

SAWMILL RIVER
WATERSHED ASSESSMENT
Franklin County, Massachusetts



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Prepared for

Franklin County Soil and Water Conservation District

Prepared by

**United States Department of Agriculture
Natural Resources Conservation Service
Amherst, Massachusetts**

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TABLE OF CONTENTS

INTRODUCTION	1
PURPOSE	1
METHODOLOGY.....	1
SETTING	2
FINDINGS.....	5
COMMENTS AND RECOMMENDATIONS	12
REFERENCES	14
APPENDIX A – SITE LOCATION MAPS.....	15
APPENDIX B – SITE REPORTS	20
SITE 1	21
SITE 2	23
SITE 3.....	25
SITE 4	27
SITE 5.....	29
SITE 6	31
SITE 7	33
SITE 8.....	35
SITE 9.....	37
SITE 10.....	39
SITE 11	41
SITE 12.....	43
SITE 13.....	45
SITE 14.....	47
APPENDIX C – COMMENTS AND RECOMMENDATIONS.....	49

SAWMILL RIVER WATERSHED ASSESSMENT

Franklin County, Massachusetts

INTRODUCTION

The Massachusetts Executive Office of Environmental Affairs (EOEA), Town of Montague, Franklin Regional Council of Governments (FRCOG), and the Franklin Conservation District (FCD) requested that The Natural Resources Conservation Service (NRCS) conduct an assessment of sediment and erosion and agricultural flood damage problems in the watershed and their related impacts on riparian and aquatic ecosystems. NRCS conducts such studies under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended (16 U.S.C. 1001-1008).

PURPOSE

The objective of watershed interests is to protect and improve riparian and aquatic habitat. Specific items of interest included riparian habitat, instream aquatic habitat, eroding streambank areas, areas impacted by sediment, and flooding of agricultural fields. The intent of this study is to inventory and assess significant problem areas, make preliminary recommendations for addressing these problems and determine the need for further study.

This report presents the results of an assessment of the river to identify problems and help facilitate an understanding of those problems. The report is intended to facilitate discussion amongst stakeholders in the watershed and provide a platform on which to build orderly action plans. This study is not meant to be a definitive determination of watershed problems or solutions.

METHODOLOGY

An interdisciplinary team consisting of a fisheries biologist, forester, engineers, geologist, and soil conservationist prepared this assessment. To familiarize the group with the watershed, the Connecticut River EOEA Watershed Team Leader guided the team on a drive along the stream corridor from Lake Wyola dam to the confluence with the Connecticut River (see Figure 1). The group stopped at

perceived problem areas. These areas were viewed, discussed and photographed. Significant sites were selected for review in more detail. Aerial photographs and other references were also reviewed. After the watershed tour, it was the general consensus of the team that the most significant erosion, sedimentation, and flooding problem areas are located between the Montague-Leverett town line and the Connecticut River.

On subsequent days, the team walked the reach of river from the Montague-Leverett town line to a point about one-quarter mile downstream from Meadow Road in Montague, a distance of about three miles. Notes were taken on the eroding areas, riparian conditions, instream habitat and flooding problems. These field observations by each discipline form the basis of this report. Additional known problem areas further downstream of Montague Center were also visited.

For the riparian corridor assessment, Riparian Buffer Inventory and Assessment worksheets (USDA-NRCS 2000) were completed for each site. The purpose of the riparian corridor assessment was to inventory and assess the composition and condition of the buffers on these stream segments. The area described on the worksheets includes the first 15 feet from the top of the bank (Zone 1), the next 20 feet (Zone 2), the next 20 feet (Zone 3, if applicable) (USDA-NRCS 2001), and the land use within 500 feet at a minimum.

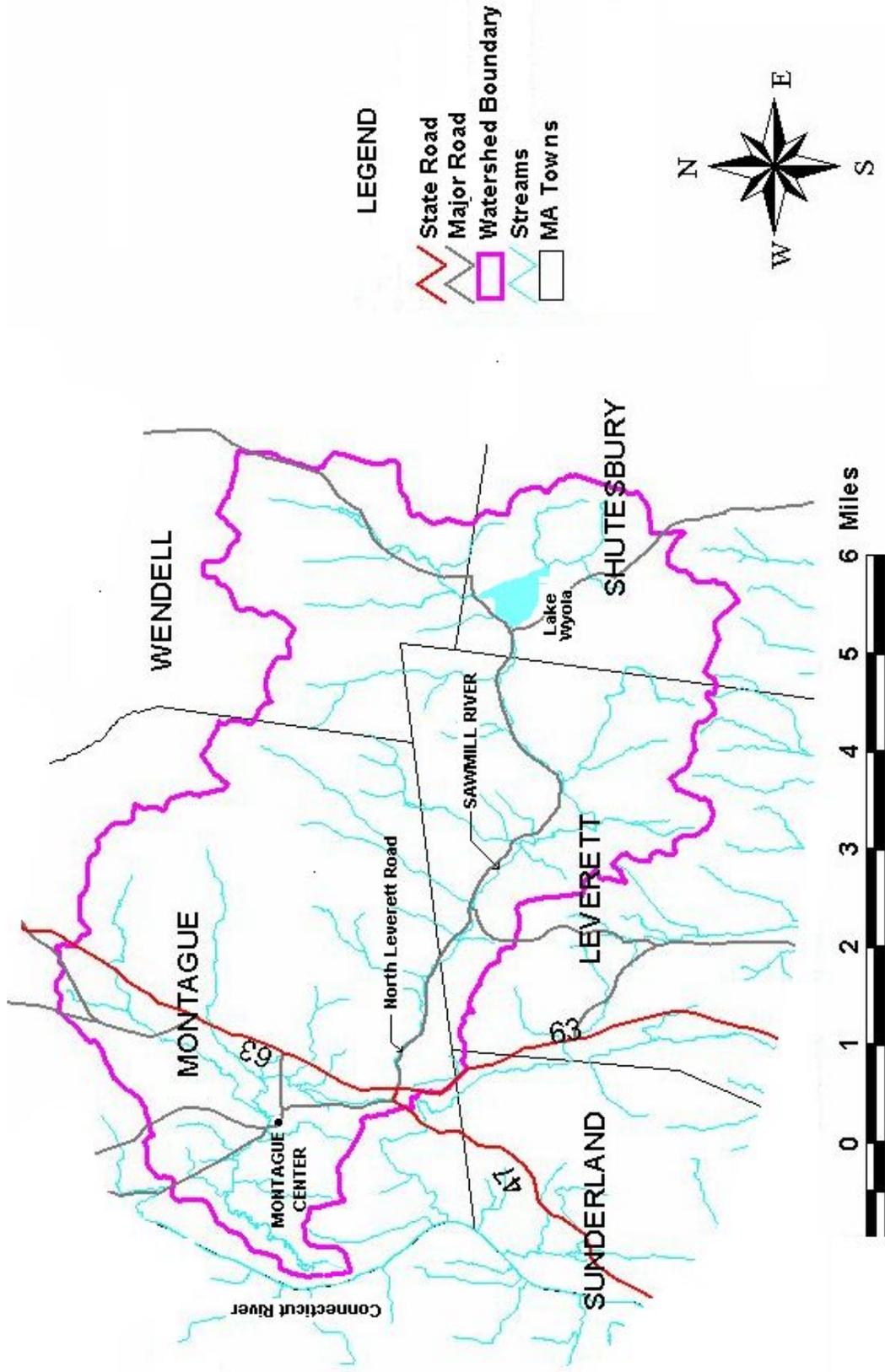
SETTING

GENERAL

The Sawmill River watershed is an area of about 32 square miles in the towns of Montague, Leverett, Shutesbury, and Wendell, Massachusetts (see Figure 1, Watershed Map). The river flows generally westerly for about 14 miles from its headwaters above Lake Wyola in Shutesbury to its confluence with the Connecticut River in Montague. The maximum width of the river is about 50 feet at its confluence with the Connecticut River. It is about 5 feet wide at the outlet of Lake Wyola.

The area upstream from State Route 63, which includes about 85 percent of the watershed area, is characterized as primarily forested. Housing density is low and generally located adjacent to roads. In the upstream reaches, topography and stream gradients tend to be fairly steep. The valleys are fairly narrow with limited floodplains. These characteristics are typical of B type streams (Rosgen).

Figure 1 – Sawmill River Watershed Map



Significant changes in geology, landform, land use, and river characteristics occur at Route 63, just west of the Montague-Leverett town line. Downstream from Route 63, the land use is a mix of cropland, pasture, forest and other open land. Development is light except within the Village of Montague Center. The river slope flattens and the valley (floodplain) widens as it enters the Connecticut River valley floor. These characteristics are typical of C type streams (Rosgen).

WATERSHED GEOLOGY

The geology of the watershed consists of both bedrock and the overlying glacial or surficial deposits. Generally, the bedrock from Lake Wyola to a point somewhere in the vicinity of the Route 63 bridge consists of metamorphic schists, gneisses, and intrusive rocks of Paleozoic age. This bedrock is exposed for a distance about 300 feet in the channel bottom immediately downstream of the sawmill dam at Cave Hill Road. The rock is hard and highly resistant to erosion.

Glacial deposits also change character near Route 63. Upstream, the surficial deposits are comprised mostly of dense silty glacial till on the steep slopes. Limited areas of sand and gravel outwash are found adjacent to the river.

From approximately the Route 63 bridge downstream to the Connecticut River, the bedrock consists of sedimentary sandstone and conglomerate. This rock forms a short gorge upstream of the former Bookmill Dam at Bridge Street in Montague. This rock forms the waterfall at the former dam site and serves as a durable grade control at that location.

Downstream of Route 63, the glacial deposits consist of outwash sand, gravel and silt, with a predominance of sand and gravel to a point just upstream of the Goddard Brook tributary confluence, where sand and silt begin to predominate. The finer sand deposit continues from Goddard Brook, through the State Wildlife Management area, to Bridge Street.

Bedrock is exposed along the right bank and for a short distance through the rock gorge upstream from the Bookmill. There are some limited alluvial silt deposits located upstream, formed from deposition behind the former dam.

