of sediment in a river, and this can lead to disequilibrium and further adjustments to the river morphology. The lower Buttahatchie River has been undergoing morphological adjustments for several years with mass wasting of river banks and rapid deposition of large gravel bars apparent along much of the river in this area (Pollen, et al. 2005). These adjustments are the result of land use practices, gravel mining adjacent to the channel, and changes resulting from the construction of the Tennessee-Tombigbee Waterway, completed in 1984.

Purpose

The purpose of this project is to demonstrate techniques to reduce non-point source (NPS) pollution within the Buttahatchie River Watershed, specifically NPS resulting from eroding river banks. This project used eight Best Management Practices (BMPs) designed to show habitat-oriented options to riverbank stabilization (Lowndes County Site, Fig. 1).

Site selection

The initial site review was conducted through an examination of aerial photographs. Following the aerial photo review, several landowners were contacted, and windshield surveys and site visits were conducted.

The selected site is situated on the Buttahatchie River in Lowndes County met all of our selection criteria which included:

- Site must be within the Buttahatchie River watershed,
- The site must be typical of erosion problems in the watershed (rapidly eroding banks in sandy soil),
- The site must be accessible for construction equipment and personnel,
- The site must be in a convenient location for tours and educational visits,
- The landowner must be willing to allow the work and to leave the completed project in place without removing or altering it.

Selected Site

The Lowndes County project site is located along the Buttahatchie River approximately 10 miles north of Columbus, Mississippi, east of Highway 45 N on the west bank of the river in Lowndes County (Latitude 33.670495 N and Longitude -88.424005 W; West, Section 16, Township 16S, Range 18W; Fig. 1) and the watershed is located in the 8-digit Hydrologic Unit Code 03160103. The property is 16th Section land owned by the Lowndes County School District, and leased by the Lowndes County Wildlife Federation for hunting; both have been highly cooperative partners in the project.

Partners

Partners for the project included the Mississippi Department of Environmental Quality, Lowndes County School District, Ellis Construction, Mossy Oak Nativ Nurseries, Wallace Environmental, Mossy Oak Productions, Phillips Contracting, Lowndes County Wildlife Federation, the Tombigbee River Valley Watershed Management District, USDA-NRCS of Lowndes and Monroe Counties, private landowners, and anonymous contributors.

Project Implementation

Lowndes County Site

Existing Conditions

The Lowndes County project site is situated on the outside of a meander bend, and in its original condition the river was eroding in a westerly direction into the property (left descending bank). The site exhibited steep, rapidly eroding banks, mass wasting, and numerous trees that had recently washed into the river or were on the verge of being undercut. A review of aerial photographs showed that the river had moved laterally up to 250 feet over the last 30 to 40 years, with a large gravel bar developing on the opposite bank.

Similar fast-eroding river bends are found up and downstream of the project site. The river in this area exhibits characteristics of channels undergoing severe erosion; the bed material is not well consolidated, an excessive number of downed trees are found in the channel, and the outside stream banks are steep and unstable (Fig. 4). These adjustments are the result of headcutting from the Tennessee-Tombigbee Waterway, meander cutoffs, and gravel mine capture (U.S. Department of Agriculture, 2005). Past incompatible agricultural practices have also cited as a cause of disturbance (Patrick, 1996).

The river banks at the project site were composed largely of unconsolidated sand and silt. However, a layer of cemented, or oxidized gravel was found at the toe of the bank along much of the reach. This cemented layer appeared to have greater resistance to erosion than the other materials. Due to the nature of the soils and the rate of erosion, there was little or no vegetation below the top of the banks except exposed tree roots.

Description of Lowndes County Site BMPs

Several Best Management Practices (BMPs) were employed at the Lowndes County site to demonstrate various stabilization practices. These BMPs, as described below, were demonstrated in various combinations. It is not typical to construct several adjacent sets of different BMP techniques at one site; however, because this is demonstration project, this approach allows different BMPs and combinations of BMPs to be viewed on a single location.

