Lower Passumpsic River Tributaries
River Corridor Plan

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Executive Summary

The Passumpsic River is one of the dominant landscape features in the Northeast Kingdom of Vermont. Its headwaters are found in the northern portions of Caledonia and Essex counties, and it empties into the Connecticut River just north of Barnet, Vermont. Numerous towns and town centers are found within its alluvial valley and along its steep banks, including St. Johnsbury and Lyndonville. The Lower Passumpsic River tributary watersheds are located primarily in Caledonia County in the southern portion of the Passumpsic watershed and drain a combined area of 141.1 square miles. Four tributaries (Joe's Brook, Water Andric, Sleepers River, and Wheelock Brook) and five sub-tributaries (Whiteman Brook, Badger Brook, Morrill Brook, North Brook, and Pope Brook) enter the Passumpsic from the west and drain the towns of Barnet, Cabot, Danville, Lyndon, Peacham, Stannard, St. Johnsbury, Walden, and Wheelock. Sheldon Brook and sub-tributary South Branch Sheldon Brook drain the towns of Kirby, Lyndon, and Victory, and enter the Passumpsic from the east near the mouth of Wheelock Brook.

A major flood along the Passumpsic River in 2002 initiated several studies and efforts to mitigate flooding and erosion hazards in Lyndonville and St. Johnsbury. A mitigation study was prepared by Gomez and Sullivan Engineers, PC to understand causes of flooding and potential mitigation measures along the river. Flooding and erosion hazards are again a top concern for citizens within the Lower Passumpsic tributary watersheds following major flooding in spring of 2011 (and again to a lesser degree during Tropical Storm Irene in the summer of 2011). These recent flood events caused major damage to roads, properties, and homes in several areas throughout the tributary watersheds.

As a result of dealing with severe, repeat flood and erosion damage throughout Vermont over the last two decades, Vermont's river scientists and engineers now understand that hazard mitigation and river restoration projects are most successful when carried out within a context of how reach and watershed-scale stressors influence flood and erosion hazards. In an effort to understand the root causes of stream channel instability and flood/fluvial erosion hazards in the Passumpsic River watershed, the Caledonia County Regional Natural Resources Conservation District (CCNRCD) and the Vermont Department of Environmental Conservation (VTDEC) have sought to develop a database of Stream Geomorphic Assessment (SGA) data for river reaches of significant size throughout the watershed. These data allow for a more comprehensive approach to flood and erosion hazard planning, in contrast to the conventional approach of multiple “spot fixes” with limited knowledge of the river system.

Fitzgerald Environmental Associates, LLC. (FEA) was retained by CCNRCD in 2012 to complete river assessments on five tributaries and six sub-tributaries in the Lower Passumpsic watershed following the Phase 1 SGA Protocols developed by the VTDEC. Following this study, a subset of the Phase 1 reaches was selected for field-based, Phase 2 SGA data collection. FEA collected Phase 2 data in 2013 for four tributaries (Water Andric, Sleepers River, Sheldon Brook, and Wheelock Brook) and four sub-tributaries (Whiteman Brook, Badger Brook, North Brook, and South Branch Sheldon Brook) for 36 reaches (approximately 25 river miles), and developed a River Corridor Plan (RCP) for these reaches.

Below are the objectives of the Phase 2 SGA and River Corridor Plan:

1) Develop a basis for understanding the overall causes of channel instability and habitat degradation along the river corridors in the watershed.
2) Develop a list of preliminary corridor restoration projects that can be further developed in the future to mitigate flood and erosion hazards.
3) Collected the information needed to map fluvial erosion hazard zones in Danville and Lyndon.

Below is a summary of key findings from the Phase 2 SGA and River Corridor Plan:

Many of the Lower Passumpsic tributary reaches are dynamic and highly erosive during flood events due to ongoing adjustments to their dimensions, patterns, and profiles. These adjustments are in response to impacts from historical sedimentation in valleys from early European settlement and deforestation that caused hillslope erosion, as well as modern day impacts from channel straightening, dredging, berming, and corridor encroachment associated with adjacent railroads, agriculture, and other land uses. Recent extreme runoff events such as the spring 2011 floods and Tropical Storm Irene have also triggered channel incision, mass wasting of valley side slopes, tremendous inputs of woody debris to the channel, and redevelopment of floodplain access in some areas. Ongoing vertical and lateral channel migration is likely in the future for many reaches in Danville and Lyndon. Given these predictions for future channel adjustments, the following watershed-scale and site-specific management observations and approaches are summarized from the Phase 2 data and RCP.

- The stressor identification analysis revealed limited watershed-scale impacts from recent land use changes (i.e., development). For example, the overall watershed land cover is 78% forest with very minimal development (3%) and limited agricultural lands (12%). Most of the agricultural land use is concentrated in the lower watershed zones along the larger tributary reaches such as the Sleepers River (T3.04) and Sheldon Brook (T4.01).
- The spring 2011 floods triggered severe channel adjustments in many of the Phase 2 reaches. The flooding unleashed an enormous volume of coarse sediment and woody debris into the channel as a result of mass failure valley erosion and stream bed erosion. In some instances, the 2011 floods triggered severe channel adjustments even in reaches with limited corridor impacts. These reaches, such as Water Andric T2.09 and T2.10, tended to be on moderate gradient, 2nd and 3rd order channels lacking natural grade controls such as bedrock ledges.
- Several segments in the tributary watersheds have undergone a departure in both sediment regime and stream type due to channel incision and/or widening as a result of: 1) historical land uses, 2) encroachments or development in the river corridor, or 3) extensive straightening and bank armoring. Many of the channel adjustments caused by these historic stressors were exacerbated by the extreme flood events of 2011, leading to further stream type departures.
- Fifteen (15) river segments have departed from reference conditions due to channel incision and entrenchment (i.e., floodwaters are contained within a narrow channel without access to the original floodplain). These departures result in a conversion of river segments to effective transporters of sediment and high velocity floodwaters to downstream areas, with a corresponding loss of storage of sediment and floodwaters within the floodplain. These segment departures included 5 along Water Andric, 7 along the Sleepers River and tributaries, and 3 along Wheelock Brook.
- 32 bridges and 15 culverts were assessed for geomorphic compatibility and aquatic organism passage (AOP) as part of the Phase 2 work. Approximately two-thirds of the bridges had spans less than the reference bankfull channel width, indicating a high degree of structure vulnerability to flooding and erosion. Similarly, only 1 of the 15 assessed culverts was considered “mostly compatible” with geomorphic processes, and all structures had some degree of reduced AOP.
- Site level approaches to restoration of dynamic equilibrium conditions were evaluated in detail at the reach scale. This effort resulted in the identification of 85 restoration project areas, including 25 projects that do not require significant further study (i.e., passive approaches such as buffer plantings and corridor protection), and 60 projects requiring further feasibility study or engineering design (i.e., active restoration approaches such as bridge replacements).

1.0 Project Background

1.1 Introduction

In 2012 the Caledonia County Natural Resources Conservation District (CCNRCD) and the Vermont Department of Environmental Conservation (VTDEC) identified tributaries to the Lower Passumpsic River in northeastern Vermont for assessment of fluvial geomorphic conditions. Prior to this, geomorphic assessment data had been collected for other areas of the Passumpsic River watershed, including the West Branch, Calendar Brook, East Branch, Dishmill Brook, Millers Run, and the Moose River.

Severe flooding and erosion damage sustained during 2011 flood events in the Towns of Danville and Lyndon led to the selection of these tributaries for further study. The tributaries included: Joe's Brook, Water Andric, and Sleepers River (and associated tributaries) in Barnet, Danville, and St. Johnsbury; and Sheldon Brook and Wheelock Brook in Lyndon. Infrastructure along the tributaries was severely impacted by flooding and erosion, and therefore this information will serve to help these towns better understand existing flood vulnerabilities, and plan for future improvements with flood risks in mind. The study is part of a larger effort to characterize the physical and biological conditions of the Passumpsic River watershed, aid in the identification of river stressors, and assist the municipalities of the watershed mitigate flood hazards and restore river corridor health.

Fitzgerald Environmental Associates, LLC. (FEA) was retained by CCNRCD in 2012 to complete river assessments on five tributaries and six sub-tributaries in the Lower Passumpsic watershed following the Phase 1 Stream Geomorphic Assessment (SGA) Protocols (VTDEC, 2009) developed by the VTDEC. FEA used the Stream Geomorphic Assessment Tool (SGAT) to develop the baseline GIS data for the watershed in 2012 and 2013. A total of 68 reaches along 48.5 river miles were assessed during the Phase 1 analysis. Full Phase 1 data, FIT, and windshield survey data were collected by FEA for five tributaries and six sub-tributaries.

Following this study, a subset of the Phase 1 reaches was selected for field-based, Phase 2 SGA data collection. FEA completed the Phase 2 field work in 2013 for 36 reaches (approximately 25 river miles), and developed a River Corridor Plan (RCP) for these reaches. This report summarizes the SGA results and the RCP into one planning document. Watershed background information, including a summary of the geographic, geologic, hydrologic, and ecological characteristics of the Lower Passumpsic River watershed, is included in a separate Phase 1 SGA summary report dated September 27, 2013.

1.2 Study Goals

Watershed restoration projects are most successful when carried out within a context for understanding how reach and watershed-scale stressors cause channel instability and increase flood hazards. The VTDEC SGA Protocols and River Corridor Planning Guide provides sound, scientifically-defensible methods for identifying stressors on channel stability and restoration projects that will address them appropriately (VTDEC, 2010). The overall goal of the VTDEC RMP is to "manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner," (VTANR, 2010) achieved through:

- Fluvial erosion hazard mitigation;
- Sediment and nutrient load reduction; and
- Aquatic and riparian protection and restoration

The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts). Ultimately, the Phase 1 results help guide planners in selecting reaches for more detailed Phase 2 data collection where this information can be valuable for flood vulnerability mapping, identification of river restoration projects, and long-term river corridor planning. The goal of the Phase 2 and RCP effort is to provide:

1) A basis for understanding the overall causes of channel instability and habitat degradation along the river corridors in the watershed.
2) A list of preliminary corridor restoration projects that can be further developed in the future to mitigate flood and erosion hazards.
3) Information needed to map fluvial erosion hazard zones in Danville and Lyndon.

2.0 Methods

2.1 Data Collection Methods

The Vermont River Management Program (RMP) has invested many person-years of effort into developing a state-of-the-art system of Stream Geomorphic Assessment (SGA) protocols. The SGA protocols are intended to be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use affect hydro-geomorphic processes at the landscape and reach scale, and how these changes alter the physical structure and biological habitat of streams in Vermont. The SGA protocols have become a key tool in the prioritization of restoration projects that will 1) reduce sediment and nutrient loading to downstream receiving waters such as Lake Champlain and the Connecticut River, 2) reduce the risk of property damage from flooding and erosion, and 3) enhance the quality of instream biological habitat. The protocols are based on defensible scientific principles and have been tested widely in many watersheds throughout the state. Data collected for the lower Passumpsic River tributary watersheds using the protocols forms the basis for preliminary project identification carried out during Phase 2 SGA and River Corridor Planning efforts.

The SGA protocols include three phases (VTDEC, 2009):

Phase 1: The Phase 1 SGA approach utilizes the Stream Geomorphic Assessment Tool (SGAT), a GIS extension developed by RMP for the collection of reach and watershed scale data. In addition to the GIS and remote sensing effort, a cursory field assessment (“windshield survey”) is included for the verification of stream and valley forms, significant channel features and the location of man-made infrastructure. The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), which provides a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts). Table 1 summarizes the parameters collected in Phase 1 using the Feature Indexing Tool (FIT), which include those utilized to develop the final impact ratings.

Phase 2: The Phase 2 approach builds upon Phase 1 data through the collection of reach-specific data about the current physical conditions. Characterization of reach conditions utilizes a suite of quantitative (e.g., channel geometry, pebble counts) and qualitative (e.g., pool-riffle habitat) measurements to calculate two indices: Rapid Geomorphic Assessment (RGA) Score; Rapid Habitat Assessment (RHA) score. Using the RGA scores in conjunction with knowledge about the background or “reference” conditions, a sensitivity rating is developed to predict the degree to which the channel will adjust to human and natural impacts in the future.

Table 1: Parameters collected with FIT.

Phase 1 Step	Phase 2 Step	Data Type	Impact	Sub-Impact
3.1	1.2	Point	Alluvial Fan	NA
3.2	1.6	Point	Grade Control	Dam Ledge Waterfall Weir
NA	3.3	Point	Mass Failure	NA
5.5	5.5	Point	Dredging	Dredging Gravel Mining Commercial Mining
NA	4.4	Point	Debris Jam	NA
NA	4.6	Point	Stormwater Input	NA
NA	4.9	Point	Beaver Dam	NA
NA	5.2	Point	Migration	Neck Cut Off Flood chute Avulsion Braiding
NA	5.3	Point	Steep Riffle or Head Cut	Head Cut Steep Riffle
NA	5.4	Point	Stream Crossing	Stream Ford Animal Crossing
NA	3.3	Point	Gully	NA
6.2	1.3	Line	Development	NA
6.1	1.3	Line	Encroachment	Berm Improved Path Road Railroad
5.3	3.1	Line	Bank Armoring or Revetment	Rip-Rap Hard Bank Other
7.2	3.1	Line	Erosion	NA
5.4	5.5	Line	Straightening	Straightening With Windrowing

Phase 3: Phase 3 surveys involve the collection of detailed, reach-scale survey data to verify or build upon Phase 2 data. These surveys are typically carried out prior to project development for an “active” channel management approach (e.g., floodplain restoration), or for long-term monitoring purposes.

2.2 Quality Assurance

The VTDEC Quality Assurance (QA) protocols outlined in the SGA protocols (VTDEC, 2009) were followed in order to ensure a complete and accurate dataset. FEA and VTDEC shared responsibility for QA for the

SGAT shapefiles and the finalized Phase 2 dataset. The DMS database for all Phase 2 assessed reaches in the watershed was finalized in April, 2014. The QA summaries for Phase 2 are included in Appendix A.

2.3 Bridge and Culvert Assessments

FEA conducted bridge and culvert surveys on all private and public bridges, culverts, and arches within the selected Phase 2 reaches. The Bridge and Culvert Assessment and Survey Protocols specified in Appendix G of the Vermont Stream Geomorphic Assessment Handbook (VTDEC, 2009) were followed. Latitude and Longitude of each structure was recorded in the field with a GPS unit or digitized based on aerial imagery. The assessment included various photographs documenting the condition of each structure.

The Vermont Culvert Geomorphic Screening Tool (MMI, 2008a) and the Vermont Culvert Aquatic Organism Passage Screen Tool (MMI, 2008b) developed by Milone and MacBroom, Inc. for VTDEC were used to identify culverts within the study area that have a higher priority for replacement/retrofit due to geomorphic incompatibility and/or for being potential barriers to movement and migration of aquatic organisms.

2.4 Stressor and Departure Analysis

FEA followed the VTDEC methods for developing river corridor plans as outlined in the Vermont River Corridor Planning Guide (VTANR, 2010). This technical guide is directed towards river scientists, planners, and engineers engaged in finding economically and ecologically sustainable solutions to the conflicts between human investments and river dynamics. The guide provides explanations for the following:

- River science and societal benefits of managing streams in a sustainable manner toward equilibrium conditions
- Methods for assessing and mapping stream geomorphic conditions, and identifying and prioritizing river corridor protection and restoration projects
- Methods for examining project feasibility and negotiating management alternatives with stakeholders
- Information on current programs available to Vermont landowners, towns, and other interested parties to implement river corridor protection and restoration projects

Included in this approach is an extensive mapping exercise to lay the foundation for understanding stressors on stream channel stability at the watershed and reach scales. These maps are compiled as part of the stressor and departure analysis, and illustrate a gradient of human impacts and stream response across the watershed. The maps provide a basis for identifying projects through a step-wise procedure to screen potential projects for compatibility with long-term equilibrium conditions.

2.4.1 Stressor Analysis

The data collected through the Phase 1 and 2 SGA studies provides the basis for assessing the impacts to the hydrologic and sediment regimes, and the channel riparian and boundary conditions. This data, when combined with other watershed-scale data developed in this study, allows for the assessment of physical departure from reference conditions, and serves to validate watershed-scale patterns and stream conditions observed in the field.

Stressor, departure and sensitivity maps have been prepared to depict the effects of significant physical processes occurring within the Lower Passumpsic River tributaries study area. These maps provide an indication of where channel adjustment processes have been altered, at both the watershed-scale and the reach-scale. The analysis of existing and historic departures from equilibrium conditions along a stream network allows for the prediction of future channel adjustments. This is helpful in developing and prioritizing potential river corridor protection and restoration projects.

2.4.2 Departure Analysis

Much research has shown that alluvial river channels in wide valleys will adjust their geometry and planform to accommodate changes in the discharge and sediment loading from the upslope watershed (Dunne and Leopold, 1978). This concept was summarized by Lane (1955) to show that stream power and sediment (size and distribution) will seek a dynamic equilibrium condition in the absence of anthropogenic disturbance or catastrophic natural storm events. Slight changes from one year to another, such as variation in rainfall amounts (and a resulting variation in discharge), may cause subtle changes in channel form. However, the cross-sectional shape and profile of a river is typically stable under reference watershed conditions, and predictable given knowledge about: 1) the geologic conditions of the watershed and river corridor, 2) the topography of the watershed and river corridor, and 3) the regional climate.

Analysis of a watershed's sediment regime is a useful approach for summarizing the reach and watershed-scale stressors affecting the equilibrium conditions of river channels. Sediment regime mapping provides a context for understanding the sediment transport and channel evolution processes (Schumm, 1977) which govern changes in geometry and planform for river channels in a state of disequilibrium. The VTANR River Corridor Planning Guide (VTANR, 2010) outlines a methodology for understanding the reference and altered sediment regimes of reaches according to data collected during the Phase 2 field assessments. The sediment regime types used in this analysis are summarized below in Table 2.

Table 2: Sediment regime types for corridor planning (VTANR, 2010).

Sediment Regime	Narrative Description
Transport	Steeper bedrock and boulder/cobble cascade and step-pool stream types; typically in more confined valleys, do not supply appreciable quantities of sediments to downstream reaches on an annual basis; little or no mass wasting; storage of fine sediment is negligible due to high transport capacity derived from both the high gradient and/natural entrenchment of the channel.
Confined Source and Transport	Cobble step pool and steep plane bed streams; confining valley walls, comprised of erodible tills, glacial lacustrine, glacial fluvial, or alluvial materials; mass wasting and landslides common and may be triggered by valley rejuvenation processes; storage of coarse or fine sediment is limited due to high transport capacity derived from both the gradient and entrenchment of the channel. Look for streams in narrow valleys where dams, culverts, encroachment (roads, houses, etc.), and subsequent channel management may trigger incision, rejuvenation, and mass wasting processes.
Unconfined Source and Transport	Sand, gravel, or cobble plane bed streams; at least one side of the channel is unconfined by valley walls; may represent a stream type departure due to entrenchment or incision and associated bed form changes; these streams are not a significant sediment supply due to boundary resistance such as bank armoring, but may begin to experience erosion and erosion and supply both coarse and fine sediment when bank failure lead to channel widening; storage of coarse or fine sediment is negligible due to high transport capacity derived from the deep incision and little or no floodplain access. Look for straightened, incised or entrenched streams in unconfined valleys, which may have been bermed and extensively armored and are in Stage II or early Stage III of channel evolution.

Table 2: Sediment regime types for corridor planning (VTANR, 2010).

Sediment Regime	**Narrative Description**
Fine Source and Transport & Coarse Deposition	Sand, gravel, or cobble streams with variable bed forms; at least one side of the channel is unconfined by valley walls; may represent a stream type departure due to vertical profile and associated bed form changes; these streams supply both coarse and fine sediments due to little or no boundary resistance; storage of fine sediment is lost or severely limited as a result of channel incision and little or no floodplain access; an increase in coarse sediment storage occurs due to a high coarse sediment load coupled with the lower transport capacity that results from a lower gradient and/or channel depth. Look for historically straightened, incised, or entrenched streams in unconfined valleys, having little or no boundary resistance, increased bank erosion, and large unvegetated bars. These streams are typically in late Stage III and Stage IV of channel evolution.
Coarse Equilibrium (in = out) & Fine Deposition	Sand, gravel, or cobble streams with equilibrium bedforms; at least one side of the channel is unconfined by valley walls; these streams transport and deposit coarse sediment in equilibrium (stream power—produce as a result of channel gradient and hydraulic radius—is balanced by the sediment load, sediment size, and channel boundary resistance); and store a relatively large volume of fine sediment due to the access of high frequency (annual) floods to the floodplain. Look for unconfined streams, which are not incised or entrenched, have boundary resistance (woody buffers), minimal bank erosion, and vegetated bars. These streams are Stage I, late IV, and Stage V.
Deposition	Silt, sand, gravel, or cobble streams with variable and braided bed forms; at least one side of the channel is unconfined by valley walls; may represent a stream type departure due to changes in slope and/or depth resulting in the predominance of transient depositional features; storage of fine and coarse sediment frequently exceeds transport**. Floodplains are accessed during high frequency (annual) floods. Look for unconfined streams, which are not incised or entrenched, have become significantly over-widened, and if high rates of bank erosion are present, it is offset by the vertical growth of unvegetated bars. These regimes may be located at zones of naturally high deposition (e.g., active alluvial fans, deltas, or upstream of bedrock controls), or may exist due to impoundment and other backwater conditions above weirs dams and other constrictions.

** Use of the "Deposition" regime characterization may be rare, but valuable as a planning tool, where the reach is storing far more than it is transporting during some defined planning period. The extreme example would be that of an impounded reach where all of the coarse and a great percentage of the fine sediments are being deposited, rather than transported downstream. This man-made condition may change, thereby changing the sediment regime, but is not likely over the period at which the corridor plan will be used.

Channel evolution models (CEM) also provide a basis for understanding the temporal scale of channel adjustments and departure in the context of SGA Phase 2 results. Both the "D" stage and "F" stage CEMs (VTDEC, 2009) are helpful for explaining the channel adjustment processes underway in the Lower Passumpsic River tributary watersheds. The "F" stage CEM is used to understand the process that occurs when a stream degrades (incises) its bed. The more dominant adjustment process for the "D" stage channel evolution is aggradation, widening and planform change. D-stage CEM typically occurs where grade controls prevent severe channel incision and abandonment of the adjacent floodplain. The common stages of both CEMs are depicted in Figure 1 below.

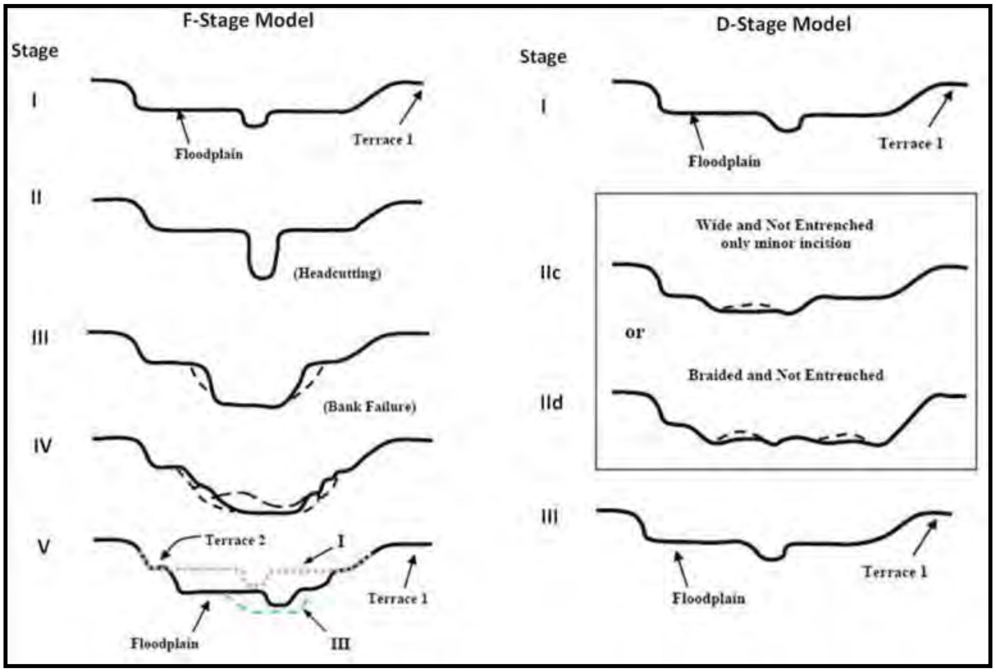


Figure 1: Typical channel evolution models for F-stage and D-stage (VTDEC, 2009).

2.4.3 Sensitivity Analysis

The following description of the sensitivity of various stream types to changes in sediment and flow regimes, boundary conditions and channel morphology, is included from the most recent version of the VTANR River Corridor Planning Guide (VTANR, 2010).

> Certain geomorphic stream types are inherently more sensitive than others, responding readily through lateral and/or vertical adjustments to high flow events and/or influxes of sediment. Other geomorphic stream types may undergo far less adjustment in response to the same watershed inputs. In general, streams receiving a large supply of sediment, having a limited capacity to transport that sediment, and flowing through finer-grained, non-cohesive materials are inherently more sensitive to adjustment and likely to experience channel evolution processes than streams with a lower sediment supply, higher transport capacity and flowing through cohesive or coarse-grained materials (Montgomery and Buffington, 1997). The geometry and roughness of the stream channel and floodplain (i.e., the width, depth, slope, sediment sizes, and floodplain relations) dictate the velocity of flow, how much erosive power is produced, and whether the stream has the competence to transport the sediment delivered from upstream (Leopold, 1994). If the energy produced by the depth and slope of the water is either too little or too great in relation to the sediment available for transport, the stream may be out of equilibrium and channel adjustments are likely to occur, especially during flood conditions (Lane, 1955).

Stream sensitivity maps have been prepared for the Lower Passumpsic River Tributaries study area. Sensitivity ratings were assigned using the VTDEC Protocols (VTDEC, 2009).

2.5 Project Identification

Site-specific projects were identified using methods outlined by VTANR in Chapter 6 Preliminary Project Identification and Prioritization (VTANR, 2010). This planning guide is intended to aid in the development of projects that protect and restore river equilibrium conditions. The projects identified for the study reaches can be classified under one of the following categories: Active Geomorphic Restoration, Passive Geomorphic Restoration, and Conservation.

Active Geomorphic Restoration implies the management of rivers to a state of geomorphic equilibrium through active, physical alteration of the channel and/or floodplain. Often this approach involves the removal of human constructed constraints or the construction of meanders, floodplains or stable banks. Riparian buffer re-vegetation and long-term protection of a river corridor is essential to this alternative.

Passive Geomorphic Restoration allows rivers to return to a state of geomorphic equilibrium by removing factors adversely impacting the river and subsequently using the river's own energy and watershed inputs to re-establish its meanders, floodplains and equilibrium conditions. In many cases, passive restoration projects may require varying degrees of active measures to achieve ideal results. Riparian buffer re-vegetation and long-term protection of a river corridor (e.g., corridor easements) is essential to this alternative.

Conservation is an option to consider when stream conditions are generally "good" or "reference" and the channel is in a state of dynamic equilibrium. Typically, conservation is applied to minimally disturbed reaches where river structure and function and vegetation associations are relatively intact, and/or where high quality aquatic habitat is found.

3.0 Phase 2 Reach Prioritization

3.1 Final Phase 1 Impact Ratings and Geomorphic Condition

Phase 2 reaches for the RCP were selected by CCNRCD in consultation with the Towns of Danville and Lyndon, and with technical input from FEA. The overall Phase 1 reach conditions and impact scores, described below and in shown in Figures 2 and 3, were used to prioritize reaches for further study.

Based on the Phase 1 impact scores, the DMS also develops predictions for channel adjustment processes (VTDEC, 2009). These predictions are based on the dominant impacts recorded for each reach, and are categorized based on the impacts typically associated with the following four channel adjustment processes: 1) Degradation (e.g., channel incision); 2) Aggradation (e.g., increased sediment deposition); 3) Channel widening (e.g., increased bank erosion); 4) Planform Changes (e.g., irregular meander patterns) (Table 3 and Figure 2). Using the channel adjustment process ratings, a provisional geomorphic rating is developed for each reach based on the methods outlined in the SGA Phase 1 protocols (VTDEC, 2009). Table 4 outlines the four possible geomorphic ratings based on the SGA methods, and Figure 3 presents the provisional geomorphic condition for all study reaches.

Table 3: Final impact score parameters for phase 1 dataset.

Phase 1 Step	Phase 1 Parameter	Impact Category
4.1	Local Watershed Land Cover/Land Use	Land Use
4.2	Corridor Watershed Land Cover/Land Use	
4.3	Riparian Buffer Width	
5.1	Flow Regulations	Channel Modifications
5.2	Bridges and Culverts	
5.3	Bank Armoring	
5.4	Channel Straightening	
5.5	Dredging and Gravel Mining	
6.1	River Corridor Encroachments	Floodplain Modifications and Planform Changes
6.2	River Corridor Development	
6.3	Depositional Features	
6.4	Meander Migration	
6.5	Meander Belt Width Departure	
6.6	Meander Wavelength Departure	
7.2	Bank Erosion	Bed and Bank Conditions
7.3	Debris and Ice Jam Potential	

Table 4: SGA reach condition ratings.

SGA Rating	Predicted Conditions and Processes
Reference	In Equilibrium – no apparent or significant channel, floodplain, or land cover modifications; channel geometry is likely to be in balance with the flow and sediment produced in its watershed.
Good	In Equilibrium but may be in transition into or out of the range of natural variability – minor erosion or lateral adjustment but adequate floodplain function; any adjustment from historic modifications nearly complete.
Fair	In Adjustment – moderate loss of floodplain function; or moderate to major planform adjustments that could lead to channel avulsions.
Poor	In Adjustment and Stream Type Departure - may have changed to a new stream type or central tendency of fluvial processes – significant channel and floodplain modifications may have altered the channel geometry such that the stream is not in balance with the flow and sediment produced in its watershed.

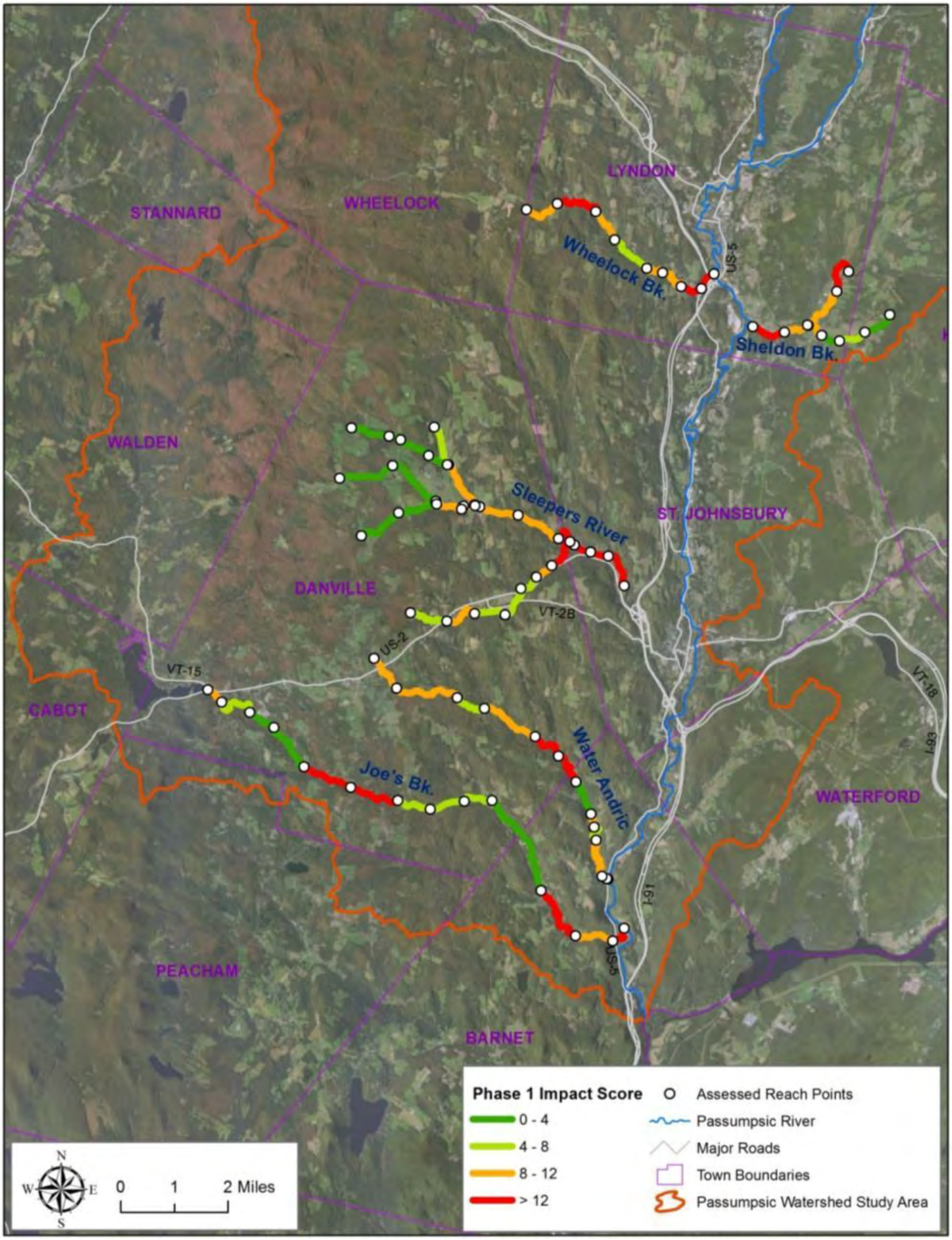


Figure 2: Phase 1 impact scores for the Lower Passumpsic River Tributaries.

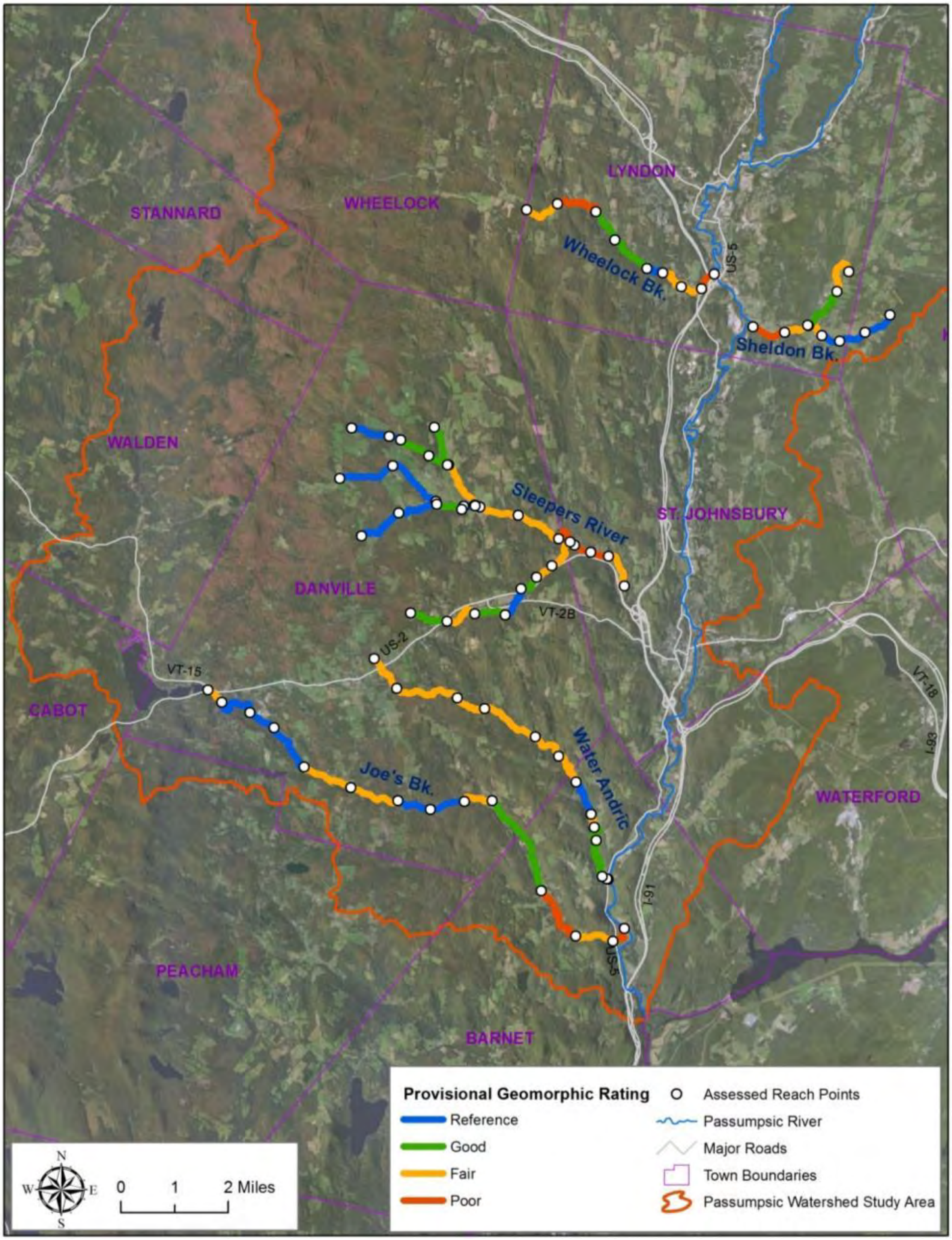


Figure 3: Provisional geomorphic ratings for the Lower Passumpsic River Tributaries.

3.2 Phase 2 Study Reaches

Using the Phase 1 Impact Ratings as the primary basis for reach selection, a list of reaches was developed for Phase 2 surveys. Table 5 summarizes the selected reaches based on watershed location, channel length, and preliminary reference stream type.

Table 5: Phase 2 Reaches and Phase 1 Impact Ratings.

Surface Water	Reach ID	Channel Length (Mi)	Reference Stream Type†	Bedform‡	Impact Score (Geo Condition)
Water Andric	T2.07	0.78	C4	Riffle-Pool	16 (Fair)
	T2.08	0.72	B3	Riffle-Pool	15 (Fair)
	T2.09	1.23	C4	Riffle-Pool	12 (Fair)
	T2.10	0.65	B3	Step-Pool	8 (Fair)
	T2.11	1.37	C3	Riffle-Pool	9 (Fair)
	T2.12	0.88	C4	Riffle-Pool	9 (Fair)
Sleepers River	T3.04	0.76	C5	Riffle-Pool	17 (Fair)
	T3.05	0.37	C4	Riffle-Pool	17 (Poor)
	T3.06	0.34	B3	Riffle-Pool	15 (Poor)
	T3.07	0.54	D3	Braided	16 (Poor)
	T3.08	0.95	B3	Riffle-Pool	12 (Fair)
	T3.09	0.78	B3	Riffle-Pool	11 (Fair)
	T3.10	0.11	B4	Riffle-Pool	13 (Fair)
Badger Bk	T3.10S1.01	0.25	B3	Riffle-Pool	10 (Reference)
	T3.10S1.02	0.07	C3	Riffle-Pool	6 (Reference)
	T3.10S1.03	0.63	C3	Riffle-Pool	9 (Good)
North Bk	T3.11	1.07	C4	Riffle-Pool	11 (Fair)
Whiteman Bk	T3.7S1.01	0.69	B3	Step-Pool	15 (Fair)
	T3.7S1.02	0.40	C4	Riffle-Pool	11 (Fair)
	T3.7S1.03	0.48	E4	Dune-Ripple	7 (Good)
	T3.7S1.04	0.79	E4	Dune-Ripple	6 (Reference)
	T3.7S1.05	0.61	B3	Riffle-Pool	5 (Good)
	T3.7S1.06	0.80	C4	Riffle-Pool	9 (Fair)
	T3.7S1.07	0.86	C4	Riffle-Pool	8 (Good)
Sheldon Bk	T4.01	0.72	C4	Riffle-Pool	19 (Poor)
	T4.02	0.50	B3	Riffle-Pool	11 (Fair)
	T4.03	1.06	B3	Riffle-Pool	10 (Good)
	T4.04	0.89	C3	Riffle-Pool	13 (Fair)
Sheldon Bk SB	T4.2S1.01	0.38	B3	Step-Pool	9 (Fair)
Wheelock Bk	T5.01	0.40	C4	Riffle-Pool	18 (Poor)
	T5.02	0.44	C4	Riffle-Pool	16 (Fair)
	T5.03	0.63	B3	Riffle-Pool	10 (Fair)
	T5.04	0.44	C4	Riffle-Pool	10 (Reference)
	T5.05	0.89	B3	Riffle-Pool	8 (Good)
	T5.06	0.69	B4	Riffle-Pool	11 (Good)
	T5.07	1.02	C4	Riffle-Pool	15 (Poor)

* SC= Semi-confined; NW= Narrow; BD=Broad; VB=Very Broad, NC=No Confinement; † per Rosgen, 1994
‡ per Montgomery and Buffington, 1997

4.0 Phase 2 Results and River Corridor Planning

Phase 2 assessments were conducted on 32 reaches from June through October of 2013. Seven (7) reaches were segmented in the field for a total of 43 Phase 2 reaches and segments covering 24.2 miles of stream channel. The following section includes a summary sheet for each assessed reach or segment and a summary of the watershed and reach-scale stressors on channel stability.

4.1 Phase 2 Segment Summary Sheets

One page summaries for each Phase 2 segment/reach are presented in this section. The impact summary section assigns Not Significant, **Low**, or **High** levels of impact based on data collected during the Phase 2 assessments. Impact levels were assigned based on the longitudinal effect (<5% - Not Significant, 5-20% - Low, and >20% - High), and the overall impact of discrete features on the reach/segment (constrictions, stormwater inputs, steep riffles, etc.). Potential impacts for arches, bridges, and culverts were summarized with the following abbreviations:

- **AOP**: Aquatic organism passage
- **D**: Deposition upstream and/or downstream
- **E**: Bank erosion upstream and/or downstream
- **I**: Ice/Debris jamming
- **R/R**: Failing bank armor upstream and/or downstream
- **S**: Scour upstream and/or downstream

Habitat assessment rankings for large woods debris and pool counts are defined in Table 6.

Table 6: LWD and Pool Ranking for RHA.

Rank	LWD		Pool	
	Diameter (ft)	Length (relative to wbkf)	Depth (ft)	Length/Width (relative to wbkf)
1	0.5≤D<1.0	<0.5	1.0≤D<2.0	<0.5
2	0.5≤D<1.0	≥0.5	1.0≤D<2.0	≥0.5
3	1.0≤D<2.0	<0.5	2.0≤D<3.0	<0.5
4	1.0≤D<2.0	≥0.5	2.0≤D<3.0	≥0.5
5	D≥2.0	<0.5	D≥3.0	<0.5
6	D≥2.0	≥0.5	D≥3.0	≥0.5
7			D≥3.0	≥1.0

4.1.1 Water Andric Summary (Reaches/Segments T2.07-T2.12B)

The Phase 2 assessed reaches on Water Andric started in Danville upstream of the Route 2 crossing and ended downstream immediately below the Keyser Hill Road bridge in the Town of Barnard (Figure 4). Water Andric Road/VAST Trail share the river valley for much of T2.07 through T2.09. T2.10 through T2.12A had minimal corridor impacts and the stream flows through a densely forested valley. Recent episodic flooding in spring of 2011 had a major impact on all of the assessed reaches. All of the reaches showed signs of degradation or widening followed by major deposition of gravel and cobbles. Huge mass failures along valley walls were observed throughout the study area, providing large inputs of sediment and large woody debris to the channel. Very high densities of large woody debris and debris jams were observed in most of the reaches. These debris jams play an important role in trapping flood-related sediments and provide habitat for aquatic organisms. Large deposits of flood related material were also stored above several undersized structures within the study area. The 2011 floods washed out Water Andric road in many locations (Reaches T2.08, T2.09) and damaged several structures along the network.

Numerous grade controls were observed throughout the middle reaches. These features limited bed scour during the recent floods, leading to increased widening and mass failure valley erosion. The reaches lacking significant grade control were more incised and many reaches/segments had a stream type departure to F-type based on incision and/or entrenchment. Bank erosion was limited throughout Water Andric due to densely forested banks and stony soils.

The level of degradation we observed was surprising based on the minimal land use impacts to the stream. We suspect that locally higher rainfall may have fallen on the area draining Water Andric and Whiteman Brook. The tight valley walls comprised of erodible lacustrine silt/clay coupled with a high magnitude flood event likely led to the large number of mass failures, producing the sediment load and huge volume of large woody debris that is visible today.

We identified several areas of concern during the Phase 2 assessments. Water Andric Road is closely intertwined with the channel for most of T2.08 and the road sustained major damage in 2011 and is at high risk of damage from future floods. A VAST trail shares the valley with all of T2.09 but is primarily located along the left valley wall and does not impact most of the reach. We identified a major avulsion risk area where the VAST trail is very close to the channel and at a lower elevation than the channel. Subsurface flow was observed from the channel to the trail and the channel could avulse (i.e., migrate and occupy the road) and follow the VAST trail, causing major damage to the trail. A new culvert along Penny Lane at the T2.09-T2.10 reach break is at risk of plugging due to a large debris jam immediately upstream. This structure is also perched above the downstream water level, presenting a barrier to AOP. The fields bordering T2.12B immediately downstream of Route 2 are the only area with significant buffer impacts. Mowed meadow and lawn occupy most of the corridor, increasing stream temperature and causing bank erosion.

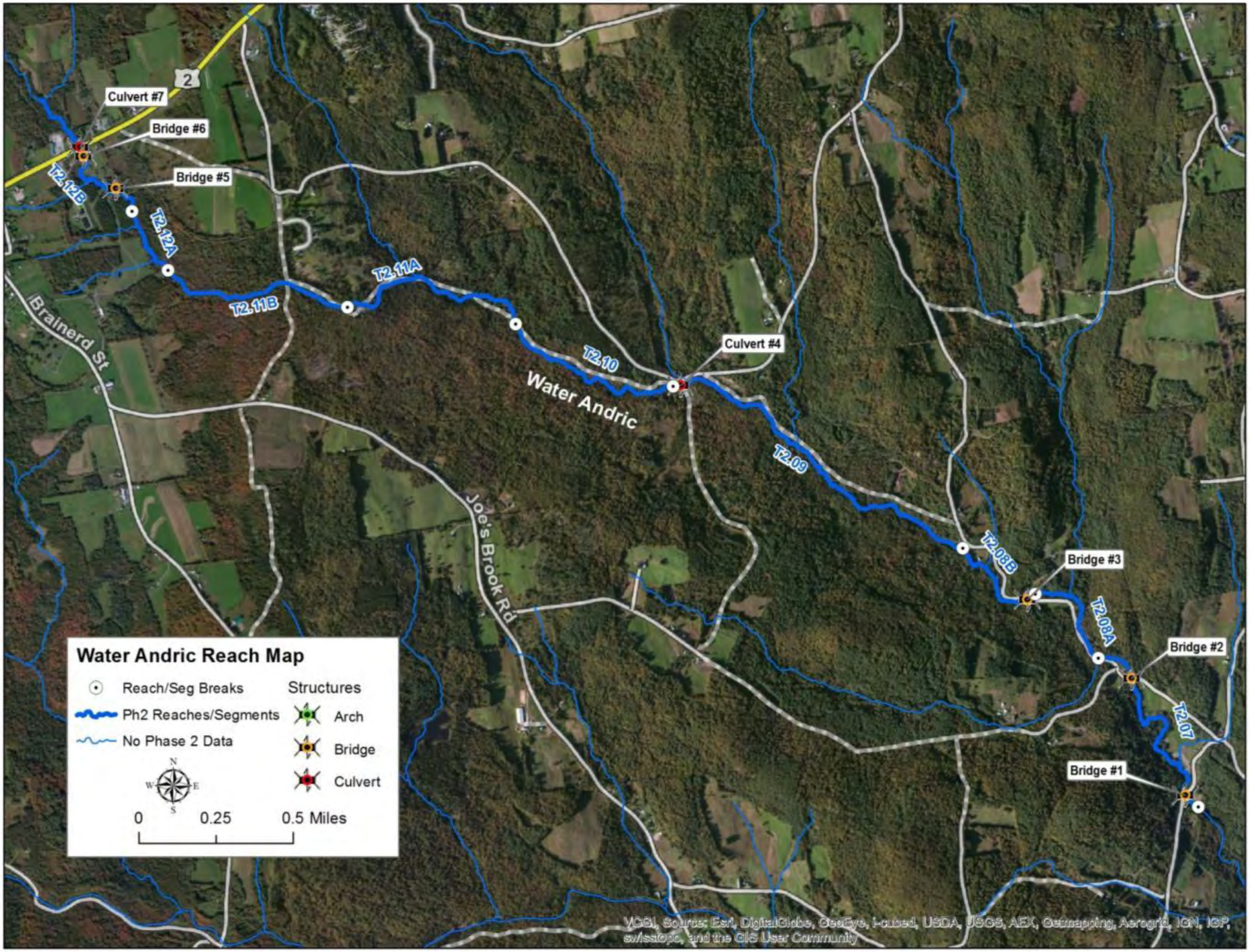


Figure 4: Water Andric reach map with crossing structures.