Immediately downstream of the Bookmill area, the river cut its channel through glacial terrace deposits. It continues downstream through sand and gravel outwash deposits of lower elevations to the bridge at Ferry Road. At this point, the channel begins to flow through glacial lake deposits and Connecticut River floodplain alluvium. In this reach it begins a series of tortuous meanders to its confluence with the Connecticut River.

FINDINGS

ANTHROPOGENIC EFFECTS ON THE STREAM and RIPARIAN CORRIDOR

From early colonial times the Sawmill River has been manipulated for various purposes. It has been used as a travelway, dammed for waterpower and as a source of sand and gravel. The fishery has likely been utilized since glacial retreat, by native peoples, for some 10,000 years.

The steep gradient of the river and adjacent forest resources created an ideal combination for early water power and sawmill development on the stream. The remaining vestiges of this water power development can be seen at the old Sawmill located at Cave Hill Road in North Leverett and at the Bookmill Dam in Montague. Remnants of other small dams can be seen throughout the stream corridor.

In addition to the dams constructed for waterpower, there has been manipulation of the channel due to well intentioned, but misguided dredging attempts to provide more capacity for floodwaters. Evidence of these dredging events can be seen along the channel in North Leverett downstream of the Sawmill Dam where about 1000 lineal feet of dredge spoils were placed in the floodplain along the stream. More spoil piles of stream sand and gravel are located downstream of Route 63 on the north side of the river for a distance of about 500 feet. These spoil piles act as dikes, containing higher flood flows within the channel rather than allowing the water to flow out across the floodplain. This lack of connection with the floodplain alters the proper functioning of the stream system.

An interview with a former long time resident of Montague revealed that before WWII, probably in the 30's, the riverbed was straightened and dredged in preparation for construction of a swimming pool. Although the pool was never completed, significant dredging and alteration of the channel occurred at that time, resulting in a lowering of the channel bottom and placement of the dredge spoil piles located along the north side of the river. His description matches what the team observed in the field along the reach of river from South Street upstream to along Sunderland Road. He mentioned that he once fished that section of the river with his father and recalled it "was ruined" after the dredging (probably due to destruction of habitat and the subsequent increase in erosion and sedimentation).

From early colonial times, the valley and floodplains of the river were used as travelways. As horse drawn buggies gave way to the automobile, the need for better paved road surfaces and bridges became necessary. In the case of the Sawmill River this meant the building of several bridges across the river which restricted or deflected natural stream flows because their abutments are located within the active floodplain. Bridges were constructed with low clearance at South Street and Center Street in Montague. The Route 63/North Leverett Road

intersection appears to have been moved when the road was relocated sometime in the 1930's as shown on historic topographic maps.

In addition to bridges, rock riprap has been placed along both North Leverett Road and Sunderland Road in Montague Center to prevent erosion of the roadway. This riprap, particularly in the area of Sunderland Road, has likely caused an increase in the stream velocity and deflects high flows across the channel to the more erodible sand and gravel deposits and spoils piles.

Although less intrusive and a minor contributor to the erosion and sedimentation issues is the practice of farmers allowing their cows to access the river and its banks. This situation contributes to both erosion and sedimentation due to hoof traffic and has a negative effect on water quality.

RECENT FLOOD EVENTS

Recent flood events have produced dramatic effects on the watershed, particularly downstream from Route 63. In June 1996, there was a significant flood caused by a very localized storm that was centered on the Sawmill River Watershed area. Observations by NRCS made following the flood indicate substantial erosion and resulting sedimentation of large amounts of cobble and small boulder size materials were carried out onto the floodplain of Goddard Brook north of the Sawmill River. Sediment deposits seen along point bars and accumulated downstream of Center Street in the Sawmill River indicate this event also moved large amounts of similar sized sediment in this watershed.

Although these floods are rare events, they are nevertheless a normal part of the dynamic process of stream channel evolution. The stream continually tends toward a dynamic equilibrium, to balance its load with the energy of the flowing water.

EROSION AND SEDIMENT SITE ASSESSMENT

Laypersons as well as the environmental professional can easily observe one of the most obvious environmental issues in the watershed. Erosion of the streambanks and resulting sedimentation is causing habitat destruction, flooding, and bridge and road maintenance problems.

There are two types of erosion: geologic erosion is steady and proceeds at a rate which is in balance with the environment; while erosion caused by human actions is often referred to as accelerated erosion and is often out of balance or equilibrium with the environment. Although geologic erosion and resulting sedimentation can sometimes be rapid, as in the case of landslides or large storm events, it is a natural process. When effects are human-induced by

building infrastructure or through aggressive agricultural or logging practices, it is accelerated.

Stream systems attempt to achieve and maintain a dynamic equilibrium. When out of balance, erosion and sedimentation forces can outweigh the available stream power to deliver the sediment load. This lack of equilibrium results in sediment buildup or aggradation. If on the other hand, sediment is removed from the stream system, subsequent large storm flows will attack the streambanks and channel bottom in an attempt to gather a sediment load to balance the stream power.

As previously mentioned, there is a distinct change in river and valley characteristics at about State Route 63. Descriptions of the river upstream and downstream of the road follow.

Upstream from Route 63 - This reach begins at the Lake Wyola dam in Shutesbury and extends downstream to the Route 63 bridge. Throughout this reach, the stream is typical of a Rosgen Type B stream. The channel flows through heavily forested areas with bedrock outcrops and boulders. The channel appears generally stable with low banks with sufficient riparian growth. Several dams occur throughout this reach, including ones at Moores Corner, Cave Hill Road, and a breached dam immediately upstream of the woodworking factory, near the Montague-Leverett town line. Upstream of the breached dam, the river appears to be reasonably stable. This is likely attributable to the fact that erosive force has been subdued by several small dams, beaver activity, bedrock channel bottom areas and ample riparian vegetation. Although each of these dams has now or has in the past trapped sediment, the stream channel remains generally stable through the reach. It may have been the regulating effects of the dams acting as channel grade control, which effectively reduced the stream's ability to erode these reaches. Downstream of the dam at Cave Hill Road there is a stretch of bedrock exposed in the channel. The shallow bedrock reduces the ability of the stream to erode any deeper. It is interesting to note the bedrock has been exposed upstream of an area that was dredged downstream. The stream meanders downstream through limited areas of glacial terrace deposits and a greenbelt. Beavers have constructed dams along the channel in two locations, again restricting the velocity.

The channel approaches and passes beneath North Leverett Road near Dry Hill Road. At this point the stream is a cobble bed stream with a fairly steep gradient as it gains greater flows from tributaries. A small concrete dam is located immediately upstream of Spaulding Road that diverts some water through a sluiceway and bypasses the main channel. This low dam restricts streamflow and fish passage. Spaulding Brook tributary enters the stream channel at this point.

Downstream of Spaulding Brook, the channel is steep with a cobble and boulder bed. Riparian vegetation in the reach is maintaining the streambanks through

this area. Where the stream approaches North Leverett Road the adjacent bank is riprapped with large rock to protect the highway. From this point downstream through the now breached concrete dam, the river increases grade and streambanks are less stable. It is at this point that stream and bank instability becomes apparent.

Downstream from Route 63 – This reach begins at the bridge and extends to the Connecticut River. The more significant disturbed areas are between Route 63 and Center Street. Throughout this reach, the river is not in equilibrium, likely due to some or all of the following factors.

1. Dredging occurred in long sections of the reach, reducing the available sediment supply and removing sediment sizes such as cobbles and boulders that would tend to stabilize the channel. This dredging resulted in the confinement of the river channel between dredge spoil on the north side of the channel and rock riprap on the other. This effectively put the stream between rock and a hard place, confining high flood flows and accelerating erosion of the channel perimeter where not covered by riprap.
2. The riparian vegetation was degraded by the earlier dredging and subsequent encroachment of invasive species, which limit the ability of native species to establish strong root networks to hold the soil in place.
3. The rebuilding of Route 63 as shown on historic maps indicate that the channel was likely relocated and filled in the 1930's.
4. Installation of the riprap along both North Leverett and Montague roads further restrict the ability for woody vegetation to become established, thus reducing the ability for native plant species to effect channel stabilization.
5. Riprap also likely increased the velocity through the stream reaches near Sunderland Road resulting in aggressive erosion on the opposite bank.
6. Previous dredging in the reach along Sunderland Road resulted in a lowering of the channel bottom and removal of large amounts of sediment. The result of this confinement can be seen downstream where large amounts of cobble size sediment lies in both point bars and mid channel bars. This sediment was delivered downstream by the higher velocities and then dropped out when the river was able to communicate with its floodplain once again. Unfortunately, at the first location where the river is no longer entrenched due to the sediment buildup is adjacent to farmland which is now flooding more frequently
7. A contributing factor to the sediment deposition was apparently a diversion that acted as a bypass about 750 feet downstream of South Street in Montague. There is a small earthen embankment at the meander apex at

this location, which appears to have been rebuilt following the flood of 1997. This diversion of flood flows effectively reduced the stream energy at the meander bend. This diversion likely resulted in deposition of much of the bedload at a large point bar immediately downstream of this meander.

8. A large point bar has been deposited upstream of Center Street. This deposition narrows the channel, reducing its flow capacity and ability to transport sediment. Flooding of the farm field on the right bank is a result. A secondary result is the beginning of a meander cutoff initiating at the apex of the meander and proceeding across the field edge. Inspection of this area shows that the new channel cut has deepened to the point where it has intercepted the groundwater and a small base flow has begun. The only impediment to this meander cutoff and formation of the new channel is a narrow row of trees and boulders piled up along the bank. It appears this area is likely to become the new channel as water continues to flow out of bank and deepen the channel.

A total of 14 significant erosion and sediment sites were identified as possibly warranting further study or remedial measures. All sites are located in Montague. Appendix A contains location maps for the sites. Appendix B contains a further description and photographs of each site. Table 1 is a summary of the sites.

Throughout the watershed there are additional areas of streambank erosion that may require more study. The previously noted sites are considered to be the most significant.