The finished site consists of five separate sets of stabilization BMPs installed side by side along 600 feet of an eroding bend in the river. Existing unstable bank material (overburden) was excavated to prevent sedimentation caused by sloughing into the river. Though the cemented gravel layer apparently had some resistance to washing from the river, the material crumbled during excavation. The banks were regraded to a stable slope of approximately 3:1, and stabilized through the BMP techniques (see as-built drawings, Appendix I). Materials and practices consist of erosion control blankets, willow stakes, root wads, native ground cover vegetation and trees, and broken, debris-free concrete. An additional 600 feet, approximately 300 feet at each end of the BMP reach, was stabilized at the toe of the slope with broken concrete (Fig. 7).

The individual BMPs are listed below with a description of each. Table 1 shows how the BMPs were grouped in different areas of the site.

Regrading of unstable river bank

Steep eroding river banks were excavated to a more stable slope of approximately 3:1. Without this project, virtually all of the soil that was removed would eventually have eroded into the river (Fig. 4).

Bank regrading is appropriate in areas of rapid erosion where the banks are too steep to stabilize in their existing configuration or unable to support vegetation that will create stability.

Erosion control blanket

The biodegradable erosion control blankets are made of coconut shell fibers and netting. The blanket holds the soil in place until vegetation becomes established, and will eventually degrade and disappear. It was installed in all areas where the bank overburden was removed (Fig.5)

Erosion control blankets are used to stabilized soils or channels exposed by construction or other disturbances. The blankets hold soil or bed material in place until vegetation or other processes create natural stability.

Stacked soil cells

Stacked soil cells consist of soil wrapped with erosion control blanket, and stacked in a staggered stair-step fashion. They are used in areas where a steeper bank slope is needed, and are included here for demonstration purposes (Fig. 6).

Appropriate locations for this technique include areas where structures or roadways are adjacent to the river or stream, and there is inadequate space to shape the bank to a shallower slope.

Rock Toe

Broken concrete was placed at the toe of the slope to prevent erosion from undercutting the bank (Fig. 7). In addition to the rock at the toe of the slope, trenches were cut perpendicular to the bank to a length of 20 feet. These trenches were filled with rock to a depth of 4 to 5 feet, and backfilled. This technique, known as "tie-backs", help to slow or prevent the movement of erosion up or down stream should a washout occur.

Though not part of the native landscape, rock is sometimes necessary in erodible soils to prevent the river from undercutting the bank, particularly in highly erodible or unconsolidated soils, such as those on the Buttahatchie River.

Root wads

On-site hardwood trees were utilized for the root wads. Ten to twelve feet of the trunk was buried into the bank with the roots exposed at the toe of the slope. This prevents erosion and provides excellent habitat. Ten root wads were installed (Fig. 8).

Where the proper trees are available, root wads are an effective stabilization technique.

Willows

Willow cuttings placed into the ground will sprout roots and leaves with the expectation that the roots will spread laterally and grow into mature trees. As they grow and spread, the willows provide habitat and protection from erosion. Willow stakes have been planted along the length of the project on the lower bank, and through the rock placed on the slopes at the ends of the BMP section (Fig 9). At the upstream end of the project, willow cuttings were placed in trenches to form living, flexible "fences" to slow down the water at high flows and reduce erosion (Fig. 10).

Willow cuttings are generally appropriate anywhere within their habitat range when placed in moist soil. As they mature, willow cuttings effectively provide soil stabilization and habitat.

Rock on Slope

Rock was placed on the slope of the bank at each end of the BMP area. This was done to stabilize the transition from the unexcavated slopes to the BMP area.

Native trees and plants

Native trees and other plants have been planted over the length of the project, Planting of native trees and other vegetation is compatible and necessary with all BMPs. As the trees mature, they will provide bank protection, and habitat and food for both terrestrial and aquatic animals. The native plants were planted in two "layers", one of overstory trees and the other of understory shrubs and low trees. The overstory consists largely of oaks, while the understory species include American beautyberry, Chickasaw plums, Pawpaw and other low maintenance plants. Each layer was planted on a 10 x 10 foot grid, with the two grids offset to form an overall grid of 5 x 5 feet. This planting system will establish a high density of roots to better stabilize the soil from erosion. The understory species will reduce pressure on the oaks from animals such as deer and beaver, and will encourage the growth of beneficial soil microorganisms (Fig. 11).

