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THE LAMOILLE RIVER AND BLACK CREEK FLOODPLAIN RESTORATION PROJECT

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ABSTRACT: The elevated rail embankment of the St. Johnsbury and Lake Champlain Railroad isolated Lamoille River and Black Creek from large floodplain areas, and is suspected of causing increased flooding, altered sediment regime, channel instability, reduced habitat quality, and excessive nutrient export. After rail service ended in the 1990's, the Vermont Agency of Transportation initiated a public process to determine the fate of the rail line. In 2005, the line was federally rail banked and the tracks were removed for conversion to a recreational trail. Subsequent to rail banking, the Vermont Agencies of Natural Resources and Transportation entered into an agreement to collaborate on removal of sections of embankment to re-connect floodplain that was isolated from the channels for 130 years. The agreement resulted in removal of 6 miles of rail embankment re-connecting 200 acres of floodplain. The project is funded by USDA Wildlife Habitat Incentives Program and the Vermont Clean & Clear Action Plan River Corridor Restoration Program. Anticipated outcomes include enhanced floodplain connection, reduction of flood and erosion hazards, improved hydrologic connectivity, increased sediment storage, enhanced nutrient attenuation, and protection of agricultural lands. In 2007, the Lamoille Valley Rail Trail was leased to the Vermont Association of Snow Travelers to develop a recreation trail, and this group has become a partner in the floodplain restoration. This project, one of the largest floodplain re-connection efforts nationally to date, demonstrates how public agencies, private organizations, and farm-owners with seemingly diverse objectives can unite to protect and restore river corridors.

KEY TERMS: floodplain restoration; lateral connectivity; river corridor restoration; rail trail.

INTRODUCTION

The St. Johnsbury and Lake Champlain Railroad was completed in 1877 establishing a 96-mile east-west connection between St. Johnsbury and Swanton, Vermont (Pelletier, 2003). The elevated rail embankment isolated the Lamoille River and Black Creek from large areas of floodplain. A hydraulics analysis by the U.S. Army Corps of Engineers indicated that the embankment was leading to increased flooding. Decreased cross section flow area through the valleys increased velocity reducing sediment deposition and storage, increasing channel instability, limiting habitat quality, and increasing nutrient export from the rural agricultural watersheds.

In 1973 the State of Vermont purchased the line and renamed it the Lamoille Valley Railroad. Flooding and changes in regional freight shipping ultimately led to the end of rail operations in the 1990's, at which time a public process was conducted and it was determined that the rail line would be converted to a recreational trail (Della Penna, 2003). In 2005 the rail line was federally rail banked and the tracks and ties were removed. Subsequent to rail banking, the Vermont Agencies of Natural Resources and Transportation entered into an agreement to collaborate on the removal of sections of rail embankment to re-connect hundreds of acres of floodplain that had largely been isolated from the channels for 130 years.

The agreement initiated a project that ultimately resulted in the removal of approximately 6 miles of the rail embankment re-connecting over 200 acres of floodplain. More natural flooding patterns were apparent in the vicinity of the project sites immediately after construction, with more frequent floodplain inundation and more rapid floodplain draining. Additional anticipated project outcomes include reduction of flood and erosion hazards due to larger cross section flow areas in the valley bottom, improved hydrologic connectivity to riparian wetlands and cut-off meanders, increased sediment deposition

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and storage, enhanced nutrient attenuation via floodplain vegetation, and protection of agricultural lands. Furthermore, the removed embankment fill was utilized in upland areas to complete beneficial projects for participating towns and landowners.

SITES

The St. Johnsbury and Lake Champlain Railroad embankment runs 96 miles in an east-west direction across northern Vermont between St. Johnsbury and Swanton. The embankment runs along the Lamoille River to the east in Caledonia and Lamoille Counties, and climbs into the Black Creek watershed in the Towns of Jeffersonville and Fletcher prior to heading northwest in Franklin County (Figure 1). The Lamoille River drains directly to Lake Champlain, and Black Creek is a tributary of the Missisquoi River that also drains to the lake.