FISHERIES HABITAT

Although transported sediment occurs in all streams, excessive sediment load and particle size can negatively impact a fishery. Fine sediment intrusion can significantly impact the quality of spawning habitat in streambed gravel by restricting permeability and intragravel water velocities, thereby restricting the supply of oxygenated water to the developing salmonid embryos.

The erosion along banks also removes overhanging vegetative cover along the riparian edge. This tends to decrease holding cover and increases water temperature. Historic dredging of sediment over the years has resulted in widening of the stream channel, reducing flow depth, and increasing water temperature.

Table 1 – Erosion and Sediment Sites

Site	General Location	Problem Summary
1	Montague-Leverett town-line	High bank erosion
2	Upstream from Route 63	Severe bank erosion
3	Sunderland Road and Rte 47	Severe bank erosion
4	Sunderland Road	Lack of riparian vegetation
5	Sunderland Road	Severe bank erosion, sediment deposition
6	Sunderland Road	Lack of riparian vegetation
7	South Street	Severe sedimentation, moderate erosion
8	Upstream from Center Street	Severe sedimentation, agricultural flooding
9	State Wildlife Management Area	Moderate bank erosion, lack of riparian vegetation
10	State Wildlife Management Area	High bank erosion, lack of riparian vegetation
11	Downstream from Meadow Road	High bank erosion
12	Greenfield Road (Lost Willows)	High bank erosion
13	Greenfield Road	Moderate bank erosion, braided channel
14	Meadow Road	Severe high bank erosion, road threatened

FISH PASSAGE

Several potential opportunities for fish passage improvements were noted. Further evaluation is warranted. Table 2 is a summary of those sites. The sites are located on the maps in Appendix A.

Table 2 – Fish Passage Sites

Site	General Location	Problem Summary
F1	Moores Corner, Leverett	Dam obstructing fish movement
F2	Sawmill Dam - near N. Leverett Rd and Cave Hill Rd	Dam obstructing fish movement
F3	Old Mill Dam - downstream of Sawmill Dam	Dam obstructing fish movement
F4	Upstream from Spaulding Brook – low-head dam	Dam obstructing fish movement
F5	Spaulding Brook – box culvert	Culvert length
F6	Site 3	Possible restricted zone of fish passage
F7	Site 7	Rock vortex weir may restrict fish passage
F8	Bookmill Dam remnants, Montague Center	Sill and woody debris restricting movement

RIPARIAN CORRIDOR

Overall, the riparian corridor is composed of tall (tall as the stream is wide), mature trees that provide 80% cover or more along the stream edge and are continuous over 2 or more stream segments both up and down stream, and connect across the stream. Exceptions are indicated in Appendix B. Where riparian forest buffer is absent, riprap, impervious surfaces (such as roads), or mowed grass is the typical land cover. The forested buffer is, on average, at least 35 feet wide (15 feet of undisturbed woodland in Zone 1 and 20 feet of undisturbed or managed woodland in Zone 2), except where indicated in Appendix B.

Invasive species, including Japanese Knotweed (*Polygonum cuspidatum* or *Fallopia japonica*), Multiflora Rose (*Rosa multiflora*), Japanese Barberry (*Berberis thunbergii*), and Japanese, Morrow's and other shrub Honeysuckle (*Lonicera japonica*, *L. morrowii*, *L. tatarica* or *L. maackii*, *L. xbella*) are present in the assessment area. Appendix B describes the general extent of invasion at each site. In some places these invasive species have taken over the understory and have successfully competed against the native regeneration. Invasive species also reduce the diversity of plants available and reduce the forest structure necessary for wildlife habitat. See references for more information on the various plants and their identification, effects and control.

Table 3 is a summary of the riparian conditions at each of the sediment and erosion sites.

Table 3 - Riparian Corridor Condition

Site	General Location	Problem Summary
1	Montague-Leverett town-line	No native regeneration, invasive species abundant, reduced buffer width
2	Upstream from Route 63	Invasive species abundant, native regeneration limited, reduced buffer width
3	Sunderland Road and Rte 47	Invasive species abundant, reduced buffer width
4	Sunderland Road	Lacks riparian vegetation, invasive species abundant at stream edge
5	Sunderland Road	Invasive species abundant at stream edge and road, reduced buffer width
6	Sunderland Road	Lacks riparian vegetation, invasive species abundant, no native regeneration
7	South Street	Invasive species abundant, native regeneration limited, reduced buffer width
8	Upstream from Center Street	Invasive species abundant, native regeneration limited, reduced buffer width
9	State Wildlife Management Area	Lacks riparian vegetation, invasive species present
10	State Wildlife Management Area	Lacks riparian vegetation, invasive species present
11	Downstream from Meadow Road	Invasive species present, lacks riparian vegetation,
12	Greenfield Road (Lost Willows)	Lacks riparian vegetation, invasive species present
13	Greenfield Road	Invasive species abundant, lacks riparian vegetation
14	Meadow Road	Invasive species abundant, native regeneration limited

OTHER

At several locations along the river, unnatural instream and streambank obstructions such as concrete slabs and other debris were observed. These can potentially cause negative impacts on the streambanks and channel bed. Farm animal crossings were also noted. These crossings disturb streambanks and may also contribute to water quality degradation. Efforts should be made to identify those situations where negative impacts as a result of these conditions could be cooperatively remedied.

COMMENTS AND RECOMMENDATIONS

Table 4 is a summary of comments and recommendations concerning further activities that should be considered in the watershed. Appendix C contains a narrative description of these observations and recommendations for priorities for future work.

Both the table and appendix are organized by resource issues. Within each of the category the actions are indicated as short (S) or long (L) term. Short term is defined as able to be accomplished within the next year with minimal or no design or permit requirements. Long term indicates that significant time may be required for adequate studies, permitting requirements, coordination with landowners, and acquisition of funding to carry out the work. Many of the studies and actions will require the resources of federal or state agencies or consultants.

This assessment report holds implications concerning ongoing Atlantic salmon restoration activities, in stream construction, private property issues and state and federal permitting. Before the project proceeds toward recommending design-specific restoration activities, discussions should be held with stakeholders in those areas to assure a partnership approach.

Sites described below are listed in order of the team's recommended priority for future work or study. These priorities are based on the team's assessment of the natural resource issues. There may be legitimate reasons for changing them based on other stakeholders' views and opinions.

Further study of the fluvial geomorphology and riparian systems may impact recommendations presented or may lead to others not yet identified.

Table 4 – Summary of Comments and Recommendations by Site

COMMENTS AND RECOMMENDATIONS	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site F1	Site F2	Site F3	Site F4	Site F5	Site F6	Site F7	Site F8
EROSION AND SEDIMENT																						
Comprehensive geomorphology study of the river	L	L	L	L	L	L	L	L			L											
Hydraulic study of restoration sites	L																					
Remove remnants of old dam near Montague/Leverett town line	S													S								
Stabilize Meadow road land slide									S	S		S										
Stabilize streambank erosion					L						L	L	L									
Stream restoration and erosion control	L	L	L	L	L		S	L			L	L	L									
Sediment and debris removal					L			L														
Management practices change									S	S												
Evaluate need to repair riprap				S																		
FISH PASSAGE																						
Evaluate existing dams for fish passage or removal															L	L	L	L	L			S
Spaulding Brook box culvert may be too long																			L			
Sediment and debris may restrict movement																				S		S
Rock vortex weir may restrict movement																						
RIPARIAN RESTORATION																						
Restore riparian vegetation and buffer																						
Improve existing riparian buffer																						
Invasive species control	L	L	L	L	L	L	L	L	L		L	L	L	L								
Maintain existing buffers	S																					
OTHER																						
Implement best management practices to control road drainage	S																					
Review land use regulations for runoff, sediment, erosion control, etc.	S																					
Review animal grazing and watering practices	S																					

NOTES: Further descriptions are in Appendix C

S - Short term is defined as able to be accomplished within the next year with minimal or no design or permit requirements.

L - Long term indicates that significant time may be required for adequate studies, permitting requirements, coordination with landowners, and acquisition of funding to carry out the work.

REFERENCES

Forman, Jennifer, University of Massachusetts at Boston. *The Introduction of Non-Native Plants in Massachusetts*. (Available on the Conservation New England web site: <http://omega.cc.umb.edu/~conne/jennjim/intro.html>)

Kyker-Snowman, Thom. *Alien Invasions and the Protection of Native Diversity on Massachusetts Woodlots*. Woodland Steward, newsletter of the Massachusetts Forestry Association. (on the web at <http://www.massforesters.org/invasive.htm>)

Rosgen, Dave. Applied River Morphology. 1996. Wildland Hydrology, Pagosa Springs, CO.

USDA Natural Resources Conservation Service. 2001. *Riparian Forest Buffer Standard and Specification, Code 391*. (Available at local NRCS Field Offices or on the MA NRCS web site: <http://www.ma.nrcs.usda.gov>)

USDA Natural Resources Conservation Service. 2000. *Riparian Area Inventory and Assessment Guide*. (Unpublished)

USGS, National Biological Survey web site on invasive plants in Massachusetts, <http://www.invasivespecies.gov/geog/state/ma.shtml>

Weatherbee, Pamela. 1994. *The Most Unwanted Plants*. Massachusetts Wildlife. Division of Fisheries and Wildlife, Westborough MA.

Weatherbee, Pamela, et.al. 1998. *A Guide to Invasive Plants in Massachusetts, 1998*. Massachusetts Division of Fisheries & Wildlife.