Volume of Erosion and Sediment Prevention

As previously discussed, it is assumed that most or all of the soil excavated from the river bank would have eventually washed into the river without the stabilization. It is therefore worthwhile to estimate the amount of erodible soil that was excavated and removed from the site as quantifiable benefit from the project.

Three cross sections of the river were measured before the construction, and were resurveyed again following construction. The cross-sectional area of excavated material was measured for each cross section, and the values were averaged. The average value was then multiplied by the length of the project to produce the estimated volume of soil removed. The volume of soil excavated from the stacked cells area was calculated separately due to the difference in the shape of the bank.
Based on this approach, it is estimated that over 4,000 cubic yards of material were removed, and thereby prevented from washing into the river. This is equivalent to a football field covered with nearly 2 feet of soil. This value assumes a 0.4 increase in volume of the excavated soil in comparison with the in-situ soil, a typical expansion of excavated soils.

Summary

The Buttahatchie River Stabilization Project has met several important goals. Most immediately, it has stabilized a rapidly eroding river bank and prevented thousands of cubic yards of soil from washing into the river. In the long term it is expected that the river bed in this area will also become more stable, and this will allow for improved habitat for fish, aquatic invertebrates, mussels, and other benthic organisms.
It has also created an open-air educational site that demonstrates several useful stabilization BMPs and sets of techniques. This unique setting allows for the comparison of various techniques in one location (Figs. 12-13).

Strong and unique partnerships have been created during this undertaking, including the use of 16th Section land and the involvement of the local school district. Other partners include the local hunting club, local businesses and individuals, and businesses from other parts of the state. Though one of our partners was unable to participate in the construction of the project as expected, they have maintained a strong interest in learning from the completed techniques, and remain a partner in future Buttahatchie and Tombigbee River projects and planning. The project has and will continue to provide positive publicity for the Buttahatchie River, the Section 319 program, and the partners who have participated in the project. Additionally, the project has lead to the preliminary planning of future studies and actions that will continue to make improvements on the stability and quality of the Buttahatchie River.

Bibliography

Alabama Natural Heritage Program 2004. Natural community Assessment and Rare Plant Survey of the Buttahatchee River bluffs, Lamar County, Alabama. Montgomery, Alabama.

Bankhead, N., Simon, A. and Klimetz, D. 2008. U.S. Department of Agriculture- Agricultural Research Service, National Sedimentation Laboratory. Analysis of Streambank Erosion Along the Lower Tombigbee River , Alabama. Oxford, Mississippi.
FTN Associates, Ltd. 2004. Buttahatchee River Watershed Implementation Plan. Little rock, Arkansas.

McGregor, S.W. 2001. Geological Survey of Alabama. A survey of Freshwater Mussels in Selected Tributaries of the Upper Tombigbee River System, Alabama and Mississippi, 1994-2001. Tuscaloosa, Alabama.

McGregor, S.W. and Cook, M.R. 2005. Geological Survey of Alabama. A Preliminary Analysis of Sedimentation Loading Rates in the Upper Buttahatchee River, Alabama, 2004-2005. Tuscaloosa, Alabama.

Miller, M. and Freeman, P. 2007. The Nature Conservancy. Conservation Action Plan for the Buttahatchie River Watershed. Arlington, Virginia.
Mississippi Department of Environmental Quality. 2002. Big Black-Tombigbee, Tennessee River Basins Prioritization and Implementation Process. Jackson, Mississippi.
Mississippi Department of Environmental Quality. 1998. Tombigbee River Basin Status Report 1998. Jackson, Mississippi.

Mississippi Department of Wildlife, Fisheries and Parks. 2004. Freshwater Mussels of Mississippi. Jackson, Mississippi.

Mississippi Department of Wildlife, Fisheries and Parks, Mississippi Museum of Natural Science. 1998. Endangered Species of Mississippi. Jackson, Mississippi.

Mississippi Museum of Natural Science, 2005. Mississippi's Comprehensive Wildlife Conservation Strategy. Mississippi Department of Wildlife, Fisheries and Parks, Mississippi Museum of natural Science, Jackson, Mississippi.

O'Neil, P.E., McGregor, S. W., and Wynn, E. A. 2004. Geological Survey of Alabama. Federal Register 69 FR 40084. Critical Habitat Units for Threatened and Endangered Mussels in the Mobile River Basin.