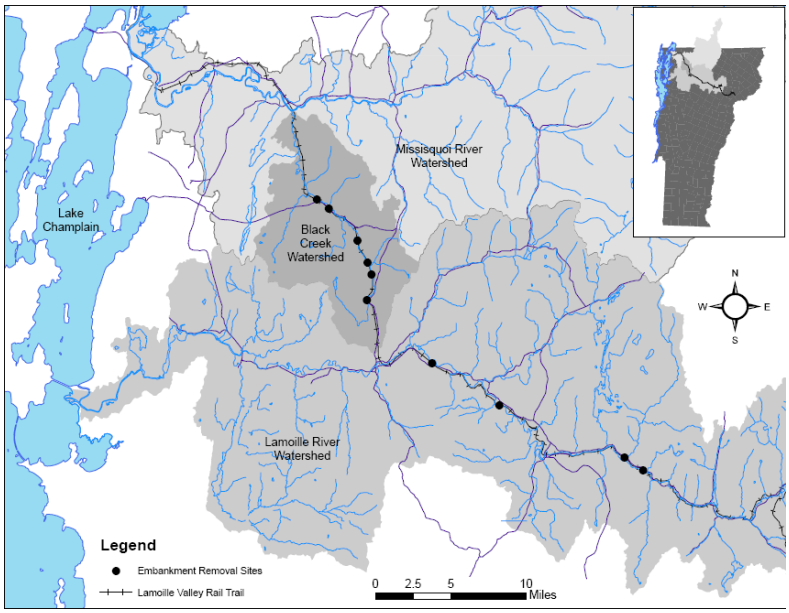

Figure 1. Project Location and Embankment Removal Sites

Geomorphic assessment results (VTANR, 2007) indicate that the Lamoille River is situated in a very broad, low gradient valley. Channel bankfull width is approximately 150 feet and depth is 7 feet. The bed material is typically fine gravel and sand. Historic signs of channel straightening are present that have likely reduced sinuosity and increased flow velocities in the channel. Incision is widespread and thus floodplain access is regularly limited unless natural grade control has prevented channel down-cutting. The combination of high spring flows and ice jams does often lead to floodplain inundation.

Black Creek runs through a broad, low gradient valley with some locations of increased confinement. Channel width is estimated at 20 feet and depth 5 feet. The bed material is typically sand and silt. Although highly sinuous in places, Black Creek has been straightened in many locations. Low channel gradient leading to low flow velocities has limited incision and preserved floodplain connection. Valley bottom floods typically occur one or more times per year.

For both the Lamoille River and Black Creek the influence of the rail line is readily apparent. Numerous disconnected meanders are present in current and disconnected floodplain areas. The river channels often run adjacent to the embankment for stretches where they are straight, typically over-widened, filled with sediment, and have poor habitat. The connection between channel and floodplain is present yet highly altered due to the elevated embankment and limited connections under it with culverts or a small bridge. Floodplain inundation and drying appeared to be delayed due to the embankment. The land use in the floodplains is typically cropland, fallow field, pasture, or wetland.

Embankment removal sites were initially identified with aerial photographs and topography maps. Field verification was performed for all of the initially selected sites to confirm the amount of floodplain that could be re-connected upon embankment removal and to verify that no agricultural, residential or commercial structures would be in harms way with the anticipated changes in flooding patterns.

PARTNERS

This project demonstrates how public agencies, private organizations, and farm-owners with seemingly diverse objectives can unite to protect and restore river corridors. The project became possible through a Memorandum of Understanding between the Vermont Agencies of Natural Resources and Transportation to pursue floodplain restoration. Over the course of operations, the rail line was continually hampered by large floods that damaged facilities at great cost. Transportation officials agreed with river managers that naturalizing the river corridor was not only a benefit to the river corridor and downstream receiving waters, but also to the public through the reduction of flood and erosion hazards.

In 2007, the Lamoille Valley Rail Trail was leased to the Vermont Association of Snow Travelers to redevelop the rail banked facility to a four-season recreation trail. This group has become a partner in the floodplain restoration project embracing the initiative as compatible with their recreation objectives. Secondary projects in addition to removing the embankment were performed to support future trail upgrades and maintenance such as removing a failed bridge from a tributary of the Lamoille River and installing culverts to carry flow in farm ditches under the lowered embankment during small storms when floodplain inundation is not expected.