APPENDIX A – SITE LOCATION MAPS

Figure A-1 Site Location Map



Figure A-2 Site Location Map

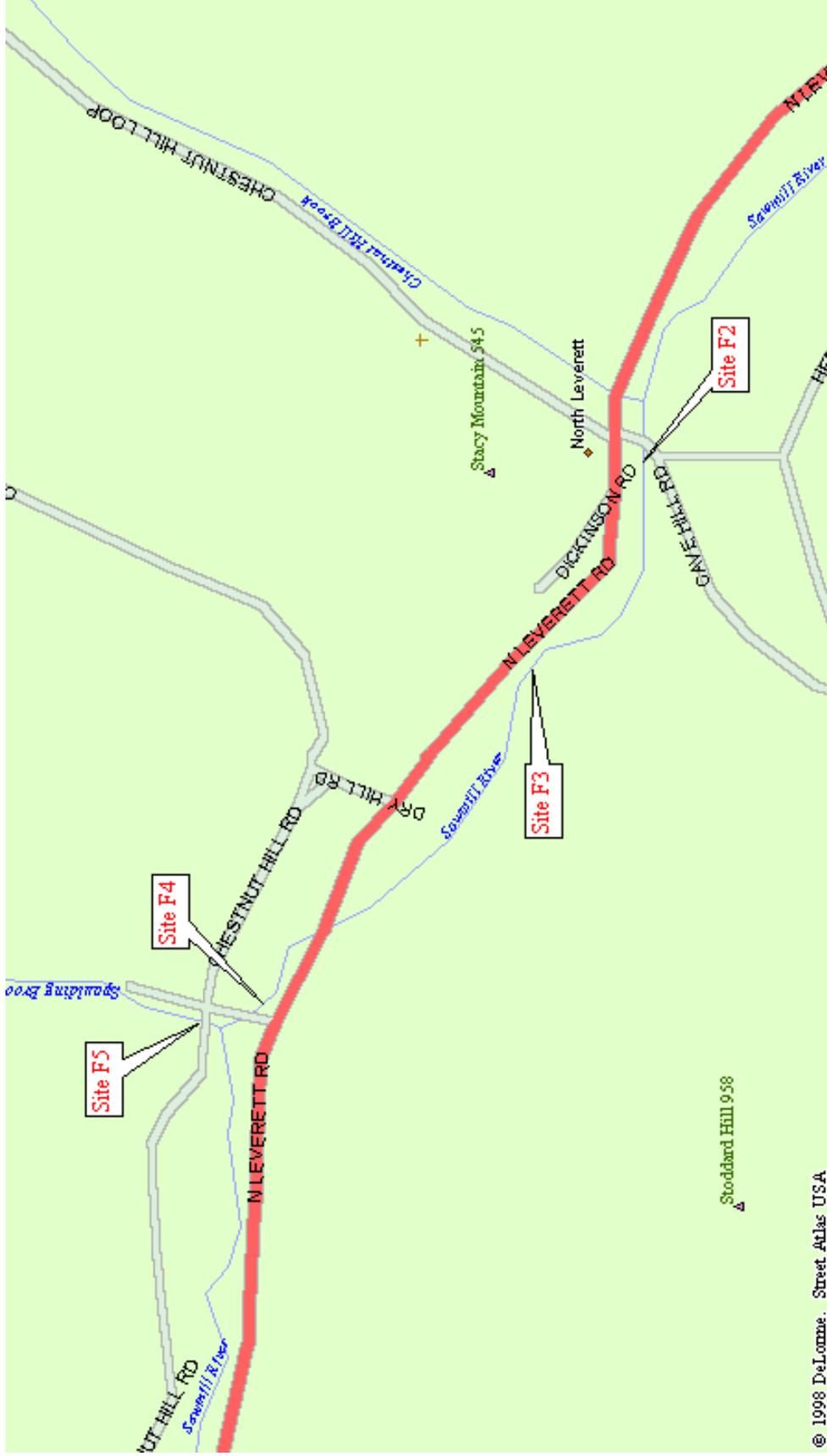


Figure A-3 Site Location Map

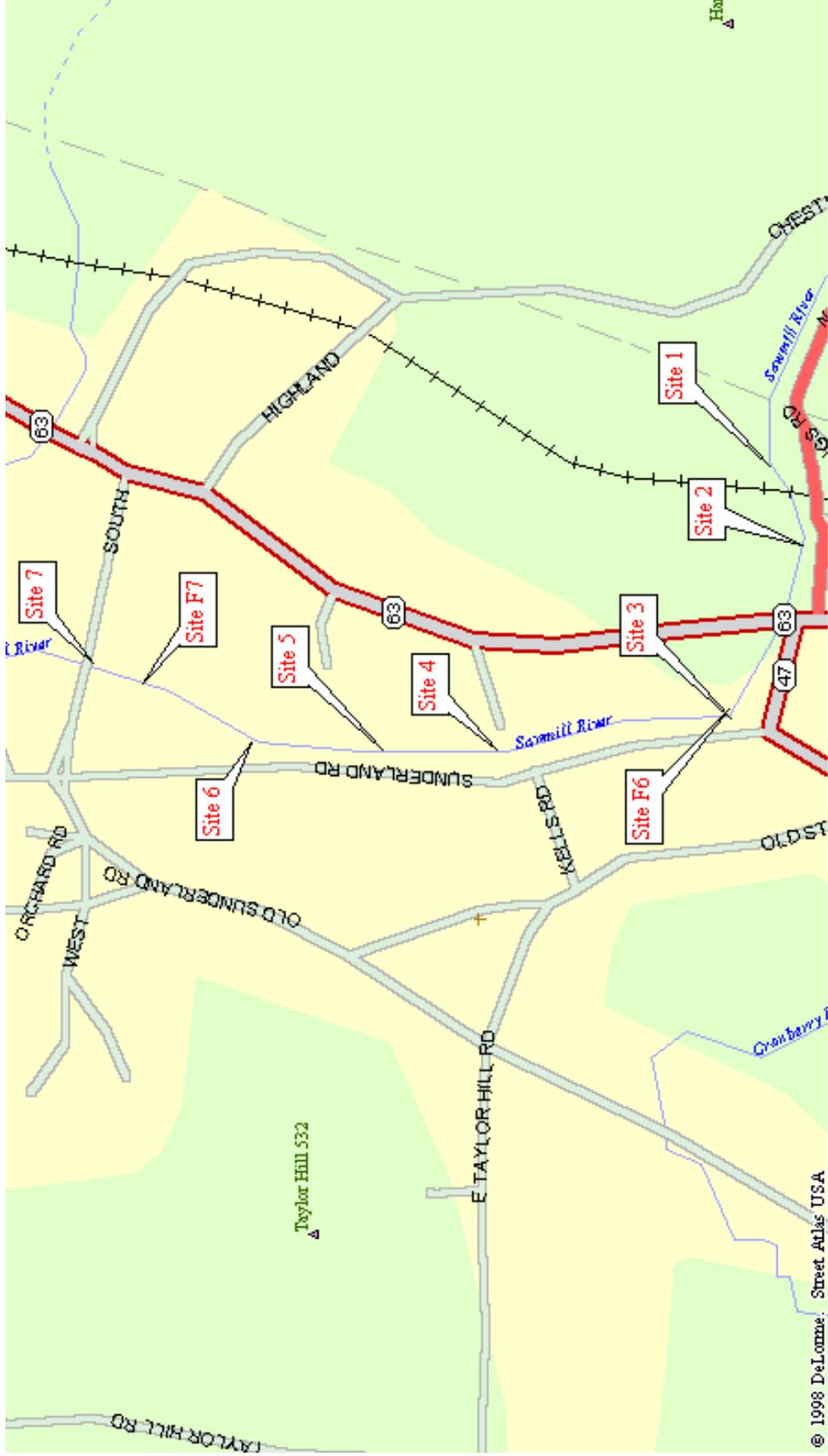
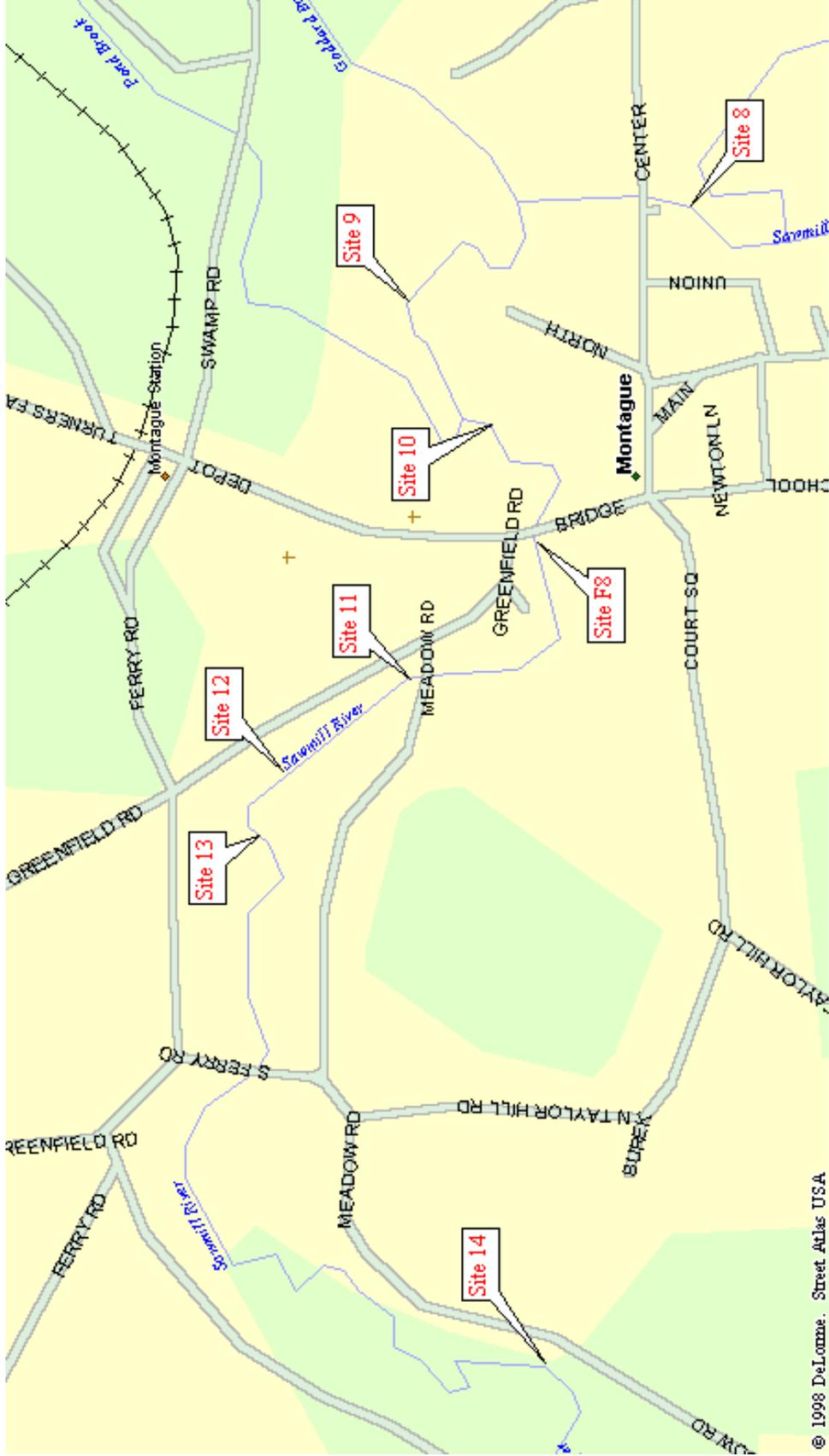


Figure A-4 Site Location Map



APPENDIX B – SITE REPORTS

SITE 1

LOCATION

Site 1 is located upstream from the railroad bridge and behind the woodworking mill on North Leverett Road.