Patrick, D. M. and Dueitt, S. 1996. University of Southern Mississippi. Geomorphology of Erosion and Channel Instability, Upper Tombigbee Drainage Basin, Northeast Mississippi. Hattiesburg, Mississippi .

Pollen, N., Simon, A., Klimetz, L. and Klimetz, D. 2005. U.S. Department of Agriculture- Agricultural Research Service, National Sedimentation Laboratory. Stability Analysis of the Buttahatchee River, Mississippi and Alabama. Oxford, Mississippi.

The Nature Conservancy. 1998. Rivers of Life: Critical Watershed for Protecting Freshwater Biodiversity. Arlington, Virginia.

The Nature Conservancy. 2000. The Five-S Framework for Site conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success. Volume I. Arlington, Virginia.

U.S. Department of Agriculture. Channel and Watershed Processes, Research Unit, National Sedimentation Laboratory. 2005. Stability Analysis of the Buttahatchee River Basin, Mississippi and Alabama. Oxford, Mississippi.

U.S. Department of Agriculture. 1979. Soil Survey of Marion County, Alabama. Auburn, Alabama.

U.S. Department of Agriculture. 1979. Soil Survey of Lowndes County, Mississippi. Jackson, Mississippi.

U.S. Department of Agriculture. 1979. Soil Survey of Monroe County, Mississippi. Jackson, Mississippi.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2007. Stream Restoration Design, National Engineering Handbook, Part 654. Washington D.C.

Table 1. BMP sets showing included individual BMPs.

BMP Set	Regrade Bank	Rock Toe	Erosion Control Blanket	Willow Stakes	Root Wads	Stacked Cells	Willow Trenches	Rock on Slope
Basic	X	X	X	X				
Root Wads	X	X	X	X	X			
Stacked Cells	X	X	X	X		X		
Willow Trenches	X	X	X	X			X	
Rock on Slope	X	X		X				X

Figure 1. Site locations map.

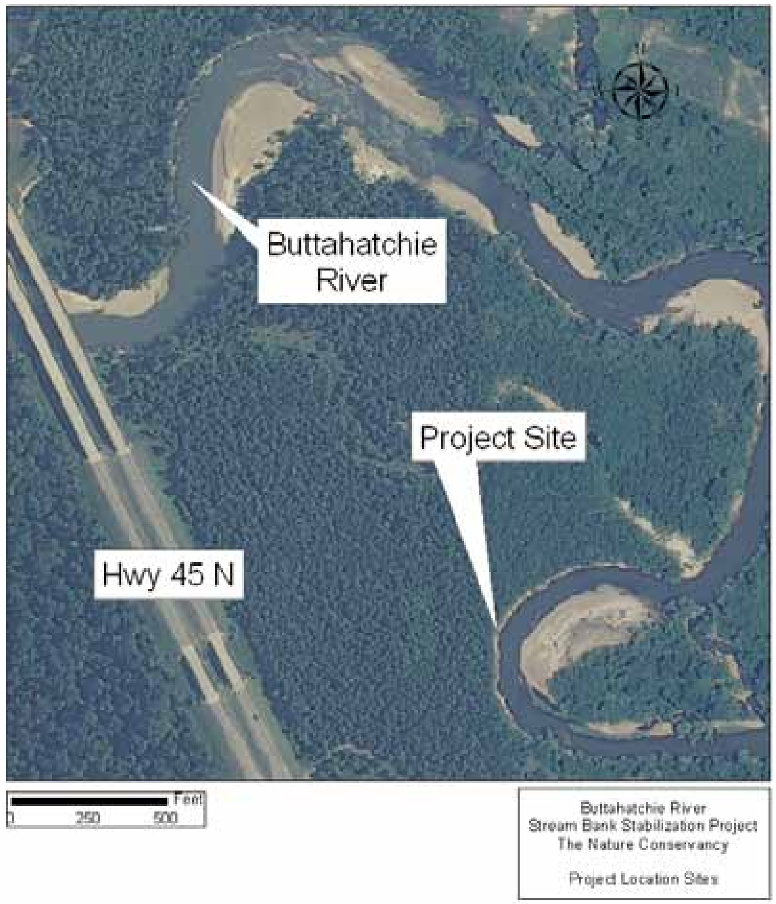

Figure 2. Pre-construction conditions at the Lowndes County site.