The Natural Resources Conservation Service funded a portion of this project to support stream and riparian habitat improvement and management as well as other public benefits. The floodplain re-connection is anticipated to improve physical, chemical, and biological functions of the stream channels and riparian areas, stated goals in the Conservation Practice Standards with origins from the Clean Water Act (1972).

Once the locations of the potential embankment removal sites that would re-connect large areas of floodplain to the channels were identified, landowner outreach was initiated to gain acceptance and support for the project. Although not required because all construction work was to be completed within the state-owned right-of-way, approval of the abutting landowner that would likely receive increased flows after embankment removal was required by the project team before design would commence. The early discussions and field trips opened dialogue about the benefits of natural channel and floodplain processes, qualitatively explored likely changes to flood patterns, and revealed that in many cases restoration would be accompanied by benefits to landowners such as less erosion due to lower flow velocities and shorter drying times of fields that flooded even with the embankment in place.

Landowner willingness to participate in the project was much higher than expected. The widespread desire to return more natural floodplain inundation patterns was particularly surprising given a very wet spring with lots of flooding was occurring as outreach efforts were under way. Many landowners of valley bottom pastures and farm fields suggested that "battling the river" was futile and that perhaps a more natural system could benefit both the river and the adjacent land. The early discussions and relationships established with landowners were the key to project implementation.

IMPLEMENTATION

Embankment removal has taken place at 4 sites on the Lamoille River and 6 sites on Black Creek (see Figure 1). A pilot project was completed on the Lamoille River near a frequent ice jam location that destroyed a train bridge and regularly flooded a nearby state highway. After the initial project, the reconnaissance for additional sites revealed 16 possible floodplain restoration sites, 6 on the Lamoille River and 10 on Black Creek. Sites were prioritized primarily based on the amount of floodplain area returned for the length of embankment removed. Landowners at 3 of the 16 sites did not support projects adjacent to their land, so the remaining 13 sites were explored further for embankment removal.

The floodplain, channel, and embankment were surveyed at representative valley cross sections to guide design. The embankment measurements were used to estimate the amount of fill to be excavated. Floodplain and river survey helped locate the embankment cut elevation to keep the recreational trail dry during smaller storms and allow regular overtopping during larger storms. The project design called for cutting the embankment at or slightly above the local elevation of the floodplain (Figure 2).

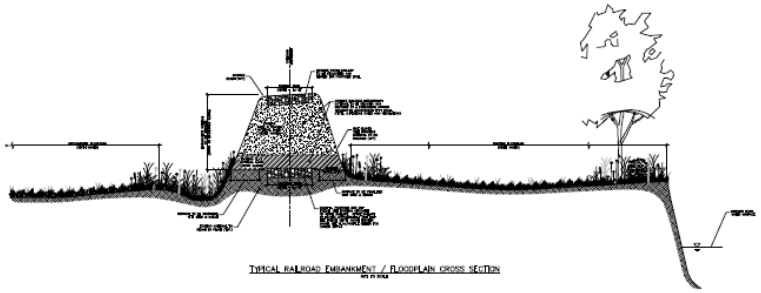

Figure 2. Embankment Removal Specifications

Stormwater construction permit clearances were obtained for all embankment removal sites and associated fill disposal locations. All fill removed from the embankment was placed out of the regulated and extended floodplain. A Vermont land use permit, Act 250, was obtained for all projects sites covering topics such as wetlands, soil erodibility, cultural resources, prime agricultural soils, construction access, and formal notification to abutters and towns.

The construction sequence consisted of clearing the sides of the embankment, removing and stockpiling the existing ballast on the rail bed, excavating the embankment fill to approximately the floodplain elevations, cutting a box trench to contain the reapplied ballast, and ballast application (Figure 3). The excavated area where the embankment side slopes previously existed were seeded and mulched for stabilization. In addition, several rows of willow fascines were planted along the excavated side slopes to slow flood water velocity and reduce the potential for erosion of the recreational trail during floodplain inundation.