GPS COORDINATES

Latitude N 42.51878
Longitude W 72.52451

PHOTOGRAPHS

Site 1 looking upstream



Downstream from Site 1



ASSESSMENT SUMMARY

General – This site is about 185 feet long and characterized by a steep, eroding right bank, about 20 feet high. There is active bank erosion with some overhanging vegetation and seeps. The bank material is generally gravel. There is a mill building on the left bank. The banks appear stable and well vegetated both upstream and downstream from the site. The channel is somewhat incised and the slope is fairly steep. The riverbed appears stable. The dominant bed materials are cobbles and boulders. Based on visual assessment only, the river is likely a B3/F3 Rosgen classification.

Riparian Corridor

Right Bank: Steep, eroding soil with a forested riparian buffer. The plant community consists of maple-ash-oak-Eastern Hemlock for an overstory and rhododendron and Japanese Knotweed as major understory species. This is a mature forest with a closed canopy (100 to 80 % shaded) the

trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream and connects across the stream as well. Japanese Knotweed has completely choked out any regeneration in the understory and is growing at the water edge.

Left bank: The stream on this side is within 15 feet of sawmill buildings and approximately 75 to 100 feet from North Leverett Road. Within the 15 feet (Zone 1), there is a plant community consistent with the right bank (except shading is only 50 to 80 %), including overhanging vegetation in the stream. Japanese Knotweed is in abundance. Impervious surfaces, including buildings, parking lots and paved road, make up the rest of the buffer (Zone 2 and 3) on this side of the stream.

Fisheries Habitat – Juvenile salmonid habit is present. The site is riffle-run habitat. The instream substrate is boulders and cobbles. There is good cover and riparian buffers upstream and downstream from this site. Downstream from the site there is good juvenile salmon habitat with large boulders, fast riffle areas and high gradient pools.

PROBLEM SUMMARY

The steep, right bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. Erosion is categorized as high. It will likely continue as high flows erode the toe and the upper slope and trees fall into the river. The conditions may be a result of the buildings on the left bank confining the higher flows and preventing the river from reaching its floodplain.

SITE 2

LOCATION

Site 2 is located on the North side of North Leverett Road, downstream (west) from railroad track, between Rte 63 and railroad track, and the behind fish hatchery (Farm 304 Tract 1609).

GPS COORDINATES

Latitude N 42.51795
Longitude W 72.52641

PHOTOGRAPHS

Site 2 looking downstream



Site 2 looking upstream



ASSESSMENT SUMMARY

General – This site is about 240 feet long and characterized by a nearly vertical eroding left bank, about 8 feet high. There is active bank erosion with overhanging vegetation. The bank material is generally gravel. The erosion is occurring on an outside meander bend. There is a significant point bar on the left bank. The banks appear stable and well vegetated both upstream and downstream from the site. The channel is somewhat incised and the slope is fairly steep. The dominant bed materials are cobbles and boulders. Based on visual assessment only, the river is likely a B3/F3 Rosgen classification.

Riparian Corridor

Right Bank: Zone 1 and 2 consist of a mature plant community of oak-ash-maple-Eastern White Pine-Eastern Hemlock with an understory of rhododendron, some regeneration of canopy species and False Lily-of-the-Valley. This buffer has a closed canopy, the trees are as tall as the stream is

wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream and connects across the stream as well. The fish hatchery is on this side beyond Zone 3. Japanese Knotweed grows along the stream edge. This side has a point bar that has willow, Japanese Knotweed and sedges growing on it. Note: the original bank along the stream has been buried with gravel excavated from the stream.

Left Bank: The paved road is within about 15 feet from the stream. The bank is eroding and has a pure stand of Japanese Knotweed growing on it. The knotweed has choked/shaded out any other ground cover (including grass) except for a very few, scattered (10 to 20 feet apart) mature trees of ash, oak, and maple. These large trees provide approximately 25 to 50 % shade. There is evidence of use by people to access the stream. There is also a ditch entering on this side (not flowing at the time), and evidence of overland flow through the vegetation.

Fisheries Habitat –The site contains a riffle area with a few pools. The instream substrate is large boulders and cobbles with more fine sediment than at Site 1. In general, there is good juvenile salmonid habitat.

Downstream from the site there is some erosion and some riprap on the right bank. There are larger boulders instream. There is a potentially good salmonid spawning area except that the cobble substrate is embedded in finer gravel. It is a riffle-run area.

PROBLEM SUMMARY

The left bank is eroding due to dredging in the 1940's, a lack of vegetative cover and an unstable toe (bottom) of slope. The erosion is categorized as severe. It will likely continue as high flows erode the toe and the upper slope and trees fall into the river.

SITE 3

LOCATION

1. Site 3 is located on the east side of Sunderland Road, just north of the Rte 47 intersection. The left bank is along the road.

GPS COORDINATES

Latitude N 42.51989
Longitude W 72.53097

PHOTOGRAPHS

Site 3 looking downstream



Site 3 looking upstream



ASSESSMENT SUMMARY

General – This site is about 270 feet long and characterized by a nearly vertical eroding left bank, about 8 feet high. There is active bank erosion with some overhanging vegetation. The bank material is generally gravel. The erosion is occurring on an outside meander bend. There is a significant point bar on the left bank. The banks appear stable and well vegetated both upstream and downstream from the site. The channel is somewhat incised and the slope is fairly steep. The riverbed appears stable. The dominant bed materials are cobbles and boulders. Based on visual assessment only, the river is likely a C3 Rosgen classification.

Riparian Corridor

Right Bank: Zone 1 and 2 consist of a mature plant community of oak-ash-Shagbark Hickory- maple with an understory of some natural regeneration of mature species, Japanese Knotweed, Japanese Barberry, Chokecherry, Sassafras, and ferns. This buffer has a closed canopy, the trees are as tall as

the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream, and connects across the stream as well (on lower part of segment only). Japanese Knotweed is abundant, especially at stream edge. This side has a point bar with no vegetation.

Left Bank: This is a vertical eroding bank that is within 10 feet of the paved road along a portion of it. Zone 1 (10 feet) consists of grasses, Multiflora Rose, False Solomon's Seal and ferns. Japanese Knotweed is abundant at the stream edge. Zone 2 and 3 do not exist (paved road). On the lower part of this segment the stream meanders away from the road and there is a small area of old-growth woods between road and stream. Larger diameter trees of Yellow Birch and Eastern Hemlock are present. There is evidence of people accessing the stream. A cross culvert outlets into this segment.

Fisheries Habitat – The left bank is eroding and there is a point bar on the right. The channel is narrow. The constriction increases velocity and there is a drop that may be a problem for fish passage. The instream substrate is gravel, cobbles and small boulders. There is woody debris on the left bank.

PROBLEM SUMMARY

The left bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. Erosion is categorized as severe. It will likely continue as high flows erode the toe and the upper slope and trees fall into the river

SITE 4

LOCATION

Site 4 is located on the east side of Sunderland Road, across from Kells Road and at the south end of a hay field (Farm 304 Tract 1609), in Montague.

GPS COORDINATES

Latitude N 42.52352
Longitude W 72.53167

PHOTOGRAPHS

Site 4 looking downstream
Upper Section



Site 4 looking downstream
Lower Section



ASSESSMENT SUMMARY

General – This site is about 160 feet long. It is characterized by two sections of riprap on the left abutment that protects the road. The left bank is about 10 feet high. There is a small area of eroded bank just upstream from the lower riprap section. The channel is low gradient with cobbles and boulders. There is a point bar on the right bank. There is a low berm on the right bank, which is probably a result of past dredging of the river. Both river banks appear stable. Based on visual observation only, the likely Rosgen classification is C3/F3.

Riparian Corridor

Right Bank: Zone 1 is forested with a mature community of maple-oak-ash with an understory of Eastern White Pine and birch regeneration. This zone has a closed canopy, the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous

over 2 or more stream segments both up and down stream. Zone 2 and 3 are residential/agricultural, consisting of hay field or natural back yard area. The natural back yard area has occasional mature ash and oak with some Chokecherry understory along the edge between Zone 1 and 2. Japanese Knotweed abundant at stream edge. There is evidence of paths to stream edge.

Left Bank: Zones 1, 2 and 3 consist of two areas of riprap (no vegetation) with some trees and shrubs (similar to what is on the right bank) between the two areas. The paved road is adjacent to the riprap. No stream shading exists within the riprap areas. Japanese Knotweed abundant at stream edge.

Fisheries Habitat – Instream fish habitat could be improved by vegetating the riprap areas to provide canopy cover, insect forage, and stream shading. Techniques such as joint planting live stakes in the riprap would establish woody vegetation that will provide shade and cover.

PROBLEM SUMMARY

There is a small, eroded area at the upstream end of the downstream riprap section on the left bank. This may become larger in future storms. The low berm (spoil pile) on the right abutment confined the channel somewhat by increasing the elevation that floodwater can flow onto the floodplain. The riprap sections are completely devoid of vegetation. This reduces habitat value and shading of the river.