Stream: Water Andric	**Reach:** T2.07	**Town:** Barnet, Danville	**Date Assessed:** 8/28/13
Channel Length (ft): 4,113	**Channel Slope (%):** 0.62	**Sinuosity:** 1.26	**Watershed Area (mi^2):** 10.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Riffle- Pool/Plane Bed
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	36.8
Bankfull Width (ft)	33.0
Max Depth (ft)	3.2
Width/Depth Ratio	13.5
Entrenchment Ratio	3.2
Incision Ratio	1.6

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Keyser H.	60	D, E, I, S, R/R
B	W. Andric	65	D, E, I, S, R/R

# of Other Constrictions: 0

# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	30	14
2	41	15
3	12	6
4	14	0
5	3	0
6	2	0
7	-	0
#/mile	131	45

Number of Debris Jams: 6

Step 6/7 Summary

RHA Score (%)	60
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	40 / Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #1 – Buffer planting
- #2 – Stormwater management – gully stabilization
- #3 & 4 - Undersized bridge replacement
- #5 - Corridor protection

Reach Highlights: Channel was historically manipulated along the edge of the agricultural field and was likely incised. Recent episodic floods led to channel widening and deposition throughout the reach. Large volumes of sand and gravel are working through the reach from upstream mass failures. Meadow/hay field along the left bank was accessed during recent flooding. VHD centerline is off for approximately 400' mid-reach as the stream flows through a forested stretch with B-type geometry. A large gully from an intermittent stream was observed on the right valley wall, mid-reach.

Debris jam, bar formation, and mass failure in middle of reach

Typical channel geometry near top of reach

Stream: Water Andric **Reach:** T2.08A **Town:** Danville **Date Assessed**: 8/28/13

Channel Length (ft): 1,922 **Channel Slope (%):** 1.5 **Sinuosity:** 1.1 **Watershed Area (mi^2):** 9.0

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V. Broad	V. Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	34.5
Bankfull Width (ft)	40
Max Depth (ft)	1.7
Width/Depth Ratio	24.2
Entrenchment Ratio	2.5
Incision Ratio	1.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in segment.			

\# of Other Constrictions: 0

\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	11	2
2	25	8
3	36	7
4	31	1
5	2	0
6	2	0
7	-	0
#/mile	293	49

Number of Debris Jams: 6

Step 6/7 Summary

RHA Score (%)	61
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	54/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #6 - Clear Debris jam near road - exacerbating road flooding/erosion
- #7 - Bank armor along road is failing at a sharp bend in channel
- #8 - Corridor protection both sides of road through segment

Reach Highlights: Widening and aggradation following a recent episodic flooding event are the dominant processes in this segment. Bank scour along lower banks (not FIT'd as erosion) and some bank failures were observed throughout the reach except for areas of heavy bank armoring along the road. Most scoured bank areas are stable due to natural rock deposition and/or dense root mats. Large unvegetated depositional features were observed throughout reach. Valuable floodplain storage is accessible mid-segment as the stream flows over Water Andric Rd (~1' above BKF). Debris jams and large sediment load is causing some channel migration and possible future bank erosion in the lower segment.

Major gravel deposition filling most of widened channel

Failing armor along Water Andric Rd

Stream: Water Andric	**Reach:** T2.08B	**Town:** Danville	**Date Assessed:** 8/28/13
Channel Length (ft): 1,896	**Channel Slope (%):** 2.5	**Sinuosity:** 1.1	**Watershed Area (mi^2):** 9.0

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Gravel
Stream Type	B	F

Ph2 Cross-Section Data

Curve Width (ft)	34.5
Bankfull Width (ft)	35.5
Max Depth (ft)	2.2
Width/Depth Ratio	21.1
Entrenchment Ratio	1.0
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	W. Andric	104	E

# of Other Constrictions: 0
# of Grade Controls: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	7	7
2	33	9
3	22	4
4	28	0
5	1	0
6	1	0
7	-	0
#/mile	256	55

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	52/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #9 – Stormwater management – check dams to reduce sediment inputs from roadside ditch
- #10 – Bank stabilization along road

Reach Highlights: The segment incised during recent episodic flooding events due to roadway encroachment and tight valley walls limiting lateral mobility. Large deposits of cobbles and gravel from these recent events buried much of the channel. Steep riffles were observed in locations where the channel is cutting down through these deposits. Vertical banks and inaccessible floodplains were observed throughout the reach. Incision was limited by several ledge grade controls leading to localized widening and mass failures. Debris jams continue to store large amounts of gravel and sand as it works through the segment.

Encroachment and armoring along Water Andric Rd

New Water Andric Rd bridge in lower segment

Stream: Water Andric **Reach:** T2.09 **Town:** Danville **Date Assessed:** 10/29/13

Channel Length (ft): 6,499 **Channel Slope (%):** 2.2 **Sinuosity:** 1.1 **Watershed Area (mi^2):** 6.8

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	Cb	B

Ph2 Cross-Section Data

Curve Width (ft)	30.4
Bankfull Width (ft)	36.7
Max Depth (ft)	2.1
Width/Depth Ratio	27
Entrenchment Ratio	1.9
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	Penny Ln	49	I, AOP, D, E

# of Other Constrictions: 0
# of Grade Controls: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	49	5
2	83	9
3	34	6
4	85	1
5	3	0
6	6	1
7	-	0
#/mile	211	17

Number of Debris Jams: 15

Step 6/7 Summary

RHA Score (%)	67
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	46/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	C->B
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #11 – Avulsion risk where VAST trail is very close to channel
- #12 – Culvert retrofit/replacement for undersized structure and AOP passage
- #13 – Corridor protection

Reach Highlights: The channel appears to have incised during recent episodic flooding. Dense bank vegetation likely limited erosion and severe widening. Major sediment inputs from mass failures upstream and within the reach led to large depositional features and fine sediments working through the reach. Steep riffles were observed in locations where the channel is cutting down through these deposits. The reach appears to be transitioning from stage II to III CEM.

Major cobble deposition along channel margin leading to incision and likely exacerbating mass failure on bends

VAST trail very close to channel - potential for major avulsion

Stream: Water Andric	**Reach:** T2.10	**Town:** Danville	**Date Assessed:** 10/29/13
Channel Length (ft): 3,423	**Channel Slope (%):** 3.2	**Sinuosity:** 1.1	**Watershed Area (mi^2):** 4.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	S. Confined	S. Confined
Bedform	Step-Pool	Riffle-Pool/Step-Pool
Median Substrate	Cobble	Cobble
Stream Type	B	F

Ph2 Cross-Section Data

Curve Width (ft)	25.6
Bankfull Width (ft)	26
Max Depth (ft)	2.1
Width/Depth Ratio	23.2
Entrenchment Ratio	1.4
Incision Ratio	2.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0
\# of Grade Controls: 2

Rapid Habitat Assessment

Rank	LWD	Pools
1	62	3
2	104	5
3	66	2
4	122	0
5	3	0
6	2	0
7	-	0
#/mile	553	15

Number of Debris Jams: 11

Step 6/7 Summary

RHA Score (%)	59
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	45/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	**Steep Riffle**
Corridor LC	**Head Cut**
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #14 – Channel Restoration/Debris Removal – Large debris jam immediately upstream of culvert
- #15 – Arrest Headcut – Recent head cut could be stabilized or restore flow to abandoned channel

Reach Highlights: The channel bed of this reach was heavily scoured during the 2011 flood events. Most scoured bank areas are stable due to natural rock deposition and/or dense root mats and therefore were not entered as erosion in FIT. In some areas there is B-type geometry, but F-type geometry is more common due to loss of floodplain access. A huge volume of cobbles of coarse sediments was deposited during and after these flood events and are working through the reach. Elevated floodplains showed minimal access except near large debris jams. Steep riffles and a major channel avulsion were observed. Steps are buried in loose cobbles and gravel.

Typical channel geometry with steep scoured banks, tall depositional features along margins

Neck cutoff leading to a headcut through old channel material and recent flood deposits

Stream: Water Andric **Reach:** T2.11A **Town:** Danville **Date Assessed**: 10/30/13

Channel Length (ft): 3,714 **Channel Slope (%):** 1.0 **Sinuosity:** 1.2 **Watershed Area (mi^2):** 4.2

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V. Broad	V. Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	24.6
Bankfull Width (ft)	23.4
Max Depth (ft)	2.2
Width/Depth Ratio	13.8
Entrenchment Ratio	7.7
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in segment.			

# of Other Constrictions: 0

# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	40	6
2	76	1
3	38	4
4	73	0
5	0	0
6	0	0
7	-	0
#/mile	322	15

Number of Debris Jams: 15

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	59/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #16 - Corridor Conservation

Reach Highlights: Aggradation and widening are the dominant processes in this segment. A huge cobble and gravel alluvial fan was observed at the top of the segment and appears to be recently deposited during episodic flooding. Large mid channel bars and diagonal bars were observed throughout the reach. Moderate lower bank scour was observed as the lower channel widened as a result of deposition. Stage III of CEM was chosen due to moderate channel incision and beginning signs of aggradation, with moderate channel widening likely in the near future. The right floodplain was recently logged for most of the reach, no major impacts to stream were observed.

Typical widened channel geometry with scoured banks, elevated but accessible floodplain and deposition

Alluvial fan at the top of segment

Stream: Water Andric	**Reach:** T2.11B	**Town:** Danville	**Date Assessed**: 10/30/13
Channel Length (ft): 3,500	**Channel Slope (%):** 2.75	**Sinuosity:** 1.03	**Watershed Area (mi^2):** 4.2

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Gravel
Stream Type	B	B

Ph2 Cross-Section Data

Curve Width (ft)	24.6
Bankfull Width (ft)	21.5
Max Depth (ft)	2.3
Width/Depth Ratio	12.5
Entrenchment Ratio	2.1
Incision Ratio	1.4

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in segment.			

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	20	1
2	53	3
3	35	1
4	48	1
5	0	0
6	2	0
7	-	0
#/mile	238	9

Number of Debris Jams: 11

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	59/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #17 – Stormwater Management: Stabilize and plant gully on LB near stream crossing

Reach Highlights: Aggradation and widening are the dominant processes in this reach. Large cobble/gravel bars are filling in the scoured out channel as a large volume of sediment works through following recent episodic flooding. Dense bank vegetation and roots will likely limit further channel widening as the stream re-establishes lower bank terraces.

Typical B-type geometry in reach, steep scoured bank and small floodplain storage on bars in widened channel

Increased sediment deposition and retention above debris jams throughout reach

Stream: Water Andric **Reach:** T2.12A **Town:** Danville **Date Assessed:** 10/30/13

Channel Length (ft): 1,291 **Channel Slope (%):** 3.0 **Sinuosity:** 1.09 **Watershed Area (mi^2):** 2.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Step-Pool	Plane-Bed/Step-Pool
Median Substrate	Cobble	Gravel
Stream Type	B	F

Ph2 Cross-Section Data

Curve Width (ft)	19.5
Bankfull Width (ft)	22
Max Depth (ft)	2.0
Width/Depth Ratio	16.2
Entrenchment Ratio	1.0
Incision Ratio	2.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in segment.			

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	9	0
2	11	2
3	2	2
4	1	0
5	0	0
6	0	0
7	-	0
#/mile	94	16

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	53
Habitat Type Departure	SP->PB
Habitat Condition	Fair
RGA Score / Condition	49/Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	**Head Cut**
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- None

Reach Highlights: Lower banks were scoured during recent episodic floods and the channel appears to have recently incised, likely as a result of the 2011 floods. Deep entrenchment and incision is possibly due to the lack of grade control compared to other reaches on the stream. Step-pool sequences were replaced with eroded continuous riffles. Floodplains are inaccessible and banks on both sides are vertical and raw. Heavy silt/clay on scoured lower banks will likely slow the widening process and potentially increase degradation. Deposits of large cobbles and boulders are slowly filling in the channel margins.

Typical F type geometry with steep scoured banks to inaccessible floodplain

Heavy clay soils along both banks are limiting widening

Stream: Water Andric **Reach:** T2.12B **Town:** Danville **Date Assessed**: 10/30/13

Channel Length (ft): 3,344 **Channel Slope (%):** 0.75 **Sinuosity:** 1.3 **Watershed Area (mi^2):** 2.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	B

Ph2 Cross-Section Data

Curve Width (ft)	19.5
Bankfull Width (ft)	15
Max Depth (ft)	2.3
Width/Depth Ratio	9.1
Entrenchment Ratio	1.5
Incision Ratio	2.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Private	103	R/R
B	VAST	308	
C	RT 2	51	I, D

# of Other Constrictions: 0

# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	9	4
2	13	4
3	1	3
4	6	0
5	0	0
6	0	0
7	-	0
#/mile	45	17

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	51
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	51/Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	C->B
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #18 – Buffer Planting
- #19 – Channel and Floodplain Restoration
- #20 – Culvert Replacement

Reach Highlights: The segment is highly variable upstream of Rt 2, transitioning from E to Bc, to C, to Bc, and then back to C-type based on valley confinement and entrenchment. The lower segment (below Rt2) is also variable and is primarily B-type close to a full departure to F. We did not add any additional segments due to the short channel lengths within each stream type change. Overall, the segment is incised and likely scoured during recent episodic floods. The undersized culvert under Rt 2 may have interrupted sediment transport increasing scour through the lower portion. The stream is beginning to widen in some areas with fresh erosion observed on the outside of bends. Historic armoring may be present along the edge of the hayfield on both banks, however it was not visible under dense herbaceous vegetation.

Typical B geometry with elevated floodplain on both sides.

Fresh erosion and fine deposition along areas with no buffer vegetation

4.1.2 Sleepers River Summary (Reaches/Segments T3.04-T3.7S1.07)

The Phase 2 assessment reaches on Sleepers River (T3.04 - T3.10) start at the confluence of North (T3.11) and Badger Brooks (T3.10s1.01-T3.10s1.03) at the Jamieson Road bridge and end downstream near Emerson Falls (Figure 5). The assessed reaches on Whiteman Brook (T3.7s1.01-T3.7s1.07) begin upstream of Cormier Road and end where the stream joins Sleepers River. The mainstem of Sleepers River is highly impacted by encroachment, development, and buffer impacts for the majority of the study area. These impacts led to reduce RHA and RGA scores, and several stream type departures due to incision. Road encroachment, armoring, and channel manipulation reducing floodplain access through the incised reaches likely increased bed scour and mass failures during the 2011 floods. Large grade controls were found in several reaches which limit incision and provide some sediment attenuation within the channel. Two dams are located on the mainstem, a USGS weir on T3.08, and a historic timber crib dam on T3.10. Both structures are filled in with sediment and are causing localized increased incision downstream. Habitat scores were lower along the mainstem due to sedimentation and scour leading to a smooth bed profile and the low amounts of woody debris in the channel. A house on the left floodplain on reach T3.08 was damaged during the 2011 floods and is located along a very active stretch with major widening and bed aggradation. Bank armoring and berming along the bank failed during the flood and we are recommending a floodplain easement to remove this structure and increase floodplain access.

Four bridges and a USGS weir trapping a large volume of fine sediment are located in the lower portion North Brook. Above these structures the stream flows through an active pasture with reduced buffer for most of the reach. A narrow strip of forest along the right bank maintains a full canopy and stabilizes the stream banks. As a result, T3.11 has "Good" ratings for RGA and RHA and is in channel evolution stage IV. A large abandoned USGS weir on Badger Brook is trapping a huge volume of coarse sediment and leading to increased incision downstream. The channel is less incised and relatively stable above the influence of the weir. A large bed and bank armoring site is located along Bruce Badger Memorial Highway near the confluence of Badger and Morrill Brooks. A windrowed cobble berm was constructed along the left bank immediately downstream of the bed/bank armoring site blocking access to the left floodplain.

Whiteman Brook is highly variable through the assessed reaches. The lowest segment contains a large alluvial fan where the stream enters the Sleepers River valley. The elevated roadbed for North Danville road and a culvert located against the right valley wall have disconnected a historically active depositional area for Whiteman and Sleepers River. Slope and confinement increase above the alluvial fan and the stream is encroached by Roy Road which is heavily armored following damage during the 2011 floods. These floods caused the channel to widen leading to large mass failures, debris jams, and major deposition of coarse material through these steeper reaches, similar to Water Andric. Stable reaches (T3.7S1.03 and T3.7S1.04) are located in the wide and flat valley which is bisected by Route 2. Confinement and slope increase above Parker Road with similar mass failure, debris jam, and coarse deposition as the lower reaches continuing to the top of the assessed reaches, excluding T3.7S1.06A; a deeply incised segment through an active hayfield. A failing stone culvert under the historic railbed (currently a VAST trail) is causing major deposition and channel instability on T3.7S1.06B.

The high density of mass failures, debris jams, and major channel degradation and widening that we observed on Water Andric, Whiteman Brook, and Badger Brook suggest that these watersheds are either more prone to flood damage, or received locally higher rainfall during the spring floods of 2011. Reaches along Wheelock Brook, North Brook, and Sheldon Brook are similar in size, slope, and land use, but were far less prone to major channel and corridor damage. We suspect that aspect and alignment of the watersheds or geology influenced the amount of flood damage within these basins.

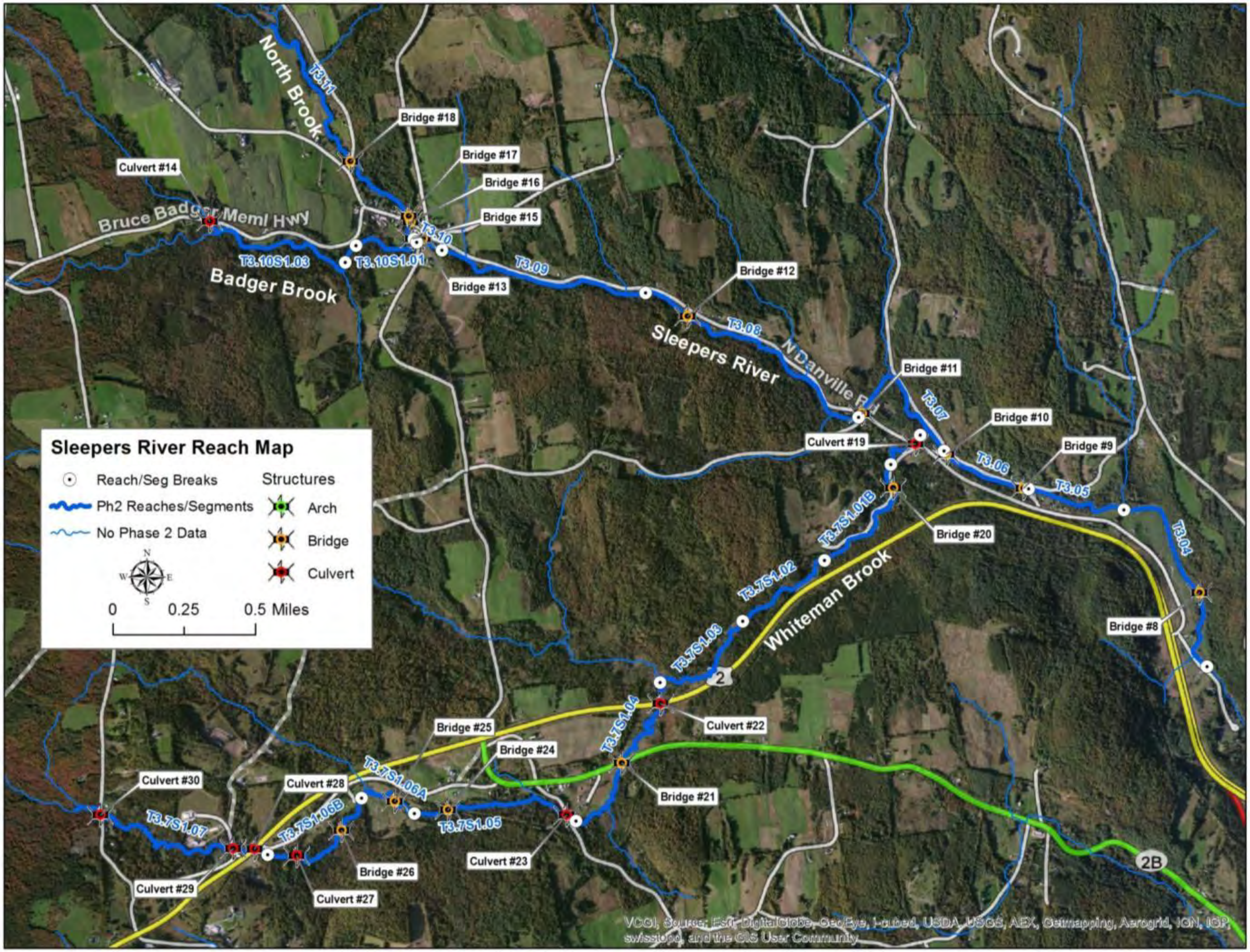


Figure 5: Sleepers River and tributaries reach map with crossing structures.

Stream: Sleepers River **Reach:** T3.04 **Town:** St. Johnsbury **Date Assessed:** 8/27/13

Channel Length (ft): 3,988 **Channel Slope (%):** 0.52 **Sinuosity:** 1.09 **Watershed Area (mi²):** 42.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Plane-Bed / Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	F

Ph2 Cross-Section Data

Curve Width (ft)	68.3
Bankfull Width (ft)	72.0
Max Depth (ft)	4.0
Width/Depth Ratio	23.3
Entrenchment Ratio	1.5
Incision Ratio	2.1

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	VAST Trail	110	R/R, BD

\# of Other Constrictions: 1
\# of Grade Controls: 8

Rapid Habitat Assessment

Rank	LWD	Pools
1	10	3
2	3	1
3	0	0
4	0	1
5	0	2
6	0	0
7	-	0
#/mile	17	9

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	35
Habitat Type Departure	RP -> PB
Habitat Condition	Fair
RGA Score / Condition	44/Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	C -> F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #21 – Channel and Floodplain Restoration

Reach Highlights: This reach is deeply incised and entrenched due to right bank armoring along the corn field and a typically tight left valley wall. Historic armoring and channel manipulation are limiting widening leading to downcutting and an inaccessible floodplain. Gravel deposits within the channel are unstable. Large grade control at top of reach appears to reduce upstream migration of incision. The river doesn't have much power through this reach due to the low slope and effect of dam downstream. There was some channel migration in the lower reach during the 2011 floods. This suggests that overall the reach would have a tendency to laterally migrate, but has become locked in place along the valley wall due to the severe incision.

Straightening, buffer impacts and deep incision mid-reach

Large bedrock grade control at top of reach

Stream: Sleepers River **Reach:** T3.05 **Town:** St. Johnsbury **Date Assessed:** 8/27/13

Channel Length (ft): 1,946 **Channel Slope (%):** 0.42 **Sinuosity:** 1.03 **Watershed Area (mi^2):** 41.9

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Plane-Bed / Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	67.8
Bankfull Width (ft)	81
Max Depth (ft)	3.8
Width/Depth Ratio	27.7
Entrenchment Ratio	3.5
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 1
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	5	0
2	0	0
3	0	1
4	0	1
5	0	1
6	0	0
7	-	0
#/mile	13	8

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	49
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	56/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #22 – Buffer Plantings

Reach Highlights: This reach likely widened during recent episodic flood events and is in stage III of channel evolution. Lower banks appear to have been scoured during recent episodic flooding and the bed has since aggraded with cobble and gravel. The reach is moderately incised but floodplain is accessible for largest events on one or both sides throughout.


Mid-reach looking upstream - stable rocky banks and a smooth bed profile


Mid-reach looking downstream - stable rocky banks and a smooth bed profile

Stream: Sleepers River **Reach:** T3.06 **Town:** St. Johnsbury **Date Assessed:** 7/17/13

Channel Length (ft): 1,773 **Channel Slope (%):** 1.12 **Sinuosity:** 1.00 **Watershed Area (mi^2):** 40.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	S Confined	N Confined
Bedform	Plane Bed	Plane Bed
Median Substrate	Cobble	Cobble
Stream Type	F	F

Ph2 Cross-Section Data

Curve Width (ft)	66.9
Bankfull Width (ft)	75.0
Max Depth (ft)	2.6
Width/Depth Ratio	39.5
Entrenchment Ratio	1.3
Incision Ratio	2.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	G Hollow	101	I, D, R/R
B	TH-8	90	D, R/R

\# of Other Constrictions: 0

\# of Grade Controls: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	19	3
2	13	4
3	5	3
4	0	0
5	0	0
6	0	2
7	-	1
#/mile	110	38

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	46
Habitat Type Departure	RP->PB
Habitat Condition	Fair
RGA Score / Condition	43/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	**Dredging**

Potential Projects in Reach

- #23 - Bridge Replacement: TH-8 bridge

Reach Highlights: The reach is deeply incised and entrenched due to the continuous encroachment from Goss Hollow Rd. The road embankment is heavily armored and elevated well above high water access. The right valley wall is tight to the channel throughout. Recent episodic floods likely scoured away any bed features leaving a flat plane bed stream with gravel and cobble. We selected modified stream type from Bc to F based on major encroachment from the road limiting any future restoration to B geometry. Most of the LWD in the habitat tally was located along the channel margins and didn't not contribute to in-stream habitat at low flows.

Mid-reach looking upstream - stable rocky banks and the undersized TH-8 bridge in disrepair

Goss Hollow Rd bridge - skewed and at a slope break, possible ice jam location

Stream: Sleepers River **Reach:** T3.07 **Town:** St. Johnsbury, Danville **Date Assessed:** 7/16/13

Channel Length (ft): 2,861 **Channel Slope (%):** 0.97 **Sinuosity:** 1.38 **Watershed Area (mi^2):** 40.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Braided	Braided / Riffle Pool
Median Substrate	Cobble	Cobble
Stream Type	D	D

Ph2 Cross-Section Data

Curve Width (ft)	66.8
Bankfull Width (ft)	106.0
Max Depth (ft)	3.6
Width/Depth Ratio	67.5
Entrenchment Ratio	3.3
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	N Danville	132	D

\# of Other Constrictions: 0
\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	49	5
2	43	2
3	3	4
4	15	1
5	2	0
6	0	0
7	-	0
#/mile	206	22

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	51
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	40/Fair
Dominant Adjustment	Widening
CEM Model Stage	D / IId
Stream Type Departure	None
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #24 – Bank Stabilization along Goss Hollow Rd
- #25 – Corridor Protection

Reach Highlights: This reach is a major depositional area and contains a large alluvial fan. The dominant adjustment process is widening as the stream braids through large cobble and gravel deposits; these adjustments would be expected in this setting, but are exacerbated by river corridor impacts. The left bank is armored along Goss Hollow Rd and the right bank shows evidence of recent scour and erosion. The stream is highly overwidened and contains numerous diagonal bars and mid channel bars braiding flow at all levels. Access to the large forested right floodplain may eventually improve if the bed aggrades, however the house in floodplain may be at risk.

Stream braiding through large cobble and gravel bars

Large cobble bar and bank armor along Goss Hollow Rd

Stream: Sleepers River **Reach:** T3.08 **Town:** Danville **Date Assessed**: 7/30/13

Channel Length (ft): 5,011 **Channel Slope (%):** 1.93 **Sinuosity:** 1.06 **Watershed Area (mi^2):** 16.9

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle Pool
Median Substrate	Cobble	Cobble
Stream Type	B_c	B_c

Ph2 Cross-Section Data

Curve Width (ft)	45.4
Bankfull Width (ft)	54.0
Max Depth (ft)	2.8
Width/Depth Ratio	26.9
Entrenchment Ratio	1.6
Incision Ratio	1.8

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Private footbridge	176	

\# of Other Constrictions: 0
\# of Grade Controls: 8

Rapid Habitat Assessment

Rank	LWD	Pools
1	7	1
2	37	4
3	3	5
4	5	3
5	0	0
6	0	2
7	-	0
#/mile	54	15

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score (%)	48
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	49/Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	None
Stream Sensitivity	High

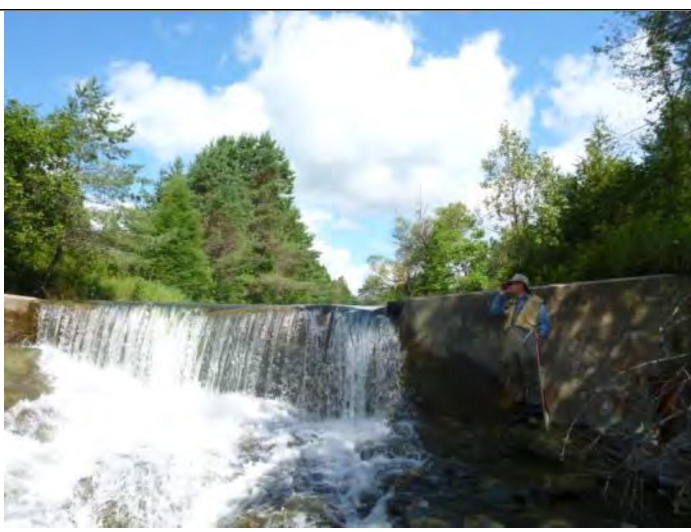
Impact Summary

Bank Erosion	**Stormwater**
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #26 – USGS Weir Removal
- #27 – Floodplain Easement for property in major flood risk location
- #28 – Bank Stabilization
- #29 – Buffer Planting

Reach Highlights: Degradation is the dominant process for this reach. This reach contains numerous bedrock grade controls and an abandoned USGS weir. Grade controls may have arrested historic incision, with widening likely in near future. These features trap large volumes of sediment and may increase degradation downstream. The right valley wall is tight for most of the reach and the left bank is heavily armored in several stretches along North Danville Road, limited widening and increasing degradation.



USGS weir over a bedrock grade control

House on a low floodplain bench near active channel area

Stream: Sleepers River **Reach:** T3.09 **Town:** Danville **Date Assessed**: 7/30/13

Channel Length (ft): 4,105 **Channel Slope (%):** 1.87 **Sinuosity:** 1.04 **Watershed Area (mi^2):** 15.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	S Confined	S Confined
Bedform	Riffle-Pool	Riffle Pool
Median Substrate	Cobble	Cobble
Stream Type	B_c	B_c

Ph2 Cross-Section Data

Curve Width (ft)	43.7
Bankfull Width (ft)	53.0
Max Depth (ft)	3.1
Width/Depth Ratio	31.2
Entrenchment Ratio	2.2
Incision Ratio	1.9

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0
\# of Grade Controls: 2

Rapid Habitat Assessment

Rank	LWD	Pools
1	10	4
2	20	3
3	5	3
4	17	0
5	1	1
6	4	1
7	-	0
#/mile	73	15

Number of Debris Jams: 5

Step 6/7 Summary

RHA Score (%)	54
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	46/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	**Stormwater**
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #30 – Channel Stabilization at two bed armoring sites

Reach Highlights: The dominant adjustment processes in this reach are widening and deposition. Large deposits of cobbles occupy half of the channel in numerous locations and the channel is widening to accommodate the large sediment load. Mass failures were observed on several bends as the stream attempts to widen on the right bank in a confined valley. Most of the mass failures were still active and had silt/clay material within the channel, likely contributing large volumes of fine sediment to the river. The left bank is armored along North Danville Rd for most of the reach. Two bed armoring sites were observed at pinch points where the stream was downcutting during the 2011 floods next to the road embankment.

Numerous large mass failures were observed along the right bank

Two bed and bank armoring sites were observed at damage sites along North Danville Rd

Stream: Sleepers River **Reach:** T3.10 **Town:** Danville **Date Assessed:** 7/30/13

Channel Length (ft): 607 **Channel Slope (%):** 1.83 **Sinuosity:** 1.05 **Watershed Area (mi^2):** 14.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	S Confined
Bedform	Riffle-Pool	Plane Bed
Median Substrate	Gravel	Gravel
Stream Type	B_c	F

Ph2 Cross-Section Data

Curve Width (ft)	42.6
Bankfull Width (ft)	60.0
Max Depth (ft)	2.1
Width/Depth Ratio	36.4
Entrenchment Ratio	1.3
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Jamieson Rd	94	D, E

# of Other Constrictions: 0

# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	1	0
2	2	0
3	2	0
4	2	0
5	1	0
6	0	0
7	-	0
#/mile	69	0

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	42
Habitat Type Departure	RP->PB
Habitat Condition	Fair
RGA Score / Condition	32/Poor
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #31 – Channel Stabilization: Dam removal and channel restoration

Reach Highlights: Channel adjustments are variable for this short reach that is strongly affected by the large timber crib dam at the bottom of the reach. The channel is attempting to reestablish planform through deep deposits of sand and gravel held by the dam. Narrow floodplain benches are forming on both sides and banks are relatively stable. Combination of adjustments suggests latter stage of channel evolution - transitioning from stage III to IV. However with the dam in place full recovery of channel equilibrium is not possible.

Timber crib dam at bottom of reach

Jamieson Road bridge and backwater from dam through most of reach

Stream: Sleepers River **Reach:** T3.11 **Town:** Danville **Date Assessed:** 8/27/13

Channel Length (ft): 5,661 **Channel Slope (%):** 1.19 **Sinuosity:** 1.14 **Watershed Area (mi²):** 6.1

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	29.1
Bankfull Width (ft)	21.4
Max Depth (ft)	3.0
Width/Depth Ratio	8.7
Entrenchment Ratio	3.5
Incision Ratio	1.3

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	N Danville	189	
B	N Church	55	I, D, E
B	Gadapee	52	I, D
B	USGS access	189	D, E

# of Other Constrictions: 0
# of Grade Controls: 2

Rapid Habitat Assessment

Rank	LWD	Pools
1	18	8
2	40	15
3	15	8
4	28	2
5	0	0
6	0	0
7	-	0
#/mile	94	30

Number of Debris Jams: 10

Step 6/7 Summary

RHA Score (%)	65
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	70/Good
Dominant Adjustment	Stable/Wide
CEM Model Stage	F / IV
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #32 – Bridge Retrofit/Replacement: Gadapee Rd
- #33 – Bridge Retrofit/Replacement: North Church Rd
- #34 – USGS Weir Removal
- #35 – Stream Access for Cattle
- #36 – Corridor Protection and Buffer Plantings

Reach Highlights: The channel appears fairly stable throughout the reach. Some evidence of widening was observed in the lower reach along unbuffered agricultural fields. The remainder of the reach has stable vegetated banks, typical riffle pool sequences, and a slight increase in bar formation from gravel substrates working through the reach following recent episodic flooding. No direct evidence of historical channel straightening, but given agricultural fields in corridor some alterations were likely. Channel likely incised historically and has re-developed floodplain access and habitat with reforestation of banks and buffers.

USGS weir and access bridge in lower reach

Cattle stream access and narrow forested buffer in upper reach

Stream: Badger Brook **Reach:** T3.10S1.01 **Town:** Danville **Date Assessed**: 7/17/13

Channel Length (ft): 1,303 **Channel Slope (%):** 1.89 **Sinuosity:** 1.09 **Watershed Area (mi^2):** 8.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	B_c	F

Ph2 Cross-Section Data

Curve Width (ft)	33.5
Bankfull Width (ft)	58.0
Max Depth (ft)	2.4
Width/Depth Ratio	43.3
Entrenchment Ratio	1.1
Incision Ratio	2.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

# of Other Constrictions: 0

# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	5	1
2	18	0
3	0	1
4	6	0
5	0	0
6	0	0
7	-	0
#/mile	117	8

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	52
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	34/Poor
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- None

Reach Highlights: This reach is deeply incised and is beginning to widen to attempt to regain access to elevated floodplains or redevelop new terraces. A large abandoned USGS weir is located at upstream reach break and is holding back a huge volume of cobble and gravel. This has likely starved the channel of sediment and caused severe historic incision. Large deposits of cobble and gravel were observed on the margins throughout the reach and most bars were at or above bankfull. Sediment was likely transferred into reach in recent floods. The banks indicated heavy scour on both sides and we observed numerous mass failures.

Widened reach with significant deposition from recent flooding

Bank scour observed through most of reach indicating recent widening

Stream: Badger Brook **Reach:** T3.10S1.02 **Town:** Danville **Date Assessed:** 7/16/13

Channel Length (ft): 389 **Channel Slope (%):** 2.4 **Sinuosity:** 1.01 **Watershed Area (mi^2):** 8.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	B	B

Ph2 Cross-Section Data

Curve Width (ft)	33.4
Bankfull Width (ft)	N/A
Max Depth (ft)	
Width/Depth Ratio	
Entrenchment Ratio	
Incision Ratio	

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0

\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	0	0
2	3	1
3	0	0
4	0	0
5	0	0
6	0	0
7	-	0
#/mile	40	13

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	-
Habitat Type Departure	-
Habitat Condition	Poor
RGA Score / Condition	-
Dominant Adjustment	Widening
CEM Model Stage	D/IId
Stream Type Departure	-
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #37 – Remove USGS Weir

Reach Highlights: This reach is affected by a USGS weir for the entire length with large depositional features and lack of bankfull indicators. Administrative judgment for stream type and sensitivity. Most of the channel is occupied by a huge side bar that is several feet above bankfull. The channel is eroding the left bank for most of the reach.

USGS weir and ledge from below

Huge cobble side bar above weir

Stream: Badger Brook **Reach:** T3.10S1.03 **Town:** Danville **Date Assessed**: 7/17/13

Channel Length (ft): 3,347 **Channel Slope (%):** 2.9 **Sinuosity:** 1.19 **Watershed Area (mi^2):** 8.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	C_b	C_b

Ph2 Cross-Section Data

Curve Width (ft)	33.4
Bankfull Width (ft)	31.0
Max Depth (ft)	2.5
Width/Depth Ratio	20.4
Entrenchment Ratio	3.6
Incision Ratio	1.6

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	Bruce Badger Highway	40	I, AOP

\# of Other Constrictions: 1
\# of Grade Controls: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	13	2
2	46	0
3	4	2
4	38	0
5	0	1
6	0	0
7	-	0
#/mile	159	7

Number of Debris Jams: 7

Step 6/7 Summary

RHA Score (%)	59
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	59/Fair
Dominant Adjustment	Stable/Wide
CEM Model Stage	F/IV
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #38 – Culvert Retrofit/Replacement: Bruce Badger Hwy
- #39 – Channel Stabilization at bed armoring site
- #40 – Berm Removal
- #41 – Bank Stabilization

Reach Highlights: This reach widened during recent episodic flooding events as indicated by scoured banks and numerous mass failures. The high sediment load following these events has produced large stable cobble/boulder/gravel bars along the channel margins for the entire reach. The bars are at or above bank full and have re-established a fairly stable channel geometry with small flood benches. A forested floodplain is typically accessible on one bank at high flows.

Reach reestablishing floodplain benches in an overwidened channel

Large bed and bank armoring site in upper reach

Stream: Whiteman Brook **Reach:** T3.7S1.01A **Town:** Danville, St. Johnsbury **Date Assessed:** 4/24/14

Channel Length (ft): 979 **Channel Slope (%):** 0.75 **Sinuosity:** 1.25 **Watershed Area (mi²):** 6.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	D	D

Ph2 Cross-Section Data

Curve Width (ft)	30.1
Bankfull Width (ft)	38
Max Depth (ft)	2.8
Width/Depth Ratio	47.7
Entrenchment Ratio	4.6
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	N Danville	50	I, D

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	18	1
2	42	2
3	13	1
4	33	2
5	0	0
6	1	0
7	-	0
#/mile	577	32

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	65
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	49 / Fair
Dominant Adjustment	Widening
CEM Model Stage	III
Stream Type Departure	None
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #42 – Culvert Retrofit/Replacement: North Danville Rd

Reach Highlights: This segment widened during recent episodic flooding and huge volumes of sand and gravel were deposited along the channel margins and over the floodplain. An alluvial fan formed at the top of the segment where the channel exits the gorge and the channel slope quickly drops to below 1%. The shape and slope of the valley and the large number of flood chutes over the floodplain suggest that this is a historic alluvial fan area and that the channel likely historically migrated throughout the left floodplain. The construction of the elevated road bed for North Danville Rd and the location of the culvert against the right valley wall have caused the channel to become moderately incised and lose some access to the large left floodplain.


Gravel deposits below N Danville Rd culvert leading to Sleepers River T3.07


Thick cobble and gravel deposits filling floodplain along alluvial fan area

Stream: Whiteman Brook **Reach:** T3.7S1.01B **Town:** Danville **Date Assessed:** 7/17/13

Channel Length (ft): 2,668 **Channel Slope (%):** 3.5 **Sinuosity:** 1.07 **Watershed Area (mi^2):** 6.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Step-Pool	Step-Pool
Median Substrate	Cobble	Cobble
Stream Type	B	B

Ph2 Cross-Section Data

Curve Width (ft)	30.1
Bankfull Width (ft)	36
Max Depth (ft)	2.0
Width/Depth Ratio	33.9
Entrenchment Ratio	2.1
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Roy Rd	53	I

\# of Other Constrictions: 1
\# of Grade Controls: 6

Rapid Habitat Assessment

Rank	LWD	Pools
1	18	1
2	42	2
3	13	1
4	33	2
5	0	0
6	1	0
7	-	0
#/mile	577	32

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	51
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	46 / Fair
Dominant Adjustment	Widening
CEM Model Stage	III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #43 – Bridge Retrofit/Replacement: Roy Rd
- #44 – USGS Weir Removal

Reach Highlights: This reach contained huge depositional features from recent episodic flood events. Many banks along the outer bends corresponding to mass failures have been scoured back ~10-40' during these events and have since been replaced with large cobble/boulder/gravel side bars throughout the reach. Steep riffles were indexed where the stream is sharply downcutting through deep aggraded sediments in the channel. Many of these bars are well above bankfull and occupy more than half of the channel. Large mass failures were observed along the right bank and the left bank was heavily armored along Roy Rd for a portion of the reach. We selected stage 3 of channel evolution due to the instability of the large depositional features and moderate incision.

Abandoned USGS weir on a natural grade control

Stacked stone wall along Roy Rd

Stream: Whiteman Brook **Reach:** T3.7S1.02 **Town:** Danville **Date Assessed:** 8/6/13

Channel Length (ft): 2,105 **Channel Slope (%):** 2.63 **Sinuosity:** 1.09 **Watershed Area (mi^2):** 6.3

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C_b	C_b

Ph2 Cross-Section Data

Curve Width (ft)	29.5
Bankfull Width (ft)	22.0
Max Depth (ft)	3.3
Width/Depth Ratio	11.5
Entrenchment Ratio	2.2
Incision Ratio	1.3

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0

\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	10	3
2	29	1
3	15	0
4	21	1
5	2	0
6	4	0
7	-	0
#/mile	159	7

Number of Debris Jams: 10

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	57/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F/II
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #45 – Bank Stabilization and Buffer Planting on Rt 2 embankment

Reach Highlights: Lower banks appear to have been scoured back during recent episodic floods followed by major deposition of cobbles, gravel, and boulders throughout the reach. The reach is only moderately incised and has a very low W/D ratio due to large cobble deposits along the margins that typically fill over half of the channel. We selected degradation as the primary adjustment process due to the numerous steep riffles (caused by erosion cutting through aggraded material at channel nickpoints) we observed at the stream tries to re-establish riffle pool sequences through the deep cobble deposits. Channel will likely widen and redevelop planform in the future as flood related sediment works through the reach and downstream.

Deposits of cobble and boulders typically filled over half of the widened channel

Numerous large mass failures were observed in the reach

Stream: Whiteman Brook **Reach:** T3.7S1.03 **Town:** Danville **Date Assessed:** 8/6/13

Channel Length (ft): 2,521 **Channel Slope (%):** 0.3 **Sinuosity:** 1.18 **Watershed Area (mi²):** 6.1

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Dune-ripple	Dune-ripple
Median Substrate	Sand	Sand
Stream Type	E	E

Ph2 Cross-Section Data

Curve Width (ft)	24.0
Bankfull Width (ft)	17.8
Max Depth (ft)	3.6
Width/Depth Ratio	8.2
Entrenchment Ratio	27.5
Incision Ratio	1.3

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0

\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	4	3
2	13	6
3	12	7
4	11	6
5	6	4
6	1	3
7	-	2
#/mile	98	64

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	69
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	75/Good
Dominant Adjustment	Stable
CEM Model Stage	F/I
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #46 - Conservation

Reach Highlights: Reach is stable and has minor incision. Active beaver dams and lodges have removed all trees reducing rooting strength of banks. Some bank slumping and a few recent avulsions were observed. Beaver dams are trapping sediment through most of reach and limiting riffle formation. Based on review of historical imagery that shows agricultural fields in the corridor we assumed this reach was likely manipulated historically but maintained connection to the floodplain.

Typical channel geometry with a beaver dam

Large point bar and a recent neck cutoff through a meander bend

Stream: Whiteman Brook **Reach:** T3.7S1.04 **Town:** Danville **Date Assessed:** 8/6/13

Channel Length (ft): 4,147 **Channel Slope (%):** 0.7 **Sinuosity:** 1.21 **Watershed Area (mi^2):** 3.3

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	E	E

Ph2 Cross-Section Data

Curve Width (ft)	18.0
Bankfull Width (ft)	19.3
Max Depth (ft)	2.9
Width/Depth Ratio	10.8
Entrenchment Ratio	29.5
Incision Ratio	1.6

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	Rt 2	67	I, AOP, D, E
B	Parker Rd	139	D

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	8	6
2	25	5
3	11	3
4	10	1
5	3	0
6	0	0
7	-	0
#/mile	72	19

Number of Debris Jams: 7

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	60/Fair
Dominant Adjustment	Stable/Wide
CEM Model Stage	F/IV
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #47 – Culvert Retrofit/Replacement: Route 2
- #48 – Bank Stabilization: Route 2 embankment

Reach Highlights: This reach appears to have widened slightly during recent episodic flooding. Banks now appear stable for most of the reach. Channel is exhibiting lateral movement and is in stage IV of channel evolution. We observed slumping banks and increased scour on outside bends (due to low severity and scale these features were not indexed as erosion). A small alluvial fan at the top of the reach and increased gravel and sand deposition throughout indicate that increased bedload from recent episodic flooding events may still be working through the reach.


Culvert under Rt 2 near bottom of reach


Typical winding gravel bottom E-type geometry

Stream: Whiteman Brook **Reach:** T3.7S1.05 **Town:** Danville **Date Assessed:** 8/7/13

Channel Length (ft): 3,246 **Channel Slope (%):** 2.63 **Sinuosity:** 1.02 **Watershed Area (mi^2):** 2.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Gravel
Stream Type	B	F

Ph2 Cross-Section Data

Curve Width (ft)	20.4
Bankfull Width (ft)	25.2
Max Depth (ft)	2.0
Width/Depth Ratio	18.1
Entrenchment Ratio	1.1
Incision Ratio	2.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	VAST	540	
C	Trestle Rd	42	I, D, E

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	13	5
2	53	3
3	34	1
4	40	0
5	0	0
6	1	0
7	-	0
#/mile	229	14

Number of Debris Jams: 9

Step 6/7 Summary

RHA Score (%)	61
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	35/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F/II
Stream Type Departure	B->F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #49 – Culvert Retrofit/Replacement: Trestle Rd
- #50 - Conservation

Reach Highlights: This reach widened during recent episodic flood events heavily scouring away lower banks. Major cobble and gravel deposits have since formed within the channel creating a low W/D, very high incision, and deep entrenchment. The stream appears to be cutting down through these deposits and further incising. These features are FIT'd as steep riffles and head cuts, but they are all due to degradation. Forested floodplain exists on one or both banks throughout the reach but is inaccessible. The incision could increase if the channel cuts deep enough to reduce access to the small floodplain areas over the cobble bars within the widened banks.