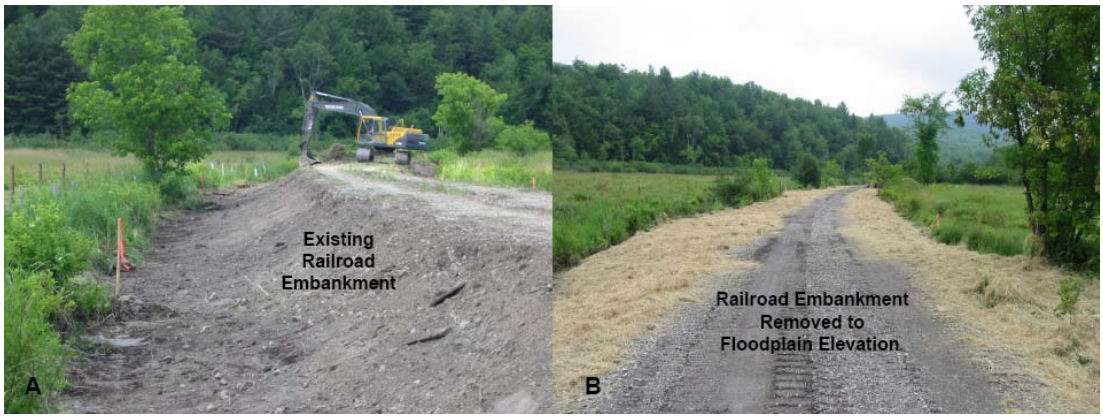

Figure 3. Existing Railroad Embankment in Fletcher, Vermont During Construction (A) and After Excavation (B)

MONITORING AND EVALUATION

Monitoring was conducted on the ground and by plane to view pre- and post- floodplain conditions during levels of inundation. Floodplain inundation area increased with embankment removal, with floods more easily accessing historic floodplains (Figure 4). Floodplains appeared to be more rapidly flooded and drained with the embankment removed, although this has not been rigorously proven.

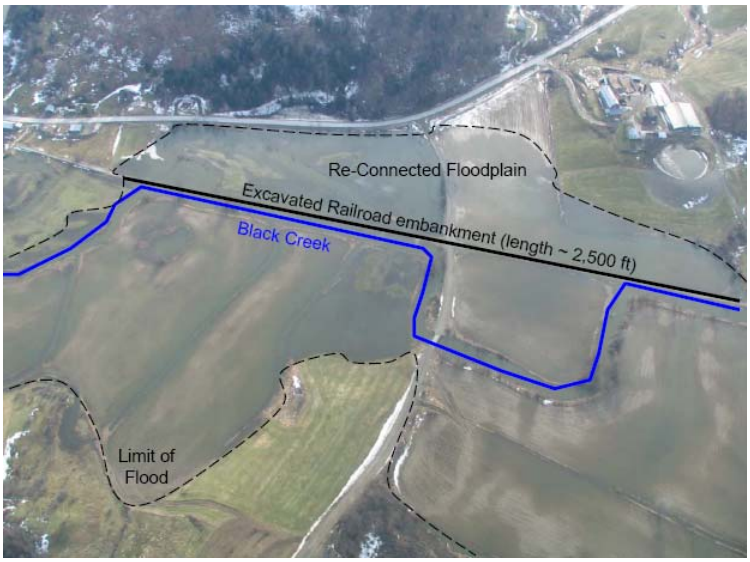

Figure 4. Inundated Re-Connected Floodplain in Fairfield, Vermont

A HEC-RAS (USACOE, 2005) hydraulics model of lower Black Creek was used to investigate the anticipated effects of floodplain reconnection. Modeled embankment removal allowed water previously flowing through the channel to spill into the overbank areas (Figure 5). Due to the large upstream watershed relative to the small amount of reconnected floodplain modeled (due to the limited coverage of the existing model), the change in flood water surface elevation following embankment removal was negligible. Channel velocities generally decreased following embankment removal. The channel velocity decreased a maximum of 28% for the 50-year storm, and a maximum of 19% for the 5-year storm. This modeling effort does not include any of the 6 embankment removal locations already implemented along Black Creek, which reconnect a larger amount of floodplain across valley. It is anticipated that the relatively small changes in water surface elevation following removal of a small section of embankment in the hydraulics model would be amplified as more floodplain area is reconnected to the channel.