SITE 5

LOCATION

Site 5 is located on the east side of Sunderland Road, across the road from middle of hay field (Farm 304 Tract 1609) and west of Farm 553 Tract 990 Field 2.

GPS COORDINATES

Latitude N 42.52523
Longitude W 72.53170

PHOTOGRAPHS

Site 5 looking downstream



Site 5 looking upstream



ASSESSMENT SUMMARY

General – This site is about 360 feet long and characterized by a near vertical eroding right bank about 6 feet high. There is active bank erosion with some overhanging vegetation. The bank material is generally gravel. Erosion is occurring on the outside meander bend. There is a large gravel point bar that is beginning to revegetate. The riverbed appears to be aggrading. The dominant bed materials are gravel and cobbles. Based on a visual assessment only, the river is likely a C4 Rosgen classification.

Riparian Corridor

Right Bank: This is an eroding, slumping bank forested with a mature community of maple-oak-ash with an understory of regeneration from the canopy species and Japanese Knotweed. The Knotweed is located mostly along the stream edge. This forest buffer has a closed canopy, the trees are

as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. There is evidence of a possible beaver dam in the past.

Left Bank: This side is 10 feet from the paved road with some widely spaced mature trees and Japanese Knotweed. Japanese Knotweed is abundant and is located on stream edge and along road. This side has a large gravel point bar that has willow, Japanese Knotweed and birch growing on it. This point bar is forcing the water to the right side causing the bank to slump and trees to fall in the water.

Fisheries Habitat – Two deep pools were noted and macro invertebrate production was observed.

PROBLEM SUMMARY

The right bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. Erosion is categorized as severe. It will likely continue as high flows erode the toe and the upper slope and trees fall into the river. The channel has overwidened and appears to be aggrading. There are large trees in the channel that serve as woody debris for habitat, but they may also deflect flood flows toward the unprotected banks and may be transported downstream in future flood events.

SITE 6

LOCATION

Site 6 is located east of Sunderland Road, across the road from the Drinking Water Supply Area and north end of hay field (Farm 304 Tract 1609) and west of the south end of hay field (Farm 553 Tract 990 Field 1), in Montague.

GPS COORDINATES

Latitude N 42.52653
Longitude W 72.53190

PHOTOGRAPH

Site 6 looking downstream



ASSESSMENT SUMMARY

General – The site is about 70 feet long. The banks are about 10 feet high. There is riprap on the left bank that protects the road embankment. The banks and riverbed appear stable.

Riparian Corridor

Right Bank: Zone 1 and 2 are forested with a mature community of red maple-ash-white birch-locust with an understory of Japanese Knotweed. This forest buffer has a closed canopy, the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Japanese Knotweed is a pure stand on the stream bank.

Left Bank: This side is riprap to the paved road with no trees, just grass and Japanese Knotweed coming up between the rocks. No stream shading exists within the riprap area. Just downstream is an old-growth stand of hardwoods.

Fisheries Habitat – Instream fish habitat could be improved by vegetating the riprap areas to provide canopy cover, insect forage, and stream shading. Techniques such as joint planting live stakes in the riprap would establish woody vegetation that will provide shade and cover.

PROBLEM SUMMARY

The only apparent problem is the lack of vegetation on the left riverbank.

SITE 7

LOCATION

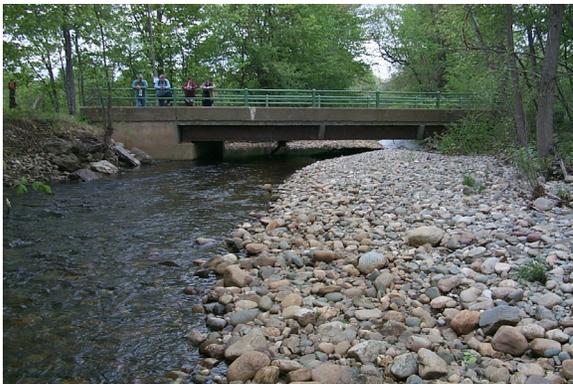
Site 7 is located upstream and downstream of the South Street bridge across Sawmill River in Montague Center. Northwest corner of Farm 553 Tract 990 Field 1.

GPS COORDINATES

Latitude N 42.53086
Longitude W 72.52937

PHOTOGRAPHS

Site 7 looking downstream
at South Street



Site 7 looking downstream
from South Street



ASSESSMENT SUMMARY

General – The entrance and exit channels and the bridge opening are clogged with sediment. The channel makes a right turn under the bridge. The flow capacity is seriously reduced. The channel slope is fairly flat. The sediment is cobbles and coarse gravel. The riverbanks near the bridge are about four feet high, vegetated, and appear stable. The banks are generally gravel. Upstream from the bridge there are berms on both abutments that appear to be old piles of dredged materials. There is also a section of channel with rock vortex weirs that were constructed after the last major storm. Based on a visual assessment only the river is likely a C4 Rosgen classification.

Riparian Corridor

Right Bank: Zone 1 both upstream and downstream of the bridge is forested with a mature canopy of red maple-poplar-birch-ash with an understory of Meadowsweet and Japanese Knotweed. The Japanese Knotweed is growing at the stream edge and has shaded out any regeneration. This forest buffer has a closed canopy, the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream and connects across the stream as well. Gravel from the stream has been piled up along the bank upstream from the bridge. Zone 2 is in agricultural use (Farm 553 Tract 990 Field 1) and appears to be a mowed hay field. Downstream from the bridge, it is an unmowed hay field or natural area, consisting of scattered trees and shrubs. Shading is less than 25 percent. Upstream from the bridge, this side has a gravel point bar, with no vegetation growing on it.

Left Bank: Zone 1 both upstream and downstream of the bridge is forested with a mature canopy of red maple-poplar-birch-ash with an understory of Meadowsweet and Japanese Knotweed. Japanese Knotweed is growing along the stream edge. This forest buffer has a closed canopy, the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream and connects across the stream as well. Zone 2, upstream and downstream of the bridge, is a wild unmanaged area. This zone consists of scattered maple-poplar-birch-ash and Meadowsweet in unmowed grass. Shading is less than 25 percent. Downstream from the bridge, this side has a gravel point bar, with no vegetation growing on it.

Fisheries Habitat – Fish habitat through the bridge area has been disturbed by sediment deposition. The rock vortex weirs may impair fish passage.

PROBLEM SUMMARY

Sediment deposition in and around the South Street bridge significantly reduces the capacity of the bridge. In future storms, debris clogging is very likely. This may cause additional upstream and road flooding. The upstream rock vortex weirs may be a restriction to fish passage upstream.

SITE 8

LOCATION

Site 8 is located upstream from the Center Street bridge adjacent to a cropped field (Farm 2378 Tract 8720).

GPS COORDINATES

Latitude N 42.53365
Longitude W 72.52808

PHOTOGRAPHS

Site 8 looking downstream



Site 8 looking upstream
from field overflow



ASSESSMENT SUMMARY

General – This site is about 250 feet long and is characterized by significant sediment deposition. The riverbanks are about four feet high and are generally vegetated. The bank material is generally gravel. There is a large point bar and debris accumulation on the left side of the channel. Obstructions are such that even small storms cause the river to overtop the right bank and flow through a cropped field. The dominant bed material is gravel and cobbles. Based on a visual assessment only, the river is likely a C4 Rosgen classification.

Riparian Corridor

Right Bank: Zone 1 is 10 feet of mature plant community consisting of red maple-ash moderately shaded (50-80%) with an understory of green brier, Multiflora Rose, Japanese Knotweed and Sensitive Fern. The trees are as tall as the stream is wide, and some are hanging over the stream. On this side Zone 1 is continuous over 2 or more stream segments both up and down

stream and connects across the stream as well. Zone 2 is a tilled field with a cover crop. This side has a gully leaving the stream, which has eroded a large gully in the tilled field. There is also evidence of beaver and a working beaver dam on the unnamed tributary just upstream from this segment.

Left Bank: This side consists of a tree/shrub floodplain that is moderately shaded. Zone 1 consists of a mature plant community of red maple-ash with an understory of Green Brier, Sensitive Fern, Multiflora Rose and Japanese Knotweed. Japanese Knotweed is a pure stand in the understory in some parts. Zone 2 consists of Red Maple with an understory of sumac, Japanese Knotweed and Green Brier. The trees are as tall as the stream is wide, and some are hanging over the stream. This buffer is continuous over 2 or more stream segments both up and down stream and connects across the stream as well.

Fisheries Habitat – Fish habitat has been disturbed by sediment deposition.

PROBLEM SUMMARY

A large point bar has formed from an unknown sediment source. The deposition has reduced the channel capacity. During floods, water overtops the right bank carrying sediment onto a farm field and creating a new channel. Under present conditions, it is likely that the existing meander will be cut off and a new river channel will be created in the future. It should be noted that the farm field is floodplain and periodic overflows should be expected.

SITE 9

LOCATION

Site 9 is located in the Massachusetts State Wildlife Management area adjacent to hay field, downstream from Goddard Brook intersection

GPS COORDINATES

Latitude N 42.53998
Longitude W 72.53159

PHOTOGRAPHS

Site 9 looking downstream



Site 9 looking upstream



ASSESSMENT SUMMARY

General – This site is about 150 feet long and is characterized by a steep eroding right bank about six feet high. There is active bank erosion, an undercut toe of slope, some seeps, and some overhang. The bank material is generally sand with a clay layer near the bottom of the slope. Erosion is occurring on the outside of the meander bend and there is a significant point bar on the left bank. The dominant bed material is gravel and sand. There is some large woody debris immediately downstream from the site. Based on a visual assessment only, the river is likely a C4-C5 Rosgen classification.

There is a significant change in the river type between Site 8 and Site 9. The slope is flatter and the bed and bank materials are smaller. This change occurs at the confluence with Goddard Brook.

This area appears to be heavily used for fishing access. The right abutment is periodically mowed to the top of the bank.

Riparian Corridor

Right Bank: This side is a managed (mowed) hay field right to the stream edge. The bank (~6 feet high) is being undercut. There is no forested riparian buffer.