Figure 3. Layout of stabilization plan

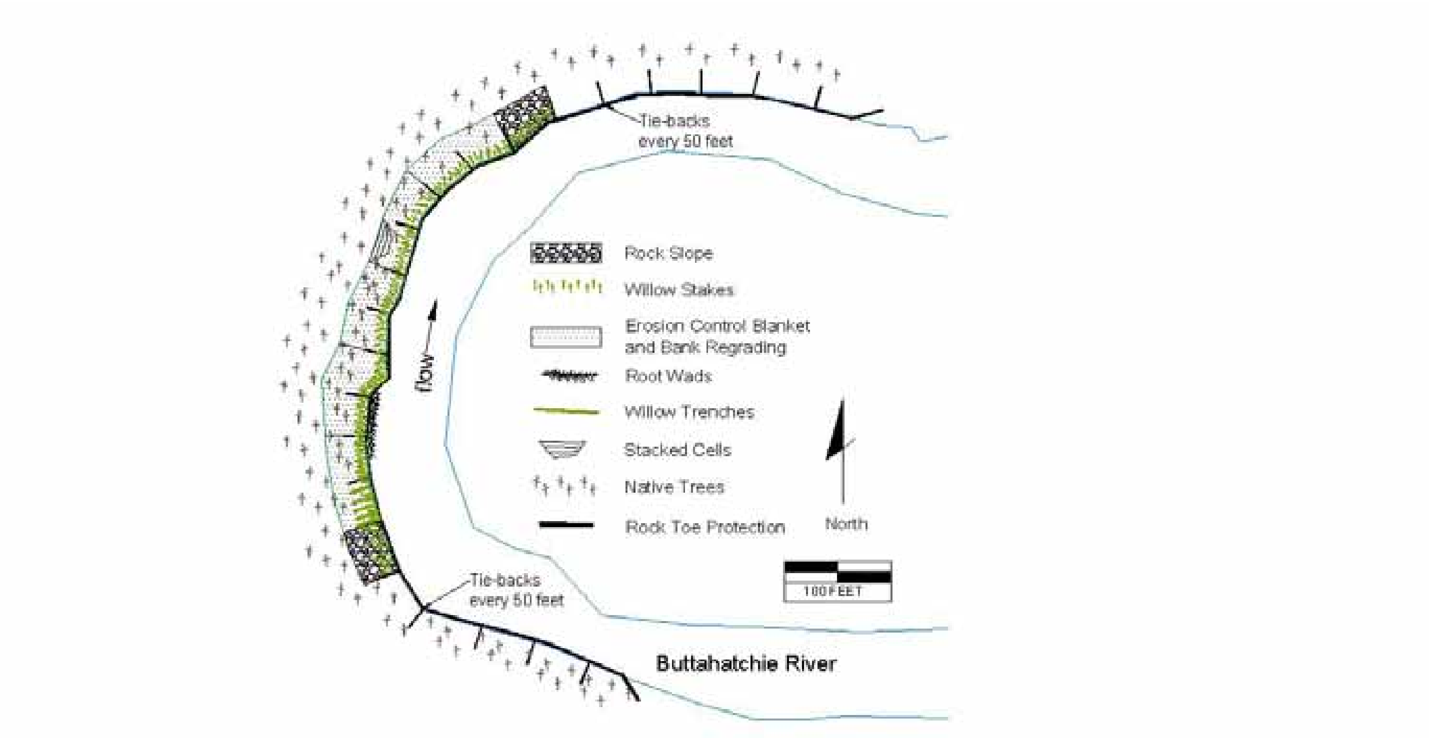

Figure 4. Regrading of unstable river bank.

Figure 5. Installation of erosion control blanket.

Figure 6. Stacked cells.

Figure 7. Rock at toe of slope.

Figure 8. Installed root wads.

Figure 9. Placement of willow stakes.

Figure 10. Installation of willow trenches.

Figure 11. Photograph taken in June, 2011, showing trees and developing vegetation. Note debris deposited by winter floods.

Figure 12. Post-construction site looking upstream.

Figure 13 . Post-construction site looking downstream.