Channel degradation above the Trestle Rd culvert

Typical channel cross-section, overwidened, side bars, elevated and inaccessible floodplain.

Stream: Whiteman Brook **Reach:** T3.7S1.06A **Town:** Danville **Date Assessed:** 8/7/13

Channel Length (ft): 1,566 **Channel Slope (%):** 0.75 **Sinuosity:** 1.3 **Watershed Area (mi^2):** 2.3

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	E

Ph2 Cross-Section Data

Curve Width (ft)	19.0
Bankfull Width (ft)	11.0
Max Depth (ft)	3.1
Width/Depth Ratio	4.6
Entrenchment Ratio	44.9
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Private Rd	79	D, E

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	18	8
2	20	8
3	8	0
4	0	0
5	2	0
6	0	0
7	-	0
#/mile	161	53

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	47
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	52/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F/II
Stream Type Departure	C->E
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #51 – Buffer Planting and Corridor Protection

Reach Highlights: This segment is deeply incised due to the presence of historic armoring and straightening along the field edges. Visible rip-rap was indexed, it is likely that further armoring was present under slumping banks. Floodplain was very wide but inaccessible except during extreme events. Channel slopes on both segments for this reach are lower than Ph1 estimated slope - this is due to increased sinuosity and likely inaccurate elevation data near the top of the reach from the elevated road bed for Rt2.

Typical incised E-type geometry

Private bridge in lower reach

Stream: Whiteman Brook **Reach:** T3.7S1.06B **Town:** Danville **Date Assessed:** 8/7/13

Channel Length (ft): 2,679 **Channel Slope (%):** 1.25 **Sinuosity:** 1.2 **Watershed Area (mi^2):** 2.3

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	19.0
Bankfull Width (ft)	18.5
Max Depth (ft)	1.9
Width/Depth Ratio	15.5
Entrenchment Ratio	5.0
Incision Ratio	1.3

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	VAST Trail	42	AOP, I, D, E, R/R, S
B	Private Rd	105	

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	30	7
2	42	2
3	33	0
4	43	0
5	0	0
6	2	0
7	-	0
#/mile	295	17

Number of Debris Jams: 12

Step 6/7 Summary

RHA Score (%)	51
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	44/Fair
Dominant Adjustment	Widening
CEM Model Stage	F/III
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #52 – Culvert Replacement and Channel Restoration: VAST trail
- #53 – Conservation

Reach Highlights: The channel adjustments in this segment are driven by the huge amount of sediment trapped behind the failing stone culvert beneath the VAST trail near the middle of the segment. Floodplain is accessible on one side below the culvert and has a high failing bank to an inaccessible terrace on the other side. Above the culvert, a deeply incised channel is carving through loose sand and gravel deposits that have been stored above the culvert. The stream is trying to re-establish planform by carving out meanders above the culvert and to a lesser extent, below the culvert. Major adjustments would likely occur if the stone culvert were repaired or replaced.

Stone culvert outlet

Deeply incised channel carving through sediments stored above culvert

Stream: Whiteman Brook	**Reach:** T3.7S1.07	**Town:** Danville	**Date Assessed:** 8/27/13
Channel Length (ft): 4,545	**Channel Slope (%):** 2.8	**Sinuosity:** 1.2	**Watershed Area (mi^2):** 1.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C_b	B

Ph2 Cross-Section Data

Curve Width (ft)	15.8
Bankfull Width (ft)	18.5
Max Depth (ft)	1.5
Width/Depth Ratio	17.3
Entrenchment Ratio	1.6
Incision Ratio	1.4

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	Rt2	51	AOP, I, D, E, R/R
C	Red Barn Rd	44	AOP, I, D, E
C	Cormier Rd	44	AOP, I, E, R/R

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	3	9
2	67	12
3	29	2
4	41	0
5	2	0
6	3	0
7	-	1
#/mile	295	17

Number of Debris Jams: 16

Step 6/7 Summary

RHA Score (%)	63
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	45/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F/II
Stream Type Departure	C->B
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #54 – Culvert Retrofit/Replacement: Route 2, Red Barn Rd, and Cormier Rd
- #55 – Channel and Bank Stabilization below Cormier Rd
- #56 - Conservation

Reach Highlights: This reach was scoured during recent episodic flooding events followed by major deposition of gravel and sand. Large mass failures were observed at the top of the reach and have increased bedload of fine material working through the reach. Three undersized culverts within the reach likely increased deposition during flooding events. Tall deposits of gravel were observed along the margins and bends throughout. The relatively fine substrates coupled with the higher slope of the reach created several small headcuts through the poorly sorted channel material. Degradation and aggradation adjustments are both present, but degradation is the dominant adjustment process as the stream cuts through recent deposits of finer material.


Perched culvert and recent bank erosion, armoring, and channel degradation below Cormier Rd


Evidence of recent major widening and degradation in the upper reach

4.1.3 Sheldon Brook and Tributary Summary (Reaches/Segments T4.01-T4.S1.01)

The assessed reaches on Sheldon Brook and South Branch Sheldon Brook flow through a range of very broad agricultural valleys to steep forested valleys (Figure 6). Reaches T4.01 and T4.04 contain many of the impacts associated with current and historic agricultural land use. Straightening, berming, bank armoring, and buffer impacts all contribute to reduced habitat and geomorphic condition, and high incision in the lower reach. T4.01 has limited opportunity for widening due to these impacts and will likely take more time to widen and transition out of stage II of channel evolution. T4.04 is less impacted by historic channel manipulation and is currently widening and adjusting planform to transition to stage IV. Reach T4.02 is encroached by Red Village Road for most of the reach; however the road is located along the valley wall and a narrow forested buffer between the road and the channel limits impacts. This is reach is relatively stable and had "Good" assessments for RHA and RGA. Both segments in T4.03 (A and B) widened and aggraded large volumes of coarse sediment during the spring 2011 floods. The upper segment (B) has continued to widen and is only moderately incised. The lower segment (A) is continuing to cut through the flood deposits and is more incised. Two berms in the lower segment reduce floodplain access and are likely increasing incision.

Mass failures are less common along Sheldon Brook, however several very large mass failures were observed that remain active and are within the channel, continuously adding fine sediment to the stream. Gullies from road ditches and agricultural fields are also fine sediment sources to the channel. Grade control was largely lacking from the study reaches, despite relatively limited incision and severe damage in this tributary in comparison to the tributaries in Danville.

Corridor protection and floodplain buffer planting projects are recommended for both T4.01 and T4.04. These reaches have wide valleys with limited floodplain access due to historic and ongoing incision. The upper reach retains some floodplain access but would benefit from buffer plantings to stabilize banks, increase shading, and increase woody debris inputs to the channel. The lower reach is deeply incised but will adjust over time to naturally restore floodplain access. A large historic cobble berm was observed on the left bank between New Boston Road and Severance Hill Road. This berm is beginning to fail on the upstream end and flow has been partially restored to a large forested wetland within an abandoned historic channel. This wetland is accessible at bankfull flows and is storing a huge volume of fine sediments. Access will increase as the berm continues to fail, increasing flow and sediment attenuation in this important floodplain feature.

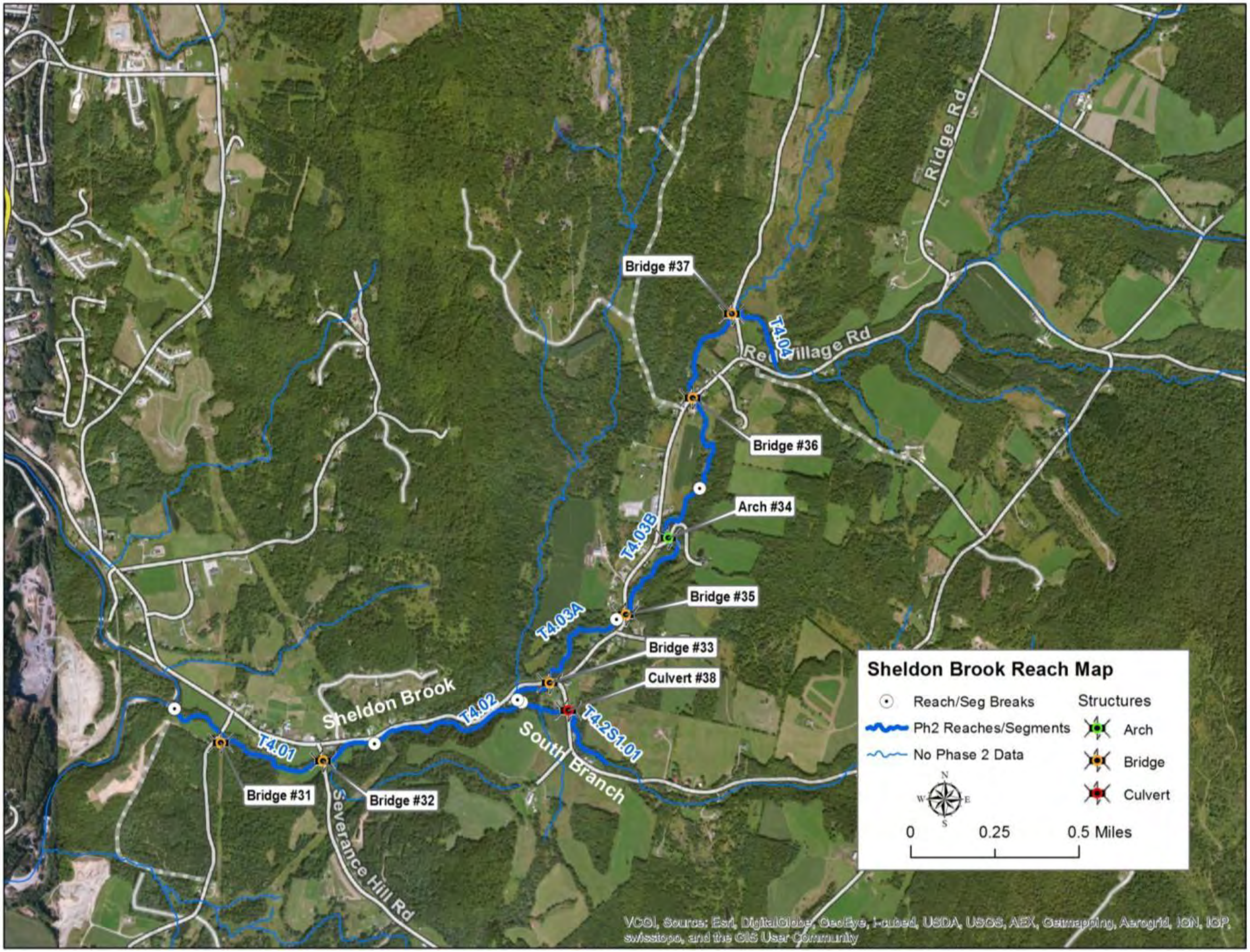


Figure 6: Sheldon Brook and South Branch Sheldon Brook reach map with crossing structures.

Stream: Sheldon Brook	**Reach:** T4.01	**Town:** Lyndon	**Date Assessed:** 6/18/13
Channel Length (ft): 4,545	**Channel Slope (%):** 1.93	**Sinuosity:** 1.06	**Watershed Area (mi^2):** 11.5

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Very Broad	Very Broad
Bedform	Riffle-Pool	Riffle- Pool/Plane Bed
Median Substrate	Cobble	Cobble
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	38.3
Bankfull Width (ft)	37.5
Max Depth (ft)	2.9
Width/Depth Ratio	18.9
Entrenchment Ratio	8.5
Incision Ratio	1.9

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	N Boston	65	D, R/R
B	Severance	60	D

\# of Other Constrictions: 0
\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	4	4
2	7	0
3	4	0
4	2	2
5	0	1
6	0	0
7	-	0
#/mile	23	9

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	57
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	48 / Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	**Stormwater**
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	**Dredging**

Potential Projects in Reach

- #57 – Bridge Retrofit/Replacement: New Boston Rd
- #58 – Bridge Retrofit/Replacement: Severance Hill Rd
- #59 – Berm Removal
- #60 – Berm Removal
- #61 – Corridor Protection

Reach Highlights: This reach has been historically straightened and armored through the agricultural fields on both sides. The channel is deeply incised and is starting to widen in the areas that are less armored or bermed. Degradation is the dominant process due to controls on channel migration. The channel has room to re-establish planform and could provide valuable floodwater and sediment storage before reaching the Passumpsic River. A small forested wetland area is located on the left bank upstream of New Boston Road. This area may have ecological significance and should be considered for conservation.

Armoring along left bank, mid-reach

Small gully from a road ditch along New Boston Road

Stream: Sheldon Brook **Reach:** T4.02 **Town:** Lyndon **Date Assessed**: 6/18/13

Channel Length (ft): 2,653 **Channel Slope (%):** 2.74 **Sinuosity:** 1.04 **Watershed Area (mi²):** 11.1

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Semi-Conf	Semi-Conf
Bedform	Riffle-Pool	Riffle- Pool
Median Substrate	Cobble	Cobble
Stream Type	B	B

Ph2 Cross-Section Data

Curve Width (ft)	37.8
Bankfull Width (ft)	42.0
Max Depth (ft)	2.5
Width/Depth Ratio	22.6
Entrenchment Ratio	1.5
Incision Ratio	1.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0
\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	2	14
2	13	1
3	1	8
4	14	1
5	0	2
6	0	0
7	-	0
#/mile	60	52

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	65 / Good
Dominant Adjustment	Stable
CEM Model Stage	F / I
Stream Type Departure	None
Stream Sensitivity	Moderate

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #62 – Bank Stabilization: Gully to field on top of valley wall
- #63 – Bank Stabilization: Large and active mass failure

Reach Highlights: Lower banks were scoured back and the channel slightly over-widened during recent episodic flood events, leading to several mass failures in the reach. Cobble deposition along the margins is rebuilding these lower banks and vegetated upper banks are stable. The close proximity of Red Village Road decreases floodprone width through most of the reach and increases entrenchment. A forested floodplain bench is present through most of the reach and is accessible at most high flows. Some erosion was observed on outside bends indicating that minor planform adjustments are ongoing.


Gully on left bank


Evidence of channel widening during recent floods

Stream: Sheldon Brook **Reach:** T4.03A **Town:** Lyndon **Date Assessed:** 6/19/13

Channel Length (ft): 2,514 **Channel Slope (%):** 1.5 **Sinuosity:** 1.15 **Watershed Area (mi²):** 9.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle- Pool
Median Substrate	Cobble	Cobble
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	37.8
Bankfull Width (ft)	33.2
Max Depth (ft)	2.4
Width/Depth Ratio	22.6
Entrenchment Ratio	4.7
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	R Village Rd	76.0	I, D

\# of Other Constrictions: 0
\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	3	11
2	32	4
3	2	1
4	17	2
5	0	1
6	1	1
7	-	0
#/mile	115	42

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	64
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	56 / Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #64 – Bridge Retrofit/Replacement: Red Village Road
- #65 – Berm Removal

Reach Highlights: Lower banks were scoured out during recent episodic flood events followed by major deposition of cobble and gravel through most of the segment. The segment is moderately incised as the stream cuts down through these deposits. Large mass failures were observed at most bends in the channel, however the mass failures are now mostly protected by large cobble side bars at the toe of slope. Newly constructed cobble berms near the top of the segment are limiting floodplain access and could contribute to further degradation downstream.

Windrowed cobble berm along left bank in upper reach

Large cobble bar and mass failure mid-segment

Stream: Sheldon Brook **Reach:** T4.03B **Town:** Lyndon **Date Assessed:** 6/19/13

Channel Length (ft): 3,083 **Channel Slope (%):** 2.0 **Sinuosity:** 1.1 **Watershed Area (mi²):** 9.6

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle- Pool
Median Substrate	Cobble	Cobble
Stream Type	B_c	B_c

Ph2 Cross-Section Data

Curve Width (ft)	37.8
Bankfull Width (ft)	36.8
Max Depth (ft)	2.2
Width/Depth Ratio	21.0
Entrenchment Ratio	2.0
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	R Village Rd	56	I, D, R/R
A	His Hill Rd	56	I, D

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	13	17
2	36	9
3	2	1
4	27	2
5	0	2
6	1	0
7	-	0
#/mile	135	53

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	51 / Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #66 – Bridge Retrofit/Replacement: Red Village Road
- #67 – Arch Retrofit/Replacement: His Hill Road
- #68 – Bank Stabilization

Reach Highlights: Lower banks were scoured out during recent episodic flood events followed by major deposition of cobble and gravel throughout the segment. The segment appears to be transitioning from degradation to widening with fresh bank erosion visible on many bends as the stream re-establishes planform through the large flood deposits. The segment is moderately incised but does retain access to narrow floodplain benches at high flows.

Major recent deposition throughout reach

Coarse deposition upstream of undersized Red Village Road bridge

Stream: Sheldon Brook	**Reach:** T4.04	**Town:** Lyndon	**Date Assessed:** 6/19/13
Channel Length (ft): 4,700	**Channel Slope (%):** 1.65	**Sinuosity:** 1.2	**Watershed Area (mi^2):** 7.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	V Broad
Bedform	Riffle-Pool	Riffle- Pool
Median Substrate	Cobble	Cobble
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	31.6
Bankfull Width (ft)	33.5
Max Depth (ft)	2.7
Width/Depth Ratio	17.7
Entrenchment Ratio	2.2
Incision Ratio	1.4

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	R Village Rd	60	I, D
B	S Maple Rd	82	I, D, R/R

# of Other Constrictions: 0
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	13	5
2	26	10
3	3	1
4	13	1
5	0	0
6	0	0
7	-	0
#/mile	61	19

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	63 / Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	**Migration**
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #69 – Bridge Retrofit/Replacement: Red Village Rd
- #70 – Buffer Planting
- #71 – Bridge Retrofit/Replacement: Sugar Maple Rd
- #72 – Corridor Protection

Reach Highlights: Majority of the reach has minor to moderate incision with limited widening and bank erosion. Lower reach has a short stretch showing signs of planform adjustments and stage III or IV of channel evolution. This area is likely responding to past channel straightening. There appears to have been an ongoing conflict with adjacent land use due to historical and recent armoring. This area of floodplain stores large volume of sediment and is a good candidate for long-term floodplain/corridor protection.

Armoring and buffer impacts in lower reach

Evidence of recent floodplain access and redeveloping planform in lower reach

Stream: Sheldon Brook **Reach:** T4.2S1.01 **Town:** Lyndon **Date Assessed**: 6/18/13

Channel Length (ft): 1,980 **Channel Slope (%):** 4.84 **Sinuosity:** 1.0 **Watershed Area (mi^2):** 1.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	S Confined	S Confined
Bedform	Step-Pool	Step-Pool
Median Substrate	Cobble	Gravel
Stream Type	B_a	B_a

Ph2 Cross-Section Data

Curve Width (ft)	15.0
Bankfull Width (ft)	14.5
Max Depth (ft)	1.8
Width/Depth Ratio	12.4
Entrenchment Ratio	1.9
Incision Ratio	1.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Sheldon Brook Rd	87	I,AOP,D, E

\# of Other Constrictions: 0
\# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	5	6
2	11	3
3	0	0
4	3	0
5	0	0
6	0	0
7	-	0
#/mile	50	24

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score (%)	53
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	70 / Good
Dominant Adjustment	Stable
CEM Model Stage	F / I
Stream Type Departure	None
Stream Sensitivity	Moderate

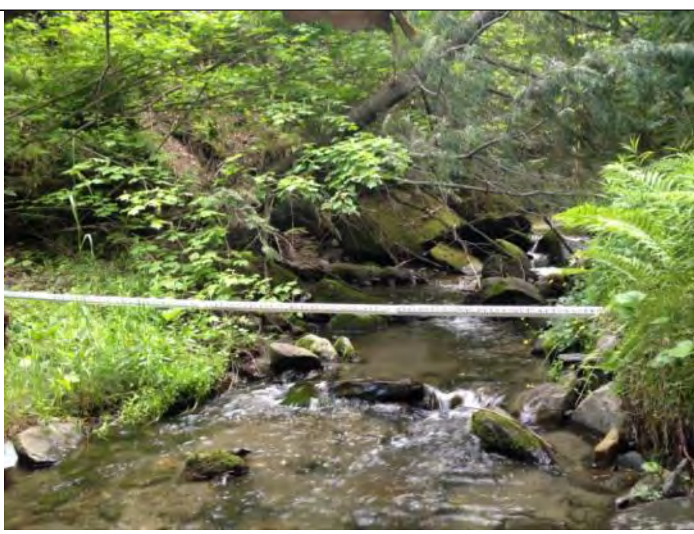
Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #73 – Bridge Retrofit/Replacement: Sheldon Brook Rd

Reach Highlights: This sub-tributary reach is highly variable. Valley confinement is consistent with the exception one small area of unconfined valley upstream of Sheldon Brook Rd. No evidence of significant channel adjustments in reach. No bedrock grade controls but larger substrate in lower reach may control degradation. Minor impacts from adjacent property and armoring along Sheldon Brook Road.


Cross-section in lower reach


Armoring along Sheldon Brook Rd mid reach

4.1.4 Wheelock Brook Summary (Reaches/Segments T5.01-T5.07)

The Phase 2 assessment reaches (T5.01 - T5.07) on Wheelock Brook flow along South Wheelock Road crossing under Interstate 91 before emptying in to the Passumpsic River (Figure 7). The first reach (T5.01) was the most impacted area encountered on the Lower Passumpsic tributaries. The entire reach is straightened, armored, and has a smooth and featureless bed. The lower portion has steep eroded banks and is deeply incised. Upstream the channel flows through a large culvert under Interstate 91 and through a man-made channel along the Interstate exit ramp. This channel was blasted out of the bedrock valley wall during road construction. Three undersized structures are located at the top of the reach. The second reach flows through a wide floodplain that is largely inaccessible due to deep incision. Incision is likely caused by historic armoring and increased due to bed scour during the 2011 floods. T5.03 is also deeply incised, primarily due to encroachment from South Wheelock Road limiting planform adjustment and widening. Encroachment and armoring are less severe for reaches T5.04 and T5.05A, and both reaches show signs of channel widening. T5.04 and T5.05A are moderately incised and the channel is slowly cutting new riffle/pool features that were buried in gravel and cobble deposits during the 2011 floods. The presence of an accessible forested floodplain within the narrow valley for T5.05B reduced bed scour during the 2011 floods and the stream is widening and transitioning to stage IV of channel evolution. T5.06 is incised but is stable due to numerous grade controls throughout the reach. T5.07 also has numerous grade controls and widened significantly due to reduced woody bank vegetation.

The impacts of the 2011 flooding were less apparent along Wheelock Brook. The large number of grade control features likely played an important role in reducing channel scour. Most of the reaches were incised due to encroachment and bank armoring, however floodplain was accessible during larger events for much of the study reaches. All flood water and sediment attenuation has been removed from T5.01, however significant floodplain area could be restored in T5.02 to reduce sediment and flow impacts to the Passumpsic River. Numerous undersized bridges were surveyed along Wheelock Brook, many of these structures had significant upstream sediment deposits and may represent potential flood hazards in the future.

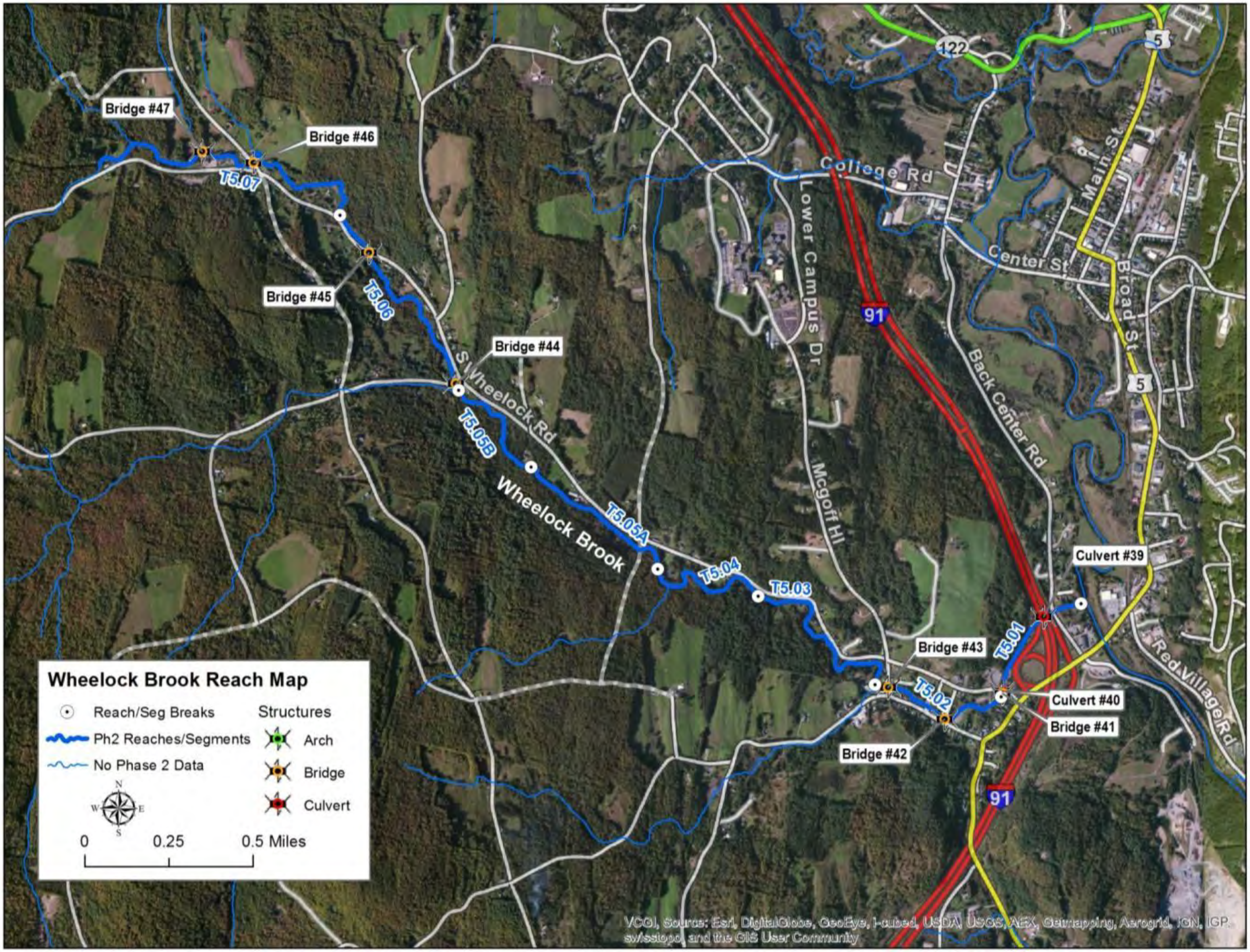


Figure 7: Wheelock Brook reach map with crossing structures.

Stream: Wheelock Brook	**Reach:** T5.01	**Town:** Lyndon	**Date Assessed:** 6/19/13
Channel Length (ft): 2,101	**Channel Slope (%):** 0.47	**Sinuosity:** 1.05	**Watershed Area (mi^2):** 17.1

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	V Broad	N Confined
Bedform	Plane-Bed	Plane-Bed
Median Substrate	Gravel	Gravel
Stream Type	F	F

Ph2 Cross-Section Data

Curve Width (ft)	45.7
Bankfull Width (ft)	28.5
Max Depth (ft)	3.6
Width/Depth Ratio	10.1
Entrenchment Ratio	1.7
Incision Ratio	1.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
C	I-91	65	I, AOP
C	S Wheelock	65	I,AOP,D, R/R
B	Schoolhouse	70	I,D

# of Other Constrictions: 1
# of Grade Controls: 0

Rapid Habitat Assessment

Rank	LWD	Pools
1	12	5
2	0	1
3	0	3
4	0	0
5	0	0
6	0	0
7	-	0
#/mile	30	22

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	34
Habitat Type Departure	RP->PB
Habitat Condition	Poor
RGA Score / Condition	44 / Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	C -> F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	**Stormwater**
Armoring	**Constrictions**
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #74 – Buffer Planting

Reach Highlights: Nearly entire reach is straightened and deeply entrenched. Lower reach (below highway) is against the left valley wall, and the right bank is armored and approximately 6ft above bankfull. The upper reach is a channel that was blasted out during highway construction lined with steep bedrock on both sides. Channel geometry indicates a slight left floodplain bench and entrenchment is 1.7, however, this reach is significantly narrowed and has no true floodplain access. Therefore we assessed this as an F-type channel (existing and modified reference type).

Schoolhouse covered bridge and South Wheelock Rd culvert in upper reach

Straightened reach through blasted bedrock flowing towards the I-91 culvert

Stream: Wheelock Brook	**Reach:** T5.02	**Town:** Lyndon	**Date Assessed:** 6/20/13
Channel Length (ft): 2,341	**Channel Slope (%):** 1.53	**Sinuosity:** 1.08	**Watershed Area (mi^2):** 17.0

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Broad	Broad
Bedform	Riffle-Pool	Plane Bed/Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	F

Ph2 Cross-Section Data

Curve Width (ft)	45.5
Bankfull Width (ft)	37.0
Max Depth (ft)	2.8
Width/Depth Ratio	16.4
Entrenchment Ratio	1.4
Incision Ratio	2.2

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Cross	55	D, E, I, S, R/R
B	Chamberlain	131	S, R/R

\# of Other Constrictions: 1
\# of Grade Controls: 2

Rapid Habitat Assessment

Rank	LWD	Pools
1	20	10
2	10	2
3	0	3
4	0	0
5	3	0
6	0	0
7	-	0
#/mile	74	34

Number of Debris Jams: 0

Step 6/7 Summary

RHA Score (%)	42
Habitat Type Departure	Plane Bed
Habitat Condition	Fair
RGA Score / Condition	43 / Fair
Dominant Adjustment	Degradation
CEM Model Stage	F / II
Stream Type Departure	C -> F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	**Stormwater**
Armoring	**Constrictions**
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	**Dredging**

Potential Projects in Reach

- #75 – Floodplain Restoration in lower reach
- #76 – Floodplain Restoration: Remove abandoned bridge abutment

Reach Highlights: Reach is highly incised and entrenched due to ongoing channel degradation likely caused by historic armoring and encroachment along agricultural fields, development, and York Street. Elevated floodplain is present on one or both banks throughout the reach, but is likely only accessible during the largest flood events. A large bedrock cascade is located at the top of the reach and flows under the historic Chamberlain Covered Bridge.

Right bank development and plane bed bedform mid-reach

Bedrock cascade and Chamberlain Covered Bridge at top of reach

Stream: Wheelock Brook	**Reach:** T5.03	**Town:** Lyndon	**Date Assessed:** 6/20/13
Channel Length (ft): 3,303	**Channel Slope (%):** 1.17	**Sinuosity:** 1.16	**Watershed Area (mi^2):** 15.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	S Confined	S Confined
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	B_c	F

Ph2 Cross-Section Data

Curve Width (ft)	44.1
Bankfull Width (ft)	50.0
Max Depth (ft)	2.9
Width/Depth Ratio	25.0
Entrenchment Ratio	1.2
Incision Ratio	2.0

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 1
\# of Grade Controls: 2

Rapid Habitat Assessment

Rank	LWD	Pools
1	17	14
2	22	6
3	2	9
4	15	2
5	0	2
6	0	1
7	-	0
#/mile	89	54

Number of Debris Jams: 1

Step 6/7 Summary

RHA Score (%)	55
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	54/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	B -> F
Stream Sensitivity	Extreme

Impact Summary

Bank Erosion	**Stormwater**
Armoring	Constrictions
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- None

Reach Highlights: Incision is transitioning to widening as the dominant process in this reach due to historic and likely recent downcutting during flood events leading to a B->F stream type departure. Some widening and aggradation was observed throughout the reach in areas of bank failure. We selected a B reference stream type due to natural valley confinement.


Encroachment and armoring along South Wheelock Road


Typical reach geometry with steep banks to elevated and inaccessible floodplain, MF visible on RB

Stream: Wheelock Brook **Reach:** T5.04 **Town:** Lyndon **Date Assessed**: 6/20/13

Channel Length (ft): 2,324 **Channel Slope (%):** 0.65 **Sinuosity:** 1.29 **Watershed Area (mi^2):** 15.4

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	43.6
Bankfull Width (ft)	42.0
Max Depth (ft)	2.8
Width/Depth Ratio	17.9
Entrenchment Ratio	2.0
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

# of Other Constrictions: 1
# of Grade Controls: 3

Rapid Habitat Assessment

Rank	LWD	Pools
1	22	10
2	45	3
3	6	4
4	21	0
5	0	0
6	0	1
7	-	0
#/mile	213	40

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score (%)	66
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	69/Good
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

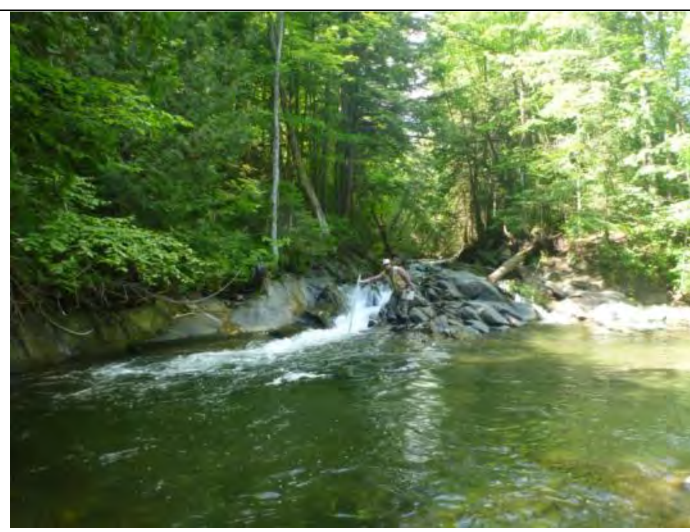
Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #77 – Obstruction Removal

Reach Highlights: Channel was typically incised but retained access to floodplain on one or both banks for larger events. Some evidence of recent widening through bank scour, however banks appear to be stable. Well vegetated and naturally armored banks (stony soils) are likely limiting widening processes and leading to moderate incision. Reach is likely transitioning to stage III after flood-related sediment deposits work through reach and downstream.


Failed cable bridge causing an unstable debris jam


Start of bedrock gorge at top of reach

Stream: Wheelock Brook **Reach:** T5.05A **Town:** Lyndon **Date Assessed:** 6/25/13

Channel Length (ft): 2,756 **Channel Slope (%):** 1.0 **Sinuosity:** 1.06 **Watershed Area (mi^2):** 14.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool / Plane Bed
Median Substrate	Cobble	Gravel
Stream Type	B_c	B_c

Ph2 Cross-Section Data

Curve Width (ft)	42.8
Bankfull Width (ft)	39.0
Max Depth (ft)	3.4
Width/Depth Ratio	18.1
Entrenchment Ratio	1.3
Incision Ratio	1.4

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 1
\# of Grade Controls: 6

Rapid Habitat Assessment

Rank	LWD	Pools
1	17	9
2	19	5
3	5	5
4	5	2
5	0	0
6	0	1
7	-	0
#/mile	88	42

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score (%)	59
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	57/Fair
Dominant Adjustment	Degrading
CEM Model Stage	F / II
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #78 – Buffer Planting along recently cleared building site

Reach Highlights: Incision is the dominant adjustment process following recent flood events. Channel was scoured out removing most bed features. These features are starting to reform as sediment moves out of the channel and is deposited along the margins. Bedrock grade controls limit the severity of channel incision. A large stretch of the right floodplain was recently cleared and appears to be a potential building site. Deposits of gravel from recent flooding appear to be working through the reach.


Failed cable bridge causing an unstable debris jam


Start of bedrock gorge at top of reach

Stream: Wheelock Brook **Reach:** T5.05B **Town:** Lyndon **Date Assessed:** 6/25/13

Channel Length (ft): 1,963 **Channel Slope (%):** 0.9 **Sinuosity:** 1.06 **Watershed Area (mi^2):** 14.7

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Gravel
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	42.8
Bankfull Width (ft)	44.2
Max Depth (ft)	2.7
Width/Depth Ratio	22.1
Entrenchment Ratio	4.5
Incision Ratio	1.5

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
None in reach.			

\# of Other Constrictions: 0

\# of Grade Controls: 1

Rapid Habitat Assessment

Rank	LWD	Pools
1	3	5
2	21	3
3	1	4
4	3	1
5	0	0
6	0	0
7	-	0
#/mile	75	34

Number of Debris Jams: 2

Step 6/7 Summary

RHA Score (%)	67
Habitat Type Departure	None
Habitat Condition	Good
RGA Score / Condition	65/Good
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

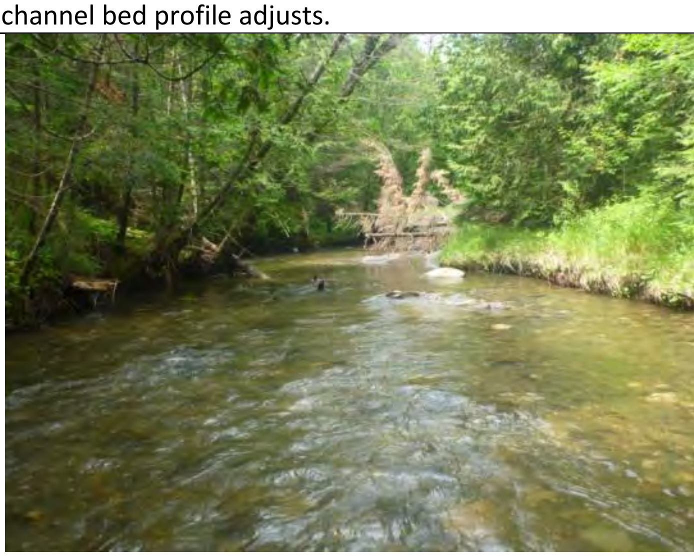
Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #79 – Buffer Planting along left bank lawn to bank
- #80 – Corridor Protection

Reach Highlights: Channel adjustments were variable throughout the segment. Recent minor widening followed by aggradation are likely the dominant processes with evidence of lower bank scour from recent episodic flooding events. Some bed features were also likely scoured during these events reducing the number and size of bed features. Recent depositional features along the channel margins indicate that the channel is beginning to aggrade and reestablish lower bank features, possibly transitioning to stage IV after flood sediments work through and channel bed profile adjusts.



Typical channel geometry for segment

Large forested floodplain on right bank at cross-section

Stream: Wheelock Brook **Reach:** T5.06 **Town:** Lyndon **Date Assessed:** 6/25/13

Channel Length (ft): 3,648 **Channel Slope (%):** 1.12 **Sinuosity:** 1.05 **Watershed Area (mi^2):** 12.3

Stream Type Summary

	P1 Reference	P2 Assessed
Confinement	Narrow	Narrow
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Gravel	Gravel
Stream Type	B_c	B_c

Ph2 Cross-Section Data

Curve Width (ft)	39.5
Bankfull Width (ft)	34.5
Max Depth (ft)	2.9
Width/Depth Ratio	15.3
Entrenchment Ratio	2.0
Incision Ratio	1.7

Crossing/Constriction Summary

Type	Location	% wbkf	Impacts
B	Cold Hill	63	I, E, R/R
B	S Wheelock	43	I, D, R/R

\# of Other Constrictions: 1
\# of Grade Controls: 5

Rapid Habitat Assessment

Rank	LWD	Pools
1	33	10
2	38	3
3	13	2
4	10	1
5	1	2
6	0	1
7	-	0
#/mile	137	27

Number of Debris Jams: 3

Step 6/7 Summary

RHA Score (%)	64
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	63/Fair
Dominant Adjustment	Aggradation
CEM Model Stage	F / IV
Stream Type Departure	None
Stream Sensitivity	Very High

Impact Summary

Bank Erosion	Stormwater
Armoring	Constrictions
Riparian Buffer	Deposition
Encroachment	Migration
Development	Steep Riffle
Corridor LC	Head Cut
Mass Failure	Straightening
Flow Regulation	Dredging

Potential Projects in Reach

- #81 – Bridge Replacement/Retrofit: Cold Hill Rd
- #82 – Bridge Replacement/Retrofit: South Wheelock Rd
- #83 – Stormwater Management: Sediment and runoff from Couture Flats Rd

Reach Highlights: Numerous bedrock grade controls were present in the reach. Riffles between these grade controls were sedimented (with coarse sediment) and poorly formed. Coarse sediment stored above the bedrock features resulted in long poorly formed riffles for most of the reach. Large and deep pools were found below the grade controls and aggradation of fine sediment was limited through most of the reach. Degradation is likely historic given limited bank erosion. Aggradation appears to be the dominant process. Stage IV CEM was selected for the reach.


Typical channel geometry for reach


Undersized bridge at South Wheelock Road

Stream: Wheelock Brook **Reach:** T5.07 **Town:** Lyndon **Date Assessed:** 7/16/13

Channel Length (ft): 5,403 **Channel Slope (%):** 1.67 **Sinuosity:** 1.24 **Watershed Area (mi^2):** 11.7

Stream Type Summary

	P1 Reference	**P2 Assessed**
Confinement	Broad	Broad
Bedform	Riffle-Pool	Riffle-Pool
Median Substrate	Cobble	Cobble
Stream Type	C	C

Ph2 Cross-Section Data

Curve Width (ft)	38.7
Bankfull Width (ft)	47.0
Max Depth (ft)	2.6
Width/Depth Ratio	29.4
Entrenchment Ratio	3.8
Incision Ratio	1.6

Crossing/Constriction Summary

Type	**Location**	**% wbkf**	**Impacts**
B	Fall Bk Rd	67	I,D, R/R
B	Private footbridge	103	None

# of Other Constrictions: 1
# of Grade Controls: 8

Rapid Habitat Assessment

Rank	**LWD**	**Pools**
1	32	12
2	44	5
3	5	4
4	29	0
5	0	4
6	1	5
7	-	0
#/mile	108	29

Number of Debris Jams: 4

Step 6/7 Summary

RHA Score (%)	54
Habitat Type Departure	None
Habitat Condition	Fair
RGA Score / Condition	47/Fair
Dominant Adjustment	Widening
CEM Model Stage	F / III
Stream Type Departure	None
Stream Sensitivity	High

Impact Summary

Bank Erosion	Stormwater
Armoring	**Constrictions**
Riparian Buffer	**Deposition**
Encroachment	Migration
Development	**Steep Riffle**
Corridor LC	Head Cut
Mass Failure	**Straightening**
Flow Regulation	Dredging

Potential Projects in Reach

- #84 – Bridge Retrofit/Replacement: Fall Brook Rd
- #85 – Corridor Protection and Buffer Planting

Reach Highlights: Widening from a recent episodic flooding event is the dominant process in this reach. The lower reach contains numerous large bedrock cascades and indicated some widening through scoured lower banks. The upper reach had several locations with major widening. Several large diagonal bars and mid channel bars were observed in the upper reach.

Buffer impacts and straightening mid-reach

Evidence of major widening during recent floods in the upper reach

4.2 Phase 2 Results Summary

RHA and RGA scores for all Phase 2 reaches/segments are summarized in Table7. Detailed summaries of geomorphic data for each segment are provided in Appendix B. Habitat assessment summary data is provided in Appendix C.

Table 7: Summary RHA and RGA data for all Phase 2 Reaches and Segments

Stream Name	Reach/Segment	RHA Score	RHA Condition	RGA Score	RGA Condition
Water Andric	T2.07	60%	Fair	50%	Fair
	T2.08A	61%	Fair	54%	Fair
	T2.08B	66%	Good	52%	Fair
	T2.09	67%	Good	46%	Fair
	T2.10	59%	Fair	45%	Fair
	T2.11A	66%	Good	59%	Fair
	T2.11B	66%	Good	59%	Fair
	T2.12B	51%	Fair	51%	Fair
	T2.12A	53%	Fair	49%	Fair
Sleepers River	T3.04	35%	Fair	44%	Fair
	T3.05	49%	Fair	56%	Fair
	T3.06	46%	Fair	43%	Fair
	T3.07	51%	Fair	40%	Fair
	T3.08	48%	Fair	49%	Fair
	T3.09	54%	Fair	46%	Fair
	T3.10	42%	Fair	32%	Poor
	T3.11	65%	Good	70%	Good
Badger Brook	T3.10S1.01	52%	Fair	34%	Poor
	T3.10S1.02*		Poor		Fair
	T3.10S1.03	59%	Fair	59%	Fair
Whiteman Brook	T3.7S1.01A	65%	Good	49%	Fair
	T3.7S1.01B	51%	Fair	46%	Fair
	T3.7S1.02	66%	Good	57%	Fair
	T3.7S1.03	69%	Good	75%	Good
	T3.7S1.04	66%	Good	60%	Fair
	T3.7S1.05	61%	Fair	35%	Fair
	T3.7S1.06A	47%	Fair	52%	Fair
	T3.7S1.06B	51%	Fair	44%	Fair
	T3.7S1.07	63%	Fair	45%	Fair
Sheldon Brook	T4.01	57%	Fair	60%	Fair
	T4.02	66%	Good	65%	Good
	T4.03A	64%	Fair	56%	Fair
	T4.03B	66%	Good	51%	Fair
	T4.04	66%	Good	63%	Fair
South Branch Sheldon Brook	T4.2S1.01	53%	Fair	70%	Good

Table 7: Summary RHA and RGA data for all Phase 2 Reaches and Segments

Stream Name	Reach/Segment	RHA Score	RHA Condition	RGA Score	RGA Condition
Wheelock Brook	T5.01	34%	Poor	44%	Fair
	T5.02	42%	Fair	54%	Fair
	T5.03	55%	Fair	54%	Fair
	T5.04	66%	Good	69%	Good
	T5.05A	59%	Fair	57%	Fair
	T5.05B	67%	Good	65%	Good
	T5.06	64%	Fair	63%	Fair
	T5.07	54%	Fair	59%	Fair

*RHA and RGA assigned based on administrative judgment, full assessments not conducted on T3.10S1.02

4.3 River Corridor Planning

The following sections summarize the stressor identification and departure maps. The mapping of physical stressors and natural or human constraints allowed for 1) a process-based approach to understanding stream conditions at different scales, and 2) an evaluation of the connectivity of stressors along the channel network. The maps were referenced during the project identification process summarized in Section 5.0.

4.3.1 Stressor Maps

Sediment Supply and Transport

The following description of the sediment regime of a river, and the general response to watershed-scale land use changes and stressors is included from the most recent version of the VTANR River Corridor Planning Guide (VTANR, 2010).

> The sediment regime may be defined as the quantity, size, transport, sorting, and distribution of sediments. The sediment regime may be influenced by the proximity of sediment sources, the hydrologic regime, and valley, floodplain and stream morphology. Understanding changes in sediment regime at the reach and watershed scales is critical to the evaluation of stream adjustments and sensitivity. The sediment erosion and deposition patterns, unique to the equilibrium conditions of a stream reach, create habitat. In all but the most dynamic areas (e.g., alluvial fans), they provide for relatively stable bed forms and bank conditions.

Summaries of agricultural area in the watersheds are provided in Sections 2.1 and 4.4 of the Phase 1 report. Agricultural land use ranged from 7% to 59% within the Phase 2 subwatersheds; however most of these areas were hayfields and were typically not located immediately adjacent to the channel. Sediment contributions from mass failures are likely far more important as current day stressors to sediment regime. Four classes of mass failure density were mapped to depict the degree of sediment supply. Sediment transport modifiers were also mapped, including grade controls, debris jam density, and structures classified by percent of bankfull width (Figure 12).

Areas impacted by high sediment load and transport stressors include:

Increases in sediment supply

- Large gullies: T2.07 (see Figure 8) and T4.02
- Extreme mass failure density: T2.08B, T2.10, T2.11B, T3.06, T3.09, T3.10, T3.10S1.01, T3.10S1.03, T3.7S1.01A, T3.7S1.01B, T3.7S1.02, T3.7S1.05, T4.02, T4.03B (see Figure 9), T4.2S1.01, and T5.05B

Sediment Transport Modifiers

- Extreme debris jam density: All Water Andric Segments (9 segments), T3.09, T3.10, T3.10S1.01, T3.10S1.03, All Whiteman Brook segments except T3.7S1.06A (8 segments), T4.02, T4.03, T4.2S1.01, and T5.05 (Figure 10)
- Large grade controls:
    - Ledge: T3.05, T3.06, T3.10S1.03, and T5.07
    - Man-made: T3.08, T3.09, T3.10, T3.11, T3.7S1.01B, and T3.10S1.02
- Extreme undersized structures: T2.09, T3.7S1.01A, T3.7S1.06B (Figure 11), T3.7S1.07, and T5.06

Figure 8: Large gully on Water Andric Reach T2.07.