Left Bank: Zone 1 consists of 10 feet of a mature plant community of Sycamore- black willow-oak-red maple with an understory of dogwood, willow, alder, Multiflora Rose, Japanese Barberry and ferns. This zone has a closed canopy, the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Zone 2 and 3 consists of a mowed hay field with Multiflora Rose, grasses and sedges. This is a well-used wildlife management area with evidence of people accessing the stream in several places and recreational trails throughout the buffer area. There is evidence of wildlife including birds and mammals such as wrens, Catbird, Yellow-rumped warbler and American Robin. Plants with berries, nuts and cones are present and snags for nesting habitat.

Fisheries Habitat – The river is slow and meandering in this area. There are deep pools and some instream woody structure. The instream substrate is cobbles and sand.

PROBLEM SUMMARY

The right bank is eroding due to a lack of vegetative cover, foot traffic, and an unstable toe (bottom) of slope. Erosion is categorized as moderate. It will likely continue as high flows erode the toe and the upper slope falls into the river.

SITE 10

LOCATION

Site 10 is located in the Massachusetts State Wildlife Management area, ,

GPS COORDINATES

Latitude N 42.53843
Longitude W 72.53311

PHOTOGRAPHS

Site 10 looking downstream



Site 10 looking upstream



ASSESSMENT SUMMARY

General – This site is about 175 feet long and is characterized by a near vertical eroding left bank about four feet high. There is active bank erosion and some overhang. The bank material is generally sand. Erosion is occurring on the outside of the meander bend and there is a significant point bar on the left bank. The dominant bed material is gravel and sand. Based on a visual assessment only, the river is likely a C4-C5 Rosgen classification.

This site is likely located in the pool area of the former Bookmill Dam located downstream. This area appears to receive heavy foot traffic from fishers and recreation trail users. The left abutment is periodically mowed to the top of the bank. Just downstream from the site is a pool used for swimming, sand bags were observed in the water.

Riparian Corridor

Right Bank: This side is a meander in the stream. Zone 1 consists of a mature plant community of Red Maple-Sycamore-Black Willow with an

understory of alder, Japanese Barberry, and Meadow Rue. This zone is moderately shaded and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Zone 2 consists of a mature plant community of Sycamore-maple-White Pine with an understory of Multiflora Rose, Japanese Barberry, Japanese Knotweed, Jewelweed, and Skunk Cabbage, which is moderately shaded. This side has a sandy point bar with no vegetation growing on it.

Left Bank: This is a mowed field to the stream edge. There is no forested riparian buffer. There are some very scattered trees including apple, birch and Sycamore in the field (zone 2 and 3). The field has Multiflora Rose, Japanese Barberry and Meadow Rue growing in it along with grasses and sedges. The bank (~4 feet high) has undercut the existing recreational trail. This is a well-used wildlife management area with evidence of people accessing the stream in several places and recreational trails throughout the buffer area. There is evidence of wildlife such as birds and mammals including American Robin and Catbird. Plants with berries, nuts and cones are present. There also is an abundant edge and snag trees for nesting habitat are present.

Fisheries Habitat – The river is slow and meandering in this area. There are deep pools and some instream woody structure. The instream substrate is cobbles, gravel, and sand.

PROBLEM SUMMARY

The right bank is eroding due to a lack of vegetative cover, foot traffic, and an unstable toe (bottom) of slope. Erosion is categorized as high. It will likely continue as high flows erode the toe and the upper slope falls into the river.

SITE 11

LOCATION

Site 11 is located west of Greenfield Road and just north of the Meadow Road intersection (downstream from the former Book Mill Dam).

GPS COORDINATES

Latitude N 42.53994
Longitude W 72.53976

PHOTOGRAPHS

Site 11 looking Upstream



Site 11 looking Downstream



ASSESSMENT SUMMARY

General – This site is about 350 feet long and characterized by a steep, eroding right bank about 12 feet high. There is active bank erosion with overhanging vegetation. The bank material is sand. The channel appears incised. The riverbed is stable. The dominant bed materials are cobbles and sand. Concrete slabs were noted on the bank and in the channel. Based on a visual assessment only, the river appears to be an F3 Rosgen classification.

Riparian Corridor

Right Bank: This side is a residential lawn with some large mature trees scattered throughout, and grass to the stream edge. The bank is steep and eroding. There is Japanese Knotweed growing on the stream edge. Just upstream from grassed area, there is some forested riparian buffer consisting of oak-Sycamore-maple with an understory of sweet fern, Multiflora Rose, Japanese Barberry, honeysuckle and Burning Bush. On the lawn (Zone 2)

are Red Maple-Eastern White Pine-oak-Sycamore and Chokecherry. There is evidence of paths to the water.

Left Bank: This side is a wild unmanaged area behind commercial/residential buildings. The buffer consists of a mature plant community of maple-Sycamore-oak with an understory of Multiflora Rose. This forest buffer is moderately shaded and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Japanese Knotweed grows along the stream edge.

Fisheries Habitat – This site is riffle-run habitat. The instream substrate is sandy with cobbles.

PROBLEM SUMMARY

The steep, right bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. Erosion is categorized as high. It will likely continue as high flows erode the toe and the upper slope and trees fall into the river.

SITE 12

LOCATION

Site 12 is located west of Greenfield Road and north of Meadow Road. The site is referred to as the “Lost Willows Site” because of the number of mature willow trees that were lost in previous large storms.

GPS COORDINATES

Latitude N 42.54173
Longitude W 72.54145

PHOTOGRAPHS

Site 12 looking Upstream



Site 12 looking Downstream



ASSESSMENT SUMMARY

General – This site is about 375 feet long and characterized by a steep, eroding right bank about 8 feet high. There is active bank erosion with overhanging vegetation. The bank material is sand. The riverbed appears stable. The dominant bed materials are cobbles and sand. Based on a visual assessment only, the river appears to be a C4 Rosgen classification.

Riparian Corridor

Right Bank: This side is residential lawn that is mowed to the stream edge. There is no forested riparian buffer. There are mature Weeping Willow and occasional Sycamore and oak scattered around the lawn area beyond zone 3. A large log in the stream is deflecting water to the right and causing erosion. The bank is high and steep. There is evidence of people accessing the stream.

Left Bank: This side is a wild unmanaged area east of a dairy farm. Zone 1 consists of a mature plant community of Sycamore-maple with an understory of Multiflora Rose, Japanese Knotweed and Japanese Barberry. Japanese Barberry and Multiflora Rose are growing along the stream edge. This forest buffer is densely canopied and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Zone 2 consists of a mature plant community of Sycamore-willow-ash-maple with an understory of Multiflora Rose. This zone is moderately shaded. Zone 3 consists of the dairy farm pasture/hay field. Sedges and Dandelions are growing in the gravel point bar.

Fisheries Habitat – This site is a known Atlantic salmon spawning area. The instream substrate is gravel with cobbles. Freshwater clams/mussels were observed.

PROBLEM SUMMARY

The steep, right bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. There is a log in the channel bottom at the upstream end of the eroded area. This log is oriented such that it directs water toward the bank causing accelerated erosion. Erosion is categorized as high. It will continue as high flows erode the toe and the upper slope and lawn fall into the river. Continued bank loss will result in the loss of additional mature willow trees.

SITE 13

LOCATION

Site 13 is located west of Greenfield Road and north of Meadow Road. The site is just downstream from Site 12.

GPS COORDINATES

Latitude N 42.54223
Longitude W 72.54278

PHOTOGRAPHS

Site 13 looking Upstream



Site 13 looking Downstream



ASSESSMENT SUMMARY

General – This site is about 400 feet long and characterized by a near vertical, eroding right bank about 5 feet high. There is active bank erosion with an undercut toe of slope. The bank material is gravel. The riverbed is appears to be aggrading. The dominant bed materials are gravel and sand. The upstream part of the site is braided channel due to large amounts of sediment deposition and debris. Based on a visual assessment only, the river appears to be a C4/D4 Rosgen classification. There is a cattle crossing at the downstream end of the site. Concrete debris was noted in the channel and on the downstream right bank.

Riparian Corridor

Right Bank: This side is pasture (downstream end of segment), wild unmanaged area and lawn (upstream end of segment) with less than 25% shading by large mature Weeping Willow and Sycamore, some shrubs and

some erosive banks. Invasive species such as Japanese Knotweed, Multiflora Rose and Japanese Barberry are abundant along stream edge, on the bank side and top. A sand point bar has sedges, dogwood and Multiflora Rose growing on it. There is evidence of livestock and human access to the stream. There is evidence of overland gullies across lawn into stream. There is a spring overflow (from across Greenfield Road) that runs across the lawn and enters the stream.

Left bank: Zone 1 is forested with a mature plant community of Sycamore-maple-ash with an understory of Multiflora Rose and Japanese Barberry. This zone is somewhat shaded (50-25%) and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream. Zone 2 consists of a mature plant community of Shagbark Hickory-Red Maple-Sycamore with an understory of Multiflora Rose. This zone is somewhat shaded. Zone 3 is the dairy farm pasture/barnyard. There is evidence of livestock accessing the stream.

Fisheries Habitat – This site contains pools and riffle-run areas. It is likely Atlantic salmon spawning habitat. The instream substrate is a sand and cobble mix with gravel/cobble point bars. Fine organic detritus was noted on the instream substrate. The dairy farm on the downstream left bank and the cattle crossing are likely sources of nutrient input to the river.

PROBLEM SUMMARY

The steep, right bank is eroding due to a lack of vegetative cover and an unstable toe (bottom) of slope. Erosion is categorized as moderate. It will continue as high flows erode the toe and the upper slope and lawn fall into the river.

SITE 14

LOCATION

Site 14 is located on Meadow Road.

GPS COORDINATES

Latitude N 42.53752
Longitude W 72.55589

PHOTOGRAPHS

Site 14 looking Downstream



Site 14 looking Upstream



ASSESSMENT SUMMARY

General – This site is about 180 feet long and characterized by a steep, eroding left bank about 40 feet high that has failed. Meadow Road is located about 20 feet from the top of the slide. There is active bank erosion with an overhanging bank and seeps. The bank material is sand. The riverbed appears to be aggrading. The dominant bed materials are gravel and sand. Based on a visual assessment only, the river appears to be a C5 Rosgen classification.