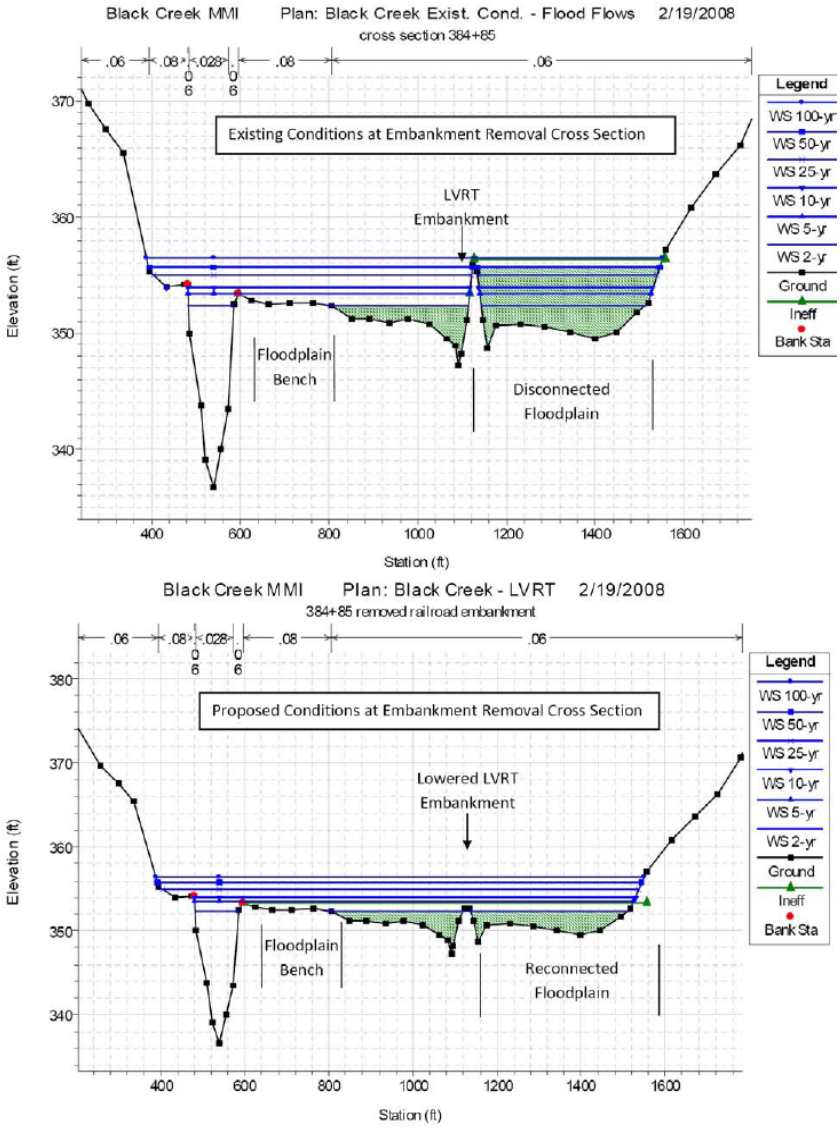

Figure 5. Existing and Proposed HEC-RAS Cross Sections

As velocity decreases the potential for channel and bank erosion is lowered as sediment deposition and storage increase. Sediment deposition also typically leads to increased nutrient attenuation via plant uptake. A monitoring program is currently under way to study sediment deposition patterns and approximate nutrient uptake. Sediment mapping at three of the ten project sites indicated that approximately 950 cubic yards of sediment was stored in the re-connected floodplains following a relatively dry spring runoff period with less than normal floodplain inundation. Stored sediment will be tested for phosphorus to estimate the amount potentially removed from Black Creek and downstream Lake Champlain.

PROJECT SUMMARY

- 6 miles of former rail embankment removed
- Over 200 acres of floodplain reconnected
- 60,000 cubic yards of fill removed from the floodplains
- Upland projects with excavated fill include stabilization of an unstable manure pit containment, improvement of unsafe roadway intersections and driveway, and farm road expansion
- Replacement of deteriorated drainage infrastructure encountered during excavation where necessary
- Removal of collapsed bridge and abutments from Wild Branch, a tributary of the Lamoille River
- Increased floodplain inundation area
- Decreased flood velocities and increased sediment deposition and storage
- Anticipated increase in nutrient attenuation

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