Figure 9: Large mass failure on Sheldon Brook Segment T4.03B.

Figure 10: Sediment retention above a large debris jam on Whiteman Brook segment T3.7S1.01B.

Figure 11: Extremely undersized stone culvert (left) leading to deep deposition of fine material and channel instability (right) on Whiteman Brook segment T3.7S1.06B.

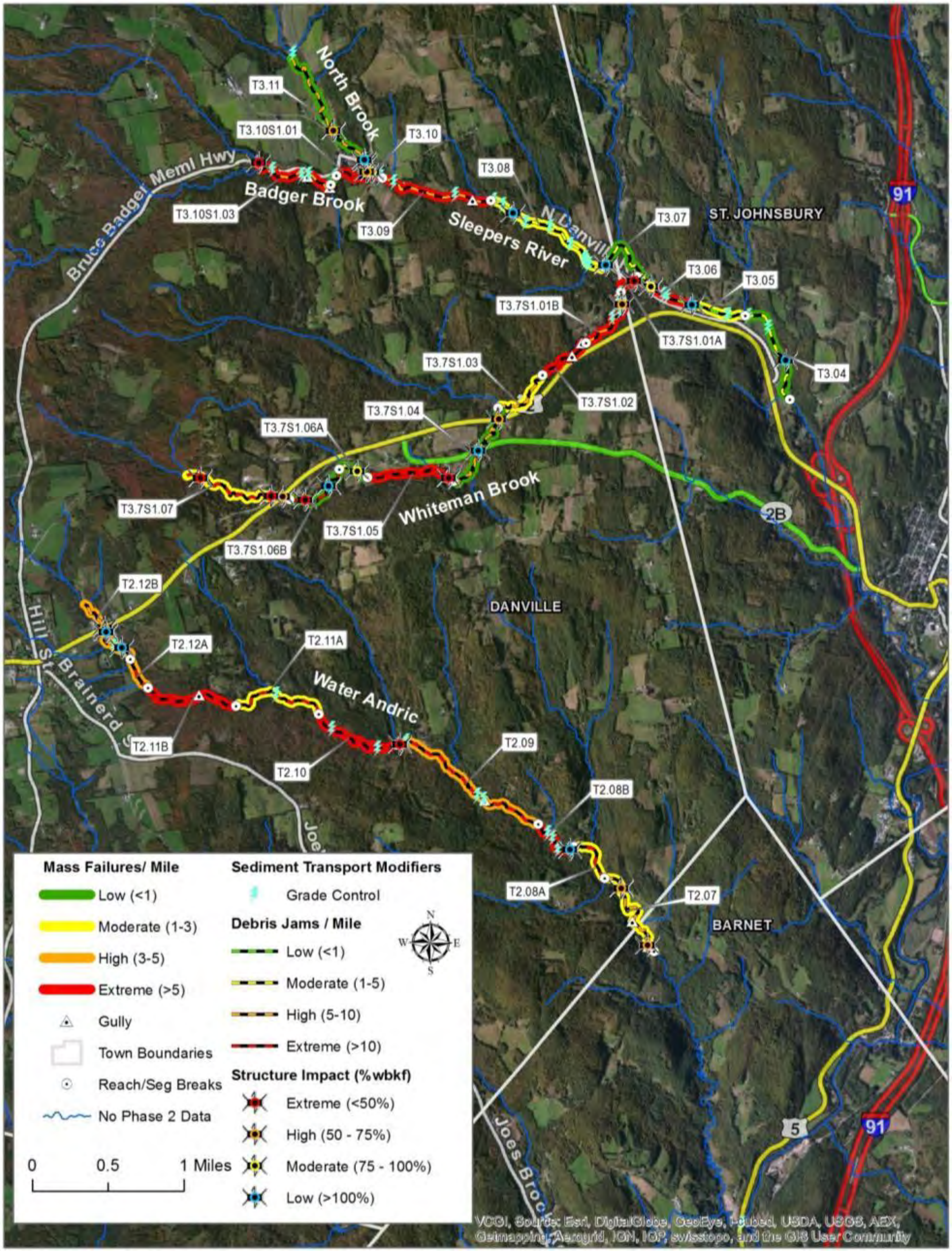


Figure 12a: Sediment supply and transport modifiers for Water Andric, Sleepers River, Badger Brook, and Whiteman Brook.

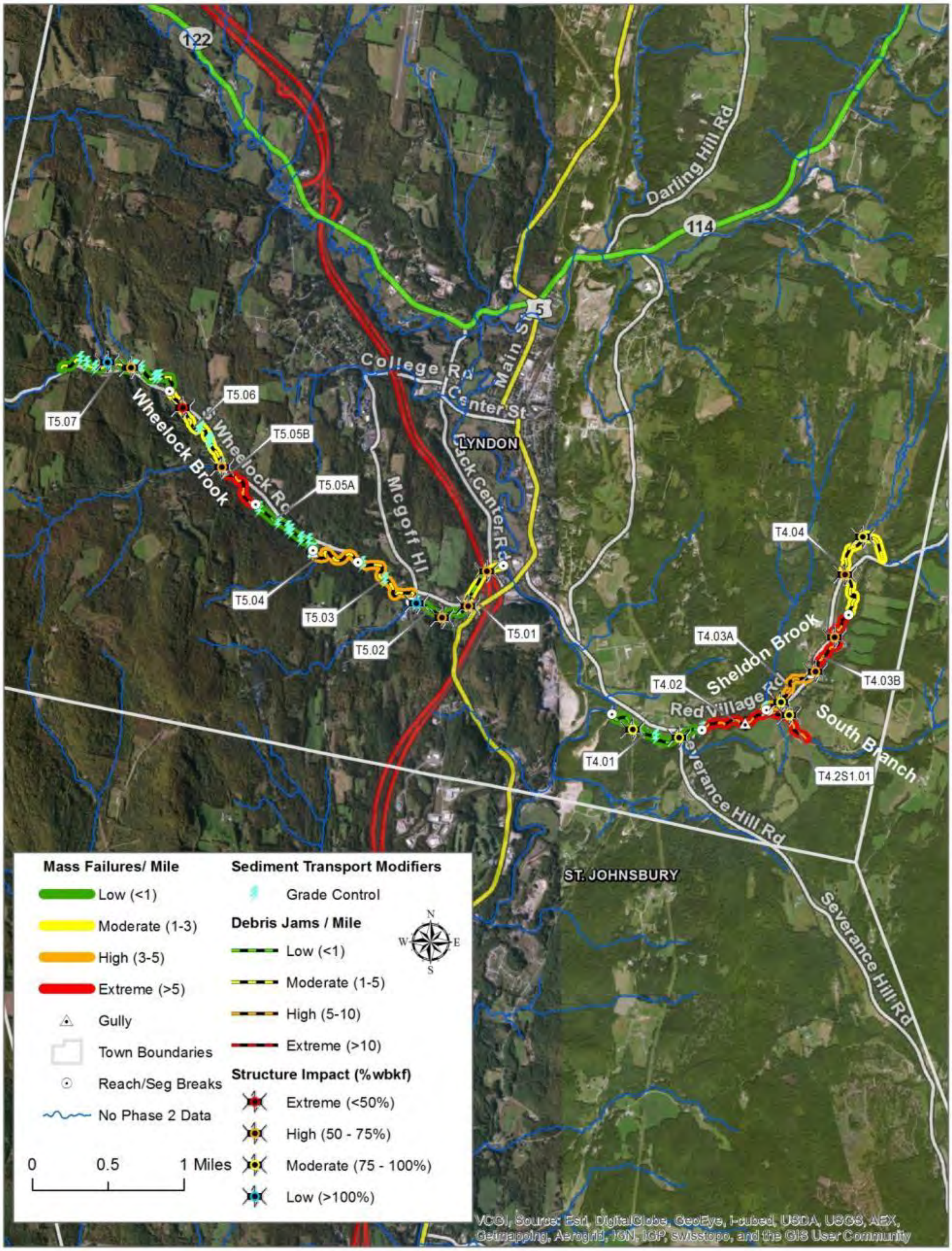


Figure 12b: Sediment supply and transport modifiers for Sheldon Brook, South Branch Sheldon Brook, and Wheelock Brook.

Channel Slope and Depth Modifiers

Many of Vermont's rivers and streams have been historically manipulated and straightened to maintain an unnaturally steep slope, allowing for a short term sense of security from flooding and subsequent encroachment of infrastructure in the floodplain. Over time, many alluvial rivers will seek to redevelop a sinuous planform through the deposition of sediments in unconfined valleys. Following flood events when alluvial rivers become energized enough to transport large amounts of coarse sediment into depositional zones of the watershed, lateral channel migration intensifies and further channel straightening is required to protect infrastructure found in the floodplain. In larger alluvial rivers of Vermont, straightening and channelization typically ranges between 25 and 75 percent of the total river channel length in Vermont (VTANR, 2010).

In addition to historic alterations to channel slope in Vermont's alluvial rivers, the lowering of stream beds (e.g., dredging) and the raising of floodplains (e.g., encroachments) have resulted in an increase in channel depth (VTANR, 2010). Channel depths have typically been increased through the encroachment on the floodplain by roads and railroads and subsequent filling and armoring required to construct and maintain this infrastructure. Increases in impervious cover have also led to the deepening and eventual widening of channels throughout urbanized areas of Vermont (Fitzgerald, 2007).

Alterations to channel slope and depth in the Lower Passumpsic River tributaries study area have been mapped using the variables extracted from the Phase 2 field dataset (Figure 17). Areas of channel straightening mapped during the Phase 1 and 2 assessments are included to depict areas of increased channel slope. Corridor encroachment data highlights where roads and development have reduced the floodplain area, typically resulting in increased stream power and channel deepening. Additional data showing the location of natural channel features (ledges) and man-made features including dams, weirs, and bed armoring sites which depict areas that have a resistance to vertical channel change. Numerous decommissioned USGS monitoring weirs were observed in the Sleepers River mainstem and tributary segments, as described in Section 2.3 of the Phase 1 report. These weirs were constructed on existing natural ledge grade controls, but each weir added several feet of vertical grade control above the ledge.

Areas impacted by increases in slope and depth or influenced by controls on slope and depth include:

Increases in Slope and Depth

- Extreme channel straightening in segments : T3.04, T3.06, T4.01, and T5.01
- High straightening in segments: T3.05, T3.07, T3.7S1.02, T3.7S1.06A, T4.04
- Extensive corridor encroachments from adjacent roadways and embankments in segments: All of Water Andric except T2.11B and T2.12B (7 segments), All of Sleepers River except T3.11 (7 segments), T3.10S1.03, T3.7S1.01A, T3.7S1.01B, T3.7S1.03, T4.02, T4.03, All of Wheelock Brook except T5.02 (6 segments) (Figure 16)
- Dredging in segments: T3.06, T3.10, T4.01, and T5.02

Controls on Slope and Depth

- Segments with numerous or large natural grade controls: T2.08B, T3.05, T3.06, T3.08, T3.10S1.03, T5.02, T5.05A, T5.06, and T5.07 (Figure 13)
- Segments with man-made grade controls (Figures 14 & 15)
    - Weirs: T2.12B, T3.08, T3.11, T3.10S1.02, T3.7S1.01B
    - Dam: T3.10
    - Bed Armoring: T2.09, T3.08, T3.09, T3.10S1.03

Figure 13: Large ledge grade control halting the progression of incision from T3.04 upstream to T3.05 on Sleepers River.

Figure 14: Bed armoring site on Sleepers River reach T3.08.

Figure 15: USGS weir on Whiteman Brook segment T3.7S1.01B.

Figure 16: Encroachment on Sheldon Brook reach T4.02.

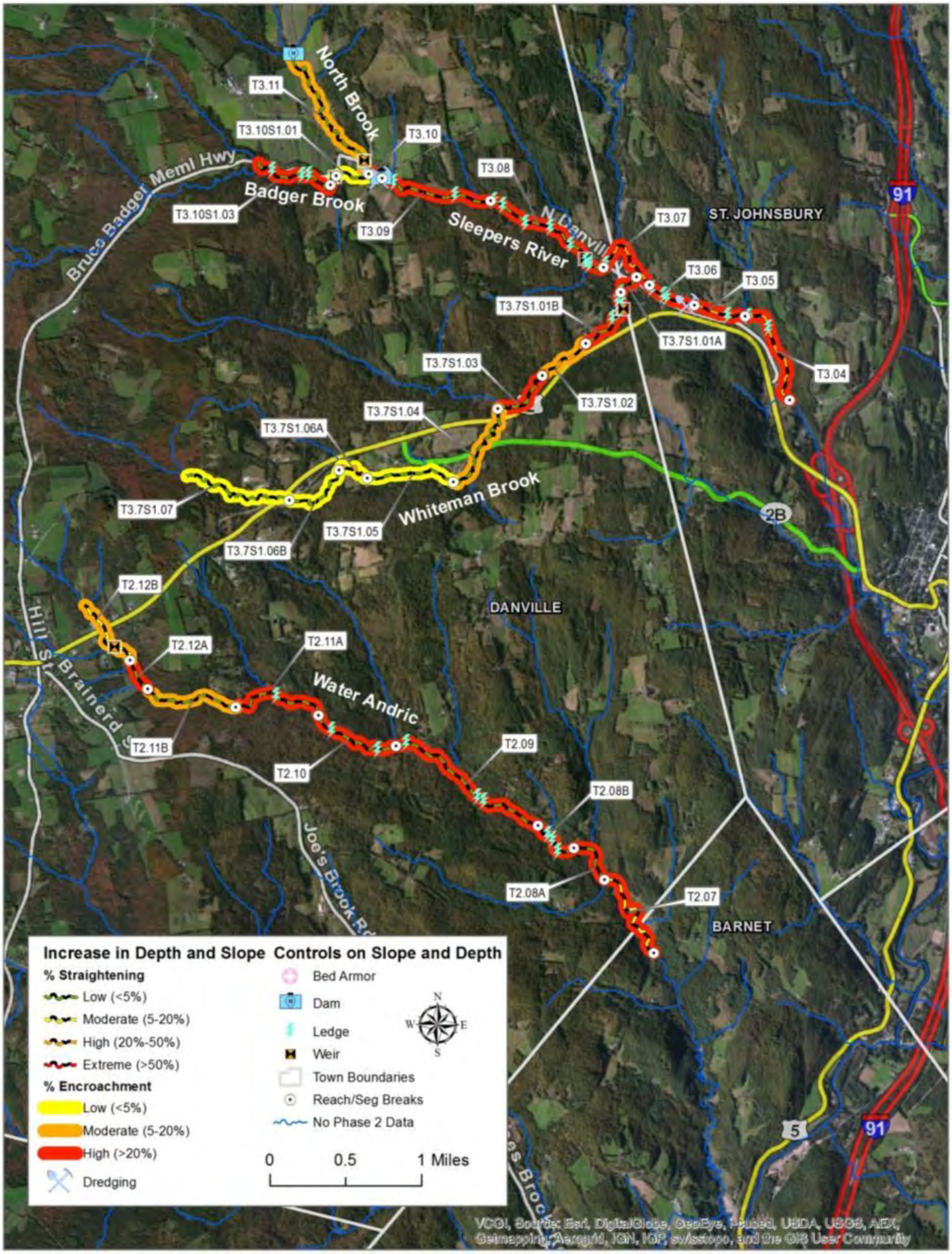


Figure 17a: Controls on slope and depth for Water Andric, Sleepers River, Badger Brook, and Whiteman Brook.

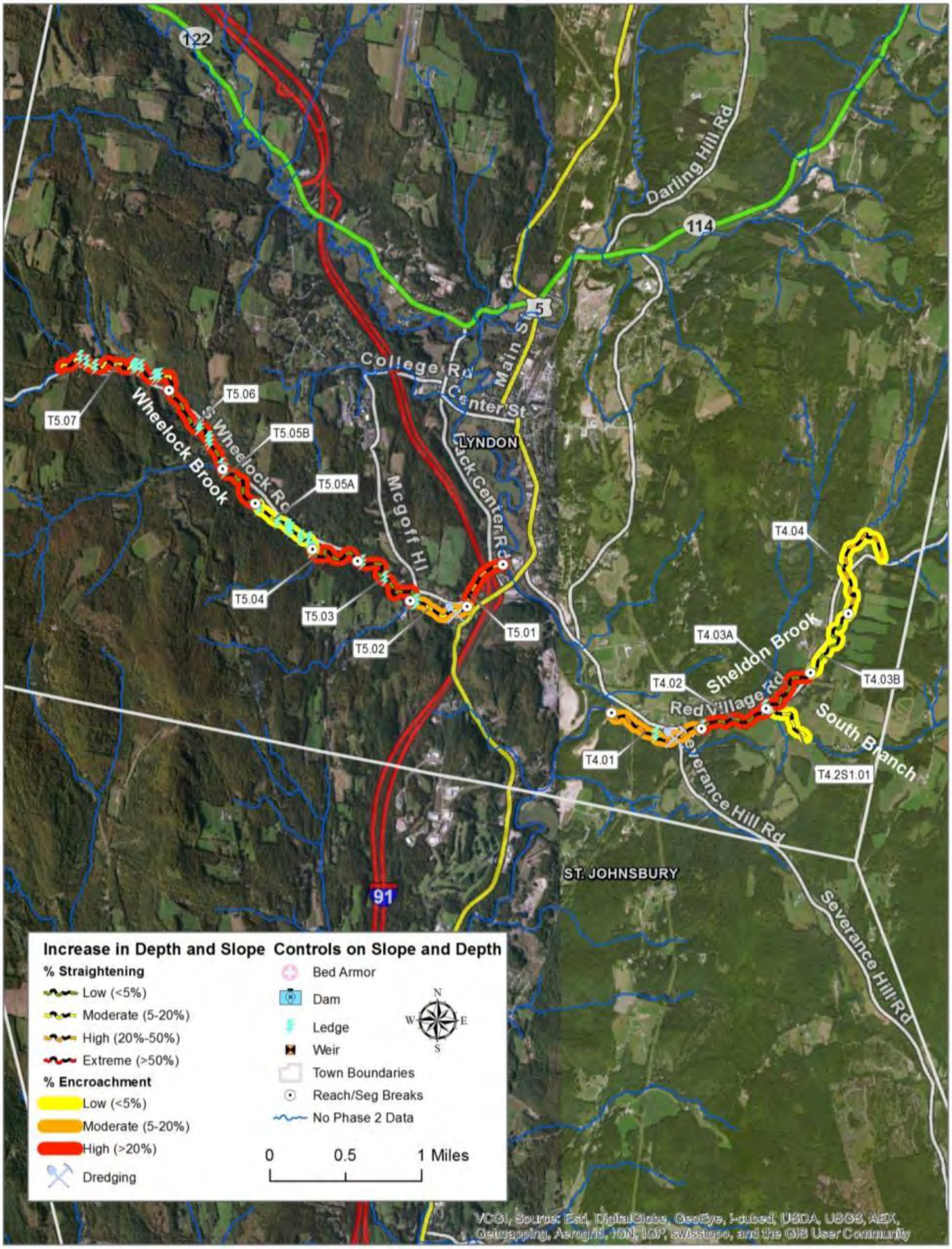


Figure 17b: Controls on slope and depth for Sheldon Brook, South Branch Sheldon Brook, and Wheelock Brook.

4.3.2 Departure Analysis

The reference and existing sediment regime types have been mapped using data from the Phase 1 and 2 assessments (Figures 18 and 19). Several segments in the Passumpsic River tributary watersheds have undergone a departure in both sediment regime and stream type due to channel incision and/or widening as a result of: 1) historical land uses, 2) encroachments or development in the river corridor, or 3) extensive straightening and bank armoring. Many of the channel adjustments caused by these historic stressors were exacerbated by the extreme flood events of 2011, leading to further stream type departures. In some instances, the 2011 floods triggered severe channel adjustments even in reaches with limited corridor impacts. These reaches, such as Water Andric T2.09 and T2.10, tended to be on moderate gradient, 3rd order channels lacking natural grade controls such as bedrock ledges. Six of the Phase 2 study reaches/segments were stable and did not contain a stream type of or sediment regime departure (T2.08A, T3.07, T3.11, T3.7S1.03, T4.02, and T4.2S1.01).

Stream type departures (per Rosgen, 1994) are summarized below (Table 8) to better describe the reaches where physical changes in channel morphology have accompanied sediment regime changes.

Table 8: Summary of stream type departures from reference conditions.

Surface Water	Phase 2 Segment ID	Stream Type Departure	Dominant Adjustment Type
Water Andric	T2.08B	B to F	Recent Incision and Corridor Encroachment
	T2.09	C to B	Recent Incision
	T2.10	B to F	Recent Incision
	T2.12A	B to F	Recent Incision
	T2.12B	C to B	Recent Incision and Historic Constriction
Sleepers River	T3.04	C to F	Historic Straightening and Incision
	T3.06	B to F	Historic Straightening, Encroachment, and Incision
	T3.10	B to F	Historic Dam, Encroachment, Incision
Badger Brook	T3.10S1.01	B to F	Recent Incision; Historic Impacts from USGS Weir
Whiteman Brook	T3.7S1.05	B to F	Recent Widening and Incision
	T3.7S1.06A	C to E	Historic Straightening and Incision
	T3.7S1.07	C to B	Recent Incision; Historic Constrictions
Wheelock Brook	T5.01	C to F	Historic Straightening and Encroachment
	T5.02	C to F	Armoring and Historic Incision, Encroachment
	T5.03	B to F	Recent Incision; Historic Encroachment

In addition to the above-described stream type departures and the associated sediment regime departures, several reaches/segments of the Passumpsic River tributaries have undergone departures in sediment regimes in the absence of stream type departures. All sediment regime departures are summarized below in Table 9.

Table 9: Summary of Sediment Regime Departures.

Surface Water	Phase 2 Segment ID	Reference Sediment Regime	Existing Sediment Regime	Cause of Departure
Water Andric	T2.07	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision from straightening and armoring, recent widening during floods
	T2.08B	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active incision and major coarse deposition from recent floods; historic and ongoing road encroachment
	T2.09	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active incision and major coarse deposition from recent floods, slowly transitioning to widening
	T2.10	Transport	Confined Source and Transport	Active incision through coarse deposits from recent floods
	T2.11A	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active widening and major fine/coarse deposition from recent floods
	T2.11B	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active widening and deposition of coarse material
	T2.12A	Transport	Confined Source and Transport	Incision during recent floods, active widening and deposition of coarse material
	T2.12B	Coarse Equilibrium and Fine Deposition	Fine Source Transport and Coarse Deposition	Incision during recent floods, some evidence of active widening
Sleepers River	T3.04	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Major historic incision from channel manipulation, evidence of minor recent widening
	T3.05	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active widening and coarse deposition
	T3.08	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active incision with future widening likely
	T3.09	Transport	Confined Source and Transport	Active widening and major deposition and mass failure
	T3.10	Transport	Confined Source and Transport	Active degradation and widening through the major deposits of fine material held by the dam
Badger Brook	T3.10S1.01	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Incision that is likely historic and from recent floods, active widening with mass failures

Table 9: Summary of Sediment Regime Departures.

Surface Water	Phase 2 Segment ID	Reference Sediment Regime	Existing Sediment Regime	Cause of Departure
	T3.10S1.03	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Recent widening with numerous mass failures
Whiteman Brook	T3.7S1.01B	Transport	Confined Source and Transport	Major deposition from recent flooding, active widening with mass failures
	T3.7S1.02	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Major deposition during recent flooding, active incision and widening through deposited materials
	T3.7S1.04	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision with minor active widening
	T3.7S1.05	Transport	Fine Source and Transport and Coarse Deposition	Recent widening and deposition from floods, active incision
	T3.7S1.06A	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Historic and active incision
	T3.7S1.06B	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Major deposition and historic incision mid-reach with active widening
	T3.7S1.07	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Active incision following major deposition in recent flooding
Sheldon Brook	T4.01	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Historically manipulated channel with historic and active incision, some minor widening
	T4.03A	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Widening and deposition during recent floods, active incision through deposited material
	T4.03B	Transport	Confined Source and Transport	Major deposition during recent flooding, active widening
	T4.04	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision, active widening
Wheelock Brook	T5.01	Coarse Equilibrium and Fine Deposition	Transport	Major alteration to reference channel, minimal deposition or sediment source

Table 9: Summary of Sediment Regime Departures.

Surface Water	Phase 2 Segment ID	Reference Sediment Regime	Existing Sediment Regime	Cause of Departure
	T5.02	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Historic and active incision
	T5.03	Transport	Confined Source and Transport	Historic and recent incision, starting to transition to widening
	T5.04	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Recent incision and some evidence of widening
	T5.05A	Coarse Equilibrium and Fine Deposition	Unconfined Source and Transport	Active incision
	T5.05B	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision, recent and active widening
	T5.06	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision, active aggradation and widening
	T5.07	Coarse Equilibrium and Fine Deposition	Fine Source and Transport and Coarse Deposition	Historic incision and active widening

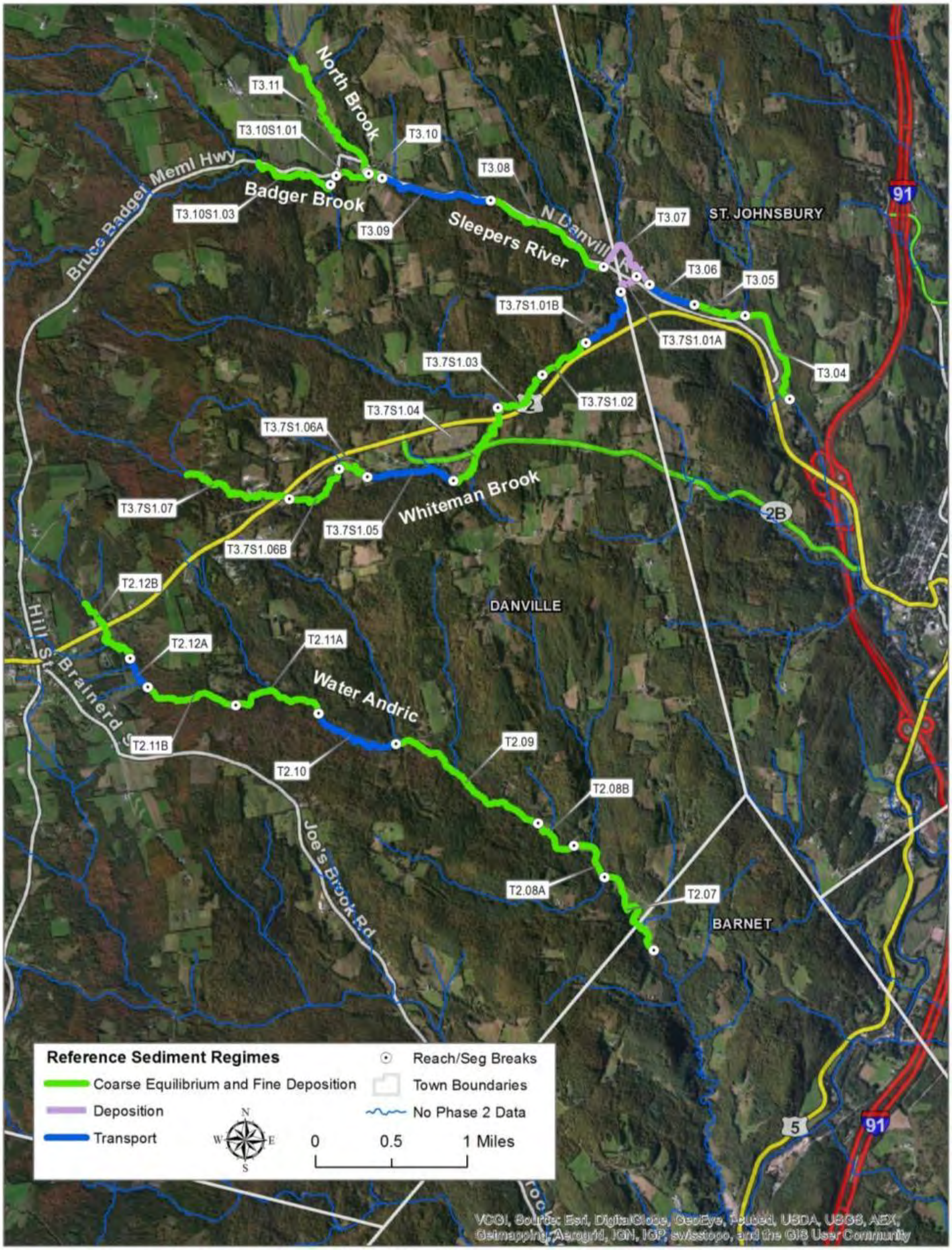


Figure 18a: Reference Sediment Regime for Water Andric, Sleepers River, Badger Brook, and Whiteman Brook.

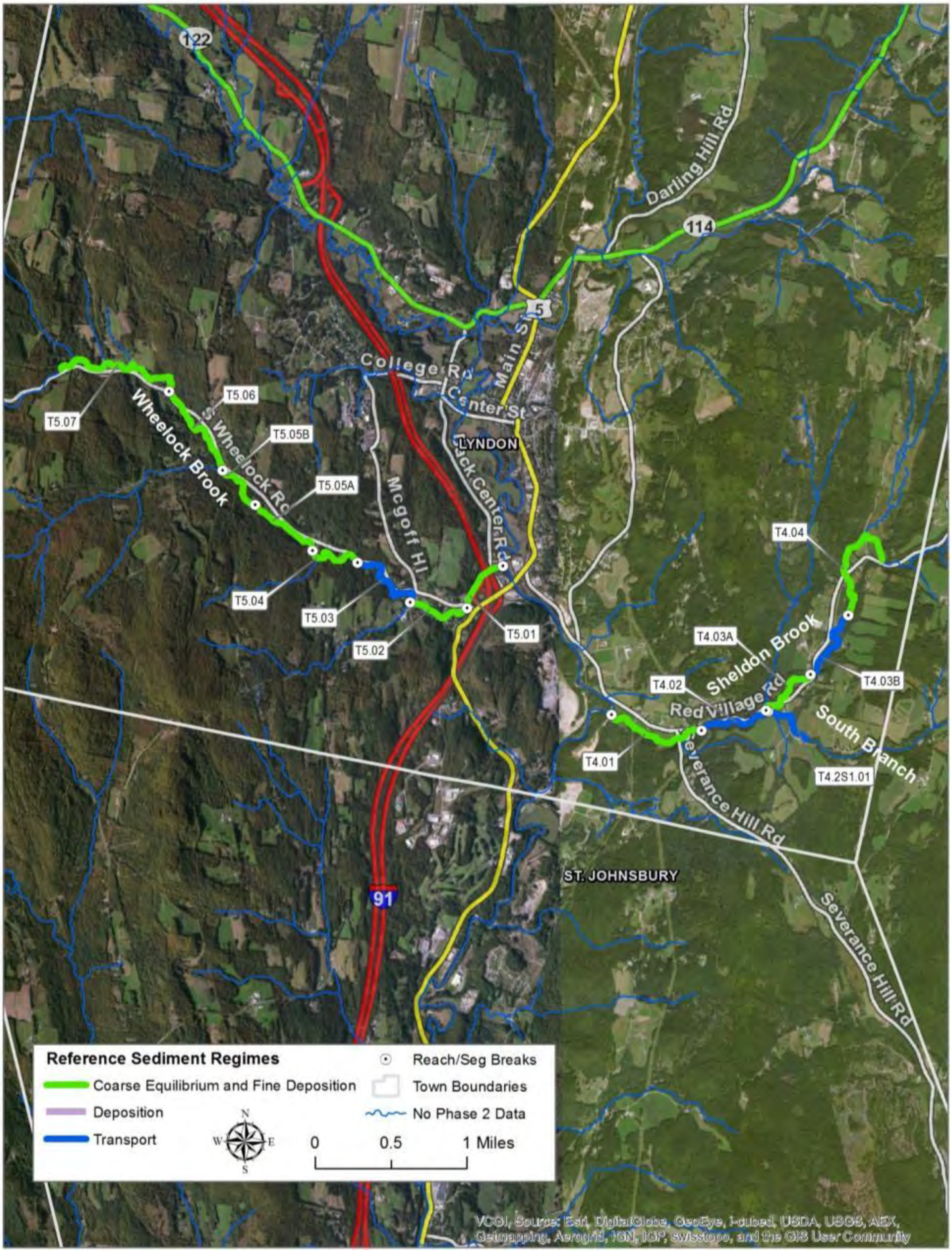


Figure 18b: Reference Sediment Regime for Sheldon Brook, South Branch Sheldon Brook, and Wheelock Brook.

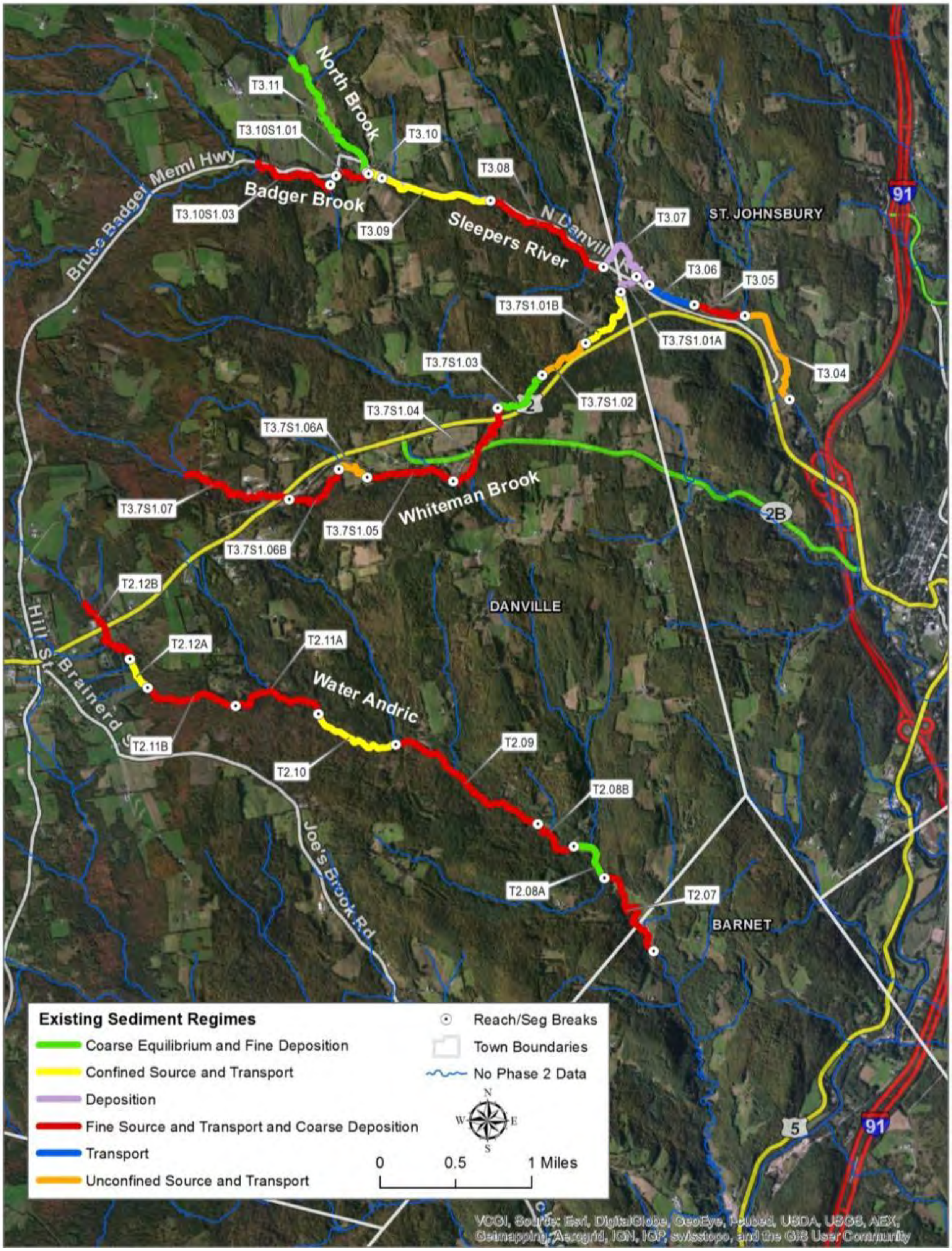


Figure 19a: Existing Sediment Regime for Water Andric, Sleepers River, Badger Brook, and Whiteman Brook

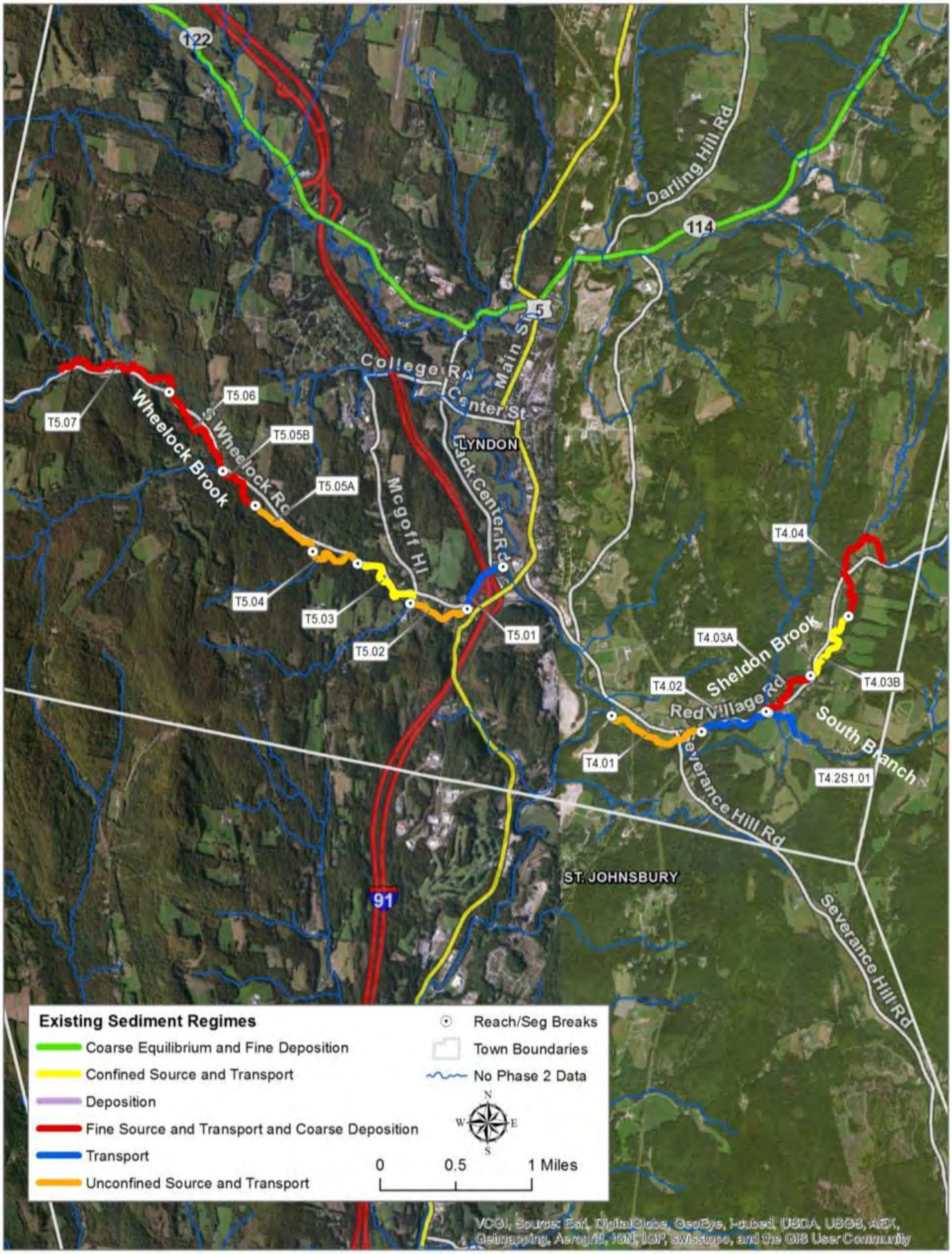


Figure 19b: Existing Sediment Regime for Sheldon Brook, South Branch Sheldon Brook, and Wheelock Brook

4.3.3 Sensitivity Analysis

The methods outlined in the VTANR Corridor Planning Guide have been used to describe the stream sensitivities of the segments in the Passumpsic River tributaries study area. Using the stream geometry and substrate data in conjunction with overall geomorphic stability (RGA score) as determined during the Phase 2 surveys, stream sensitivity ratings have been assigned to each segment (Figure 20). 14 segments have heightened sensitivities of "Extreme" and 11 segments have heightened sensitivities of "Very High" due to human impacts. The increased stream sensitivity ratings are most often because of stream type departures (STD) (Table 10).

Incision due to encroachment, armoring, or straightening was the most common scenario for "Extreme" sensitivity in the study area. Areas of major deposition coupled with encroachment also led to "Extreme" sensitivity on some segments. "Very High" sensitivity segments were typically due to incision, however some of the reaches were impacted by major deposition from recent floods leading to widening and aggradation.

Table 10: Very High and Extreme sensitivity segments and descriptions of the specific impacts and adjustments.

Surface Water	Phase 2 Segment ID	Stream Sensitivity	Description of Impacts
Water Andric	T2.07	Very High	Straightening, Armoring, Incision
	T2.08A	Very High	Armoring, Deposition, Encroachment
	T2.08B	Extreme	Incision, Encroachment, Armoring
	T2.10	Extreme	Incision, Deposition
	T2.12A	Extreme	Incision, Berming
	T2.12B	Very High	Straightening, Armoring, Encroachment, Widening
Sleepers River	T3.04	Extreme	Incision, Straightening
	T3.05	Very High	Incision
	T3.06	Extreme	Incision, Encroachment, Armoring
	T3.07	Extreme	Deposition, Widening, Encroachment
	T3.10	Extreme	Deposition, Channel Modification
Badger Bk	T3.10S1.01	Extreme	Incision
Whiteman Brook	T3.7S1.01A	Extreme	Deposition, Widening
	T3.7S1.02	Very High	Deposition, Incision
	T3.7S1.04	Very High	Widening, Deposition
	T3.7S1.05	Extreme	Incision
	T3.7S1.06A	Extreme	Historic Incision, Armoring, Straightening

Table 10: Very High and Extreme sensitivity segments and descriptions of the specific impacts and adjustments.

Surface Water	Phase 2 Segment ID	Stream Sensitivity	Description of Impacts
	T3.7S1.06B	Very High	Widening, Constrictions
	T3.7S1.07	Very High	Incision
Sheldon Bk	T4.01	Very High	Incision, Historic Armoring and Straightening
Wheelock Brook	T5.01	Extreme	Major Channel Modification
	T5.02	Extreme	Incision and Historic Armoring
	T5.03	Extreme	Incision, Encroachment
	T5.05A	Very High	Incision
	T5.06	Very High	Aggradation

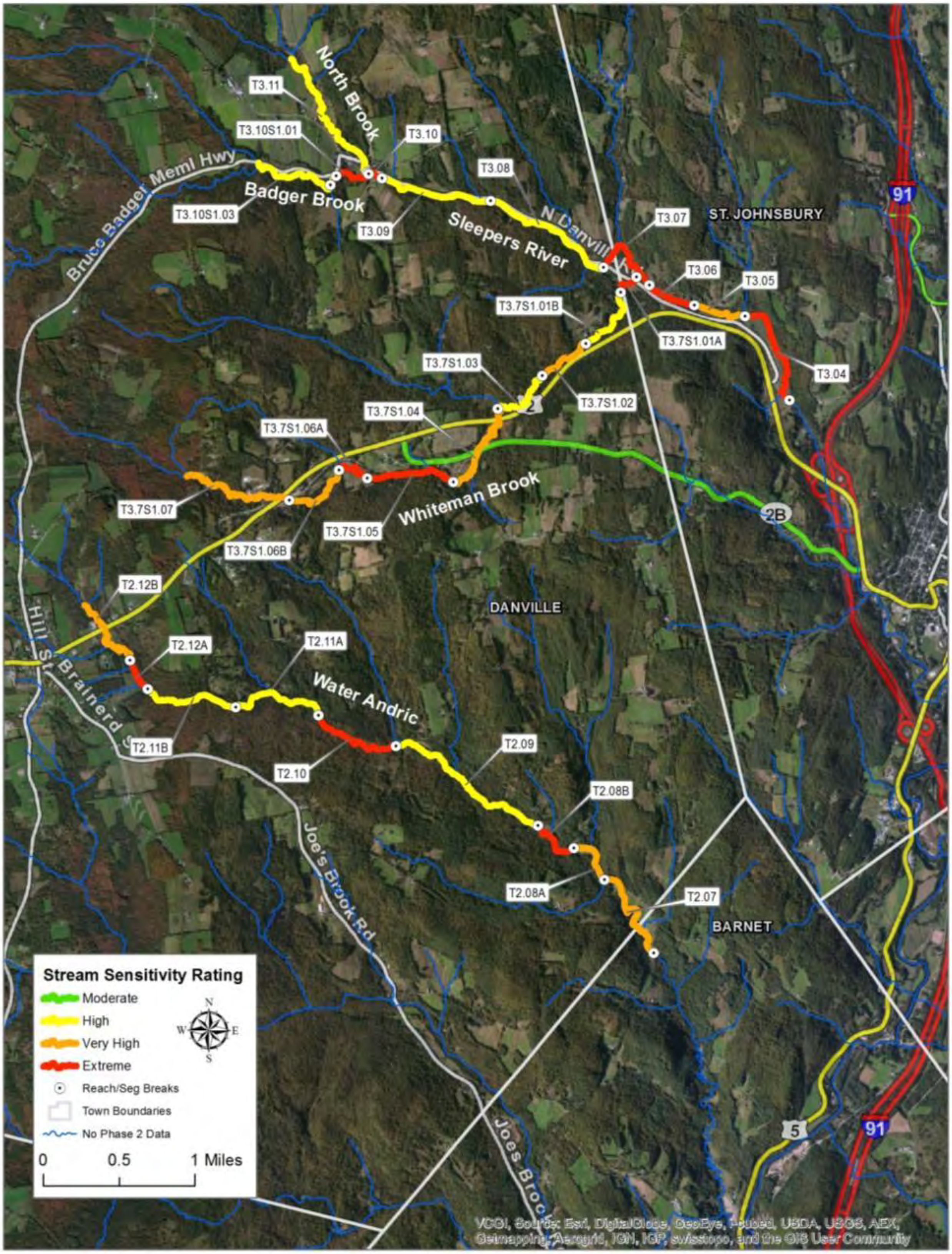


Figure 20a: Stream Sensitivity Ratings for Water Andric, Sleepers River, Badger Brook, and Whiteman Brook.