Riparian Corridor

Right Bank: This forested buffer consists of a mature plant community of Sycamore-Red Maple with an understory of Japanese Knotweed. It is densely canopied and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segment is continuous over 2 or more stream segments both up and down stream and connects across the stream as well (up and downstream from the eroded bank). A gravel point bar has Japanese Knotweed growing on it.

Left Bank: This side has a very large, very high, very steep erosive bank with several large (40 feet or greater) trees falling into the stream. Where bank is gone (almost to the road), there is zero shading of the stream. Up and downstream of this area, the forested buffer consists of a mature plant community of Sycamore-Red Maple-Oak-Shagbark Hickory-American Beech-Poplar-Black Birch-Eastern White Pine-Eastern Hemlock with an understory of regeneration of these species, Japanese Knotweed, False Solomon's Seal, Skunk Cabbage, Princess Pine and ferns. It is densely canopied and the trees are as tall as the stream is wide, and some are hanging over the stream. On this side the buffer segments (up and down stream from the eroded bank) are continuous over 2 or more stream segments both up and down stream from the eroded bank and connect across the stream as well. Japanese Knotweed is growing along the stream edge. There is evidence of birds and mammals. Several trees have been half chewed down by beavers and Rose-breasted Grosbeaks were observed. Plants with berries, nuts and cones were present, as well as snags for nesting.

Fisheries Habitat – This site has an instream gravel and cobble substrate, with sandbars and deep pools. The area has potential for salmonid spawning habitat. Macroinvertebrates were observed.

PROBLEM SUMMARY

The steep, left bank is eroding due to an unstable toe (bottom) of slope. Erosion is categorized as severe. It will continue as high flows erode the toe and the upper slope and eventually Meadow Road will fall into the river. Continued erosion also contributes fine grained sediment to the river that is detrimental to downstream habitat.

APPENDIX C – COMMENTS AND RECOMMENDATIONS

The following are comments and recommendations concerning further activities. They are organized by resource issues. Within each of the category the actions are indicated as short (S) or long (L) term. Short term is defined as able to be accomplished within the next year with minimal or no design or permit requirements. Long term indicates that significant time may be required for adequate studies, permitting requirements, coordination with landowners, and acquisition of funding to carry out the work. Many of the studies and actions will require the resources of federal or state agencies or consultants.

Site location maps are in Appendix A.

EROSION AND SEDIMENT - Stream stability is morphologically defined as the ability of the stream to maintain, over time its dimension, pattern, and profile in such a manner that it is neither aggrading nor degrading and is able to transport without adverse consequence the flows and detritus of its watershed (Rosgen). Erosion and sediment issues below should be considered with this statement in mind.

1. A more comprehensive analysis can be done of the fluvial geomorphology of the river. The purpose of the study would be to identify processes that are contributing to instability, develop restoration concepts to help achieve dynamic equilibrium, and gather data that would be useful for a watershed management plan. Typical information required includes channel geometry, flow characteristics, sediment regime, etc. This study could form the basis for corrective actions to restore the river and its riparian area. (L)
2. An hydraulic analysis of river reaches identified in 1 above could be done to evaluate corrective actions needed at locations such as Center Street, South Street, and others. The analysis consists of developing a computer model using programs such as the Corps of Engineers HEC-RAS or the NRCS WSP-2. (L)
3. The breached concrete dam on North Leverett Road upstream of the woodworking factory should be removed from the channel. It deflects high flows across the channel toward a high bank downstream creating an unstable slope that contributes sediment to the channel. There are opportunities here for stream restoration activities as well. (S)
4. Site 14, adjacent to Meadow Road, warrants immediate corrective action because of the threat to Meadow Road. As of October 2001, this site is being addressed and repair funded under the NRCS Emergency Watershed Protection Program. This action will remove the threat to

Meadow Road and reduce the sediment load entering the river at this point. **(S)**

5. Site 12, off Greenfield Road, is eroding and will continue to add fine sediment to the river system that may be detrimental to salmon spawning habitat. It would be best to consider remedial measures at this site in the context of a fluvial geomorphology study. However short term actions would alleviate some severe erosion of the bank and plantings would re-establish some riparian buffer. **(S)**
6. Site 7, the South Street Bridge, is severely restricted due to sediment deposition under the bridge and immediately upstream and downstream. Future floods will likely plug the bridge with sediment and/or woody debris, threatening the bridge or South Street. Although this sediment removal should correctly be evaluated in the context of a fluvial geomorphology study, its removal is recommended due to the possibility of near term flood damage to the bridge and roadway. It should be recognized that removal of sediment from the fluvial system at this location might have an upstream effect of increasing erosion. **(S)**
7. Site 8, upstream from Center Street, has experienced significant deposition. Overflows into the field, which is floodplain, have begun a new channel, which will cut off the meander. The channel has also aggraded to the point where future storm events will likely create a new channel through agricultural fields. This site should be evaluated as part of a fluvial geomorphology study for sediment removal and stream restoration. **(L)**
8. Sites 12 and 13, off Greenfield Road, have been identified as spawning areas for Atlantic salmon. These sites should be evaluated for stream restoration and erosion control. **(L)**
9. Site 5, adjacent to Sunderland Road, is aggrading and experiencing severe erosion. This area is likely contributing sediment to downstream areas. Stream restoration and sediment/debris removal is recommended. **(L)**
10. Sites 9 and 10, in the Wildlife Management Area, could benefit immediately from a change in management practices by avoiding mowing within 35 feet of the riverbank. Future work should involve stabilization of the eroded banks, planting a riparian buffer and establishing stable river access for recreation. These measures would benefit fish, wildlife, and people. **(S)**
11. Sites 1, 2, 3, 4, and 11 are significant erosion areas that contribute sediment to the river at accelerate rates. The need for remedial measures

to address these problems can be best evaluated within the context of a fluvial geomorphology study. (L)

12. The eroded area at the upstream end of the riprap at Site 4 should be evaluated by highway personnel and repaired as necessary. Future storms could undermine the riprap and impact the road embankment. (S)

FISH PASSAGE

Several potential barriers to fish migration were noted.

1. Dams at Moores Corner (Site F1), the old sawmill at Cave Hill Road (Site F2), the old mill dam downstream from Cave Hill Road (Site F3), and a small dam upstream from Spaulding Brook (Site F4) restrict fish movement. The dam upstream of Spaulding Brook is currently being studied under a Coastal America grant. Further study of bypasses or dam removal should be considered for the other sites. (L)
2. The box culvert on Spaulding Brook (Site F5) may be too long to allow for effective fish passage for resident species such as American eel, blacknose dace, sculpin, and trout. (L)
3. A study should be completed at Site F6 (also designated Site 3) to determine if sediment and debris are an unnatural restriction to fish movement. (S)
4. The rock vortex weir at Site F7 should be further evaluated to determine if it impedes fish movement. (S)
5. The debris and wooden sill that remains at the former Book Mill Dam (Site F8) should be further evaluated to determine if they restrict fish passage. If so, they should be removed. (S)

RIPARIAN RESTORATION

Sites described below are listed in recommended priority for future work. The stream bank needs to be stable before the riparian buffer is established. Where possible, bioengineering materials should be incorporated into the design of the stabilization measures.

1. Sites 4, 6, 9, and 10 lack riparian vegetation and riparian buffers need to be established. Further study is needed to design a buffer appropriate for each site. Local native plants should be used, if at all possible. (L)
2. Sites 1, 2, 3, 5, 11, 12, 13, and 14 have less than the minimum buffer width and composition necessary for sediment and erosion control.

Further study is needed to evaluate each site and design a riparian buffer appropriate for the site. Local native plants should be used, if at all possible. **(L)**

3. All sites need some invasive species control. Mechanical control is recommended near or in water. Spot chemical application may be possible in Zone 2 and 3 (depending on local, state and federal pesticide control laws). This would also depend on the severity of the invasion. Further study is needed to assess the severity of the invasions and the appropriate control measures at each site. **(L)**
4. At all sites that have good existing riparian buffers, maintain 80% of overstory and understory density with continuous cover parallel and across the streambank. Keep breaks to a minimum, less than 25% of total canopy, for recreational/farm access to water's edge. **(S)**
5. To preserve existing forested riparian buffers, measures should be taken to require protection of their width and composition, if not already included in state or local regulations. **(S)**

OTHER

1. Various road crossings along the river were viewed. Sand and silt were observed in the river channel downstream from some of them. These fine-grained materials tend to degrade salmonid spawning habitat. The source of these materials is likely to be road sanding and drainage ditches that empty into the river at crossings. Town highway departments should consider best management practices such as periodic removal of sand from road near the river. Road ditches for permanent roads and temporary roads, such as for logging, should be constructed to direct runoff to sediment collection devices or otherwise prevent sediment-laden water from directly entering the river. **(S)**
2. Municipalities in the watershed should review their existing land use regulations with respect to activities that impact runoff and riparian corridors. Future development or activities such as logging may increase runoff and/or sediment production that will have an impact on the stability of the river, habitat, and flooding. Regulations limiting increases in discharge may be appropriate. Likewise, provisions for sediment control should be included. **(S)**
3. Volunteers could help re-establish riparian vegetation at several locations, including some of those noted above. **(S)**
4. Planting willows on the sand and gravel point bars will help provide long term stability to the channel form. Citizen groups can be enlisted to plant willow

shoots on point bars and in riprap to help stabilize the channel and provide overhead cover for fish. **(S)**

5. A stream cleanup day each year is recommended to help remove trash and promote citizen involvement in the watershed. **(S)**
6. Watershed residents can be enlisted to help remove the invasive herbaceous species, in particular the Japanese knotweed. **(S)**
7. Farmers can help improve water quality and reduce erosion of the riverbanks by changing animal grazing and watering practices. Assistance with this is available through the NRCS office in Greenfield **(S)**