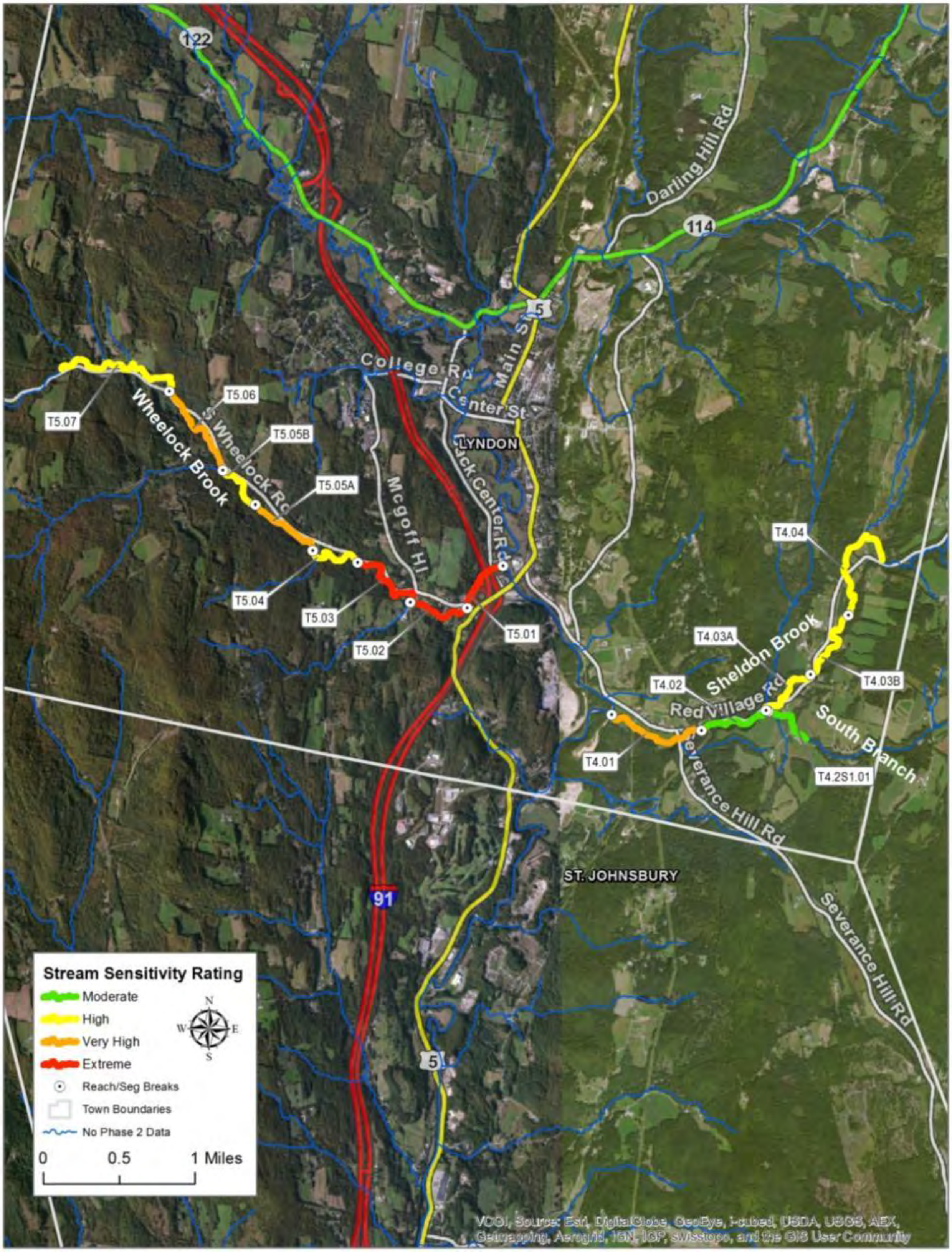


Figure 20b: Stream Sensitivity Ratings for Sheldon Brook, South Branch Sheldon Brook, and Wheelock Brook.

5.0 Preliminary Project Identification

5.1 Watershed Level Opportunities

5.1.1 Stormwater Runoff

Increased stormwater runoff, even in rural areas of Vermont, can increase peak flood flows and the erosive power of the streams. Stormwater runoff originating from gravel roads and exposed soil during development, or over farm fields can add significant sediment inputs to streams. Increasing development results in more driveways and roads, which funnels sediment and runoff directly into streams. Sediment from roads and driveways can be addressed with improved drainage ditch networks, limiting future driveway lengths in sensitive areas, and other approaches. The Vermont Better Back Roads program provides assistance for towns seeking ways to reduce rural stormwater problems.

The Passumpsic River tributary watersheds generally have limited stormwater impacts because of the largely forested watersheds and low road densities. In the future, if development pressures heighten concerns about impacts from stormwater runoff, the towns in the watershed could consider enacting local standards and guidelines for stormwater treatment or mitigation. Local planning efforts are important to control and monitor stormwater and development impacts on natural resources. By planning proactively, towns can reduce long-term costs and risks associated with stormwater runoff. Options that the towns could consider at the local level include:

- Requiring stormwater controls for development projects which are not large enough in size to fall under state regulatory permits (less than 1 acre impervious cover), but likely have a measurable impact on the conditions of adjacent waterbodies (e.g., habitat, water quality).
- Incorporating more rigorous requirements for stormwater control of new development in headwaters areas. Research in Vermont has shown that physical and biotic conditions in small watersheds (< 5 square miles in area) are impacted by very low levels of impervious cover (as low as 5 percent; Fitzgerald, 2007).
- Encouraging Low Impact Development (LID) by offering development density incentives for those projects which result in reduced footprints of impervious cover.

5.1.2 Fluvial Erosion Hazard Zones

Many Vermont communities found along rivers large and small have faced significant property losses and risks to public safety during past flood events. While inundation-related flood loss is a significant component of flood disasters, the predominant mode of damage during floods in Vermont is fluvial erosion. Fluvial erosion hazards have been increased and exacerbated by historical channel management practices in Vermont such as channel straightening, berming, and floodplain encroachment.

Towns can reduce flood recovery and infrastructure maintenance costs and increase public safety by limiting development in areas adjacent to rivers with a high potential for vertical and lateral adjustment. The Fluvial Erosion Hazard (FEH) zone can be thought of as the corridor a river or stream requires to redevelop or maintain equilibrium conditions over the long term. FEH zones also indicate which reaches that have a higher propensity for severe migration during flood events. These reaches, which are given elevated ratings of “very high” or “extreme”, are high priority reaches for protection, especially when there is little existing protection afforded by wetlands or conservation easements.

5.1.3 Stream Crossings

Throughout Vermont, undersized and poorly aligned river crossings interrupt floodflows, sediment and woody debris movement downstream, and fish and wildlife migration. These conditions result in 1) channel instability and/or damage to infrastructure and personal property, 2) increased flooding, and 3) decreased fish and wildlife population health. Some culverts and bridges in the Lower Passumpsic River tributaries study area are currently undersized and causing various problems such as upstream deposition, excessive erosion and downstream bed degradation (Tables 11 and 12). As such structures come up for replacement, resizing them to accommodate expected discharge and sediment loads and placing them in proper alignment with stream channels is highly recommended.

Table 11: Summary of culvert data in the Lower Passumpsic tributary watersheds.

Surface Water	Reach	Map ID #	Location	% Bankfull Width	Geomorphic Compatibility	Aquatic Organism Passage* (AOP)	AOP Retrofit Potential**
Water Andric	T2.09	4	PENNY LN	49	Partially Compatible	Red	MLL
	T2.12B	7	ROUTE 2	51	Mostly Compatible	Gray	MLL
Badger Brook	T3.10S1.03	14	BRUCE BADGER HWY	39	Mostly Incompatible	Red	MLL
Whiteman Brook	T3.7S1.01A	19	N DANVILLE RD	50	Mostly Incompatible	Gray	MLL
	T3.7S1.04	22	ROUTE 2 E	67	Partially Compatible	Gray	MLL
	T3.7S1.05	23	TRESTLE RD	43	Mostly Incompatible	Gray	MLL
	T3.7S1.06B	27	VAST	42	Mostly Incompatible	Gray	LLL
	T3.7S1.07	28	ROUTE 2 E	51	Partially Compatible	Gray	MLL
	T3.7S1.07	29	RED BARN RD	44	Partially Compatible	Gray	MLL
	T3.7S1.07	30	CORMIER RD	44	Mostly Incompatible	Red	MLL
South Branch Sheldon Brook	T4.2S1.01	38	SHELDON BROOK RD	87	Partially Compatible	Gray	HHM
Wheelock Brook	T5.01	39	I-91	66	Partially Compatible	Gray	LLL
	T5.01	40	S WHEELOCK RD	65	Mostly Incompatible	Gray	MML

*Notes on AOP
Green: Full AOP for all aquatic organisms
Gray: Reduced AOP for all aquatic organisms
Orange: No AOP for all aquatic organisms except adult salmonids
Red: No AOP for all aquatic organisms including adult salmonids

** Notes on AOP Retrofit Potential:
H: High probability the existing culvert can be retrofitted
M: Medium probability the existing culvert can be retrofitted
L: Low probability the existing culvert can be retrofitted
Position 1 (left): For strong swimmers
Position 2 (Center): For moderate swimmers
Position 3 (right): For weak swimmers

Table 12: Summary of Bridge and Arch Data in the Lower Passumpsic River Tributary Watersheds.

Surface Water	Map ID #	SGA Reach/ Segment	Town	SGAID	Road	Material	Curve Channel Width (ft)	Structure Length (ft)	Structure Height (ft)	Structure Width (ft)	% Bankfull Width
Water Andric	1	T2.07	Barnet	400019000003011	Keyser Hill Rd	Concrete	36.8	18	8.5	24	65
	2	T2.07	Danville	100061000003031	Water Andric Rd	Concrete	36.8	22	7.6	22	60
	3	T2.08B	Danville	100061000103031	Water Andric Rd	Concrete	34.5	24	8.5	36	104
	5	T2.12B	Danville	700000000003033	Private Rd	Timber	19.5	12	6	20	103
	6	T2.12B	Danville	700000000103033	VAST	Steel	19.5	12	10	60	308
Sleepers River	8	T3.04	St. Johnsbury	700000000003113	VAST	Steel	68.3	12	13	75	110
	9	T3.06	St. Johnsbury	100008000003111	Goss Hollow Rd	Concrete	66.9	36	8	68	102
	10	T3.06	St. Johnsbury	100008000103111	TH-8	Concrete	66.9	24	11.5	60	90
	11	T3.07	Danville	100002000003031	N Danville Rd	Concrete	45.4	26	15	60	132
	12	T3.08	Danville	700000000203033	Private Rd	Timber	45.4	4	12.5	80	176
	13	T3.10	Danville	100040000003031	Jamieson Rd	Concrete	42.6	24	15	40	94
North Brook	15	T3.11	Danville	100102000003031	Gadapee Rd	Concrete	29.1	20	7.2	15	52
	16	T3.11	Danville	100002000103031	N Danville Rd	Steel	29.1	24	25	55	189
	17	T3.11	Danville	700000000303033	USGS Footbridge	Timber	29.1	6	9	55	189
	18	T3.11	Danville	100033000003031	N Church Rd	Concrete	29.1	25	7.3	16	55
Whiteman Brook	20	T3.7S1.01B	Danville	400065000003031	Roy Rd	Concrete	30.1	16	7	16	53
	21	T3.7S1.04	Danville	300000000003032	Parker Rd	Concrete	18.0	18	5	25	139
	24	T3.7S1.05	Danville	700000000403033	VAST	Steel	20.4	10	25	110	539
	25	T3.7S1.06A	Danville	700000000503033	Private Rd	Timber	19.0	12	6	15	79
	26	T3.7S1.06B	Danville	700000000703033	Private Rd	Timber	19.0	9	3	20	105
Sheldon Brook	31	T4.01	Lyndon	100069000003071	New Boston Rd	Concrete	38.4	28	8	32	83
	32	T4.01	Lyndon	100006000003071	Severance Hill Rd	Concrete	38.4	25	8.1	36	94
	33	T4.03A	Lyndon	100002000003071	Red Village Rd	Concrete	35.5	22.5	9.7	27	76
	34	T4.03B	Lyndon	100074000003071	His Hill Rd	Steel	35.5	60	11	20	56
	35	T4.03B	Lyndon	100002000103071	Red Village Rd	Concrete	35.5	34	14.5	20	56
	36	T4.04	Lyndon	100002000203071	Red Village Rd	Concrete	31.6	23	9.2	19	60
	37	T4.04	Lyndon	100045000003071	Sugar Maple Rd	Concrete	31.6	23	11	26	82
Wheelock	41	T5.01	Lyndon	700000000003073	Schoolhouse Bridge	Timber	45.7	28	9.8	32	70

Table 12: Summary of Bridge and Arch Data in the Lower Passumpsic River Tributary Watersheds.

Surface Water	Map ID #	SGA Reach/ Segment	Town	SGAID	Road	Material	Curve Channel Width (ft)	Structure Length (ft)	Structure Height (ft)	Structure Width (ft)	% Bankfull Width
Brook	42	T5.02	Lyndon	100082000003071	Cross St	Concrete	45.7	25	6.3	25	55
	43	T5.02	Lyndon	100058000003071	Chamberlain Bridge	Timber	45.7	22	16.5	60	131
	44	T5.06	Lyndon	100046000003071	Cold Hill Rd	Concrete	39.5	25	8	25	63
	45	T5.06	Lyndon	100001000103071	S Wheelock Rd	Concrete	39.5	30	10.5	17	43
	46	T5.07	Lyndon	100024000003071	S Wheelock Rd	Concrete	38.7	20	9	26	67
	47	T5.07	Lyndon	700000000103073	Private Rd	Timber	38.7	6	5	40	103

5.2 Site-Level Project Opportunities

The site-level projects developed for the Lower Passumpsic River Tributary watersheds are provided below in Table 13. The project strategy, technical feasibility, and priority for each project are listed by project number and reach/segment. A total of 85 projects were identified to promote the restoration or protection of channel stability and aquatic habitat. The table summarizes key information for each project, including the site stressors and constraints, project strategy, priorities for hazard mitigation and ecological benefit, relative costs, and potential partners.

Table 13 includes a ranking of project priority, using our best professional judgment (and input from VTDEC and CCNRCD), of hazard mitigation and ecological benefits. Many river corridor restoration projects help mitigate flood and erosion hazards **and** improve the ecological conditions of the reach and watershed as a whole (e.g., improved habitat, protection of water quality, etc.). However, some project types provide a greater benefit to one over the other. While it is difficult to place a specific value on each project, rankings of “low,” “medium,” and “high” are intended to provide a means to compare the types of benefits each project provides relative to the others. A summary of what is meant by these two priority types is provided below.

> *Hazard Mitigation Priority:* refers to the potential for the project to mitigate flood and erosion hazards for the river corridor in the reach and in downstream areas. For example, replacing an undersized culvert with an appropriately sized structure could reduce flood/erosion hazards around the structure and downstream.
>
> *Ecological Benefits Priority:* refers to the potential for the project to improve aquatic habitat conditions and water quality in the reach and watershed. For example, a riparian buffer planting will improve habitat by increasing shading along the river and reducing long-term bank erosion.

The project locations for the study area are included on the maps provided in Appendix D. The 85 projects are further broken down by category as follows: Sixty (60) active geomorphic restoration projects and twenty five (25) passive geomorphic restoration projects, including three conservation projects.

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#1 Riparian Corridor Water Andric Reach T2.07 44.3856 N 72.0592 W	**Passive Restoration** Buffer Plantings	The majority of the reach borders an active hayfield on the left bank with minimal woody buffer vegetation. Some historic armoring was observed.	Plant stream buffer with native woody vegetation in areas lacking canopy cover to reduce streambank erosion and improve water quality and habitat. Coordinate with landowner to assess interest, cooperation, and potential for removing bank armor and/or preventing future bank armoring.	Low	Moderate	Improved biotic habitat within reach; Potentially reduced property loss from erosion; improve stream planform to restore equilibrium.	Low to moderate costs for buffer planting, moderate costs for potential armor removal.	NRCS CREP; CCNRCD and Trees for Streams
#2 Keyser Hill Rd Water Andric Reach T2.07 44.3840 N 72.0588 W	**Active Restoration** Stormwater Management	A moderate sized gully has formed on the right bank where runoff from the very steep Keyser Hill road cuts to the stream; gully could get much larger if a stabilizing tree continues to erode.	Construct a vegetated swale between road and gully, stabilize the failing bank and gully with armor and/or weirs (or check dams) and buffer plantings.	Low	Moderate	Reduced sediment loading from road washoff and from gully erosion.	Low to moderate costs for design and implementation of BMP's	Town of Barnet; VTDEC Better Backroads Program
#3 Keyser Hill Rd Bridge Water Andric Reach T2.07 44.3841 N 72.0589 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 24 feet wide (65%wbkf) and is a constriction to the channel and floodprone width. Bridge abutments rest on timbers spanning the channel and show signs of scour.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 37 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion. Improved conveyance of floodwaters and sediment throughout the reach.	Potentially high costs for structure redesign and replacement.	Town of Barnet
#4 Water Andric Rd Bridge Water Andric Reach T2.07 44.3897 N 72.0624 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 22 feet wide (60%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 37 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion. Improved conveyance of floodwaters and sediment throughout the reach.	Potentially high costs for structure redesign and replacement.	Town of Danville

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#5 Water Andric Reach T2.07	**Passive Restoration** Corridor Protection	Forested floodplain on the right bank mid-reach provides valuable area for sediment and flow attenuation. Left bank protection would ensure sufficient room for lateral migration as the stream equilibrates.	Protect stream corridor from future development.	Moderate	Low	Important sediment and flow attenuation area due to high sediment load and reduced floodplain area upstream.	Potentially moderate to high costs for easements due to private land ownership; Needs further landowner investigation.	CCNRCD; VTDEC ERP
#6 **Water Andric Road** Water Andric Segment T2.08A 44.3917 N 72.0655 W	**Active Restoration** Channel Stabilization and Debris Removal	A series of large debris jams are causing sediment deposition and channel instability that is aggravating flooding and erosion along Water Andric Road.	Remove debris jam and stabilize or reshape adjacent eroding banks while equipment is on-site.	**High**	Low	Reduced risk of damage to road, reduced bank erosion, improve sediment transport through segment.	Moderate cost for equipment operation and small area of buffer plantings.	Town of Danville
#7 **Water Andric Road** Water Andric Segment T2.08A 44.3922 N 72.0658 W	**Active Restoration** Bank Stabilization	Rip-rap bank armoring along Water Andric Road is failing at a sharp bend in the channel; channel is immediately adjacent to road.	Replace failing rip-rap with appropriately sized material, continue armoring upstream around bend for a sufficient distance to limit risk of erosion behind armoring.	Moderate	Low	Reduced risk of damage to road.	Moderate cost dependent on amount of rip-rap to be replaced.	Town of Danville
#8 **Water Andric Road** Water Andric Segment T2.08A 44.3930 N 72.0656 W	**Passive Restoration** Corridor Protection	Forested floodplain throughout the left bank and portions of the right bank provide valuable area for sediment and flow attenuation. Segment is widening and will likely continue to widen where possible.	Protect stream corridor from future development, preserve high flow floodplain area across road that is accessible during large events	Moderate	Low	Important sediment and flow attenuation area doe to high sediment load and reduced floodplain area upstream. Increasing available floodplain through this segment will lessen risk of damage to Water Andric Road during flood events.	Potentially moderate to high costs for easements due to private land ownership: Needs further landowner investigation.	CCNRCD; VTDEC ERP

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#9 **Water Andric Road** Water Andric Segment T2.08B 44.3944 N 72.0713 W	**Active Restoration** Stormwater Treatment	Two stormwater inputs in the upper segment carry stormwater from a sediment filled roadside ditch to the channel.	Install stone check dams in newly graded ditch to reduce sediment runoff to river.	Low	Low	Reduced fine sediment input to the channel from gravel road washoff.	Low cost for BMP design and implementation.	Town of Danville; VTDEC Better Backroads Program
#10 **Water Andric Road** Water Andric Segment T2.08B 44.3939 N 72.0712 W	**Active Restoration** Bank Stabilization	Recently constructed bank armoring where road is immediately adjacent to channel is undersized and restricting bankfull width.	Replace undersized armoring with a thick armor slope or stacked stone wall, keyed in to channel bottom to eliminate risk of undercutting.	Moderate	Low	Increasing available bankfull width will alleviate scour on opposite bank, reduce incision, provide some room for sediment storage in channel.	Moderate to High costs for design and construction implementation.	Town of Danville
#11 **VAST Trail** Water Andric Reach T2.09 44.0183 N 72.0858 W	**Active Restoration** Avulsion Risk	VAST trail is immediately adjacent to channel and at a similar/lower elevation, potential for a major channel avulsion.	Relocate VAST trail along the valley wall to the east. Fill and plant existing stretch of trail at low elevation	**High**	Moderate	Relocated channel would remove risk for major channel avulsion, erosion, and severe damage to the VAST trail.	High cost to relocate ~1000' of VAST trail and fill and plant ~300 of trail susceptible to avulsion. Needs further landowner investigation.	VAST
#12 **TH78 Culvert at Penny Lane** Water Andric Reach T2.09 44.4034 N 72.0918 W	**Active Restoration** Culvert Retrofit/ Replacement	New culvert installed post-Irene is 15 feet wide (49%wbkf) and is a constriction to the channel and floodprone width. Culvert is also perched and represents an AOP barrier.	Structure is new and will not likely come up for replacement in the near future. Tailwater control could be added downstream to raise pool elevation and increase AOP through the structure. VTDEC RMP guidance is for a minimum span of bankfull width of 30 feet.	**High**	Moderate	Culvert replacement would improve geomorphic compatibility, decrease risk of plugging with debris, and improve AOP. Installing a tailwater control would improve AOP.	High cost for culvert replacement, moderate cost for tailwater control construction.	Town of Danville; VTANR ERP

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#13 Water Andric Reach T2.09 44.0404 N 72.0896 W	**Passive Restoration** Corridor Protection	Forested floodplain is available on one or both sides throughout reach. These areas provide valuable sediment and flow attenuation during high flow events; Recent logging on right floodplain in upper reach retained ~100' forested buffer.	Protect stream corridor from future development and/or logging.	Moderate	Low	Corridor is currently undeveloped and provides important floodplain for sediment and flow attenuation. Channel is beginning to widen and aggrade, eventually increasing floodplain accessibility.	Potentially moderate to high costs for easements due to private land ownership: Needs further landowner investigation.	CCNRCD; VTDEC ERP
#14 **TH78 Culvert at Penny Lane** Water Andric Reach T2.10 44.4034 N 72.0924 W	**Active Restoration** Channel Restoration - Debris Removal	Huge debris jam immediately upstream of the culvert presents major risk to clog the culvert and cause flooding of TH78 and Penny Lane. Channel is braided through deep gravel deposits and fills corridor above debris jam.	Stabilize channel and remove excess fine material filling corridor, remove debris jam.	**High**	Low	Debris jam presents a major clogging risk to the new culvert on TH78. Large volume of sediment retained behind debris jam could quickly flow downstream and degrade aquatic habitat.	Moderate cost to remove debris jam, moderate to high cost to restore channel.	Town of Danville
#15 **Mid-Reach Headcut** Water Andric Reach T2.10 44.4047 N 72.1000 W	**Active Restoration** Arrest Headcut	Channel recently cut off a meander bend and a headcut and mass failure formed where the channel carved through the edge of a tight valley wall.	Restore flow to abandoned channel and stabilize headcut.	Low	Moderate	Stop headcut from advancing upstream, decrease sediment loading to channel.	High costs due to difficult access and equipment/ operator time.	CCNRCD; VTDEC ERP
#16 Water Andric Reach T2.11A	**Passive Restoration** Conservation	Excellent conservation reach given highly active channel (deposition and alluvial fan) and minimal existing development or infrastructure.	Prevent stream corridor from future development of logging, and monitor recently logged area for erosion/runoff.	Moderate	Low	Downstream benefits through the maintenance of water and sediment attenuation in this riparian and wetland area.	Low to moderate due to private land ownership: Needs further landowner investigation.	CCNRCD; Landowner; PVLT

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#17 **VAST crossing** Water Andric Reach T2.11B 44.4083 N 72.11784W	**Active Restoration** Stormwater Management	Gully on left bank draining the VAST trail to the north.	Construct a vegetated swale between road and gully, stabilize the failing bank and gully with armor and/or weirs (or check dams) and buffer plantings.	Low	Moderate	Reduced sediment loading from road washoff and from gully erosion.	Low to moderate costs for design and implementation of BMP's.	VAST
#18 **East of US Rt. 2** Water Andric Segment T2.12B 44.4128 N 72.1294 W	**Passive Restoration** Buffer Planting	Portions of the segment border active hayfields on the left bank with minimal woody buffer vegetation. Some historic armoring was observed.	Plant stream buffer with native woody vegetation in areas lacking canopy cover to reduce streambank erosion and improve water quality and habitat. Coordinate with landowner to assess interest, cooperation, and potential for removing bank armor.	Low	**High**	Improved biotic habitat within reach; Decreased stream temperature. This is the only stretch of open canopy in the entire upper watershed, increased shading would decrease water temperature for a large portion of the stream.	Low to moderate costs for buffer planting	CCNRCD; VTANR ERP; VYCC; Trees for Streams
#19 **East of US Rt. 2** Water Andric Segment T2.12B 44.4135 N 72.1311 W	**Active Restoration** Channel and Floodplain Restoration	Highly incised segment (IR=2.0) with historic straightening and armoring downstream of Rt 2 culvert; woody buffer vegetation is limited and erosion was observed in several areas	Alternatives analysis for range of channel and floodplain restoration options; ranging from buffer plantings to full meandering channel restoration - land is potentially owned by town and easy access for equipment	**High**	**High**	Restore flow and sediment attenuation, increase shading, decrease bank erosion, increase habitat	Moderate to high depending on selected alternative	Landowner; CCNRCD; VTDEC; Town of Danville
#20 **Rt 2 Crossing** Water Andric Segment T2.12B 44.4148 N 72.1311 W	**Active Restoration** Culvert Replacement	Existing culvert is 10 feet wide (51%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 20 feet.	Moderate	Moderate	Culvert replacement would improve geomorphic compatibility, decrease risk of plugging with debris, and improve AOP. Improved conveyance of floodwaters and sediment throughout the reach.	High cost for culvert replacement given roadway size	VTrans

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#21 **East of North Danville Rd** Sleepers River Reach T3.04 44.4403 N 72.0403 W	**Active or Passive Restoration** Restore incised reach with bed forms and floodplain features	The channel is deeply incised due to historic channel manipulation. no buffer exists on the right bank for most of the reach and severe erosion would result from any channel widening or planform adjustment	Alternatives analysis to examine restoring stable planform and bedform throughout reach. Potential options include re-grading right bank, restoring sinuosity, increasing aggradation through engineered log jams, etc .Buffer plantings and corridor protection should incorporated in all potential restoration plans	Low	Moderate	Buffer restoration to increase shading and inputs of woody material, planform restoration to increase sediment attenuation and improve habitat, improved floodplain access.	Moderate to very high cost likely	CCNRCD; VTANR; landowner; VYCC; Trees for Streams
#22 Sleepers River Reach T3.05 44.4444 N 72.0462 W	**Passive Restoration** Buffer Planting	The right bank in the lower segment borders an active cornfield with no woody buffer, the upper reach right bank borders a residential area with some woody vegetation.	Plant stream buffer with native woody vegetation in areas lacking canopy cover to reduce streambank erosion and improve water quality and habitat. Coordinate with landowner to assess interest, cooperation.	Low	Moderate	Improved biotic habitat within reach; Decrease stream temperature.	Low to moderate costs for buffer planting	CCNRCD; VTANR ERP; VYCC; Trees for Streams
#23 **TH-8 Bridge** Sleepers River Reach T3.06 44.4477 N 72.0580 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 60 feet wide (90%wbkf) and is a constriction to the channel and floodprone width. Bridge is in need of abutment, deck, and structural repair.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 67 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion.	High costs for bridge redesign and replacement	Town of Danville; VTrans
#24 **Goss Hollow Rd** Sleepers River Reach T3.07 44.4507 N 72.0613 W	**Active Restoration** Bank Stabilization	Recently repaired bank armoring where road is immediately adjacent to channel is not sufficiently sized or placed for long-term protection.	Replace undersized armoring with a appropriately sized armor slope or stacked stone wall, keyed in to channel bottom to eliminate risk of undercutting; possibly some room for tree plantings between road and stream. If project is a repeat damage site FEMA hazard mitigation funding is possible.	**High**	Low	Reduced risk of damage to Goss Hollow Rd, tree plantings would add shading provide habitat if possible.	Moderate to High costs for design and construction implementation	Town of Danville; VTrans

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# 25 **West of Goss Hollow Rd** Sleepers River Reach T3.07 44.4501 N 72.0612 W	**Passive Restoration** Corridor Protection	Large elevated forest floodplain on the right bank for most of reach with a house in the middle of the historic floodplain. Alluvial fan setting with braiding and large bedload storage throughout reach.	Protect from future development to allow for some floodplain access during high flow events.	Moderate	Low	Downstream benefits through the maintenance of water and sediment attenuation in this riparian area	Moderate to high due to private land ownership: Land ownership needs further investigation	CCNRCD; VTANR
#26 **USGS Weir** Sleepers River Reach T3.08 44.4496 N 72.0666 W	**Active Restoration** USGS Weir Removal	Abandoned USGS weir is trapping large volumes of sediment and likely increasing downstream incision. Backwater has minimal canopy and increases stream temperature.	Alternatives analysis for weir removal options; weir is built on natural grade control so long term channel downcutting is not a major concern.	Moderate	Moderate	Remove barrier to AOP, decrease stream temperatures, restore natural sediment transport, remove possible risk of structure failure	Moderate to high cost depending on alternatives	VTANR, USGS
#27 **House in Floodplain** Sleepers River Reach T3.08 44.4536 N 72.0755 W	**Passive Restoration** Floodplain Easement	Occupied house is located in a major flood risk area, previous attempts to stabilize bank and berms are failing, we spoke to a neighbor during Ph2 surveys and he said that the house was damaged during recent floods and that attempts to repair the bank were not holding	Floodplain easements to purchase and demolish the house, buffer plantings to restore forested floodplain	**High**	Low	Remove risk of major flood damage to existing structure, restore floodplain for flow and sediment attenuation	High	FEMA; Town of Danville
#28 Sleepers River Reach T3.08 44.4555 N 72.0791 W	**Active Restoration** Bank Stabilization	Recently installed armor is very small and poorly placed. Buffer is primarily herbaceous plants on left bank.	Replace armor with larger material and/or a stacked stone wall, plant woody vegetation in buffer if possible.	Moderate	Low	Bank and buffer stabilization to lower vulnerability of road during the future floods. Increased shading in stream.	Moderate given small scale and length of slope	Town of Danville

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#29 Above USGS Weir Sleepers River Reach T3.08 44.4503 N 72.0670 W	**Passive Restoration** Buffer Planting	Left bank immediately upstream of the USGS weir has no woody buffer vegetation and is increasing stream temperature.	Plant woody vegetation in buffer along narrow strip between road and river.	Low	Moderate	Increase shading, habitat, and inputs of organic matter to channel, slack water above dam is especially susceptible to increased temperature.	Low costs for buffer planting	CCNRCD; VTANR ERP; VYCC
#30 N Danville Road Sleepers River Reach T3.09 44.4560 N 72.0839 W and 44.4572 N 72.0921 W	**Active Restoration** Channel Stabilization	Two recently installed bed armoring sites end with an abrupt slope change leading to bed scour and possible AOP barrier.	Improve bed slope transition from bed armoring site to natural channel with installation of large rip-rap at 10% slope.	Low	Moderate	Decrease channel scour, improve AOP	Moderate costs for materials and labor	Town of Danville; VTANR
#31 Timber Crib Dam Sleepers River Reach T3.10 44.4577 N 72.0939 W	**Active Restoration** Channel Restoration	Historic and inactive timber crib dam is completely filled in with sediment and likely increasing downstream erosion and incision.	Conduct an alternatives analysis for potential dam removal, bank stabilization, and channel restoration projects.	Moderate	**High**	Restore natural channel slope and bedform, remove AOP barrier, remove potential dam failure hazard.	High depending on alternative selected	Town of Danville; VTANR; PVLT; USFWS
#32 Gadapee Rd Bridge North Brook Reach T3.11 44.4582 N 72.0958 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 15 feet wide (52%wbkf) and is a major constriction to the channel and floodprone width. Bridge is in need of abutment and structural repair	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 29 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, alleviation of upstream bank erosion - channel is deeply incised and armored so less impact than the 50% wbkf would suggest	Potentially high costs for bridge redesign and replacement	Town of Danville; VTrans

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#33 **N Church Rd Bridge** North Brook Reach T3.11 44.4622 N 72.1002 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 16 feet wide (55%wbkf) and is a major constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 29 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, alleviation of upstream bank erosion - channel is active and unconfined above bridge, likely more benefit from replacement than Gadapee Rd bridge.	Potentially high costs for bridge redesign and replacement	Town of Danville; VTrans
#34 **USGS Weir** North Brook Reach T3.11 44.4593 N 72.0961 W	**Active Restoration** USGS Weir Removal	Abandoned USGS weir is trapping large volumes of sediment and likely increasing downstream incision.	Alternatives analysis for weir removal options; weir is built on natural grade control so long term channel downcutting is not a major concern.	Moderate	Moderate	Remove barrier to AOP, restore natural sediment transport, remove possible risk of structure failure.	Moderate to high cost depending on alternatives	VTANR, USGS
#35 North Brook Reach T3.11 44.4678 N 72.1040 W	**Passive Restoration** Cattle access to stream	Current cattle access is well located with minimal bank erosion and electric fencing to limit access area.	Work with farmer to maintain appropriate water access for cattle	Low	Moderate	Poorly designed cattle water access or lack of livestock exclosures can rapidly cause major bank erosion and channel degradation.	Low	CCNRCD; Landowner
#36 **Pasture along N Church Road** North Brook Reach T3.11 44.4661 N 72.1036 W	**Passive Restoration** Corridor Protection and Buffer Plantings	An active cattle pasture is located along the right bank for the upper portion of the reach, a narrow woody buffer exists providing adequate shading and bank stability.	Easements to protect the corridor for grazing or future development.	Low	Low	Increase the width of the woody buffer vegetation on the right bank, potentially decrease nutrient and sediment inputs to channel	Low to Moderate dependant on size of area protected	NRCS CREP; CCNRCD and Trees for Streams
#37 **USGS Weir** Badger Brook Reach T3.10S1.02 44.4578 N 72.1000 W	**Active Restoration** USGS Weir Removal	Abandoned USGS weir is trapping a huge volume of coarse sediment leading to upstream bank erosion and major incision downstream; Open canopy is increasing stream temperatures above weir.	Alternatives analysis for weir removal options; weir is built on natural grade control so long term channel downcutting is not a major issue, huge upstream cobble bar will likely need to be moved if channel is restored, left bank should be stabilized and planted.	Moderate	High	Remove barrier to AOP, restore natural sediment transport, remove possible risk of structure failure, reduce stream temperature.	Moderate to high cost depending on alternatives	VTANR; USGS

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#38 **Bruce Badger HWY** Badger Brook Reach T3.10S1.03 44.4591 N 72.1102 W	**Active Restoration** Culvert Retrofit/ Replacement	Culvert is 8 feet wide (40%wbkf) and is a major constriction to the channel and floodprone width, major erosion observed upstream and downstream of the crossing.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 33 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, alleviation of upstream and downstream bank erosion. Improved conveyance of floodwaters and sediment throughout the reach.	Potentially high costs for culvert redesign and replacement	Town of Danville
#39 **N Danville Rd** Badger Brook Reach T3.10S1.03 44.4584 N 72.1083 W	**Active Restoration** Channel Stabilization	Recently installed bed armoring site ends with an abrupt slope change leading to bed scour and possible AOP barrier; bed armoring is also causing excessive flooding and sedimentation along left floodplain.	Improve bed slope transition from bed armoring site to natural channel, check right floodplain for erosion, possibly lower bed armoring thickness to reduce flows over floodplain.	Low	Low	Decrease channel scour, improve AOP	Moderate costs for materials and labor	Town of Danville; VTANR
#40 **N Danville Rd** Badger Brook Reach T3.10S1.03 44.4582 N 72.1081 W	**Active Restoration** Berm Removal	Recently windrowed cobbles are restricting access to an abandoned hayfield on the left bank. There is minimal additional floodplain available in reach.	Remove cobble berm to restore floodplain access on left bank,	Moderate	Low	Important sediment and floodwater attenuation area.	Low cost of berm removal	CCNRCD; VTANR ERP
#41 Badger Brook Reach T3.10S1.03 44.4581 N 72.1047 W	**Active Restoration** Bank Stabilization	Steep and raw eroding bank along edge of hay field.	Regrade bank to a stable slope and plant bank and buffer with woody vegetation.	Low	Moderate	Decrease sediment inputs to channel, increase shading and inputs of organic matter.	Moderate - easy access, sufficient room for bank regrading	NRCS; CCNRCD; VTANR

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#42 **N Danville Rd** Whiteman Brook Segment T3.7S1.01A 44.4477 N 72.0602 W	**Active Restoration** Culvert Retrofit/ Replacement	Culvert is 15 feet wide (50%wbkf) and is a major constriction to the channel and floodprone width, major deposition observed upstream.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 30 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, improved sediment transport through reach.	Potentially high costs for culvert redesign and replacement	Town of Danville
#43 **Roy Rd** Whiteman Brook Segment T3.7S1.01B 44.4454 N 72.0618 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 16 feet wide (53%wbkf) and is a major constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 30 feet.	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, numerous grade controls and ledge constrictions along segment make this structure a lower priority for replacement	Potentially high costs for bridge redesign and replacement	Town of Danville
#44 **USGS Weir** Whiteman Brook Segment T3.7S1.01B 44.4454 N 72.0617 W	**Active Restoration** USGS Weir Removal	Abandoned USGS weir is trapping a large volume of coarse sediment and presents a major AOP barrier.	Alternatives analysis for weir removal options; weir is built on natural grade control so long term channel downcutting is not a major issue.	Moderate	Moderate	Remove barrier to AOP, restore natural sediment transport, remove possible risk of structure failure, reduce stream temperature.	Moderate to high cost depending on alternatives	VTANR; USGS
#45 **Rt 2 Embankment** Whiteman Brook Reach T3.7S1.02 44.4405 N 72.0685 W	**Active Restoration** Bank Stabilization and Buffer Planting	The Route 2 embankment lacks woody vegetation, increasing stream temperature, and a moderate sized gully is forming from road runoff on the slope.	Stabilize the gully with weirs and armor, plant woody vegetation along the embankment.	Low	Moderate	Reduced erosion from gully and increased shading of channel.	Low to moderate	VTrans
#46 Whiteman Brook Reach T3.7S1.03	**Passive Restoration** Conservation	Reach is stable with access to large floodplain areas throughout.	Easement to protect corridor from future development to retain important sediment and flow attenuation areas.	Low	Moderate	Protect important sediment and flow attenuation areas.	Low to moderate due to private land ownership; land ownership needs further investigation.	CCNRCD; VTANR

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#47 **Rt 2** Whiteman Brook Reach T3.7S1.04 44.4345 N 72.0784 W	**Active Restoration** Culvert Retrofit/ Replacement	Culvert is 12 feet wide (67%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations for a minimum span of bankfull width of 18 feet.	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, improved sediment transport through reach.	Potentially high costs for culvert redesign and replacement	VTrans
#48 **Rt 2 Embankment** Whiteman Brook Reach T3.7S1.04 44.4341 N 72.0790 W	**Active Restoration** Bank Stabilization	Channel is migrating upstream of the culvert and is eroding the road embankment.	Stabilize the road embankment with armor.	High	Low	Reduced risk of road embankment erosion and possible damage to major roadway.	Moderate	VTrans
#49 **Trestle Rd** Whiteman Brook T3.7S1.05 44.4289 N 72.0851 W	**Active Restoration** Culvert Retrofit/ Replacement	Culvert is 8.5 feet wide (42%wbkf) and is a major constriction to the channel and floodprone width, major deposition and erosion was observed upstream, leading to the formation of a small headcut upstream.	Structure should be replaced according to VTDEC recommendations (20ft); alternatives analysis for stabilizing the upstream channel should be conducted to arrest headcut and stabilize eroding banks.	High	Moderate	Reduced risk of debris catchment during large floods which cause flooding and erosion, improved sediment transport through reach.	Potentially high costs for culvert redesign and replacement, and upstream channel stabilization.	Town of Danville; VTrans
#50 Whiteman Brook Reach T3.7S1.05	**Passive Restoration** Conservation	Reach is highly active and will likely widen and adjust planform in the near future.	Easement to protect corridor from future development to retain important sediment and flow attenuation areas.	Low	Moderate	Protect important sediment and flow attenuation areas	Moderate to high due to private land ownership; land ownership needs further investigation	CCNRCD; VTANR
#51 Whiteman Brook Segment T3.7S1.06A 44.4300 N 72.0976 W	**Passive Restoration** Buffer Planting and Corridor Protection	Woody buffer vegetation is almost completely lacking, channel is deeply incised but relatively stable (vertically) due to low slope and power.	Plant woody vegetation throughout buffer and protect a sufficient corridor width.	Low	Moderate	Increased shading and inputs of organic matter including LWD which will help the bed to aggrade and reduce incision over time.	Low to moderate due to private land ownership; land ownership needs further investigating.	NRCS CREP; CCNRCD and Trees for Streams

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#52 **VAST Trail** Whiteman Brook Segment T3.7S1.06B 44.4269 N 72.1043 W	**Active Restoration** Culvert Replacement and Channel Restoration	Culvert is 8 feet wide (42%wbkf) and the inlet has collapsed representing a major channel constriction. Sediment deposits in the upstream floodplain are over 8' deep and the embankment is failing. Upstream channel is highly unstable.	Conduct an alternatives analysis for culvert replacement and upstream channel stabilization. Access is difficult and a huge a volume of fine material is stored above the culvert. Culvert replacement would be very costly given fill volume over structure.	**High**	**High**	Restore natural flow and sediment transport to reach, reduce sediment inputs, remove risk of major damage to VAST trail, improve AOP.	High	VAST; VTrans
#53 Whiteman Brook Segment T3.7S1.06B	**Passive Restoration** Corridor Protection	Reach is highly active and will likely widen and adjust planform in the near future, especially if VAST culvert is replaced	Easement to protect corridor from future development to retain important sediment and flow attenuation areas in the lower segment	Moderate	Moderate	Protect important sediment and flow attenuation areas, and allow room for channel adjustment if other projects are implemented	Moderate to high due to private land ownership; land ownership needs further investigation	CCNRCD; VTANR
#54 **Rt2, Red Barn Rd, and Cormier Rd** Whiteman Brook Reach T3.7S1.07 44.4272 N 72.1073 W and 44.4273 N 72.1088 W and 44.4292 N 72.1182 W	**Active Restoration** Culvert Retrofit/ Replacement	Three culverts exist in this reach and all represent major bankfull constrictions; Rt2 and Red Barn road are 7' wide (44%wbkf) and Cormier is 8' wide (51%wbkf). All three have fish passage structures installed within the culvert, but are perched, limiting AOP	Conduct alternatives analysis for potential culvert replacement or retrofit. AOP could be restored to each culvert through tailwater control. Rt2 and Red Barn road would only require a single tailwater structure, Cormier has a much higher outlet drop and would require more construction effort	Low	Moderate	Tailwater control would improve AOP through reach, culvert replacement would decrease risk of debris catchment leading to flooding and erosion.	Potentially high costs for culvert redesign and replacement, and upstream channel stabilization.	Town of Danville; VTrans; USFWS; VTANR; CCNRCD
#55 **Cormier Rd** Whiteman Brook Reach T3.7S1.07 44.4292N 72.1182W	**Active Restoration** Channel and Bank stabilization	Channel and banks were heavily scoured during recent floods, bank armor was poorly installed along the left bank and is eroding.	Conduct alternatives analysis considering possible culvert replacement or tailwater project listed above. Buffer planting should be incorporated along the left bank.	Moderate	Moderate	Reduce sediment inputs to channel, improve shading, improve AOP.	Potentially high depending on alternative selected and private land ownership	Landowner; VTANR; CCNRCD

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#56 Whiteman Brook Reach T3.7S1.07	**Passive Restoration** Corridor Protection	Reach is highly active and will likely widen and adjust planform in the near future	Easement to protect corridor from future development to retain important sediment and flow attenuation areas	Low	Moderate	Protect important sediment and flow attenuation areas	Moderate to high due to private land ownership; land ownership needs further investigation	CCNRCD; VTANR
#57 **New Boston Rd** Sheldon Brook Reach T4.01 44.5046 N 71.9878 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 36 feet wide (65%wbkf) and is a constriction to the channel and floodprone width. A small gully on the southwest side from a roadside ditch could also be addressed.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (38ft). Gully could be stabilized and planted as part of this project	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, reduce sediment inputs from gully.	Potentially high costs for bridge redesign and replacement.	Town of Lyndon; VTrans
#58 **Severance Hill Rd** Sheldon Brook Reach T4.01 44.5034 N 71.9816 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 32 feet wide (60%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (38ft).	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion.	Potentially high costs for bridge redesign and replacement.	Town of Lyndon; VTrans
#59 Sheldon Brook Reach T4.01 44.5032 N 71.9822 W	**Active Restoration** Berm Removal	Historic cobble berm blocks flow to a large hayfield floodplain on the right bank. There is elevated floodplain on one or both banks for most of the reach	Remove berm to restore flow and sediment attenuation in floodplain.	Moderate	Low	Flow and sediment attenuation in floodplain.	Moderate to High	Landowner; VTANR; CCNRCD
#60 Sheldon Brook Reach T4.01 44.5036 N 71.9857 W	**Active Restoration** Berm Removal	Historic cobble berm blocks flow to a forested wetland on the left bank. The upstream edge of berm is failing and significant flow recently accessed the forested floodplain	Alternatives analysis to determine whether berm should be removed partially or completely, or allowed to slowly erode as-is. Forested wetland should be protected under all scenarios.	Moderate	Moderate	Flow and sediment attenuation - restore natural hydrology to a potentially diverse riverine wetland area.	Moderate	Landowner; VTANR; CCNRCD

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#61 Sheldon Brook Reach T4.01	**Passive Restoration** Corridor Protection	An active hayfield is located along much of the reach with a narrow woody buffer	Easements to protect the corridor from future development and to allow room for a wider riparian buffer. Channel will begin to migrate laterally in near future.	Moderate	Low	Increase the width of the woody buffer vegetation on the right bank, potentially decrease nutrient and sediment inputs to channel	Moderate to high dependant on private landownership; land ownership needs further investigation	Landowner; VTANR; CCNRCD
#62 Sheldon Brook Reach T4.02 44.5047 N 71.9727 W	**Active Restoration** Bank Stabilization	A large and steep gully was observed leading to the top of the valley wall, there appears to be a mass failure along the valley wall and the flow is likely concentrated by runoff from hayfields on top of the valley wall.	Alternatives analysis to assess runoff source, potential for mass failure, and options for addressing the gully and slope stability.	Moderate	Moderate	Reduce sediment inputs, reduce nutrient inputs, potentially stabilize an actively failing slope.	Moderate to high depending on alternative selected.	Landowner; VTANR; CCNRCD
#63 **Mass failure at top of reach** Sheldon Brook Reach T4.02 44.5056 N 71.9701 W	**Active Restoration** Bank Stabilization	A large and fresh mass failure is located along the outer bend on the left bank, actively contributing large volumes of sediment and could potentially trigger additional failure	Alternatives analysis to address lower slope stability and potentially regrade upper slope and plant with woody vegetation. Slope is very tall so full stabilization is not feasible	Moderate	Moderate	Reduce sediment inputs, reduce risk of future failure which could damage nearby property and infrastructure.	Moderate to high depending on alternative selected.	Landowner; VTANR; CCNRCD
#64 **Red Village Rd** Sheldon Brook Segment T4.03A 44.5067 N 71.9680 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 27 feet wide (76%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (36ft).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion.	Potentially high costs for bridge redesign and replacement.	Town of Lyndon; VTrans
#65 Sheldon Brook Segment T4.03A 44.5090 N 71.9663 W	**Active Restoration** Berm Removal	Two recently constructed windrowed cobble berms were observed on the left bank restricting floodplain.	Remove berms to restore connectivity to left floodplain. Small shed on floodplain would likely need to be moved	Moderate	Low	Flow and sediment attenuation, may help reach transition past Stage II channel evolution.	Low to moderate	Landowner; VTANR; CCNRCD

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Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#66 **Red Village Rd** Sheldon Brook Segment T4.03B 44.5096N 71.9634 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 20 feet wide (56%wbkf) and is a constriction to the channel and floodprone width. Major sediment deposition was observed upstream and through the structure	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (36ft).	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion, improve sediment transport	Potentially high costs for bridge redesign and replacement - this bridge is a higher priority than other structure projects on T4	Town of Lyndon; VTrans
#67 **His Hill Rd** Sheldon Brook Segment T4.03B 44.5129N 71.9608 W	**Active Restoration** Arch Retrofit/ Replacement	Arch is 20 feet wide (56%wbkf) and is a constriction to the channel and floodprone width. No change in slope or substrate through the structure, minimal geomorphic impact observed	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (36ft).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans
#68 Sheldon Brook Segment T4.03 B 44.511 N 71.9624 W	**Active Restoration** Bank Stabilization	Large eroded bank where the stream recently widened, historic woody buffer failed in to channel and further erosion is likely through hayfield.	Alternatives analysis to address slope stability and replant buffer.	Moderate	Moderate	Reduce major sediment inputs, reduce risk of future failure .	Moderate to high depending on alternative selected.	NRCS; CCNRCD
#69 **Red Village Rd** Sheldon Brook Reach T4.04 44.5189N 71.9592 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 19 feet wide (60%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (32ft).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#70 Downstream of Red Village Rd Sheldon Brook Reach T4.04 44.5185 N 71.9589 W	**Passive Restoration** Buffer Planting	Woody buffer vegetation is lacking along one or both banks below the bridge.	Plant woody vegetation throughout buffer .	Low	Moderate	Increased shading and inputs of organic matter including LWD.	Low to moderate due to private land ownership; land ownership needs further investigating	NRCS CREP; CCNRCD and Trees for Streams
#71 Sugar Maple Rd Sheldon Brook Reach T4.04 44.5226 N 71.9567 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 26 feet wide (82%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (32ft).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans
#72 Sheldon Brook Reach T4.04	**Passive Restoration** Corridor Protection	Approximately half of the reach has adequate forested buffer, some road encroachment, development. and agricultural impacts, channel is actively widening..	Easements to protect the corridor from future development, allow room for a wider riparian buffer, allow room for channel adjustments.	Low	Low	Increase width of woody buffer vegetation, potentially decrease nutrient and sediment inputs to channel, allow room for ongoing channel adjustments.	Moderate to high dependant on private landownership; land ownership needs further investigation.	Landowner; VTANR; CCNRCD
#73 Sheldon Bk Rd South Branch Sheldon Brook Reach T4.2S1.01 44.5055 N 71.9670 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 13 feet wide (87%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (32ft).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans
#74 Downstream of S. Wheelock Rd Wheelock Brook Reach T5.01 44.5167 N 72.0098 W	**Passive Restoration** Buffer Planting	Woody buffer vegetation is absent along right bank below culvert	Plant woody vegetation throughout buffer	Low	Low	Increased shading and inputs of organic matter including LWD	Low to moderate due to private land ownership; land ownership needs further investigating	Landowner; CCNRCD Trees for Streams

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#75 Downstream of Cross St Wheelock Brook Reach T5.02 44.5152 N 72.0124 W	**Active Restoration** Floodplain Restoration	Large floodplain area on both banks is only accessible during largest events, historic armoring was observed for most of this section	Conduct an alternatives analysis for restoring access to floodplain, remove bank armor, add wood to channel, buffer planting, corridor conservation	Moderate	Moderate	Restore access to large floodplain for flow and sediment attenuation. Buffer planting would decrease stream temperature and increase organic matter inputs	Low to high depending on alternative selected	Landowner; VTANR; CCNRCD
#76 Wheelock Brook Reach T5.02 44.5156 N 72.0142 W	**Active Restoration** Floodplain Restoration	An abandoned road bed and bridge abutment for Branch Brook Rd is likely cutting off access to a small forested floodplain on the left bank	Alternatives analysis to potentially remove abutment and road bed to restore access to left floodplain	Low	Low	Sediment and flow attenuation during large events	Moderate to high depending on alternative selected	Landowner; VTANR; CCNRCD
#77 Wheelock Brook Reach T5.04 44.5208 N 72.0262 W	**Active Restoration** Obstruction Removal	Recent floods destroyed a cable bridge across the river, the remaining infrastructure is trapping a large volume of wood and sediment and leading to localized channel instability	Remove obstruction and accumulated wood and sediment	Moderate	Low	Stop localized instability, remove risk of further debris catchment leading to flooding or avulsion, restore sediment transport	Moderate to high	Landowner
#78 Building Site Wheelock Brook Segment T5.05A 44.5247 N 72.0361 W	**Passive Restoration** Buffer Planting	Woody buffer was recently removed along the right bank where land was cleared for a future building site	Plant woody vegetation throughout buffer	Low	Moderate	Increased shading and inputs of organic matter including LWD	Low to moderate due to private land ownership; land ownership needs further investigating	Landowner; CCNRCD Trees for Streams
#79 Wheelock Brook Segment T5.05B 44.5261N 72.03865 W	**Passive Restoration** Buffer Planting	House on left bank has mowed lawn to the top of the bank causing some erosion	Plant woody vegetation to restore buffer and reduce future erosion	Low	Moderate	Increased shading and inputs of organic matter including LWD	Low to moderate due to private land ownership; land ownership needs further investigating	Landowner; CCNRCD Trees for Streams

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#80 Wheelock Brook Segment T5.05B	**Passive Restoration** Corridor Protection	Corridor is mostly forested and has a large area of accessible forest floodplain	Easements to protect the corridor from future development or clearing, retain access to forested floodplain	Low	Moderate	Protect valuable forested floodplain area, sediment and flow attenuation	Moderate to high dependant on private landownership; land ownership needs further investigation	Landowner; VTANR; CCNRCD
#81 **Cold Hill Rd** Wheelock Brook Reach T5.06 44.5296N 72.0423 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 25 feet wide (63%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (40 feet).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans
#82 **South Wheelock Rd** Wheelock Brook Reach T5.06 44.5352N 72.0477 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 17 feet wide (43%wbkf) and is a major constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (40 feet).	Moderate	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans
#83 **Couture Flats Rd** Wheelock Brook Reach T5.06 44.5322 N 72.0437 W	**Active Restoration** Stormwater Management	Stormwater from a roadside ditch along Couture Flats Rd flows under South Wheelock Rd, across a narrow hay field and down to the Brook. The stormwater is carrying a large sediment load	Alternatives analysis to mitigate stormwater before reaching the stream	Low	Moderate	Reduce sediment inputs to channel, remove risk of future gully formation or mass failure	Low to moderate depending on alternative selected	Town of Lyndon; VTDEC Better Backroads Program
#84 **Fall Brook Rd** Wheelock Brook Reach T5.07 44.5352N 72.0477 W	**Active Restoration** Bridge Retrofit/ Replacement	Bridge is 26 feet wide (67%wbkf) and is a constriction to the channel and floodprone width.	If structure comes up for replacement, it should be resized according to the VTDEC RMP recommendations (39 feet).	Low	Low	Reduced risk of debris catchment during large floods which cause flooding and erosion	Potentially high costs for bridge redesign and replacement	Town of Lyndon; VTrans

Table 13: Site-Level Project Identification for the Lower Passumpsic River Tributaries.

Project #, Location, Reach, Lat/Long	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Hazard Mitigation Priority	Ecological Benefits Priority	Project Benefits	Costs	Potential Partners & Funding
#85 Wheelock Brook Reach T5.07	**Passive Restoration** Corridor Protection and Buffer Planting	Active hayfield or pasture borders approximately half of the reach, buffer vegetation is lacking or non-existent, stream is widening and beginning to adjust planform	Corridor easements and buffer plantings to reestablish a functioning woody buffer area	Low	Moderate	Reduce bank erosion, sediment and nutrient inputs to stream, decrease stream temperature, increase organic matter inputs, allow room for future channel adjustments	Moderate to high costs dependant on private landownership; land ownership needs further investigation	Landowner; CCNRCD Trees for Streams

6.0 Conclusions & Recommendations

Many of the Lower Passumpsic tributary reaches are dynamic and highly erosive during flood events due to ongoing adjustments to their dimensions, patterns, and profiles. These adjustments are in response to impacts from historical sedimentation in valleys from early European settlement and deforestation that caused hillslope erosion, as well as modern day impacts from channel straightening, dredging, berming, and corridor encroachment associated with adjacent railroads, agriculture, and other land uses.

Recent extreme runoff events such as the spring 2011 floods and Tropical Storm Irene have also triggered channel incision and redevelopment of floodplain access in most reaches in Danville and Lyndon. The spring 2011 floods unleashed an enormous volume of coarse sediment and woody debris into the channel as a result of mass failure valley erosion and stream bed erosion. In some instances, the 2011 floods triggered severe channel adjustments even in reaches with limited river corridor impacts. These reaches, such as Water Andric T2.09 and T2.10, tended to be on moderate gradient, 2nd and 3rd order channels lacking natural grade controls such as bedrock ledges.

Ongoing vertical and lateral channel migration is likely in the future for many river reaches in Danville and Lyndon. Given these predictions for future channel adjustments, the municipalities in the watershed (in cooperation with CCNRCD and VTDEC) are wise to take a long-term corridor planning approach to better understand, plan for, and mitigate flooding and fluvial erosion hazards. The watershed-scale and site-specific projects summarized in this plan provide opportunities for towns to reduce flood vulnerabilities along rivers by proactively pursuing mitigation and restoration projects that will pay dividends in the long-term. For example, bridge and culvert replacements can be prioritized at the municipal level based on the data provided in this report. Other longer term projects affecting multiple landowners, such as high-priority corridor protection areas, will require engaging many stakeholders in the community to improve each town's flood resiliency.

It is recommended that the following flood resiliency strategies and projects be pursued by the towns:

- Severely undersized structures (i.e., width less than 50% bankfull channel width) are extremely vulnerable to failure in future floods due to the volume of coarse sediment and woody debris currently stored in the channel that will be mobilized. These structure replacements and retrofits are prioritized in Section 5 of the report.
- Many of the streams included in this study do not have detailed flood hazard mapping from the FEMA Flood Insurance Studies. As such, flood risks are either unknown or underestimated in many cases, particularly in areas where the streams are smaller (i.e., less than 50 feet wide) but still transport large volumes of sediment and debris. Fluvial Erosion Hazard (FEH) zones should be considered by Danville and Lyndon to better map flood and erosion risks for both the safety and protection of their citizens, and the infrastructure controlled by the municipality.
- High priority river corridor protection projects, such as those included in Table 13, provide opportunities for comprehensive planning at the river corridor scale to mitigate flood and erosion hazards. Although these projects may take years of planning and community interaction to implement, they are equally important as the "active" projects.

7.0 References

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8.0 Glossary of Terms

Adapted from:

Restoration Terms, by Craig Fischenich, February, 2000, USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180

And

Vermont Stream Geomorphic Assessment Handbook, 2007, Vermont Agency of Natural Resources, Waterbury, VT http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm

Acre -- A measure of area equal to 43,560 ft^2 (4,046.87 m^2). One square mile equals 640 acres.

Adjustment process --or type of change, that is underway due to natural causes or human activity that has or will result in a change to the valley, floodplain, and/or channel condition (e.g., vertical, lateral, or channel plan form adjustment processes)

Aggradation -- A progressive buildup or raising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that stream discharge and/or bed-load characteristics are changing. Opposite of degradation.

Algae -- Microscopic plants that grow in sunlit water containing phosphates, nitrates, and other nutrients. Algae, like all aquatic plants, add oxygen to the water and are important in the fish food chain.

Alluvial -- Deposited by running water.

Alluvium -- A general term for detrital deposits make by streams on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.

Anadromous -- Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.

Aquatic ecosystem -- Any body of water, such as a stream, lake, or estuary, and all organisms and nonliving components within it, functioning as a natural system.

Armoring -- A natural process where an erosion-resistant layer of relatively large particles is established on the surface of the streambed through removal of finer particles by stream flow. A properly armored streambed generally resists movement of bed material at discharges up to approximately 3/4 bank-full depth. Augmentation (of stream flow) – Increasing flow under normal conditions, by releasing storage water from reservoirs.

Avulsion -- A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.

Backwater -- (1) A small, generally shallow body of water attached to the main channel, with little or no current of its own, or (2) A condition in subcritical flow where the water surface elevation is raised by downstream flow impediments.

Backwater pool -- A pool that formed as a result of an obstruction like a large tree, weir, dam, or boulder.

Bank stability -- The ability of a streambank to counteract erosion or gravity forces.

Bankfull channel depth -- The maximum depth of a channel within a riffle segment when flowing at a bank-full discharge.

Bankfull channel width -- The top surface width of a stream channel when flowing at a bank-full discharge.

Bankfull discharge -- The stream discharge corresponding to the water stage that overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years and given its frequency and magnitude is responsible for the shaping of most stream or river channels.

Bankfull width -- The width of a river or stream channel between the highest banks on either side of a stream.

Bar -- An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an overwide channel.

Barrier -- A physical block or impediment to the movement or migration of fish, such as a waterfall (natural barrier) or a dam (man-made barrier).

Base flow -- The sustained portion of stream discharge that is drawn from natural storage sources, and not affected by human activity or regulation.

Bed load -- Sediment moving on or near the streambed and transported by jumping, rolling, or sliding on the bed layer of a stream. See also suspended load.

Bed material -- The sediment mixture that a streambed is composed of.

Bed material load -- That portion of the total sediment load with sediments of a size found in the streambed.

Bed roughness -- A measure of the irregularity of the streambed as it contributes to flow resistance. Commonly expressed as a Manning "n" value.

Bed slope -- The inclination of the channel bottom, measured as the elevation drop per unit length of channel.

Bedform -- Individual patterns which streams follow that characterize the condition of the stream bed into several categories. (*See*: braided, dune-ripple, plane bed, riffle-pool, step-pool, and cascade)

Benthic invertebrates -- Aquatic animals without backbones that dwell on or in the bottom sediments of fresh or salt water. Examples: clams, crayfish, and a wide variety of worms.

Berms -- mounds of dirt, earth, gravel, or other fill built parallel to the stream banks designed to keep flood flows from entering the adjacent floodplain.

Biota -- All living organisms of a region, as in a stream or other body of water.

Boulder -- A large substrate particle that is larger than cobble, between 10 and 160 inches in diameter.

Boundary resistance -- The ability a stream bank has to withstand the erosional forces of the flowing water at varying intensities. Under natural conditions boundary resistance is increased due to stream bank vegetation (roots), cohesive clays, large boulder substrate, etc.

Braided -- A stream channel characterized by flow within several channels, which successively meet and divide. Braiding often occurs when sediment loading is too large to be carried by a single channel.

Braiding (of river channels) -- Successive division and rejoining of riverflow with accompanying islands.

Buffer strip -- A barrier of permanent vegetation, either forest or other vegetation, between waterways and land uses such as agriculture or urban development, designed to intercept and filter out pollution before it reaches the surface water resource.

Canopy -- A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand. Leaves, branches and vegetation that are above ground and/or water that provide shade and cover for fish and wildlife.

Cascade -- A short, steep drop in streambed elevation often marked by boulders and agitated white water.

Catchment -- (1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught. (4) A watershed.

Channel -- An area that contains continuously or periodically flowing water that is confined by banks and a streambed.

Channelization -- The process of changing (usually straightening) the natural path of a waterway.

Channel evolution model (CEM) -- A series of stages used to describe the erosional or depositional processes that occur within a stream or river in order to regain a dynamic equilibrium following a disturbance.

Clay -- Substrate particles that are smaller than silt and generally less than 0.0001 inches in diameter.

Coarse gravel -- Substrate that is smaller than cobble, but larger than fine gravel. The diameter of this stream-bottom particulate is between 0.63 and 2.5 inches.

Cobble -- Substrate particles that are smaller than boulders and larger than gravels, and are generally between 2.5 and 10 inches in diameter.

Confinement -- *see* Valley confinement

Confluence -- (1) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. (2) The stream or body of water formed by the junction of two or more streams; a combined flood.

Conifer -- A tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence, coniferous) and have needle-shaped or scalelike leaves.

Conservation -- The process or means of achieving recovery of viable populations.

Contiguous habitat -- Habitat suitable to support the life needs of a species that is distributed continuously or nearly continuously across the landscape.

Cover -- “cover” is the general term used to describe any structure that provides refuge for fish, reptiles or amphibians. These animals seek cover to hide from predators, to avoid warm water temperatures, and to rest, by avoiding higher velocity water. These animals come in all sizes, so even cobbles on the stream bottom that are not sedimented in with fine sands and silt can serve as cover for small fish and salamanders. Larger fish and reptiles often use large boulders, undercut banks, submerged logs, and snags for cover.

Critical shear stress -- The minimum amount of shear stress exerted by stream currents required to initiate soil particle motion. Because gravity also contributes to streambank particle movement but not on streambeds, critical shear stress along streambanks is less than for streambeds.]

Cross-section -- A series of measurements, relative to bankfull, that are taken across a stream channel that are representative of the geomorphic condition and stream type of the reach.

Crown -- The upper part of a tree or other woody plant that carries the main system of branches and the foliage.

Crown cover -- The degree to which the crowns of trees are nearing general contact with one another.

Cubic feet per second (cfs) -- A unit used to measure water flow. One cubic foot per second is equal to 449 gallons per minute.

Culvert -- A buried pipe that allows flows to pass under a road.

Debris flow -- A rapidly moving mass of rock fragments, soil, and mud, with more than half of the particles being larger than sand size.

Deciduous -- Trees and plants that shed their leaves at the end of the growing season.

Degradation -- (1) A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation. (2) A decrease in value for a designated use.

Detritus -- is organic material, such as leaves, twigs, and other dead plant matter, that collects on the stream bottom. It may occur in clumps, such as leaf packs at the bottom of a pool, or as single pieces, such as a fallen tree branch.

Dike -- (1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. (2) A low wall that can act as a barrier to prevent a spill from spreading. (3) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of adjacent rocks or cuts massive rocks.

Dissolved oxygen (DO) -- The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation.

Ditch -- A long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line.

Drainage area -- The total surface area upstream of a point on a stream that drains toward that point. Not to be confused with watershed. The drainage area may include one or more watersheds.

Drainage basin -- The total area of land from which water drains into a specific river.

Dredging -- Removing material (usually sediments) from wetlands or waterways, usually to make them deeper or wider.

Dune-ripple -- A bedform associated with low-gradient, sand-bed channels; the low gradient nature of the channel causes the sand to form a sequence of dunes and small ripples; significant sediment transport typically occurs at most stream stages.

Ecology -- The study of the interrelationships of living organisms to one another and to their surroundings.

Ecosystem -- Recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them.

Embankment -- An artificial deposit of material that is raised above the natural surface of the land and used to contain, divert, or store water, support roads or railways, or for other similar purposes.

Embeddedness -- is a measure of the amount of surface area of cobbles, boulders, snags and other stream bottom structures that is covered with sand and silt. An embedded streambed may be packed hard with sand and silt such that rocks in the stream bottom are difficult or impossible to pick up. The spaces between the rocks are filled with fine sediments, leaving little room for fish, amphibians, and bugs to use the structures for cover, resting, spawning, and feeding. A streambed that is not embedded has loose rocks that are easily removed from the stream bottom, and may even "roll" on one another when you walk on them.

Entrenchment ratio --The width of the flood-prone area divided by the bankfull width.

Epifaunal – "epi" means surface, and "fauna" means animals. Thus, "epifaunal substrate" is structures in the stream (on the stream bed) that provide surfaces on which animals can live. In this case, the animals are aquatic invertebrates (such as aquatic insects and other "bugs"). These bugs live on or under cobbles, boulders, logs, and snags, and the many cracks and crevices found in these structures. In general, older decaying logs are better suited for bugs to live on/in than newly fallen "green" logs and trees.

Ephemeral streams -- Streams that flow only in direct response to precipitation and whose channel is at all times above the water table.

Equilibrium Condition -- The state of a river reach in which the upstream input of energy (flow of water) and materials (sediment and debris) is equal to its output to downstream reaches. Natural river reaches without human impacts tend towards a "stable" state where predictable channel forms are maintained over the long term under varying flow conditions.

Erosion -- Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.

Eutrophic -- Usually refers to a nutrient-enriched, highly productive body of water.

Eutrophication -- The process of enrichment of water bodies by nutrients.

Fine gravel -- Is substrate which is larger than sand, but smaller than coarse gravel. It is between 0.08 and 0.63 inches in diameter.

Flash flood -- A sudden flood of great volume, usually caused by a heavy rain. Also, a flood that crests in a short length of time and is often characterized by high velocity flows.

Floodplain -- Land built of fine particulate organic matter and small substrate that is regularly covered with water as a result of the flooding of a nearby stream.

Floodplain (100-year) -- The area adjacent to a stream that is on average inundated once a century.

Floodplain Function – Flood water access of floodplain which effects the velocity, depth, and slope (stream power) of the flood flow thereby influencing the sediment transport characteristics of the flood (i.e., loss of floodplain access and function may lead to higher stream power and erosion during flood).

Flow -- The amount of water passing a particular point in a stream or river, usually expressed in cubic feet per second (cfs).

Fluvial -- Migrating between main rivers and tributaries. Of or pertaining to streams or rivers.

Fluvial Geomorphology—The study of how rivers and their landforms interact over time through different climatic conditions.

Ford -- A shallow place in a body of water, such as a river, where one can cross by walking or riding on an animal or in a vehicle.

Fry -- A recently hatched fish.

Gabion -- A wire basket or cage that is filled with gravel or cobble and generally used to stabilize streambanks.

Gaging station -- A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.

Gallons per minute (gpm) -- A unit used to measure water flow.

Geographic information system (GIS) -- A computer system capable of storing and manipulating spatial data.

Geomorphology -- A branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place due to erosion of the primary elements and the buildup of erosional debris.

Glide -- A section of stream that has little or no turbulence.

Grade control -- A fixed feature on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision; typically bedrock, dams. or culverts.

Gradient -- Vertical drop per unit of horizontal distance.

Grass/forb -- Herbaceous vegetation.

Gravel -- An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these.

Groundwater -- Subsurface water and underground streams that can be collected with wells, or that flow naturally to the earth's surface through springs.

Groundwater basin -- A groundwater reservoir, defined by an overlying land surface and the underlying aquifers that contain water stored in the reservoir. In some cases, the boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.

Groundwater recharge -- Increases in groundwater storage by natural conditions or by human activity. See also artificial recharge.

Groundwater Table -- The upper surface of the zone of saturation, except where the surface is formed by an impermeable body.

Habitat -- The local environment in which organisms normally live and grow.

Habitat diversity -- The number of different types of habitat within a given area.

Habitat fragmentation -- The breaking up of habitat into discrete islands through modification or conversion of habitat by management activities.

Headcut -- A sharp change in slope, almost vertical, where the streambed is being eroded from downstream to upstream.

Headwater -- Referring to the source of a stream or river.

High gradient streams -- typically appear as steep cascading streams, step/pool streams, or streams that exhibit riffle/pool sequences. Most of the streams in Vermont are high gradient streams.

Hydraulic gradient -- The slope of the water surface. See also streambed gradient.

Hydraulic radius -- The cross-sectional area of a stream divided by the wetted perimeter.

Hydric -- oil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper horizon.

Hydrograph -- A curve showing stream discharge over time.

Hydrologic balance -- An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period of time. Hydrologic region -- A study area, consisting of one or more planning subareas, that has a common hydrologic character.

Hydrologic unit Code (HUC) -- A distinct watershed or river basin defined by an 8-digit code.

Hydrology -- The scientific study of the water of the earth, its occurrence, circulation and distribution, its chemical and physical properties, and its interaction with its environment, including its relationship to living things.

Hyporheic zone -- The area under the stream channel and floodplain where groundwater and the surface waters of the stream are exchanged freely.

Impoundment -- An area where the natural flow of the river has been disrupted by the presence of human-made or natural structure (e.g. weir or beaver dam). The impoundment backwater extends upstream causing sediment to be deposited on the stream bottom.

Improved paths – Paths that are maintained and typically involve paved, gravel or macadam surfaces.

Incised river -- A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.

Incision ratio -- The low bank height divided by the bankfull maximum depth.

Infiltration (soil) -- The movement of water through the soil surface into the soil.

Inflow -- Water that flows into a stream, lake,

Instream cover -- The layers of vegetation, like trees, shrubs, and overhanging vegetation, that are in the stream or immediately adjacent to the wetted channel.

Instream flows -- (1) Portion of a flood flow that is contained by the channel. (2) A minimum flow requirement to maintain ecological health in a stream.

Instream use -- Use of water that does not require diversion from its natural watercourse. For example, the use of water for navigation, recreation, fish and wildlife, aesthetics, and scenic enjoyment.

Intermittent stream -- Any nonpermanent flowing drainage feature having a definable channel and evidence of scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria.

Irrigation diversion -- Generally, a ditch or channel that deflects water from a stream channel for irrigation purposes.

Islands -- mid-channel bars that are above the average water level and have established woody vegetation.

Kame – a deposit of stratified glacial drift in isolated mounds or steep-sided hills.

Lake -- An inland body of standing water deeper than a pond, an expanded part of a river, a reservoir behind a dam

Landslide -- A movement of earth mass down a steep slope.

Large woody debris (LWD) -- Pieces of wood at least 6 ft. long and 1 ft. in diameter (at the large end) contained, at least partially, within the bankfull area of a channel.

Levee -- An embankment constructed to prevent a river from overflowing (flooding).

Limiting factor -- A requirement such as food, cover, or another physical, chemical, or biological factor that is in shortest supply with respect to all resources necessary to sustain life and thus "limits" the size or retards production of a population.

Low gradient -- streams typically appear slow moving and winding, and have poorly defined riffles and pools.

Macroinvertebrate -- Invertebrates visible to the naked eye, such as insect larvae and crayfish.

Macrophytes -- Aquatic plants that are large enough to be seen with the naked eye.

Main Stem -- The principal channel of a drainage system into which other smaller streams or rivers flow.

Mass movement -- The downslope movement of earth caused by gravity. Includes but is not limited to landslides, rock falls, debris avalanches, and creep. It does not however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).

Mean annual discharge -- Daily mean discharge averaged over a period of years. Mean annual discharge generally fills a channel to about one-third of its bank-full depth.

Mean velocity -- The average cross-sectional velocity of water in a stream channel. Surface values typically are much higher than bottom velocities. May be approximated in the field by multiplying the surface velocity, as determined with a float, times 0.8.

Meander -- The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.

Meander amplitude -- The distance between points of maximum curvature of successive meanders of opposite phase in a direction normal to the general course of the meander belt, measured between center lines of channels.

Meander belt width -- the distance between lines drawn tangential to the extreme limits of fully developed meanders. Not to be confused with meander amplitude.

Meander length -- The lineal distance down valley between two corresponding points of successive meanders of the same phase.

Mid-channel Bars – bars located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.

Milligrams per liter (mg/l) -- The weight in milligrams of any substance dissolved in 1 liter of liquid; nearly the same as parts per million by weight.

Moraine – a mass of till either carried by an active glacier or deposited on the land after a glacier recedes.

Natural flow -- The flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use.

Neck cutoff -- A channel migration feature where the land that separates a meander bend is cut off by the lateral migration of the channel. This process may be part of the equilibrium regime or associated with channel instability.

Outfall -- The mouth or outlet of a river, stream, lake, drain or sewer.

Outwash – water-transported material carried away from the ablation zone of a melting glacier.

Oxbow -- An abandoned meander in a river or stream, caused by cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.

Peat -- Partially decomposed plants and other organic material that build up in poorly drained wetland habitats.

Perched groundwater -- Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater with which it is not hydrostatically connected.

Perennial streams -- Streams that flow continuously.

Permeability -- The capability of soil or other geologic formations to transmit water.

pH -- The negative logarithm of the molar concentration of the hydrogen ion, or, more simply acidity.

Planform -- The channel shape as if observed from the air. Changes in planform often involve shifts in large amount of sediment, bank erosion, or the migration of the channel. A channel straightened for agricultural purposes has a highly impacted planform.

Point bar -- The convex side of a meander bend that is built up due to sediment deposition.

Pond -- A body of water smaller than a lake, often artificially formed.

Pool -- A reach of stream that is characterized by deep, low-velocity water and a smooth surface.

Potential plant height -- the height to which a plant, shrub or tree would grow if undisturbed.

Probability of exceedance -- The probability that a random flood will exceed a specified magnitude in a given period of time.

Railroads – Used or unused railroad infrastructure.

Rapids -- A reach of stream that is characterized by small falls and turbulent, high-velocity water.

Reach -- A section of stream having relatively uniform physical attributes, such as valley confinement, valley slope, sinuosity, dominant bed material, and bed form, as determined in the Phase 1 assessment.

Rearing habitat -- Areas in rivers or streams where juvenile fish find food and shelter to live and grow.

Reference stream type --Uses preliminary observations to determine the natural channel form and process that would be present in the absence of anthropogenic impacts to the channel and the surrounding watershed.

Refuge area -- An area within a stream that provides protection to aquatic species during very low and/or high flows.

Regime theory -- A theory of channel formation that applies to streams that make a part of their boundaries from their transported sediment load and a portion of their transported sediment load from their boundaries. Channels are considered in regime or equilibrium when bank erosion and bank formation are equal.

Restoration -- The return of an ecosystem to a close approximation of its condition prior to disturbance.

Riffle -- A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle-pool ratio -- The ratio of surface area or length of pools to the surface area or length of riffles in a given stream reach; frequently expressed as the relative percentage of each category. Used to describe fish habitat rearing quality.

Riffle-step ratio-- ratio of the distance between riffles to the stream width.

Riparian area -- An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains. Riparian buffer is the width of naturally vegetated land adjacent to the stream between the top of the bank (or top of slope, depending on site characteristics) and the edge of other land uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface. The buffer serves to protect the water body from the impacts of adjacent land uses. Riparian corridor includes lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime. For instance, in stable pool-riffle streams, riparian corridors may be as wide as 10-12 times the channel's bankfull width. In addition the riparian corridor typically corresponds to the land area surrounding and including the stream that supports (or could support if unimpacted) a distinct ecosystem, generally with abundant and diverse plant and animal communities (as compared with upland communities).

Riparian habitat -- The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.

Riparian -- Located on the banks of a stream or other body of water.

Riparian vegetation -- The plants that grow adjacent to a wetland area such as a river, stream, reservoir, pond, spring, marsh, bog, meadow, etc., and that rely upon the hydrology of the associated water body.

Ripple -- (1) A specific undulated bed form found in sand bed streams. (2) Undulations or waves on the surface of flowing water.

Riprap -- Rock or other material with a specific mixture of sizes referred to as a "gradation," used to stabilize streambanks or riverbanks from erosion or to create habitat features in a stream.

River channels --Large natural or artificial open streams that continuously or periodically contain moving water, or which form a connection between two bodies of water.

River miles --Generally, miles from the mouth of a river to a specific destination or, for upstream tributaries, from the confluence with the main river to a specific destination.

River reach -- Any defined length of a river.

River stage -- The elevation of the water surface at a specified station above some arbitrary zero datum (level).

Riverine -- Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc.

Riverine habitat -- The aquatic habitat within streams and rivers.

Roads -- Transportation infrastructure. Includes private, town, state roads, and roads that are dirt, gravel, or paved.

Rock -- A naturally formed mass of minerals.

Rootwad -- The mass of roots associated with a tree adjacent to or in a stream that provides refuge for fish and other aquatic life.

Run (in stream or river) -- A reach of stream characterized by fast-flowing, low-turbulence water.

Runoff -- Water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.

Sand -- Small substrate particles, generally from 0.002 to 0.08 in diameter. Sand is larger than silt and smaller than gravel.

Scour -- The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material and can be classed as general, contraction, or local scour.

Sediment -- Soil or mineral material transported by water or wind and deposited in streams or other bodies of water.

Sedimentation -- (1) The combined processes of soil erosion, entrainment, transport, deposition, and consolidation. (2) Deposition of sediment.

Seepage -- The gradual movement of a fluid into, through, or from a porous medium. Segment: A relatively homogenous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach in one or more of the following parameters: degree of floodplain encroachment, presence/absence of grade controls, bankfull channel dimensions (W/D ratio, entrenchment), channel sinuosity and slope, riparian buffer and corridor conditions, abundance of springs/seeps/adjacent wetlands/stormwater inputs, and degree of channel alterations.

Sensitivity -- of the valley, floodplain, and/or channel condition to change due to natural causes and/or anticipated human activity.

Shoals -- unvegetated deposits of gravels and cobbles adjacent to the banks that have a height less than the average water level. In channels that are over-widened, the stream does not have the power to transport these larger sediments, and thus they are deposited throughout the channel as shoals.

Silt -- Substrate particles smaller than sand and larger than clay; between 0.0001 and 0.002 inches in diameter.

Siltation -- The deposition or accumulation of fine soil particles.

Sinuosity -- The ratio of channel length to direct down-valley distance. Also may be expressed as the ratio of down-valley slope to channel slope.

Slope -- The ratio of the change in elevation over distance.

Slope stability -- The resistance of a natural or artificial slope or other inclined surface to failure by mass movement.

Snag -- Any standing dead, partially dead, or defective (cull) tree at least 10 in. in diameter at breast height and at least 6 ft tall. Snags are important riparian habitat features.

Spawning -- The depositing and fertilizing of eggs (or roe) by fish and other aquatic life.

Spillway -- A channel for reservoir overflow.

Stable channel -- A stream channel with the right balance of slope, planform, and cross section to transport both the water and sediment load without net long-term bed or bank sediment deposition or erosion throughout the stream segment.

Stone -- Rock or rock fragments used for construction.

Straightening -- the removal of meander bends, often done in towns and along roadways, railroads, and agricultural fields.

Stream -- A general term for a body of water flowing by gravity; natural watercourse containing water at least part of the year. In hydrology, the term is generally applied to the water flowing in a natural narrow channel as distinct from a canal. Stream banks are features that define the channel sides and contain stream flow within the channel; this is the portion of the channel bank that is between the toe of the bank slope and the bankfull elevation. The banks are distinct from the streambed, which is normally wetted and provides a substrate that supports aquatic organisms. The top of bank is the point where an abrupt change in slope is evident, and where the stream is generally able to overflow the banks and enter the adjacent floodplain during flows at or exceeding the average annual high water.

Stream channel -- A long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.

Stream condition -- Given the land use, channel and floodplain modifications documented at the assessment sites, the current degree of change in the channel and floodplain from the reference condition for parameters such as dimension, pattern, profile, sediment regime, and vegetation.

Stream gradient -- A general slope or rate of change in vertical elevation per unit of horizontal distance of the bed, water surface, or energy grade of a stream.

Stream morphology -- The form and structure of streams.

Stream order -- A hydrologic system of stream classification. Each small unbranched tributary is a first-order stream. Two first-order streams join to make a second-order stream. A third-order stream has only first-and second-order tributaries, and so forth.

Stream reach -- An individual segment of stream that has beginning and ending points defined by identifiable features such as where a tributary confluence changes the channel character or order.

Stream type -- Gives the overall physical characteristics of the channel and helps predict the reference or stable condition of the reach.

Stream type departure -- When the current stream type differs from the reference stream type as a response to anthropogenic or severe natural disturbances. These departures are often characterized by large-scale incision, deposition, or changes in planform.

Streambank armoring – The installation of concrete walls, gabions, stone riprap, and other large erosion resistant material along stream banks.

Streambank erosion -- The removal of soil from streambanks by flowing water.

Streambank stabilization -- The lining of streambanks with riprap, matting, etc., or other measures intended to control erosion.

Streambed -- (1) The unvegetated portion of a channel boundary below the baseflow level. (2) The channel through which a natural stream of water runs or used to run, as a dry streambed.

Streamflow -- The rate at which water passes a given point in a stream or river, usually expressed in cubic feet per second (cfs).

Step (in a river system) --A step is a steep, step-like feature in a high gradient stream (> 2%). Steps are composed of large boulders lines across the stream. Steps are important for providing grade-control, and for dissipating energy. As fast-shallow water flows over the steps it takes various flow paths thus dissipating energy during high flow events.

Substrate -- (1) The composition of a streambed, including either mineral or organic materials. (2) Material that forms an attachment medium for organisms.

Surface erosion -- The detachment and transport of soil particles by wind, water, or gravity. Or a group of processes whereby soil materials are removed by running water, waves and currents, moving ice, or wind.

Surface water -- All waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water.

Suspended sediment -- Sediment suspended in a fluid by the upward components of turbulent currents, moving ice, or wind.

Suspended sediment load -- That portion of a stream's total sediment load that is transported within the body of water and has very little contact with the streambed.

Tailwater -- (1) The area immediately downstream of a spillway. (2) Applied irrigation water that runs off the end of a field.

Thalweg -- (1) The lowest thread along the axial part of a valley or stream channel. (2) A subsurface, groundwater stream percolating beneath and in the general direction of a surface stream course or valley. (3) The middle, chief, or deepest part of a navigable channel or waterway.

Tractive Force --The drag on a streambed or bank caused by passing water, which tends to pull soil particles along with the streamflow.

Transpiration -- An essential physiological process in which plant tissues give off water vapor to the atmosphere.

Tributary -- A stream that flows into another stream, river, or lake.

Turbidity -- A measure of the content of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Suspended sediments are only one component of turbidity.

Urban runoff -- Storm water from city streets and gutters that usually carries a great deal of litter and organic and bacterial wastes into the sewer systems and receiving waters.

Valley confinement -- Referring to the ratio of valley width to channel width. Unconfined channels (confinement of 4 or greater) flow through broader valleys and typically have higher sinuosity and area for floodplain. Confined channels (confinement of less than 4) typically flow through narrower valleys.

Valley wall -- The side slope of a valley, which begins where the topography transitions from the gentle-sloped valley floor. The distance between valley walls is used to calculate the valley confinement.

Variable-stage stream -- Stream flows perennially but water level rises and falls significantly with storm and runoff events.

Velocity -- In this concept, the speed of water flowing in a watercourse, such as a river.

Washout -- (1) Erosion of a relatively soft surface, such as a roadbed, by a sudden gush of water, as from a downpour or floods. (2) A channel produced by such erosion.

Water quality -- A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Waterfall -- A sudden, nearly vertical drop in a stream, as it flows over rock.

Watershed -- An area of land whose total surface drainage flows to a single point in a stream.

Watershed management -- The analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents.

Watershed project -- A comprehensive program of structural and nonstructural measures to preserve or restore a watershed to good hydrologic condition. These measures may include detention reservoirs, dikes, channels, contour trenches, terraces, furrows, gully plugs, revegetation, and possibly other practices to reduce flood peaks and sediment production.

Watershed restoration -- Improving current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic and riparian resources.

Weir -- A structure to control water levels in a stream. Depending upon the configuration, weirs can provide a specific "rating" for discharge as a function of the upstream water level.

Wetland -- Areas adjacent to, or within the stream, with sufficient surface/groundwater influence to have present hydric soils and aquatic vegetation (e.g. cattails, sedges, rushes, willows or alders).

Width/depth ratio -- The ratio of channel bankfull width to the average bankfull depth. An indicator of channel widening or aggradation, and used for stream type classification.

APPENDIX A

PHASE 2 QA/QC SUMMARY

March 25, 2014

Phase 2 QA Notes For: **Lower Passumpsic Tributaries:**
Water Andric, Sleepers River, Badger Brook (Morrill Brook), Whiteman Brook, Sheldon Brook, Wheelock Brook
Ph2 Assessment by Fitzgerald Environmental
Data checked by Staci Pomeroy

Responses by Fitzgerald Environmental - 3/21/2014 Reviewed by Staci – 3/25/14 FEA Final Comments 3/25/14

The questions raised in this Quality Assurance assessment are meant to address potential discrepancies within the data set, uncover data entry errors, or otherwise clarify and confirm those observations that might not have been expected. It is important to take into consideration how data might be viewed or interpreted by the myriad of users who are familiar with the science and protocols but may be unfamiliar with the assessed reaches. While providing notes and comments, try to anticipate the types of questions that may arise due to outliers and exceptions observed within the reach or segment. While attempting to clarify the data for those users wishing to utilize it years after collected, it's better to err on the side of making excessive comments than it is for them to be insufficient.

After reviewing the information noted, the consultant should update this document (preferably in a second color) with what steps, if any, were taken to address the comments/questions.

General Comments:

- The notes and narratives for all reaches were well done and provide additional data to help with interpretation of the data and understanding of why certain segments/reaches were done the way they were. It is greatly appreciated that this level of effort was taken to help provide this data.
- For all reaches that have segments, please provide a comment in Phase 1 step 7.4 to indicate that the reach has been segmented and brief information about the segment. This will help folks using Phase 1 data know the reach has multiple parts and/or has sub-reaches (please note if sub-reach) of a different natural stream type. Example – M101A-subreach – 870',Cb4-riff/pool ; M101B- 1,030', B4-riff/pool; M101C-STD- 589', F4-plane bed.
  - **Reaches** : **- T2.08, T2.11, T2.12; T3.7S1.06, T4.03, T5.05, and T3.7S1.01**
  - **Added comments to Ph1 step 7for all segmented reaches - T3.7S1.01 is pending for field segmentation later in spring** **Thank you.**
- For Phase 1 Step 7.3 Debris Jam Potential, was blank in close to every reach. In almost every Phase 2 reach there were debris jams and/or lots of LWD. Please update the Phase 1 step 7.3 and impact score for that parameter based on your Phase 2 info.
  - Updated ice/debris jam impact and added comments to step 7 ok

Reach Notes:

<u>Water Andric</u>

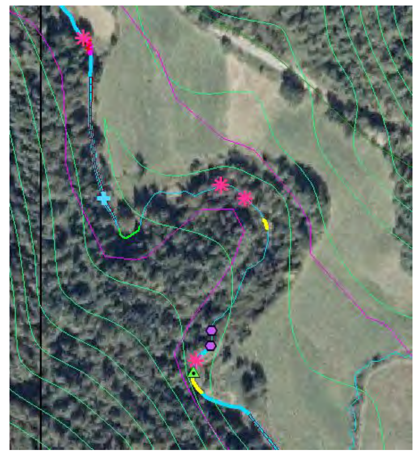
General note – I was going to note a WOW! On many of these reaches as to the amount of LWD and number of debris jams, but felt that perhaps this is a broader discussion. It appears most of the reaches have extensive LWD – averaging ~100+ up to 300+ on a reach, and extensive number of debris jams – averaging ~10+ per reach. This much wood within the stream seems like it would have potential to contribute to the processes happening in the system. Do you think most of this wood has recently been recruited in the last flood? Yes and we suspect that a lot of the wood actually came down after the flood due to bank scour and undercutting, some of the jams had trees that were very fresh, we also saw lots of trees that are ready to come down in the next flood. How are they influencing sediment storage and transport; the CEM process? Tons of sediment is stored above and in the jams, there are also numerous major sediment sources (mass failures) that have yet to stabilize. Are they helping to maintain floodplain access? Yes but I think that for now most of the FP access in the areas with lots of LWD is limited to larger events due to incision and scour. Are there structures that should be flagged for potential issues with debris jams? ---- This is not as much a QA note, more of an observation to consider as developing the reach notes and overall process happening in the Water Andric. Yes we will include some potential project sites involving jams and structures. There is often concern over large amounts of LWD/debris jams in the stream after a flood, understanding more of how you see the LWD and debris jams playing a role in the system can help understand the pros/cons/considerations that may be important to look at for strategies in these reaches. Thanks good note

<u>T2.07</u> –

- Narrative – "channel was likely incised due to historic armoring….." - ? There is only a small amount ~ 200' of rip-rap shown on either bank in a ~4,000'+ reach. This does not seem a significant amount to cause reach wide incision.

It also does not seem to be located with the straightened, ~ 600+. Just looking at the amount of rip-rap and where it is FIT'd along the reach, it is not clear how this may have caused the entire reach to become incised. "and failed armoring were observed…." Was this FIT'd? Did these areas created pinch points, or enough increased localized slope to cause a "head cut process" to move through the reach? The cross-section was taken was upstream of the large meander bend, has the incision process moved from downstream through that meander? Incision was consistent for all of the reach along the field edge. Added bank armoring along the LB through the straightened reaches where we observed failed armoring. Ok, thanks for updating FIT

- Narrative – " heavily scoured lower banks (not FIT'd) with failing trees….." Why were these not FIT'd? Only ~142' & 182' of erosion were indexed. The amount of heavily scoured banks appears to have influenced your RGA scores (Step 7.3 – row 2 – Fair "mod/high scour" ; Step 7.4 – row1 – Fair "mod/high erosion"). It seems the erosion/scour was significant enough to capture in the adjustment process as contributing to that process, and not simply the natural background erosion you may see. Please explain why you did not capture in the FIT, review your RGA scores to see if still appropriate given the low level of erosion noted, and/or update the FIT to reflect the level of erosion/scour that was seen on the reach. Added comment to step 7 for scour/erosion. Ok
- Phase 2 valley wall file – The valley wall (purple line) at the large meander upstream of the road crossing, appears to follow the meander shape. Is there a ledge or hill side there that is not evident in the contours? Also the trees appear as if the meander at one time bumped out in this area, but the valley wall clips the top of the "tree meander" off; is this an inset valley in the field? The VHD is off for that stretch, the actual channel is close to the field edge and the VW edits reflect our observations in the field. Ok



- Step 7.1 – "Historic" Degradation is noted as "no". Is this still an active and/or likely to be active process on this reach? From the narrative it appeared to be historic, but not clear if still degradation happening such that additional incision may occur. Updated to historic "yes". Ok

T2.08

- Phase 1 Step 5.2-bridg/culvert indicates **1**, Phase 2 step 4.8 channel constrictions (both segments) = none. Please be sure to indicate which segment the bridge/culvert (channel constriction) is in for Phase 2.
- Added floodplain constriction to T2.08B Ok
  - SegA&B - Step 5 – notes : very helpful note to understand access across Water Andric Road. Is this an area likely to maintain floodplain access in the incised reach? Minimal access across road through the incised segment (B). Is this something to flag and work with the town to make sure is protected area long term for floodplain access? Yes , will add to project list for conserved areas. Ok
-

T2.08A:

- Step 2.14 & 2.15 – stream type noted as C-gravel-riff/pool; Phase 1 = C-cobble-riff/pool. Both segments are about the same length, and segment B, appears to be a sub-reach. You do not need to fill in 2.15 for this segment unless you feel it is a different reference stream type than the overall reference stream type listed for the reach. Should this actually be a "C3" as noted in Phase 1, or is a C4 and Phase 1 should be updated? There is "none" noted for subslope in P1 & P2; the slope is >2%; is that reflective of the slope in the reach. This would generally indicate a "b"; but not always. Should a subclass slope be noted for the reference "C" stream type? Updated 2.14 with field measured slope for A and B, removed sub-reach for A, updated Ph1 to C4. Ok
- Step 5 notes – "several large debris jams and beaver dams…." Only one beaver dam noted, were there other? Updated step 5 comments to reflect 1 dam and two failed dams. Ok
- Step 7 narrative – "bank sour along lower bank (not FIT'd)" Explain why? Scores in RGA indicate mod/high scour/erosion by only ~40'/bank are shown. Is the evidence of erosion/scour what you would expect to see on that reach even without the flood? If the scour/erosion is such that it is impacting your adjustment scores, it should be FIT'd to help indicate the level at which the process is happening. Please review and update the FIT and/or the RGA to reflect the level of erosion/scour. Or provide further explanation as to why it was not FIT'd but captured in the RGA scores. Added text to 7.5 to describe scoured/eroded bank difference. Ok
- Step 7.2 – Row 1 –Fair "incomplete riffles" – Step 2.10 – shows "complete"; should this be in "good". For step 7.1 – is noted as "good" mostly complete…. Updated to "good" Ok

- Step 7.3 - Row 5 – Fair – “major channel/flow alteration…” - there are no flow and/or channel alterations shown. If because of flood sediment/widening – could be in “good” Episodic (flood) discharges resulting in short-term enlargement. Updated to "good" for episodic enlargement Ok
- Step 7.4 – Row 4 – Fair – major channel planform/floodprone width change…..” There are no valley width changes noted, no channel planform changes noted, and no dredging noted. While the road is noted as encroachment, you do not indicate it changes the valley width or floodprone area, or that it changed the channel planform. This may fit better in “good” minor/mod. If you feel the road is impacting the channel planform and/or floodprone area. Agreed, encroachment is main impact, planform is not changed - Updated to "good" Ok

T2.08B

- Step 1.1 –Segment reason – Please indicate as “sub-reach”. This will help quickly flag that the segment is a naturally different reference stream type. Updated Ok
- Step 2.8 – Incision ratio of 1.66 – Was the incision similar between grade controls? The cross-section appears to be below the lower ledge area, was there additional scour below these ledge areas? Is the ledge limiting incision above it, storing sediment? Incision was similar because the road bed was at a similar height to the incised banks in the lower section near the two cross-sections. Major sediment deposition throughout the reach, no apparent difference due to grade controls. Ok
- Step 5 notes – “several large debris jams and beaver dams….”; there are no beaver dams shown in this segment, should there be? No beaver dams in segment, updated. Ok
- Step 7 narrative – “segment incised during recent episodic flooding event due to roadway encroachment, and tight valley wall limiting lateral mobility….”. The notes indicate that Water Andric Rd. was not considered a valley wall because it was seen floodwater accessed across it. I see some rip-rap along parts of it, is the road being eroded in those areas not rip-rapped? Is this something that needs to be looked at for long term protection of the road – will further rip-rapping it cause additional incision? Was area not immediately next to road (upper portion of the segment) as incised where there was no rip-rap? The areas without rip-rap had an area of natural vegetation between the channel and the road, incision was fairly consistent through reach. We have a potential project site flagged near the middle mass failure where the road is potentially at risk. Ok
- Step 7.1 – Historic Deg. Noted as “no” – is this still an active process? Step 5 notes -“illustrating the B and F type geometry ? How is the amount of aggradation; debris jams, and grade controls noted influencing the connection to floodplain? This has been noted as a STD segment, and still in CEM-II. Are we likely to lose floodplain connection in those “B” areas and become an “F” or are more of the F likely to move back to B? Side bars were observed throughout the reach, might be reestablishing lower banks/benches to start back towards B geometry. Grade controls should limit further incision, especially in mid to upper reach where XS2 was located. Upper reach along road is likely stuck in "F" for a longer time due to road armoring on LB and dense vegetation and roots on RB. Ok, good to consider if any specific management needs along road will be in an incised condition.
- Step 7.1 – Row 1 – Fair – sharp change slope/headcut/trib rejuvenating - There are no head cuts, trib rejuvenating or other indications of sharp changes in slope. I see the could steep riffles, but these are generally associated with aggradation; should this be considered in good? If not, what other clues may not be evident? Added comment to 7.5 to describe the active incising through channel deposits from recent floods. Ok
- Step 7.4 – Row 4 – Fair – major channel/floodprone area change – none are noted;see note for Seg. A -Step 7.4 updated to good and increased 7.4 score to 12 Ok
- Step 7 CEM- With level of aggradation noted, is this moved into CEM 3 or still sitting incised? Based on our observations it is still incising as the channel cuts through recent coarse deposits, widening is limited by dense bank vegetation. Ok…helpful to see what good bank vegetation can do to protect banks, but appears may also limit channel to move toward equilibrium with the level of protection it is providing…hmmm…

T2.09

- Phase 1 – Step 7.4 – comments – notes “field verification of bedform needed…..” have you confirmed this such that the comment can be updated/removed? Yes and updated. Ok
- Step 2.8 – human incision ratio - = 0 ; should the improved path be noted for any level of incision? No - the VAST trail is separated by a decent buffer of natural vegetation for almost the entire reach and is typically at or below the natural bank elevation. The only exception is a short stretch at the top of the reach, which includes a wider flood bench on the right bank keeping incision consistent. Ok
- Step 2.10 - Riffle type – Eroded – with the level of sediment/diagonal bars, was surprised that these were still eroded. Riffles are cutting through recent channel deposits, overall process is stage II based on our observations. Ok

- Step 2.14 – Stream type is B- and noted as a STD – the entrenchment is close to 2, are there areas that are still "C" (ie: by road with floodplain access)? Large floodplains are elevated and the stream has access to narrow benches on or both sides throughout. XS is representative and is close to C but we think B is appropriate. Ok. Good in consideration of management strategies that may help shift/allow it to move back to C.
- Step 1.6 - How are the ledge features influencing the level of incision on the reach? Is it the same between grade controls? Ledge features in this reach typically were only above BKF on one side of the channel, did not cause major breaks in slope. Some additional deposition was observed above GC's but not a significant change in incision - see picture 1100011. Ok
- Step 3.1 – upper bank type = mix /cohesive – I was surprised by this, is the mix a till with clay in it? With the non-cohesive material on lower bank, is that influencing the erosion type (ie: scour of the toe, but not upper bank)? Updated to cohesive mix for both upper and lower based on reach photos. Clay till was observed on upper banks through most of reach, lower banks were rocky but likely had clay immediately under the rocks. Ok
- Step 5 – notes, similar to T2.08 – How important to protect floodplain access along Water Andric Road; how do road protection projects influence channel adjustments, etc . Water Andric Road is located on the left valley wall for most of reach and therefore not a major concern for channel adjustments, we will have a project in the one stretch where the road is at major risk of causing an avulsion. Ok
- Step 7.1 – Row 1 – Fair –sharp slope change/head cut/trib rejuv. – none noted – what features are you indicating as sharp slope change. Steep riffles usually associated with aggradation. Added comment to 7.5 to describe the active incision through channel deposits from recent floods. Ok
    - Historic noted as "no" – is this still an active process – further incision possible - Yes but likely transitioning to stage III soon. Ok
- Step 7 – CEM – noted as II, see narrative is transitioning from II to III – what is limiting it from being in stage III? The channel is still cutting through channel deposits from recent floods. Ok – will our incision ratio increase from 1.49?

T2.10

- Phase 1 comments – "field verification of beform needed…." Have you confirmed this? - Yes updated. Ok
- Phase 1 step 3.4 -hilly; Phase 2 – step 1.4 =very steep. Are the adjacent hillsides and valley slopes that different? Updated Ph1 3.4. Ok
- Step 1.2 – Alluvial fan – noted as "yes". Will this always form here? Or now that the culvert has been upgraded will it transition to normal deposition area? This is important as can influence the width of corridor and possible management strategies. We don't think it is a permanent feature - added text to Step 5 and will include a potential project to remove the huge log jam that likely caused the fan to form. Ok. Is it a bad thing the alluvial material is being deposited here, such that removal of the jam is a priority need?
- Step 2.8 Human incision – noted as 0 ; should the improved path be noted with any level of incision associated with it? - No the VAST trail is located on the valley wall and does not change incision. Ok
- Step 2.10 riffle type – eroded – with the level of sediment noted, was surprised these were still eroded in most of the reach. Riffles are cutting through recent flood deposits as described in previous reaches. Ok – I often picture these as steep riffles being associated with the aggradation.
- Step 3.1 – upper bank – mix / cohesive – similar to note for T2.09 – not expected, how is this influencing bank erosion? Changed to non-cohesive, less clay more sand than in T2.09. Ok
- Step 3.1 Erosion – only 75' shown on one bank – notes indicate "reach was heavily scoured during 2011 flood". The amount of erosion does not seem to indicate a large amount of scour. How is the "heavily scoured" captured to reflect the adjustment associated with it? Added language to 7.5 for scour/erosion Ok
- Step 5.1 – bar type – Phase 1 notes – indicate "channel is braided and up to 120' wide"; there are no "braided" bar types noted. Would you expect there to be? Should the note in P1 be updated? - Added braiding migration feature in FIT Ok
- Step 5.1 – Trib rejuv. Noted as "yes". I do not see any tribs to this reach on the VHD. Are there small tribs that are not showing up on the VHD to this reach? Or is this capturing the neck cut off noted in the notes? Typo - updated to "no" Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible
- Step 5 – notes – "a 5' tall head cut…." – is this a priority to fix? How will it impact incision ; already at 2, if not addressed? Headcut is located at a very recent neck cutoff, will likely stabilize pretty quickly, not likely to move upstream very far, as bed material is very coarse, and there is sufficient slope upstream to mitigate headcut progression. Will include as a potential project site. Ok- if not a priority and/or is likely to stabilize on its own do not necessarily have to put as a project; only if likely to cause other impacts if not addressed.

- Step 7 narrative – huge volume of cobbles and coarse sediment…..” – Is the level of aggradation moderating the incision? Are these helping maintain a “B” stream type by reducing entrenchment? The lack of grade control likely increased incision during recent floods, the coarse material deposited during these floods are limiting further incision but not preventing it throughout the reach. Ok

T2.11-A

- Step 1.2 Alluvial fan - noted as “yes”. Will this always form here? How much of the reach is influenced by the alluvial fan? This is important as can influence the width of corridor and possible management strategies. The fan is not visible in 70's or 90's imagery, but it is a logical place for a fan based on channel slope and valley shape. May be in response to increased sediment loads but will likely last for a long time. More stable than the fan in T2.10. Ok – on maps for the reach please indicate area likely influenced by alluvial fan, so management considerations can take that into account in that portion of the segment influenced by this.
- Step 2.8 Human incision – noted as 0 ; should the improved path be noted with any level of incision associated with it? No - the VAST trail was not elevated above the floodplain and was typically located against the valley wall. Ok
- Step 2.14 – subclass slope noted as “none”, in Phase 1 = b. I see a field measure noted as “1”, review Phase 1/Phase 2 and determine what is the dominant reference stream type for the reach and what is the subreach stream type; update the subclass slope to reflect the dominant condition and note the subreach information in the comments for Phase 1. Switched sub-reach to A and changed Ph1 type to B. Ok
- Step 3.1 – lower bank noted as “sand”; this seems very erosive toe. There is no erosion noted. This surprised me, as the CEM in III. How do you see the banks being able to maintain resistance to erosion with such erosive material on the lower bank? Changed to gravel after reviewing pictures, no real erosion was observed, some minor slumping. Ok
    - I see note about veg. along the bank moderating widening. Is the veg. keeping any erosion from happening; how will this influence ability to reach equilibrium? Vegetation isn't preventing erosion, just slowing it and the widening process down. Ok
- Step 7.1 - Historic noted as “no” – is this still an active process – further incision possible? Probably not, changed to historic. Ok
- Step 7 narrative – notes “channel widening likely in near future”. The channel width, 23’, is similar to expected in Phase 1, 24’. Is this channel resistant enough to erosion (as none noted) that aggradation may build up without further widening? Or is widening needed to create floodplain at lower elevation? Further widening is likely, Primarily shrubby and herbaceous vegetation, banks more prone to slumping that in other reaches of Andric that are densely wooded. Ok

T2.11-B

- Step 1.1 –Segment reason – Please indicate as “sub-reach”. This will help quickly flag that the segment is a naturally different reference stream type. Set T2.11A as subreach and changed Ph1 stream type Ok
- Step 2.14 – bed material noted as “cobble”, looking at substrate composition, you reach 57% at gravel. Please review and update. Updated to gravel Ok
- Step 2.15 – noted as subreach B3-step pool; and current stream type as B3-riffle-pool. Have the steps filled in such that they now are “riffles” and you would expect steps to reform ? Updated to riffle-pool Ok
- Step 7.1 - Historic noted as “no” – is this still an active process – further incision possible? Probably not, updated "yes" for historic Ok
- Step 7 narrative – is the same note as in step 5 notes. Is there other aspects of the reach/adjustments to make note of? Updated 7.5 with a better description of channel process. Ok

T2.12

- Phase 1 Step 5.2 –bridge/culvert noted as 3 ; only 2 are noted in Seg. B; Please be sure to indicate all 3 constriction in P2; update appropriate segment with remaining constriction. Added VAST bridge to Seg B as a constriction. Ok
- Seg. A &B Step 2.12 – LWD only at 23 & 29 pieces respectively. These are the lowest LWD on the entire system. How do you see the recruitment of LWD in this reach being different than the downstream reaches? Was such a significant difference from the other reaches it caught my eye, and was curious if something you also picked up on and thoughts as to how this does/does not influence the reach. Segment B transitioned to shrubby/herbaceous riparian zone so there was less recruitment. We think the large mass failures from T2.11B and down were the primary source of LWD to the channel. Only a few small MFs were observed in T2.12. Ok

T2.12-A

- Step 1.1 –Segment reason – Please indicate as "sub-reach". This will help quickly flag that the segment is a naturally different reference stream type. Updated Ok
- Step 2.14 – bed material noted as "cobble", looking at substrate composition, you reach 54% at gravel. Please review and update. Updated Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible - Yes further incision is possible, especially since widening will be limited due to dense clay lower banks. Ok
- Step 7 – Sensitivity – noted as very high, will be "extreme" with STD. Updated Ok

T2.12-B

- Step 2.10 – riffle type "complete". Given the very high incision ratio, 2, were you surprised these were complete? This also was not reflected in some of the RGA scores; please review. Updated to "eroded" to better match channel adjustment process Ok
    - Step 7.1 Row 3 – Fair – riffles/dunes may appear incomplete…
    - Step 7.2 Row 1 – Fair – incomplete riffles/dunes….
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible - Reach appears to have recently incised, but was likely incised due to historic corridor manipulation, changed to "historic" and is not likely to incise much more in the future. Ok

Sleepers River:

T3.04

- Phase 1 comments – "need to confirm if C vs E", have you confirmed this? Please update. Updated Ok
- Step 1.4 – left hillside "hilly" , Phase 1 left valley slope "steep" are the adjacent hill side slope different from the valley wall? Updated to steep. Ok
- Step 2.14 – bed material noted as "gravel"; Phase 1 bed material is "sand". Please review and update appropriate reference bed material for Phase 1. Updated Ph1 to gravel. Ok
- Step 1.6 grade controls – will the ledge reduce further incision in the reach?, it looks to be in the upstream portion, is it keeping the incision from this reach migrating upstream? Yes and updated comments in Step 7. Ok
- Step 7 narrative – "channel incision and entrenchment due to bank armoring….." There is only about 780' of rip-rap shown on the right bank out of ~3,988 ft of channel. It looks like about ~2,600 ft of the channel was straightened. This may be more of the cause for incision, then just the bank armoring. With the level of incision was there any evidence of bank armoring failing? With what appears to be somewhat limited bank armoring on the areas of straightened channel, how do you think the channel is able to maintain the straighter condition? The width, 72' is similar to P1, 68'. How is this influencing incision? Added some text to 7.5 to describe the following: the river doesn't have much power through this reach due to the low slope and effect of dam downstream. There was some channel migration in the lower reach during the 2011 floods. This suggests that the overall reach would have a tendency to laterally migrate, but has become locked in place along the valley wall due to the severe incision. Also it is possible that we missed some historic armoring buried under herbaceous vegetation along the banks. Ok
- Was there any evidence that the fields were accessed in the recent flood events? - No and the banks were so high that I strongly doubt they were. Ok.
- Step 4.8 – no channel constrictions shown; there is 1 bridge/culvert for Phase 1 step 5.2 – please update channel constriction/bridge/culvert in Phase 2. Added VAST bridge as a constriction Ok
- Step 4.9 – 2 beaver dams noted; how are these influencing incision / flood plain connection? Minimally - dams are very low and banks are very high. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible - Stream isn't yet widening so some additional incision is likely. Ok

T3.05

- Step 2.1 width = 81', this is quite a bit wider than Phase 1 , 68' estimate.
    - Step 3.1 – upper/lower bank = sand Changed lowers to mixed for sand/gravel/cobble based on pictures
    - Step 3 erosion - ~ 232' on right bank - banks were well vegetated or stony
    - Step 3 – no rip-rap - none was observed, a little bit of bedrock along left VW near GC
    - Step 7 CEM = II - Changed to III after reviewing measurements and pictures

With very susceptible material to lateral erosion and a moderately incised channel, why do you think this reach has been able to maintain a straighter (~ 857' straightened) condition with no rip-rap, and low/no erosion along the reach? Reach is pinned up against a naturally straight left VW, right bank was definitely altered at some point; there may be some historic armoring along the road embankment covered in vegetation that we couldn't see. Ok

- Step 7 CEM = II, with the wider channel, is this moving into stage III? Yes, updated to III Ok

- Step 7.1 - Historic noted as “no” – is this still an active process – further incision possible Not likely - "yes" Ok

T3.06

- Step 1.4 –hillside – left=hilly, right = steep; Phase 1 valley slope = steep/very steep respectively. Are the adjacent hillside and valley walls different? Changed both to steep/steep Ok
- Step 1.6 – grade controls – Is the ledge helping to moderate the incision in the reach, sediment transport and/or storage? Storing some sediment above, incision was fairly consistent throughout. Ok
- Step 2.8 incision ratio =2.5. How “recent” is the feature noted for RAF? (notes =elevated bench on south side of channel)? Was that bench seen throughout the reach? Yes it was seen throughout the reach and had ~50+ year old hemlocks on top of bank. Likely was abandoned during channel manipulation from road construction. Ok
- Step 2.14 – subclass slope noted as “none”; Phase1 = “c”. Reference stream type noted as “B”, so subclass slope would be noted.
  - Is there any level of floodplain development possible given road and close valley wall….can we ever move back to a “B”; or is this something that should be looked at for a modified ref. stream type given the level of encroachment. Should we be managing towards a B? Selected modified reference stream type, updated P1 and P2, comment in Step 7 Ok – Be sure to mention this in your report, and considerations for management strategies . Also, please add a note in Phase 1 to explain why “modified ref.” stream type used. Added a note to P1 step 7 about modified reference stream type.
- Step 4.8 – no constrictions noted; there are 2 bridge/culverts in Phase 1. Please review and update. Added 1 constriction to 4.8. Ok
- Step 7.1 - Historic noted as “no” – is this still an active process – further incision possible? Widening is unlikely and the channel will likely be stuck in II, therefore further incision is possible. Ok – important to understand for strategies on this reach.
- Step 7 CEM = II. The channel is 75’, Phase 1 estimate of 67’. Is the channel moving toward III, or is it not able to, given the road, so will always be stuck in II? I think it is stuck in II, heavily armored road on LB, steep rocky bank w/ some bedrock and dense cedars on RB. Ok

T3.07

- Step 2.10 – riffle type = complete; given the level of aggradation and widening noted, were you surprised the riffles were setting up well? Updated to "sedimented" based on reach pictures. Ok
- Step 2.8 – incision = 1.67 ; and CEM = IId; do you see the level of aggradation enough to provide moderation to the incision, or is this setting up a new floodplain at a lower elevation? We predict that the aggradation will establish a new lower floodplain over many years. Ok – So no possible further incision on this reach…. There is enough aggradation that that will be the driving factor?
- Step 4.8 – no constrictions noted; there is 1 bridge/culverts in Phase 1. Please review and update. Updated Ok
- Step 7.1 - Historic noted as “no” – is this still an active process – further incision possible (if yes, then the “D” CEM model may not be appropriate to use for this reach even with the level of aggradation noted). Changed to "yes" for historic, further incision is not likely. Ok. Still given the high incision the “D” model may not fit. The bed will likely continue to aggrade due to the large volumes of sediment working through the reach. Incision should be stable or decrease over time.

T3.08

- Step 1.6 – Is one of the ledge features “bed armoring”? FIT impact #901 for bed armoring notes is bed armoring. Please provide a note that one of the ledge features is actually bed rip-rap, to help with tracking of these type of management strategies. Comment added to 5.6. Ok - thanks
- Step 2.8 – human incision – There is a berm noted, how is this influencing incision ratio? The IR would be lower along the short stretch at the top of the reach impacted by the berm. With the berm it is likely in the range of the IR measured at the XS. Ok – looking to see if a worthwhile project to remove berm; would we gain any floodplain?
- Step 2.10 – riffle type – eroded; with level of aggradation and steep riffles, are riffles not setting up yet? Not yet, still working through thick channel deposits. Based on our field notes and pictures, "eroded" is appropriate. Ok
- Step 4.8 – no constrictions noted; there is 1 bridge/culverts in Phase 1. Please review and update. Bridge is very high and does not constrict channel or floodprone area. That is okay, to show is not a constriction with the data, but want to track the structure information in P2, be sure to add. Added bridge in constrictions.
- Step 5 notes- “house located in ….at risk of major flood damage” – Please be sure to flag this in report. Included as a potential project site. Ok - thanks
- Step 7 narrative – “degradation is dominant……”. Given the amount of ledge, how is this influencing the incision process on the reach? “trapping large volume of sediment and may increase degradation

downstream"….Is incision consistent between the ledge grade controls or is the amount of sediment tapped moderating incision above the ledge and increase below? The amount of sediment trapped above each GC is moderating incision above, and likely increasing below each GC. Ok

- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible? Channel has not yet begun to widen and may incise further in some stretches. Ok – good to keep in mind for management strategies

T3.09

- Step 1.6 – Are two of the ledge features "bed armoring"? FIT impact #902 & 903 for bed armoring notes is bed armoring. Please provide a note that two of the ledge features are actually bed rip-rap, to help with tracking of these type of management strategies. Yes they are both bed armoring sites, added a comment in step 5. Ok
- Step 2.1 - Right upper bank, noted as silt "cohesive". In most instances silt is non-cohesive. Please review and update and/or provide notes as appropriate. Changed to "clay", right upper banks were primarily varved silt/clay and were cohesive. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible? Changed to "yes" for historic, widening process has begun, further incision is unlikely. Ok

T3.10

- Step 1.5 valley type = SC; Step 5- notes "valley confinement was assessed as narrow in P1, and was kept for P2". Is the valley type NW or SC. RGA step 7.1 – Row 4=Poor "human caused change in valley type….." Please review your note and update as needed. Updated to SC with note for human caused change in valley type. Ok
- Step 2.8 – incision ratio = 1.48 ; with the level of aggradation seen were you surprised by the level of incision? Since the crib dam is holding sediment, is this cyclical. .with aggradation and then down cutting through it? A management question if will fluctuate between B & F as sediment is dumped and eroded? Or did recent flooding dump a bunch of sediment and now working back through? I think it is the former, the gravel trapped above the dam was very unstable and likely moves around a lot with every storm. Ok – consideration if something for dam removal and/or other project needs in the area.
- Step 3.1 – Erosion = 0. No erosion? Added some RB erosion, but it's not major, banks are fairly stable due to vegetation and rocky lower banks. Ok
- Step 4.8 – no constrictions noted; there is 1 bridge/culverts in Phase 1. Please review and update. Added one constriction Ok
- Step 5 notes – "due to widened channel leading to <u>high</u> entrenchment." The entrenchment is 1.27, this seems "low". ? Updated wording, highly entrenched/low ratio. Ok
- Step 7.1 – Row 5 – Fair "evidence of significant channel straightening, dredge, gravel, avulsion…". None of these type of impacts are noted. Should there be? This is getting at activities that would degrade the bed. I was considering the high level of road encroachment to effectively be straightening and assumed that some type of dredging was likely routinely performed as part of the mill operations. Ok- perhaps put an "FIT –dredge" at the mill dam if think this may have been a location of dredging. Added dredging
- Step 7.1 – Row 6 – Poor " major flow alteration - >flow and/or <sediment". This does not seem to be the case, it is an increase in sediment, and there are no increases (such as stormwater) in flow indicated. While there have been alterations, the question under this category is looking at those that would degrade the bed. You would capture the modification that increased the sediment load under Step 7.2 Row 5 – with major existing alteration, <flow and/or >sediment (is currently in "fair" and could be in "poor"). Agreed, updated 7.1 row 6 to good, and 7.2 row 5 to poor, scores are unchanged. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible? Yes due to cyclical deposition/degradation due to the dam. Ok – how does this area influence rest of reach incision process, or is it just behind the dam. Is a short reach, so mostly thinking if it can incision process can migrate to upstream reach, or is just in the vicinity of the dam this process is to influencing the channel adjustments. I think the cyclical incision/deposition above the dam is limited to that area due to the flat profile and the finer sediment that is moving around. Slope picks up pretty quickly on both T3.10S1.01 and T3.11 and they should be protected from any degradation through fine material above the bridge.
- Step 7 - narrative – very helpful note, as level of aggradation not easily captured in just looking at the number of bars, provides support for RGA choices for level of aggradation. Thanks.

T3.11

- Phase 1 – step 6.3 – channel bars: noted as "point", there are "multiple" in P2. Please update. Updated Ph1 Ok
- Step 2.12 LWD =101, wow. The CEM is IV; how is the LWD/debris jams in the reach contributing to channel stability /instability? LWD is definitely helping stabilize channel, most of the depositional areas were above the dam or the debris jams. Ok – good to keep in mind for strategies on the reach

- Step 3 – canopy =closed. With the level of < 25' buffer, this caught my eye. Is the near bank vegetation playing a very large role on this reach to maintain good canopy? Yes there is a narrow strip of dense cedars along the edge of the field, channel was fully shaded for large majority or reach. Ok, good to see how important these areas are
- Step 4.8 – 1 constriction noted; there are 4 bridge/culverts in Phase 1. Please review and update. Added the North Church bridge, N Danville and USGS footbridge are not constrictions. Ok – please add them to the P2 data for tracking purposes and basic data that help show they are not constriction but areas where we have infrastructure. Added two bridges to constrictions, the second bridge is the USGS footbridge to access their gaging station in the middle of the floodplain. It is only 25' wide because the bridge ends in the middle of the FP, it is not a constriction to channel or floodprone.
- Step 7.3 – Widening – historic "yes". The Phase 1 channel width estimate is 29', the P2 = 21'. Do you think there is any further widening that is likely or is an estimate of ~ 21' a good channel width to use for this reach? Some potential for future widening, changed back to "no" for historic. Ok
- Step 7 narrative – "the channel appears fairly stable….". What do you think was different about this reach that it remained stable from the 2011 floods, while much of the lower reaches appear to have significant adjustments? My guess would be geology and/or valley wall configuration, and the higher degree of floodplain access and width of floodplain in this reach. Badger/Morrill is similar sized and had numerous mass failures leading to major bed transport and jamming. Pope brook also looked stable during Ph1 windshield surveys. North also has much less road confinement, less chance of the stream being forced up against the VW leading to MF and jamming. Ok – good to keep in mind as doing report for highlights of why areas may/may not have be as stable as other areas.

<u>Badger Brook (Morrill Brook on VHD):</u>
<u>T3.10S1.01</u>

- Phase 1 – comments – "Field verification needed to confirm reference stream type…." Have you done this? Yes and updated. Ok
- Phase 1 – step 7.2 – bank height "no data". Please update with Phase 2 data. DMS not showing FIT, Staci is aware. Ok
- Step 3 lower bank material – mix "cohesive". Not expected, does this have clay content? Yes - varved clay/silt with some gravel that is cohesive. Ok
- Step 3 – Erosion = 0. This caught my eye given the Step 7 note "the banks indicated heavy scour on both sides…". This also does not seem to reflect the RGA Step 7.3 row 2 "fair – mod/high scour". If significant enough to influence RGA , should likely be FIT'd. Banks were either scoured but stable with roots and rocks, or mass failures. No spots with raw banks for erosion that weren't mass failure. See picture P1050335, this is a good example of the high end of what we are calling heavy scour but not erosion. Hmmm….seems like a fine line between scour and erosion given that this is indicated in CEM III. – If not the normal process by which we'd expect erosion to happen on the reach to widen/bank failure, be sure to help explain how this reach is able to move toward a more stable condition with no erosion taking place/indicated. If weir removed and any additional sediment added to reach, would the "scour" change to "erosion" to accommodate the increase in sediment? We think this reach rapidly widened during recent flood events and the erosion process was arrested at the now stable "scoured" banks due to stony soils and dense roots. The stream widened and is now still in that process as it works through the deposits from the floods. Mass failures spanned most of the outside banks through the reach, the rest of banks were stable and most were protected by cobble bars along the margins.
- Step 5 – notes – "major deposition…especially <u>below</u> the USGS…"… Do you mean "above"? Or was there a large dump of sediment from the USGS that is now below? Large dump of gravel and sand in channel margins below weir. Ok – not usually where you'd expect it. Was there a change in the area that helped cause these to set up? Bedrock in channel below the weir creates some slack water along margins, allowing for large sand bars to form.
- Step 7 narrative "large abandoned USGS weir …at top of reach" Please change to "at upstream reach break", as sounds almost like weir was in this reach. Updated
    - If this seems like it would make a project for possible removal, how do you think the change in sediment transport will move this from CEM III to CEM IV/V? Added to potential project list. There is a large GC under the weir so it would still be a major sediment trap without the weir. The huge volume of material trapped by the weir could work downstream and aggrade the bed to reduce incision as observed in the downstream reach. Ok
- Step 7.1 – Row 5- good –"evidence of minor bar scalping and/or avulsion". No indication of either of these impacts, should there be? Updated to "reference". Ok

- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible? Further incision is possible as the channel is still fairly unstable due to scour and deposition from recent floods. Ok
- Step 7.2 Row 6 & Step 7.4 Row 5 - poor "human made constrictions significantly smaller…". There are no human made constrictions shown; should there be? Updated both to reference, weir is not a constriction and the impact is captured in other rows. Ok

T3.10S1.02

- Phase 1 – comments – "Field verification needed to confirm reference stream type…." Have you done this?
    - Step 2.14 – Stream type "B3 step –pool". Phase 1 Step 2.11 stream type "Cb4 riffle-pool" Changed both to B3 riffle-pool. Hard to know with the dam there but this is a reasonable guess based on neighboring reaches. Ok
    - Is this a stream type departure? Or should P1 reference stream type to be updated. Updated Ok
    - Step 5 Notes = Admin judgment for stream type – Please provide a brief note as to what based on, ie: field observation (if no xs data, what info. helped you determine B) , or P1 data, etc. ; Especially if this is a STD, to understand what lead you to feel there was a change in stream type. Updated with more detail. Ok
- Step 1.4 left – ext. steep, right –very steep / Phase 1 step 3 – valley both sides = steep. Are the adjacent hill slopes different than valley walls? No - updated both to extra steep and steep. Ok
- Step 2 xs data – was it just so aggradational that not able to get data. I see note indicates no bankfull features. This seems to be functioning slightly different than some of the aggradational areas, that are cutting back through the aggradation and becoming more entrenched and shifting to F. Thoughts? Definitely looked different than any of the other aggradational areas. Stream is pushed up against the left bank and eroding in to the pasture. The right bank is a huge cobble bar that extends well above bkf. At high flows a large side channel is accessed on the far side of the cobble bar. Might form a big eddy around the cobble bar during high flows. Ok – things to keep in mind as possible management strategies considered on this reach and/or if weir were removed how this reach may respond.
- Step 3.2 right bank sub-dom. buffer width = blank. Please update. It's all >100', no sub-dom. Ok indicate "none" Updated
- Step 7.1 - ? if STD No STD as observed Ok
- Step 7 CEM/Sensitivity – Do you feel you are able to make an Admin. Judgment on these? Entered IId as administrative judgment. Ok

T3.10S1.03

- Phase 1 comments – "VW width estimated from hydro DEM". Are your Phase 2 measures able to be more accurate than this? Updated with Ph2 range finder estimate. Ok
- Step 4.8 constrictions – "bedrock outcrop" – is this a natural pinch point in the valley (bedrock both sides of channel)? Is it at one of the ledge grade control features? If yes, please note; if not, would you please provide a point shapefile of location on reach to help understand where/how it may be affecting reach. Thank you. The constriction is at the 2nd grade control. Not really a VW pinch point as there is some floodplain on RB that is accessed. Pictures P1050346 and P1050347. Ok
    - The instream culvert is 8' wide. Yikes, that is significantly smaller than bkf width. Would this be a priority for replacement…any evidence of flood damage? The culvert is also at a big bend in the channel. outer bank erosion upstream and downstream with a big mass failure. Culvert and headwall are well built and road is up high, I'm guessing it filled up and shot out of the culvert and ripped up the channel and banks downstream. Definitely recommending replacement as a project. Ok – good info.
- Step 5 notes "flow was braided throughout….". There is no braiding showing in Step 5 bar types. Should there be? Area with a huge amount of deposition above the first grade control, added braiding in FIT. Ok
    - "large bed armoring". I see note in FIT with ledge grade control. Please just add in notes, that is captured as "ledge" to help with tracking. Added note in Step 5. Ok
- Step 7 narrative – "a forested floodplain is typically accessible…." Given the incision ratio, is this at higher flows, or because in CEM IV, is now a lower floodplain accessible at bkf flows? - high flows only, lower floodplain is still being established and is not vegetated. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible. Yes channel still has a huge volume of sediment working through, some incision and widening is possible. Ok
- Step 7 CEM – IV – Looking at the bkf width of 31 is similar to P1 width, 33'. Step 7 narrative " reach likely widened during recent episodic flood…". Do you think the flood pushed this channel to CEM IV by widening back toward the expected channel width? Reach widened to ~60' in most spots but then returned to ~30' following deposition of large cobble bars at or above bankfull throughout the reach. Ok

<u>Whiteman Brook</u>:

<u>T3.7S1.01 - Will segment as soon as reach is accessible and update accordingly.</u>

- Phase 1 comments – "average slope high for reach, and Cb picked…." – current reference stream type noted as "B-step pool". Update the note if not accurate for Cb to be reference stream type.
    - "Segmentation likely in Phase 2" – why was no segmentation done given the various stream type/confinement issues noted; especially for the alluvial fan area?
    - "Field verification needed to confirm ref. stream type" – Have you determined this?
- Phase 1 – Step 7.2 bank height – "no data" – please update with Phase 2 data
- Step 1.2 – Alluvial fan – Is this always likely to form in this area? Even if culvert upgraded? Would this be a "D" stream type naturally? Given this was not segmented, please provide a general location as to the upstream end of the alluvial fan, to help determine area of the fan. This is important as will influence the corridor with in this area. Based on our observations, the alluvial fan will form again and is likely more influenced by the sharp bend in the channel immediately below the slope transition. Enlarging the culvert might help, but the stream wants to move around more than it can due to the road embankment and culvert. Ok – important to highlight in report and on map, please indicate area influenced by fan.
- Step 1.6 grade controls – The USGS weir is noted as a flow reg. , but is not noted as a grade control. Should it be? Yes - added in FIT Ok
- Step 2 LWD = 220 WOW! How is the wood influencing the channel /is it? Most of the wood was located in 3 giant log jams. The uppermost jam in the reach was actually causing forcing the channel into the RB and exacerbating a large mass failure. The log jams are definitely trapping a huge volume of sediment in the reach. Ok
- Step 3 Erosion = 0. No erosion as the channel widens in CEM III? Step 7.3 row 2 = fair "moderate/high scour and erosion…" Are the only areas of erosion at the mass failures? No erosion other than mass failures was observed. It's certainly possible that some of the banks were eroded and are now buried in cobble deposits. Ok
- Step 3 – left revetment type – 'multiple" – please provide a note as to types, to help with knowing what being used for bank protection. Thanks. Added comment in Step 5, 530' of hard bank where a stacked stone wall runs along the edge of Roy Rd, the rest is rip-rap. Ok – thanks, helpful to know .
- Step 4.8 constrictions – "bedrock outcrop" – is this a natural pinch point in the valley (bedrock both sides of channel)? Is it at one of the ledge grade control features? If yes, please note; if not, would you please provide a point shapefile of location on reach to help understand where/how it may be affecting reach. Thank you. This constriction is located at the downstream grade control (immediately above the alluvial fan). The stream can get over the ledge and out of the gorge at very high flows. I edited the LVW to pull it in at the gorge to better match pictures. Ok - thanks
- Step 5 notes – "large bars upstream of grade controls…" How is the USGS weir influencing sediment transport? Is it something to consider for removal? The weir is trapping a lot of gravel on the right margin and scouring down on the left margin. Likely not much room for additional storage. Alluvial fan not far downstream (and no mass failures between the AF and the dam) indicates that plenty of material made it over the weir during the floods. We will add the weir removal as a potential project, although it would be lower priority compared to other weirs in the watershed. Ok – helpful to know is a lower priority, and may not be a necessary project, but something to explore if opportunity available.

<u>T3.7S1.02</u>

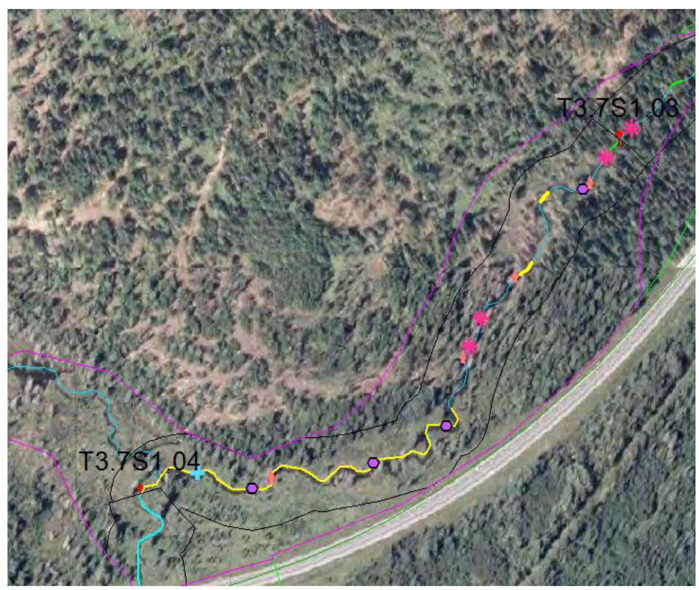
- Phase 1 comments – "field verification needed to confirm ref. stream type" – Have you determine this? Yes and updated. Ok
- Step 1.4 – left = very steep / right = extr. Steep ; Phase 1step 3.4 left=hilly / right = steep. Are the valley walls and adjacent hillsides different? Updated both to steep/X steep based on photos and field notes Ok
- Step 2.10 – Riffle type =eroded. Given the amount of aggradation and steep riffles, are the riffles still eroded? Riffles are typically narrow and cutting through aggraded channel material, degradation is the dominant channel process so we selected "eroded" for riffles. Ok
- Step 7 narrative – "we selected degradation as primary adjustment due to number of steep riffles cutting…". How do you think the floodplain connection on left bank will be affected as the slope adjusts through the sediment. Will a STD occur? Will the incision increase from 1.3? Or will the sediment transport dampen the incision? The reach is narrower than predicted indicating that incision is likely still ongoing and will continue as the channel works through the flood deposits. A STD is possible given the large volume of loose and unsorted material remaining in the channel. Ok – important to understand as look at strategies for the reach

  Step 5.1 - While associated with aggradation - If the "steep riffles" are actually locations of bed degradation, such that further incision and/or loss of floodplain will occur, it may be better to term them "head-cuts" to better represent the level of adjustment anticipated through further degradation. Are these locations potential areas to be addressed to arrest the head-cutting process and reduce further incision? We observed these steep-riffle/head cut areas in several reaches, we assessed them as steep riffles where the channel is cutting through thick cobble deposits. These are a temporary feature in response to major deposition from recent storms. We expect these to moderate once the channel has established a stable profile. Ok – given that potential to still to have a STD, and in many instances yes to further incision noted on this and other reaches where these are occurring; this process seems important to talk about in the report and how it may influence management strategies in these areas.

You do not seem to be consistent in how these type of features are being labeled, some are "steep riffles' and a few are "head cuts" – associated with sediment (as on T3.7S1.07). What level of difference in the feature did you consider to determine it as a "head cut" versus a "steep riffle" if all are associated with aggradation? The Steep Riffle / Head Cut demarcation is tricky in these reaches. We assessed the more severe instances as head cuts, these features are more likely to move upstream and possibly locally change channel geometry. The steep riffles are temporary features where the channel is cutting through the downstream edge of a thick bed material deposit. These areas will naturally arrest once the slope has been smoothed through upstream cutting and downstream deposition.

- Step 7.1 – Row 1 – Fair "sharp change in slope, head cut present.." As above, are the steep riffles significant changes in slope, and effectively acting as head-cuts ? We assessed them as steep riffles for the reasons mentioned above - not bad enough to be considered head-cuts and should resolve themselves as the bed profile stabilizes. Ok – but if potential to have STD in this process, are there areas to focus on to make sure that STD does not occur? There is enough coarse material still working through the channel that I don't think an STD is likely as the channel stabilizes.

T3.7S1.03



- Step 1.3 – encroachment roads -1,352. In looking at the S09 corridor, the road does not fall within the corridor; so is not considered an encroachment in this instance. Please review. The fill material used to build up the road bed affects most of the area FIT'd as encroachment, updated to remove middle portion that does not have fill material within the corridor. Ok
- Step 1.4 valley width/human changed valley width = yes. The Phase 2 and Phase 1 valley walls are the same in this area and road is valley wall in both instances. Should there be? Changed to "no". Ok
- Step 1.4 side slope = flat; Phase1 = hilly. Are the side slopes and valley slopes different? Yes, corridor is totally flat, valley slopes outside of the corridor are hilly/steep. Ok
- Step 2.14 – bed material = sand. Phase 1 = gravel. Has there been a change in bed material? No, updated Ph1 Ok
- Step 7 CEM = V, narrative "assumed this reach went through adjustment and has stabilized in V CEM". The cross section did not appear to have an upper terrace or other feature that appeared as an old floodplain at a higher elevation. Was there evidence of this in other locations along the reach? Could it have remained in CEM 1? What makes you feel that it gone through the entire CEM and has developed a floodplain at a lower elevation? Review of historical imagery shows agricultural field management through the reach. We suspect that historic straightening or channel manipulation likely occurred and the channel has since progressed through the CEM. I'm not sure that is always the case, some channels can be managed extensively, but retain their floodplain connection and are just modified in their plan form. Unless there is good evidence this is now at a lower elevation than the rest of the floodplain; it could still be in CEM 1. By putting it in CEM 5, it is implying a bunch of incision/widening/aggradation occurred on this reach to get it to where it is today. Is that the case? Agreed, the channel does not appear to have reestablished at a lower elevation, changed to CEM I.

T3.7S1.04

- Step 1.4 – alluvial fan = yes. Is this a location that will always set up a fan? Please provide the general extent of the fan, as it will influence the corridor width. Probably just in response to major bedload from the recent storms and likely not a permanent feature. Approximately 100' long and 50' wide. Ok- please add note, so can help track for strategies on the reach, that may not need wider corridor for this type of fan. Added a note in Step 5.
- Step 4.8 – 1 constriction noted; there are 2 bridge/culverts in Phase 1. Please review and update. Added parker rd culvert as a constriction. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible - changed to "yes", reach appears to primarily be widening and has lots of room to adjust within the corridor. Ok
- Step 7 narrative – "showing increased bank slumping (not indexed as erosion)". Please explain why – if this is in CEM III is this evidence of the process happening? Width of bkf = 19', and P1 channel width 18'; will this channel become wider, or is it moving more laterally and maintaining width? Only indexed areas with raw banks, did not index areas of slowly slumping vegetated banks. Added some additional erosion on outer bends. Stream is moving laterally and not widening, changed CEM to IV and updated Step 7 comments. Ok

T3.7S1.05

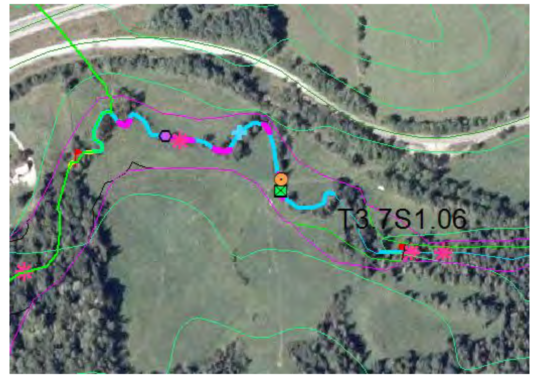
- Step 2 LWD = 141, Wow. Is the LWD playing any role in channel storage of sediment and/or causing other channel adjustments? Yes there are some huge cobble/gravel/sand deposits stored behind debris jams, causing localized widening above and increased scour below. Ok
- Step 4.8 – 1 constriction noted; there are 2 bridge/culverts in Phase 1. Please review and update.
    - In-stream culvert is 8.5', yikes that is significantly smaller than bkf of 25'. Would this be a priority for project; any evidence of flood damage? Large cobble deposits above, erosion, and flood chute above. Some evidence of road work - definitely possible the culvert was exceeded or plugged and the stream came over the road. On the potential project list. Ok
- Step 5 notes – "large unstable bars filling ~ 75% of channel…" Are there bars at bankfull/lower/higher? Are they being accessed as floodplain and/or will become abandoned floodplain as incision process works through? Bars are mostly at bankfull and are used as floodplain. Would become abandoned floodplain if the channel continues to incise. Ok - seems good to note given the headcuts noted. Added note in Step 7.
- Step 7 narrative – "FIT'd as steep riffles, but they are due to degradation…." While these may be associated with aggradation if they are actually degradation of the bed such that there will be further incision, increasing it > than current 2!, then it may make more sense to be FIT'd as "head-cuts" to document the degradation process of the channel. Are these locations potential areas to be addressed to arrest the head-cutting process and reduce further incision? Changed the downstream two SR's to headcuts, the other is a localized slope increase where the channel is cutting through a thick depositional layer. Ok – should these headcuts be addressed to reduce potential floodplain loss? The large headcut at the bottom of the reach is on the project list, it is more severe and likely should be addressed.
- Step 7.1 – Row 1 – fair – "sharp change in slope/head cut/trib rejuv." None are noted, if steep riffles are causing a significant slope change in the bed and/or degradation, perhaps should be indexed as head-cuts. Updated with a headcut, and the SR is a sharp changes in slope. Ok
    - Row 5 – fair – "evidence of significant historic channel straightening/dredging/gravel mining and/or channel avulsions" – None are noted. Changed to "good" numerous flood chutes, could be old avulsions? Ok
- Step 7 sensitivity = very high; would be "extreme" with STD. Updated Ok

T3.7S1.06

- Phase 1 comments – "channel slope close to 1%,….elevation data is likely in accurate due to close proximity to elevated road…". Could you make an estimate of the elevation, such that it is more accurate? How would this affect the slope of the upstream reach (< > slope ?)? Stream type subclass slope noted as "b"; is this accurate given note that is close to1%?
- Seg. A&B Step 4.8 – 1 constriction noted in each segment; there are 3 bridge/culverts in Phase 1. Please review and update to appropriate segment. Added timber bridge as a constriction on segment B. Ok
-

T3.7S1.06A

- Step 1.1 –Segment reason – Please indicate as "sub-reach". This will help quickly flag that the segment is a naturally different reference stream type Updated Ok



- Step 1.5 valley – review of the P2 valley wall lines – it looks like the valley wall delineation (purple line)is on the stream buffer area. When looking at the NAIP and contours it looks like a large field with no obvious change in feature heights. What feature is not obvious that is being called the valley wall? VW delineation is good and based on field observations, there is a flat area within the corridor and then a moderate gradient up for the entire cleared area. Ok hard to see this, will look to do field visit to get more familiar with it
- Step 3 – upper/lower bank = mix coshesive. Not expected, what is this made up of ? Sand/silt/gravel, changed to non-cohesive. Ok
- Step 5 notes – "likely inaccurate elevation…" Same as P1 comment, any ability to improve this? Channel can be re-mapped using current imagery. Elevation from Hydrodem is likely ~10ft high at the top of the reach due to the roadway fill.
- Step 7 narrative "deeply incised due to presence of historic armoring on field edge". I see mostly on rip-rap on outside of bends, not too much on both banks at same time. Is this creating localized pinch points and/or increase in slope that would trigger a head-cut? No straightening noted. Does not seem like bank armoring alone would have caused the level of incision given the limited amount; what other evidence may support this? Added two stretches of straightening and a comment to step 7. Sediment trapped by the upstream stone culvert may also increase incision downstream. Ok
- Step 7.1 – STD = Other. This is noted as a subreach of "E" for the reference of "C" ; what is the "other" STD. No STD option for C to E? This appears to NOT be a STD, given you have put this as a "reference E" sub-reach in step 2. If this is truly a STD, then should not have information in step 2 for "sub-reach stream type". Please review and determine if really a STD or an "E" by reference. Mistake during last set of updates– segment should be C under reference and an STD to E.
- Step 7.1 Row 2 & Step 7.3 Row 3– poor "incision > =2 and/or entrenchment <= 2", the incision ratio is 1.74 and entrenchment =44. Would land in "fair". Updated
- Step 7.3 Row 2 & Step 7.4 Row 1 – fair "moderate to high scour/erosion". Only 18' of erosion document on one bank. No mass failures or other evidence of mod/high scour/erosion. Should there be? Added some additional erosion based on pictures, lots of vegetated slumping banks throughout. Ok
- Revisit stream type/ departure, channel evolution etc. With the added straightening we like the selection of C->E STD with Stage II. Ok – see note above for Step 2 ref. stream type.

T3.7S1.06B

- Step 2 LWD = 150, wow, is this influencing the channel? Big jams at the top and bottom of the reach are holding a large volume of sand. Ok
- Step 2.8 – incision =1.26. Given the very high incision ratio in Seg. A; is there any concern that the incision process may move up into this segment and cause loss of floodplain? No, the return to natural buffer vegetation and LWD seem to protect the channel from incision. Ok – good to note for importance on how this helps the reach
- Step 2.14 subclass slope = "b". Given the note on slope and elevation being inaccurate, is the subslope of "b" accurate? No - removed subslope b from P1 and P2 Ok
- Step 5 notes – "likely inaccurate elevation…" Same as P1 comment, any ability to improve this?
- Step 7 narrative – "major adjustments could likely occur if stone culvert repaired/replaced". It looks like the cross section was taken just below the culvert. Were you surprised the incision ratio was only 1.2 given the level of sediment trapped above the culvert? Somewhat, if the sediment has been there for a long time (likely since Rt 2 construction) then the channel has had time to stabilize. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible; CEM=III Changed to "yes" Ok
- Step 7.4 Row 4 =poor "major alteration of channel planform and the width of floodprone area from <u>recent</u>/<u>extensive</u> encroachment dredging and/or channel straightening". None of these are present. May fit in good or fair to capture the historic culverts encroachment in floodprone area. Updated to "fair" Ok

T3.7S1.07

- Step 2.10 = eroded. With the level of aggradation noted are the riffles still eroded in most of the reach? Riffles tended to be narrow as the channel is cutting down through recent deposits. Ok
- Step 2 LWD = 174, wow, is this influencing the channel? Large jams are definitely storing sediment. Ok

- Step 4.8 – Yikes, all 3 culverts are significantly smaller than bkf. Are these potential projects, see in Step 5 notes, that one caused major scour and upstream deposition. Other flood damage seen? Not much flood damage, maybe some damage between #1 and #2 was due to the culverts. Culverts will be included in project list, both for potential replacement, and for fish passage. Ok
- Step 7 narrative "several headcuts….. degradation dominant adjustment as process cuts through deposits…." Will the incision increase from 1.4 as this process continues? How will sediment and/or will sediment moving through the system mitigate the potential increase in incision? Incision will likely increase throughout the reach, there was still a lot of fine material on the bed to work through. Ok – *
    - Do the headcuts need to be addressed to stop further incision and loss of floodplain? Probably not, they are mostly just working through recent deposits of sand and gravel. Ok - * given further incision likely, how are these areas additional loss of floodplain access going to impact the reach.
- Step 7.1 – row 5 – good "evidence of bar scalping/channel avulsion". None are noted. Should there be? Changed to fair, no bar scalping was observed, but some of the flood chutes could be old avulsions. The flood chute immediately downstream of Cormier is a new channel locations but this is likely due to the culvert being re-aligned after the floods (as described by neighboring land owner). Ok

Sheldon Brook

T4.01

- Step 2.10 = eroded; with number of steep riffles are most riffles still eroded? Riffles tended to be narrow as the channel is cutting down through recent deposits. Ok
- Step 2.14 bed material = cobble. Phase 1 = gravel, Please review and update for appropriate ref. bed material. Updated P1 to cobble Ok
- Step 4.8 – 1 constriction noted; there are 2 bridge/culverts in Phase 1. Please review and update. Updated Ok
- Step 7 narrative – "degradation is dominate process due to controls on migration" Will this reach always be in stage 2? Is the reach going to continue to incise such that the incision ratio will be great than 1.74? Are the berms effectively stopping any potential for migration. Rip-rap looks limited to one side at a time in most spots, is it enough to prevent movement in other areas? Channel width is similar to expected width from HGC and still maintaining a "C" stream type; is this likely to change with degradation as dominant process? Would active restoration be needed to allow it to move from CEM II? Reach is starting to move around some in the lower half. If the banks aren't further armored or if some armoring is removed, the channel will likely get out of Stage II, but this will likely take many decades and more floods to energize the channel. The berm and armoring would need to be removed for the upstream to have much chance of getting past stage II. Ok – important to understand for strategies on the reach

T4.02

- Step 2.8 - = 1. Wow, a reach that is not significantly and/or at all incised. What do you think helped this reach maintain its floodplain connection during the recent flood when many other reaches appeared to incise? I think the relatively coarse substrate size and the consistent slope help move sediment through the reach without major deposition leading to channel constriction and incision. Ok
- Step 7 narrative – "floodplain bench is present and accessible at most high flows.." Is this also at bankfull flows? Is this contributing to this reach not incising as other reaches did? At or slightly above bankfull for most of reach, yes this bench likely helped to reduce incision. Ok

T4.03

- Seg. A&B Step 4.8 – 1 constriction noted in each segment; there are 3 bridge/culverts in Phase 1. Please review and update to appropriate segment.

T4.03A

- Step 1.1 –Segment reason – Please indicate as "sub-reach". This will help quickly flag that the segment is a naturally different reference stream type. Updated Ok
- Step 2.8 – human incision ratio - = 0 ; should the berm be noted for any level of incision? The tall berm is short and has a little bench in front of it, didn't get full measurements but I would estimate that incision is closer to 2 for the short stretch with the tall berm. Added a note in Step 5. Ok –
- Step 3.1 – lower material = sand. Very erodible material. Surprised only 29' on one bank of erosion. With flood scour noted in Seg. B, why do you think this reach less erosion? With this in CEM II, would you expect increased erosion? Changed both lower banks to "mixed". Pictures show no erosion outside of mass failures. Banks were either stable and vegetated with gravel/cobble, or were scoured back but very stable with dense roots. Given the exposed varved clay on the mass failures, might be more cohesive throughout. Ok

- Step 7 narrative – "newly constructed berm limiting floodplain access and contributing to further degradation…" Would this be a priority project to look at for providing floodplain access? On the project list. Ok – help highlight what benefits would be if removed to understand priority needs.

T4.03B

- Step 7 CEM = III. Given Seg. A is in CEM II, do you think the increase erosion potential from channel widening in this segment as moves through CEM III will contribute additional sediment to Seg. A that may help move CEM to next stage in Seg. A? Yes I do, might help things along if the berms are removed in the upper reach also. Ok

T4.04

- Step 4.8 – bridges with width of 23', not noted as channel constrictions. Bankfull width is ~31' in Phase 1 and 33' in Phase 2. Appear to be channel constrictions. Yes – updated Ok
- Step 7 narrative – "short stretch showing planform adjustments and CEM IV….". The overall reach is noted as CEM II. Is there significant difference in the area of planform adjustment that it has leaped two stages of CEM from rest of reach. This short stretch is different from the rest of the reach, but after reviewing the data we agree that the predominant CEM should be stage III. Ok
  - Would the CEM for reach be still in II or has it moved to III? Changed to stage III and degradation updated to historic. Ok

T4.2S1.01

- Step 2.8 bed material = gravel; Phase 1 step 2.11 = cobble. Is this a shift in bed material from reference? A large portion of sand in the pebble count, did this surprise you? Does it seem natural or an increase in these fines, such that it is shift in bed material? Likely a shift in bed material, could be temporary as flood deposits work through the channel. Given the slope and the size of the stream, would definitely expect cobble or boulder for dominant substrate. Ok

Wheelock Brook

T5.01

- Step 2.10 – riffle type "na". If not plane bed by reference, is applicable. Would these be "eroded" and now is plane bed instead of riffle/pool? There were no riffles in entire reach, changed to eroded with spacing 0. Ok
- Step 2.8 = 1.2. This seemed like a moderate incision ratio given level of straightening and no grade controls. Most of the area straightened did not show rip-rap, are these ledge banks? Is level of rip-rap accurate (only rip-rap shown near bridge and below Rt. 2 culverts. Channel width is also much narrower, 28' vs 45' . What may be limiting incision.
  - Step 7 narrative – "incision is dominant process with aggradation, widening, and planform limited due to straightening and armoring throughout reach…" Given level of incision seen in other reaches from flood what may have reduced this reach from incising more if incision is dominant process? Bedrock on both sides, channel was blasted out, might be bedrock underlaying channel under a layer of cobble/gravel. Lower reach can't incise more due to slope and elevation of the CT river.
- Step 2.14 =F4 plane bed - ? if this is worth looking at for modified ref. stream type given level of modification and limited opportunity to go to "C" . Given narrow channel with "bedrock on both banks" in notes, will it have the opportunity to move from F condition? No opportunity above the highway, could go back to C for downstream stretch with major restoration effort. Changed to modified reference F4 plane bed. Ok – be sure to also note reason in Phase 1 comments to indicate reasons for modified ref. stream type. Added P1 Step 7 comment.
- Step 3.1 upper bank material = sand <u>cohesive</u>; should be "non" Actually should be bedrock for upper - updated
- Step 5 notes – "lined with bedrock on both sides…." These are not noted as channel constrictions or grade controls. Seems like important to capture as appears to be influencing the channel. Are these grade controls, or simply on the banks? Consider FIT as "other" for rip-rap; and make note of it as bedrock control, to help capture that channel is going limited due to hard banks. Added a bedrock constriction. Added hard bank armor for upper section, both banks. Ok
- Step 7.2 – score of 5. Row 1 is in poor, but Row 2 is in good; only if both Row 1 & 2 are in poor would you automatically score the process as "poor". Do you still feel a score of 5 is appropriate for aggradation? - updated to fair and score to 8. Ok
  - Row 6 –Fair " human made constrictions causing major up/down deposition" None of the structures are causing any deposition. Perhaps "good" is appropriate. Agreed, updated Ok

T5.02

- Step 1.4 – left/right = hilly; Phase 1 valley = steep; are the adjacent hill slides and valley walls different? Yes, especially in lower reach
- Step 1.5 – looking at valley file, was the development on right bank up on fill such that it narrowed the valley from the road (pink P2vw, green P1vw)? We saw some bedrock under several of the houses so I'm guessing it is not on fill. Ok –good to know
- Step 2.8 – human incision – There is a berm noted, how is this influencing incision ratio?
    - incision = 2.2. Looking at the cross section it looked like the left bank 2x bkf floodplain is almost being accessed but for a small rise at the front and perhaps a little high in the middle. Do you think this area would be worth exploring floodplain restoration? Might be accessed in a few low points as is, would be a lot of work to restore access, raising bed elevation is probably the best bet but would be difficult if it might threaten the road or the low bridge. Ok
- Step 2.10 = sedimented. Did not seem like much sediment bars, and with high incision, caught my eye. Step 5 notes "bar formation minimal…indicating sediment transport through the reach." Would these be an indication the channel is starting to get sediment set up in the system and start moving to CEM III? Transitioning to III is definitely possible, especially in the lower reach. Fairly extensive armoring is limiting this transition. Ok
- Step 3 revetment type = multiple. Please note types in comments for tracking, thanks. Updated step 5 comments. Ok
- Step 4.8 old abutments. Would these be a potential project for removal? Does not seem like any problems associated with them, but was curious if any potential benefits for removal. Removing the LB abutment and possibly the old elevated road bed is on the project list. Would likely increase accessibility to LB floodplain and allow additional planform adjustment. Ok
- Step7 narrative "incision is dominant process….." Is this still an active process; the Step 7.1 is "historic = yes"? Is the channel likely to incise greater than the current 2.2? Incision will likely continue until the armoring fails or is removed in the downstream section. Ok – yikes, that is very important to keep in mind for management strategies given infrastructure along this reach.
- Step 7 sensitivity = very high; would be "extreme" width STD to F4 Updated

T5.03

- Step 1.4 right hillside = hilly; Phase 1 = very steep. Are the adjacent hillside and valley slope different? Yes Ok
- Step 4.8 old abutments width = 40', not noted as channel constriction. Seemed narrower than bankfull. Updated and changed to 30' based on photos. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible; CEM=III Updated step 7 comments, further incision is possible in some areas. Ok
- Step 7 narrative " incision is the dominant process…". Is incision still likely, with an increase in incision ratio of 1.97? You have CEM in III, appearing to be moving to widening? The P2 width is 50, and P1 is 44 which may support some level of widening process. Updated comments
    - Do you think there is room in the valley and floodplain to move this back to a "B", or is the channel likely to maintain an "F" given level of encroachment and confined valley. Management considerations? STD to F was likely due to recent flooding. Banks are fairly stable now and bars are reestablishing along the channel margins. Should be able to return to B eventually. Ok

T5.04

- Step 1.4 right hillside = hilly; Phase 1 = very steep. Are the adjacent hillside and valley slope different? Yes Ok
- Step 3 upper banks = sand, lower banks = gravel. Step 5 notes "well vegetated and naturally armored banks (stony soils) are likely limiting….." With sand/gravel banks, would not appear strong armoring of banks as noted in comments. How are these soils/banks perhaps different to resist widening? Is the vegetation playing that big of a role? Changed to gravel uppers and cobble lowers. The banks had naturally armored themselves as the finer materials were scoured away. Dense roots in upper banks in sandy gravel soils. Ok
- Step 4.8 constrictions – "bedrock outcrop" – is this a natural pinch point in the valley (bedrock both sides of channel)? Is it at one of the ledge grade control features? If yes, please note; if not, would you please provide a

point shapefile of location on reach to help understand where/how it may be affecting reach. Thank you. Bedrock gorge for approximately 80' at the top of the reach, FIT'd as 3 grade controls. Ok

- Step 7 CEM=II; Step 5 notes "several areas of widened channel with large side bars observed throughout reach…" Step 7 narrative notes "some widening through bank scour, but banks appear stable" Are the areas an indication moving to CEM III? Still II but transitioning to III soon, updated step 7 comment. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible; Yes in some areas Ok

T5.05

- Seg A & Seg. B- Step 1.4 right =hilly, Phase 1 Step 3.4 = very steep; are the hillside and valley slope different? Changed P2 to very steep Ok
- Seg. A & Seg. B – Step 2.15 subreach stream type is filled in for both segments. Please choose the dominant condition for reference stream type in Phase 1, with the other segment making up a subreach with different ref. Removed subreach from B, gravel substrate in P2 reflects recent deposits working through. Ok

T5.05A

- Step 1.1 –Segment reason – Please indicate as "sub-reach". This will help quickly flag that the segment is a naturally different reference stream type. Updated
- Step 3 lower bank =boulder/cobble. Interesting change from Seg. B lower material of gravel. This seg. is CEM II, and Seg. B is CEM III. How do you think influencing channel adjustments? Natural bank armoring is definitely reducing channel migration and widening in A. Ok
- Step 4.5 flow feg. = none. There is a dam in the grade controls. Is this also a flow reg? Run of river? Typo - bedrock GC not a dam, updated in FIT Ok
- Step 5 notes " elevated and inaccessible terrace….." Was this a "recent abandoned floodplain" or an old glacial terrace?
- Step 5 notes "may have been historically straightened and armored along left bank to protect ag. fields in upper segment…". There is no straightening FIT'd or noted, should there be? Bank armoring is only ~160' out of ~ 2,756', and does not seem associated with ag. fields, rather at points near the road. Was there old/ failing rip-rap somewhere not FIT'd? We did not observe any armoring along fields, added some straightening in that area.
- Step 7 narrative "incision is the dominant process…..". Will further incision occur? There are a significant number of grade controls on this reach, is the incision the same between grade controls? Are they moderating the incision? Is the dam capturing sediment? Further incision is possible, bed is fairly flat due to recent gravel and cobble deposits, some incision is likely if the channel attempts to reestablish riffle pool sequences between the grade controls. Ok
    - Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible;

T5.05B

- Step 3 erosion = 0. With channel in CEM III and Step 5 notes "bank scour during recent flooding", it caught my eye that no erosion was happening. It also notes "banks generally very stable". Do you expect erosion to increase with CEM III process? Not much, banks are well vegetated, rocky, lots of roots, and there is some bedrock in areas that would be more likely to erode otherwise. Ok
- Step 7 narrative " recent deposition features along channel margins indicate the channel is beginning to aggrade and reestablish lower bank features" Is this an indication it may have and/or is moving from CEM III to CEM IV? Possibly given the limited opportunity for further widening. Added comment in step 7. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible; CEM=III. Less likely in this segment, changed to "yes" Ok

T5.06

- Step 1.4 left/right hillside = hilly; Phase 1 = very steep/steep. Are the adjacent hillside and valley slope different? Changed P2 right corridor to steep, left corridor is flatter, valley walls are very steep. Ok
- Step 4.8 constrictions – "bedrock outcrop" No width is noted; please provide if possible. – is this a natural pinch point in the valley (bedrock both sides of channel)? Is it at one of the ledge grade control features? If yes, please note; if not, would you please provide a point shapefile of location on reach to help understand where/how it may be affecting reach. Thank you - The constriction is at the second grade control (picture P1050196), bedrock continues up both banks and the channel in constricted to ~30'.
- Step 5 notes "wide terrace (not recently abandoned floodplain)…." Is this glacial? Most likely. Ok
- Step 7 narrative "Aggradation appears to be dominant process. D-stage CM chosen due to abundant grade controls". Step 7 CEM = D-IIb Agreed, changed to F Ok

- This is not consistent with other reaches that have as many/more grade controls as this reach; ie: T5.05A, T5.07 both have 6 or 7 grade controls. It also appears this reach has a moderately high incision ratio of 1.7. Given level of incision and other reaches being placed in "F" CEM, this reach seems like it would also fall under that CEM process. Is this reach moving to CEM IV with the level of aggradation. The width seems similar to what might be expected. Updated to IV Ok
- How are the numerous grade controls moderating the incision? Is the incision the same ~1.7 between grade controls, or are some areas higher/lower? Incision is consistent through reach, lower along the large grade control at the bottom of reach. Ok

T5.07

- Step 1.6 – multiple grade controls: How are the numerous grade controls moderating the incision? Is the incision the same ~1.6 between grade controls, or are some areas higher/lower? Incision consistent through reach. Banks are lower along some of the larger GC's but channel slope and width are increased so floodplain access is likely similar to rest of reach. Ok
  - There is a "dam" noted in grade controls. I was looking to see if this was the flow reg. but does not appear to be. Looking at the FIT, impact ID #749, description for dam is "ledge grade control that has moderate gradient and extends ~ 250'" Is this a dam, or ledge? Typo - updated to ledge. Ok
- Step 2.8 – human incision – There is a berm noted, how is this influencing incision ratio? Minimally, berm is fairly low and in an area where the bed is raised and smoothed due to deposition and possibly machinery. Ok
- Step 2.12 LWD = 111, wow. Is this influencing channel process? Yes and variably, no wood was observed in the stretches that had buffer <25, lots of wood in the forested reaches. Jams caused mid-channel accumulation of gravel in several locations. Ok
- Step 2.14 bed material = cobble. Phase 1 bed material = gravel. Confirm reference bed material for Phase 1. Updated P1 Ok
- Step 4.5 – Flow reg as small withdrawal – I see in FIT is a pipe and not necessarily an impoundment; does it appear to a primary water source? It looked to be on the eroding bank, and not armored. Is it something likely to be protected? That pipe used to be on the bank! The withdrawal is not functional but we assumed another withdrawal was operating elsewhere to pump water to the cow pasture. Ok – perhaps something to highlight to see if another water source is more appropriate/needed to reduce the potential conflict at this area if still active water source.
- Step 4.8 – 1 constriction noted; there are 2 bridge/culverts in Phase 1. 2nd bridge is not a constriction for floodplain or channel. Please add to Phase 2 data to help with tracking of structures and provides a minimum amount of data to show structure is not an issue. Added footbridge to constrictions
  - For bedrock outcrop, please note if with ledge grade control point; or please provide point shapefile for location. Thank you. Located at the grade control immediately upstream of the water withdrawal pipe. Picture 1050259. Ok
- Step 7.1 - Historic noted as "no" – is this still an active process – further incision possible; CEM=III, Probably not, changed to "yes". Ok

APPENDIX B

PHASE 2 STREAM GEOMORPHIC ASSESSMENT DATA

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.07-0	Organization:	
Segment Length(ft):	4,113	Observers:	JHB,MPL,EPF
Rain:	No	Completion Date:	8/28/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break Southeast of Keyser Hill Rd and continues upstream to the reach break Northwest of the Water Andric Rd crossing**

Step 5 - Notes: **Reach has been historically straightened and armored, primarily along the hayfield edge on the left bank. Slumping but somewhat stable banks likely covered additional historic armoring on the left bank. The stream is trying to widen along the right bank leading to several areas of erosion, mass failure, and debris jams. Two short stretches (~300') of steeper and narrower B geometry were observed mid reach and at the top of the reach. Neither section was long enough to justify segmentation and the cross-section was representative of the typical channel geometry for the reach.**

Step 7 - Narrative: **Channel was likely incised due to historic armoring along the left bank to protect hayfields and a tight valley wall along the right bank. Recent episodic flooding lead to the widening and subsequent deposition throughout the reach. Vertical banks and failed armoring were observed along the left banks and heavily scoured lower banks (not indexed in FIT) with falling trees were observed along the right banks. Most scoured bank areas are stable due to natural rock deposition and/or dense root mats. Areas with raw and failing soils were indexed as erosion. Large unvegetated depositional features were observed throughout reach. W/D ratio is low due to recent deposition within the channel, likely due to huge inputs of sand and fine gravel from numerous large mass failures immediately upstream.**

Step 1. Valley and Floodplain

1.1 Segmentation: None

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	922	5	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	180		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Very Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Never	Sometimes
Texture:	Sand	Sand

1.5 Valley Features	
Valley Width (ft):	260
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls: None

Stream: **Water Andric** Reach: **T2.07-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**32.72**	2.11 Riffle/Step Spacing:	**110 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.20**	2.12 Substrate Composition		Bed:	**170 mm**
2.3 Mean Depth (tf):	**2.43**	Bedrock:	**0.0 %**	Bar:	**130 mm**
2.4 Floodprone Width (ft.):	**106.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.10**	Cobble:	**19.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**64.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**13.47**	Fine Gravel:	**9.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.24**	Sand:	**8.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.59**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**6.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**102**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**142.8**	**182.2**
Erosion Height (ft.):	**3.6**	**5.7**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**814.3**	**209.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Coniferous**
Sub-dominant:	**Coniferous**	**Herbaceous**
Bank Canopy		
Canopy %:	**1-25**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**2,270**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Hay**	**Forest**
Sub-dominant	**Forest**	**Hay**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**20.0**
Gullies	**Multiple**	**7.0**

	Left	Right
Mass Failures		**98.899 99**
Height		**23.4**
Gullies Number	**2**	
Gullies Length	**300**	

Stream: **Water Andric** Reach: **T2.07-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **6**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **1**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **2**

Affected Length (ft): **120**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	22	Yes	No	Yes	Yes	Deposition Above,Scour Below
Bridge	24	No	No	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: **1**

Mid: **9** Delta: **0**

Point: **9** Island: **0**

Side: **11** Braiding: **0**

5.2 Other Features

Flood chutes: **1**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **1**

Neck Cutoff: **0**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **628**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic
7.1 Channel Degradation		10	None	Yes
7.2 Channel Aggradation		11	None	No
7.3 Widening Channel		9	None	No
7.4 Change in Planforml		10	None	No
Total Score		40		

Geomorphic Rating **0.50**

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.08-A	Organization:	
Segment Length(ft):	1,922	Observers:	JHB,MPL,EPF
Rain:	No	Completion Date:	8/28/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break Northwest of the intersection of Water Andric Rd and Excelsior Farm Rd and continues upstream to the segment break 180 feet downstream from the Water Andric Rd crossing**

Step 5 - Notes: **Water Andric Road was not used to define Ph2 valley walls due to the very low height of the encroachment and clear evidence that recent high flows accessed the floodplain on the far side of the road in numerous locations. Major sand and gravel deposition throughout reach with bars typically occupying half of the channel. Several large debris jams and beaver dams (1 full, 2 failed) are also increasing sediment deposition.**

Step 7 - Narrative: **Widening and aggradation following a recent episodic flooding event are the dominant processes in this segment. Bank scour along lower banks (not FIT'd as erosion) and some bank failures were observed throughout the reach except for areas of heavy bank armoring along the road. Most scoured bank areas are stable due to natural rock deposition and/or dense root mats. Areas with raw and failing soils were indexed as erosion. Large unvegetated depositional features were observed throughout reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	1,917	3	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features	
Valley Width (ft):	230
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream: **Water Andric** Reach: **T2.08-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**40.37**	2.11 Riffle/Step Spacing:	**120 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.00**	2.12 Substrate Composition		Bed:	**50 mm**
2.3 Mean Depth (tf):	**1.67**	Bedrock:	**0.0 %**	Bar:	**40 mm**
2.4 Floodprone Width (ft.):	**100.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.65**	Cobble:	**0.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**37.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**24.17**	Fine Gravel:	**48.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**2.48**	Sand:	**15.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.22**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**1.5**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**4.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**107**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**39.8**	**34.0**
Erosion Height (ft.):	**7.0**	**3.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**222.9**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Herbaceous**
Sub-dominant:	**Herbaceous**	**Coniferous**
Bank Canopy		
Canopy %:	**76-100**	**26-50**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**26-50**
Sub-Dominant	**26-50**	**0-25**
W less than 25	**0**	**605**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Herbaceous**
Sub-Dominant	**Shrubs/Sapling**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Shrubs/Sapling**
Sub-dominant	**None**	**Hay**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**10.0**
Gullies	**None**	

	Left	Right
Mass Failures	**27.84**	
Height	**10.0**	
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report

Lower Passumpsic

Stream: **Water Andric** Reach: **T2.08-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **6**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **1**
Affected Length (ft): **25**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**		
Mid:	**6**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**		
Point:	**5**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**		
Side:	**6**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**		

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**14**	**None**	**No**	Geomorphic Rating	**0.54**
7.2 Channel Aggradation	**9**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**10**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**10**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**43**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: Water Andric
Reach: T2.08-B
Segment Length(ft): 1,896
Rain: No

SGAT Version: 4.56
Organization:
Observers: JHB,MPL,EPF
Completion Date: 8/28/2013
Qualtiy Control Status - Consultant: Provisional
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **Begins at the segmentation point ~180 feet downstream of the Water Andric Rd Crossing and continues upstream to the next reach point where the road tuns back towards the river.**

Step 5 - Notes: **Water Andric Road was not used to define Ph2 valley walls due to the very low height of the encroachment and clear evidence that recent high flows accessed the floodplain on the far side of the road in numerous locations. Major sand and gravel deposition throughout reach with bars typically occupying half of the channel. Several large debris jams are also increasing sediment retention. Lower cross-section was located at a representative riffle near the bottom of the segment, just downstream of the bridge. A second cross-section was taken to illustrate B and F type geometry present in reach, and the reference conditions for the sub-reach. Large debris jams and multiple grade controls were observed throughout the reach.**

Step 7 - Narrative: **The segment incised during recent episodic flooding events due to roadway encroachment and tight valley walls limiting lateral mobility. Large deposits of cobbles and gravel from these recent events buried much of the channel. Steep riffles were observed in locations where the channel is cutting down through these deposits. Vertical banks and inaccessible floodplains were observed throughout the reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: Substrate Size
1.2 Alluvial Fan: None
1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	0		0	
Road:	818	3	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	364		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Hilly
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Sometimes
Texture:	Sand	Sand

1.5 Valley Features
Valley Width (ft): 180
Width Determination: Measured
Confinement Type: NW
In Rock Gorge: No
Human Caused Change in Valley Width?: No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	7.0	5.0	No	
Ledge	Mid-segment	5.0	4.0	Yes	
Ledge	Mid-segment	8.0	7.0	No	

Stream: **Water Andric** Reach: **T2.08-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**35.53**	2.11 Riffle/Step Spacing:	**180 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**2.20**	2.12 Substrate Composition		Bed:	**400**	**mm**
2.3 Mean Depth (tf):	**1.68**	Bedrock:	**0.0 %**	Bar:	**180**	**mm**
2.4 Floodprone Width (ft.):	**36.00**	Boulder:	**7.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**3.65**	Cobble:	**49.0 %**	Stream Type:	**F**	
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**18.0 %**	Bed Material:	**Cobble**	
2.6 Width/Depth Ratio:	**21.15**	Fine Gravel:	**21.0 %**	Subclass Slope:	**b**	
2.7 Entrenchment Ratio:	**1.01**	Sand:	**5.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.66**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**2.5**	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type		
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	**B**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**92**	Reference Bed Material:	**Cobble**	
				Reference Subclass Slope:	**None**	
				Reference Bedform:	**Riffle-Pool**	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**442.6**	**53.9**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**376**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Residential**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**25.0**
Gullies	**None**	

	Left	Right
Mass Failures		**320.26**
Height		**26.3**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Water Andric** Reach: **T2.08-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **4**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **2**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	36	Yes	No	No	Yes	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **5** Point: **5** Side: **10**

Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **0**

Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **2**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **None**

Straightening Length (ft.): **0**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type	Left	Right
6.8 Bank Stability:		
6.9 Bank Vegetation Protection		
6.10 Riparian Veg. Zone Width:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	5	B to F	No
7.2 Channel Aggradation	13	None	No
7.3 Widening Channel	12	None	No
7.4 Change in Planforml	12	None	No
Total Score	42		

Geomorphic Rating	**0.52**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.09-0	Organization:	
Segment Length(ft):	6,499	Observers:	JHB, MPL, FEA
Rain:	Yes	Completion Date:	10/29/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break located at the intersection of Water Andric Road and Winn High Drive. Reach closely follows Water Andric Rd (VAST trail) and ends immediately upstream of the trail crossing near Penny Ln.**

Step 5 - Notes: **Water Andric Road (VAST trail) was not used to define Ph2 valley walls due to the very low height of the encroachment and clear evidence that recent high flows accessed the floodplain on the far side of the road in numerous locations. Floodplains and/or terraces were typically elevated 3-6' above bankfull and were inaccessible. However, floodplain access was observed around large debris jams at sharp bends in the stream. One of these areas is immediately downstream of the stretch where the VAST trail is located very close to the left bank. The VAST trail is lower than the stream channel for approximately 300' and is separated by a narrow forested strip that is only 1-2' above bankfull. Therefore we expect this area to flood regularly and could lead to major channel avulsion.**

Step 7 - Narrative: **The channel appears to have incised during recent episodic flooding. Dense bank vegetation likely limited erosion and severe widening. Major sediment inputs from mass failures upstream and within the reach led to large depositional features and fine sediments working through the reach. Steep riffles were observed in locations where the channel is cutting down through these deposits. The reach appears to be transitioning from stage II to III CEM.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	0	8	0	
Railroad:	0		0	
Imp. Path:	3,534	6	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	250
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	3.0	2.0	No	
Ledge	Mid-segment	3.0	2.0	No	
Ledge	Mid-segment	1.0	0.0	No	

Stream: **Water Andric** Reach: **T2.09-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**36.70**	2.11 Riffle/Step Spacing:	**160 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.05**	2.12 Substrate Composition		Bed:	**350 mm**
2.3 Mean Depth (tf):	**1.36**	Bedrock:	**0.0 %**	Bar:	**80 mm**
2.4 Floodprone Width (ft.):	**70.00**	Boulder:	**3.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.05**	Cobble:	**38.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**33.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**26.99**	Fine Gravel:	**5.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.91**	Sand:	**21.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.49**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**10.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**260**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**743.7**	**37.5**
Erosion Height (ft.):	**4.6**	**6.0**
Revetment Type:	**Multiple**	**None**
Revetment Length:	**610.1**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**22.5**
Gullies	**One**	**2.0**

	Left	Right
Mass Failures	**87.77**	**333.23**
Height	**20.0**	**26.4**
Gullies Number	**1**	
Gullies Length	**80**	

Stream: **Water Andric** Reach: **T2.09-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **15**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	15	Yes	No	Yes	Yes	Deposition Above,Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **9** Point: **15** Side: **14**
Diagonal: **3** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **5**
Neck Cutoff: **0**
Avulsion: **1**
5.3 Steep Riffles and Head Cuts
Head Cuts: **0**
Steep Riffles: **6**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to B**	**No**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**11**	**None**	**No**
7.4 Change in Planforml	**12**	**None**	**No**
Total Score	**37**		

Geomorphic Rating	**0.46**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.10-0	Organization:	
Segment Length(ft):	3,423	Observers:	JHB, MPL, EPF
Rain:	Yes	Completion Date:	10/29/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at reach break immediately upstream of VAST crossing near Penny Ln. Reach ends at slope change and valley opening near recently logged area.**

Step 5 - Notes: **This reach had similar geometry to T2.09, however the increased slope has further cutoff access to the elevated floodplains. Large debris jams were present throughout the reach, and most of these were accompanied with flood chutes and deep deposits of sand and gravel in the floodplain. Floodplain access was not observed in areas not immediately upstream or around debris jams. A neck cutoff was observed in the upper reach where the stream carved through a tight clay valley wall on the right bank to cut off approximately 300' of meander to the left. This happened recently and a ~5' tall headcut is working through the feature. A possible alluvial fan was observed at the bottom of the reach immediately upstream of the large new culvert off of Penny Lane. It is likely that the old culvert plugged during high flows leading to the formation of a giant debris jam and significant deposition (2-3' deep filling valley) were observed upstream. This alluvial fan is likely not a permanent feature and may eventually reestablish and single thread channel after the sediment depots work through.**

Step 7 - Narrative: **The channel bed of this reach was heavily scoured during the 2011 flood events. Most scoured bank areas are stable due to natural rock deposition and/or dense root mats and therefore were not entered as erosion in FIT. Areas with raw and failing soils were indexed as erosion. In some areas there is B-type geometry, but F-type geometry is more common due to loss of floodplain access in many locations. A huge volume of cobbles of coarse sediments were deposited during and after these flood events and are working through the reach. Elevated floodplains showed minimal access except near large debris jams. Steep riffles and a major channel avulsion were observed. Steps are buried in loose cobbles and gravel.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	1,280	5	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	95
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	1.0	0.0	No	
Ledge	Mid-segment	5.0	3.0	No	

Stream: **Water Andric** Reach: **T2.10-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**26.00**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.10**	2.12 Substrate Composition		Bed:	**500 mm**
2.3 Mean Depth (tf):	**1.12**	Bedrock:	**0.0 %**	Bar:	**150 mm**
2.4 Floodprone Width (ft.):	**37.00**	Boulder:	**12.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.30**	Cobble:	**36.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**27.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**23.21**	Fine Gravel:	**5.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.42**	Sand:	**20.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**2.05**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**0.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**359**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**75.0**	**0.0**
Erosion Height (ft.):	**7.2**	**0.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Herbaceous**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**28.5**
Gullies	**None**	

	Left	Right
Mass Failures	**121.3**	**821.03**
Height	**36.0**	**26.5**
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **Water Andric** Reach: **T2.10-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**11**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**4**	Delta:	**0**	Flood chutes:	**8**	Avulsion:	**1**	5.5 Straightening:	**None**
Point:	**6**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**0**
Side:	**6**	Braiding:	**2**	Steep Riffles:	**4**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**					
Habitat Stream Condition:						

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**B to F**	**No**	Geomorphic Rating	**0.45**
7.2 Channel Aggradation	**11**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**10**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**10**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**36**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.11-A	Organization:	
Segment Length(ft):	3,714	Observers:	JHB, MPL, EPF
Rain:	Yes	Completion Date:	10/30/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at reach break located near start of logged area at valley wall opening. Reach follows a skidder track through logging area to the segment break at a significant increase in channel slope and valley confinement.**

Step 5 - Notes: **The cross-section was located at a representative riffle with typical C-type dimensions. Banks were well vegetated and relatively stable throughout segment. Floodplain access was limited to one bank for most of segment, but was accessible and significant cobble, gravel, and sand deposits were observed in several areas. Bar formation increased towards the top of the segment, most bars appeared stable and were vegetated. A large alluvial fan was observed at the top of the segment for approximately 400 feet and was located at a natural slope break and valley wall opening.**

Step 7 - Narrative: **Aggradation and widening are the dominant processes in this segment. A huge cobble and gravel alluvial fan was observed at the top of the segment and appears to be recently deposited during episodic flooding. Large mid channel bars and diagonal bars were observed throughout the reach. Moderate lower bank scour was observed as the lower channel widened as a result of deposition. Stage III of CEM was chosen due to moderate channel incision and beginning signs of aggradation, with moderate channel widening likely in the near future. Channel widening will be moderated by natural woody vegetation along the banks throughout the reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	1,820	8	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Hilly
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features	
Valley Width (ft):	380
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	6.0	3.0	No	

Stream: **Water Andric**   Reach: **T2.11-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**23.40**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.20**	2.12 Substrate Composition		Bed:	**350 mm**
2.3 Mean Depth (tf):	**1.70**	Bedrock:	**0.0 %**	Bar:	**80 mm**
2.4 Floodprone Width (ft.):	**180.00**	Boulder:	**10.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.30**	Cobble:	**43.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**24.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**13.76**	Fine Gravel:	**10.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**7.69**	Sand:	**13.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.50**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**1**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**227**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**0.0**	Dominant:	**Coniferous**	**Deciduous**
Material Type:	**Gravel**	**Gravel**	Erosion Height (ft.):	**0.0**	**0.0**	Sub-dominant:	**Shrubs/Sapling**	**Coniferous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**51-75**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**51-100**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Shrubs/Sapling**
Sub-Dominant	**Shrubs/Sapling**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Shrubs/Sapling**	Mass Failures		**41.07**
Sub-dominant	**None**	**Forest**	Height		**10.0**
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**One**	**10.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Water Andric** Reach: **T2.11-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs **None**	
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**15**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**4**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**11**	Delta:	**0**	Flood chutes:	**1**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**7**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**13**	**None**	**Yes**	Geomorphic Rating	**0.59**
7.2 Channel Aggradation	**10**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**10**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**14**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**47**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	**Water Andric**	SGAT Version:	**4.56**
Reach:	**T2.11-B**	Organization:	
Segment Length(ft):	**3,500**	Observers:	**JHB, MPL, FEA**
Rain:	**Yes**	Completion Date:	**10/30/2013**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Segment begins at slope and confinement increase upstream of logged area and continues upstream to valley wall opening near a mowed meadow on the right bank.**

Step 5 - Notes: **Lower stable terraces were scoured out during recent floods and have been filling in with large cobble/gravel bars. These unvegetated bars typically occupy >50% of the channel width. Large mid channel bars, diagonal bars, and steep riffles indicated that a large volume of unstable sediment are working through the channel.**

Step 7 - Narrative: **Aggradation and widening are the dominant processes in this reach. Large cobble/gravel bars are filling in the scoured out channel as a large volume of sediment works through following recent episodic flooding. Dense bank vegetation and roots will likely limit further channel widening as the stream re-establishes lower bank terraces.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	336	8	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Very Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Always**	**Always**
Texture:	**Mixed**	**Mixed**

1.5 Valley Features	
Valley Width (ft):	**140**
Width Determination:	**Measured**
Confinement Type:	**NW**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls: **None**

Stream: **Water Andric** Reach: **T2.11-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**21.50**	2.11 Riffle/Step Spacing:	**70 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.30**	2.12 Substrate Composition		Bed:	**450 mm**
2.3 Mean Depth (tf):	**1.72**	Bedrock:	**0.0 %**	Bar:	**320 mm**
2.4 Floodprone Width (ft.):	**45.00**	Boulder:	**12.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.30**	Cobble:	**31.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**29.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**12.50**	Fine Gravel:	**16.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**2.09**	Sand:	**12.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.43**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**2.75**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**10.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**158**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**190.4**	**240.2**
Erosion Height (ft.):	**9.9**	**4.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**91.4**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Shrubs/Sapling**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**None**
W less than 25	**0**	**136**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**26.0**
Gullies	**One**	**6.0**

	Left	Right
Mass Failures	**224.61**	**108.44**
Height	**27.6**	**29.5**
Gullies Number	**1**	
Gullies Length	**400**	

Stream: **Water Andric** Reach: **T2.11-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**10**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**2**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**7**	Delta:	**0**	Flood chutes:	**2**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**7**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**14**	Braiding:	**0**	Steep Riffles:	**9**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**13**	**None**	**Yes**	Geomorphic Rating	**0.59**
7.2 Channel Aggradation	**10**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**11**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**13**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**47**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.12-A	Organization:	
Segment Length(ft):	1,291	Observers:	JHB, MPL, FEA
Rain:	Yes	Completion Date:	10/30/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Segment begins at reach break located at valley wall opening near a mowed meadow and continues upstream to a segment break at slope decrease and valley wall opening.**

Step 5 - Notes: **Vertical eroded silt/clay banks were observed throughout this segment. The stream appears to have recently incised (likely in response to 2011 flood events) and is deeply entrenched. Lack of natural grade control may explain severity of incision in this reach compared with others along Water Andric. Generally no evidence of floodplain access in reach. Minimal deposition was observed in the channel, and the expected step-pool sequences were typically replaced with eroded continuous riffles and plane bedform in many places.**

Step 7 - Narrative: **Lower banks were scoured during recent episodic floods and the channel appears to have incised. Floodplains are inaccessible and banks on both sides are vertical and raw. Deposits of large cobbles and boulders are slowly filling in the channel margins.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	312	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.6 Grade Controls: **None**

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	120
Width Determination:	Measured
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

Stream: **Water Andric** Reach: **T2.12-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**22.00**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.00**	2.12 Substrate Composition		Bed:	**500 mm**
2.3 Mean Depth (tf):	**1.36**	Bedrock:	**0.0 %**	Bar:	**250 mm**
2.4 Floodprone Width (ft.):	**23.00**	Boulder:	**4.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**42.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**24.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**16.18**	Fine Gravel:	**19.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.05**	Sand:	**11.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.05**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**3**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**10.0 %**	Reference Stream Type:	**B**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**23**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**None**
				Reference Bedform:	**Step-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**689.9**	**327.8**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Gravel**	**Sand**	Erosion Height (ft.):	**3.1**	**2.9**	Sub-dominant:	**Shrubs/Sapling**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**195.6**	Canopy %:	**76-100**	**76-100**
Material Type:	**Clay**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**0-25**
W less than 25	**0**	**47**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**10.0**
Gullies	**None**	

	Left	Right
Mass Failures		**30.32**
Height		**10.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Water Andric** Reach: **T2.12-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**4**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**1**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**0**
Side:	**3**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**B to F**	**No**	Geomorphic Rating	**0.49**
7.2 Channel Aggradation	**14**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**5**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**15**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**39**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Water Andric	SGAT Version:	4.56
Reach:	T2.12-B	Organization:	
Segment Length(ft):	3,344	Observers:	JHB, MPL, FEA
Rain:	Yes	Completion Date:	10/30/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at segment break at slope decrease and valley wall increase and continues upstream through private property with mowed lawn and gravel roads. Segment ends approximately 1000ft upstream of the Rt 2 crossing.**

Step 5 - Notes: **Banks were high throughout reach with no evidence of good floodplain access. Vegetated side bars within the channel provide a small amount of additional area at bankfull. The mid to lower segment flows through an area of mowed lawn with armoring on bends and fresh bank erosion in numerous locations. The meadow upstream of the lawn area has steep vegetated banks indicating some recent slumping. The reach is highly variable upstream of Rt 2, transitioning from E to Bc, to C, to Bc, and then back to C-type based on valley confinement and entrenchment. We did not add any additional segments due to the short channel lengths within each stream type change.**

Step 7 - Narrative: **Reach is incised and likely scoured during recent episodic floods. The undersized culvert under Rt 2 may have interrupted sediment transport increasing scour through the segment. The stream is beginning to widen in some areas with fresh erosion observed on the outside of bends. Historic armoring may be present along the edge of the hayfield on both banks, however it was not visible under dense herbaceous vegetation.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	622	3	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	180		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Flat	Flat
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	Mixed	Mixed

1.5 Valley Features	
Valley Width (ft):	350
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Weir	Mid-segment	2.0	1.0	Yes	

Stream: **Water Andric**   Reach: **T2.12-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**15.00**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.30**	2.12 Substrate Composition		Bed:	**200 mm**
2.3 Mean Depth (tf):	**1.65**	Bedrock:	**0.0 %**	Bar:	**50 mm**
2.4 Floodprone Width (ft.):	**23.00**	Boulder:	**2.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.50**	Cobble:	**39.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**42.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**9.09**	Fine Gravel:	**5.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**1.53**	Sand:	**12.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.96**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**0.75**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**29**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Moderate**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**91.0**	**329.9**	Dominant:	**Herbaceous**	**Herbaceous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**3.9**	**6.5**	Sub-dominant:	**Coniferous**	**Coniferous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**255.1**	**204.2**	Canopy %:	**26-50**	**51-75**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**26-50**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**589**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Shrubs/Sapling**
Sub-dominant	**Shrubs/Sapling**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**10.0**
Gullies	**None**	

	Left	Right
Mass Failures	**72.210 01**	
Height	**10.0**	
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Water Andric** Reach: **T2.12-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **4**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	10	Yes	No	Yes	Yes	None
Bridge	12	Yes	No	Yes	Yes	Scour Above
Bridge	60	Yes	No	No	Yes	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: **2**
Mid: **6** Delta: **0**
Point: **5** Island: **0**
Side: **3** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **2**

Neck Cutoff: **0**
Avulsion: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **437**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic
7.1 Channel Degradation	**5**	**C to B**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**12**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**41**		

Geomorphic Rating	**0.51**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	T3 - Sleepers River	SGAT Version:	4.56
Reach:	T3.04-0	Organization:	
Segment Length(ft):	3,988	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/27/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break at VW opening ~500' upstream of Emerson Falls and continues upstream to the reach break at tributary north of N Danville road**

Step 5 - Notes: **Reach is deeply entrenched and straightened along right bank corn field. Very few riffles were observed due to to two beaver dams and one grade control in the middle of the reach. Bar formation was limited to the lower reach where a single meander sequence was observed and the upper reach downstream of the large grade control.**

Step 7 - Narrative: **This reach is incised and entrenched due to right bank armoring along the corn field and a typically tight left valley wall. Historic armoring and channel manipulation are limiting widening leading to downcutting and an inaccessible floodplain. Gravel and small cobble deposits within the channel are unstable. Large grade control at top of reach appears to reduce upstream migration of incision. The reach doesn't have much power through this reach due to the low slope and effect of dam downstream. There was some channel migration in the lower reach during the 2011 floods. This suggests that the overall reach would have a tendency to laterally migrate, but has become locked in place along the valley wall due to the severe incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	2,006	6	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	425		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Sand	Sand

1.5 Valley Features	
Valley Width (ft):	420
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	11.0	7.0	Yes	
Ledge	Mid-segment	1.0	0.0	No	

Stream: **T3 - Sleepers River** Reach: **T3.04-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**71.85**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**4.00**	2.12 Substrate Composition		Bed:	**250** mm
2.3 Mean Depth (tf):	**3.09**	Bedrock:	**0.0 %**	Bar:	**100** mm
2.4 Floodprone Width (ft.):	**108.00**	Boulder:	**3.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**8.35**	Cobble:	**32.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**39.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**23.25**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.50**	Sand:	**19.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.09**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**6.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**13**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**181.7**	**215.4**
Erosion Height (ft.):	**6.8**	**5.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**780.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**51-75**	**26-50**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**0**	**3,109**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Herbaceous**
Sub-Dominant	**Shrubs/Sapling**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Crop**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **T3 - Sleepers River** Reach: **T3.04-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **1**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch:

Road Ditch:

Other:

Tile Drain:

Overland Flow:

Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **2**

Affected Length (ft): **600**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	75	Yes	No	No	Yes	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **3**

Point: **2**

Side: **8**

Diagonal: **0**

Delta: **0**

Island: **0**

Braiding: **0**

5.2 Other Features

Flood chutes: **0**

Neck Cutoff: **0**

Avulsion: **0**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **2,681**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type	Left	Right
6.8 Bank Stability:		
6.9 Bank Vegetation Protection		
6.10 Riparian Veg. Zone Width:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	4	C to F	No
7.2 Channel Aggradation	10	None	No
7.3 Widening Channel	9	None	No
7.4 Change in Planforml	12	None	No
Total Score	35		

Geomorphic Rating	**0.44**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: T3 - Sleepers River
Reach: T3.05-0
Segment Length(ft): 1,946
Rain: No

SGAT Version: 4.56
Organization:
Observers: JHB,MPL,FEA
Completion Date: 8/27/2013
Qualtiy Control Status - Consultant: Provisional
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This reach starts at the reach break upstream of the large corn field at the valley width reduction. The upstream reach break is located immediately below the Goss Hollow Rd bridge.**

Step 5 - Notes: **This reach had less straightening and armoring than T3.04 and was less entrenched with limited high floodplain access.**

Step 7 - Narrative: **This reach like widened during recent episodic flood events and is in stage III. Lower banks appear to have been scoured during recent episodic flooding and the bed has since aggraded with cobble and gravel. The reach is moderately incised but floodplain is accessible for largest events on one or both sides throughout.**

Step 1. Valley and Floodplain

1.1 Segmentation: None

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0	15	454	10
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	945		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft): 300
Width Determination: Measured
Confinement Type: NW
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	4.0	2.0	Yes	

Stream: **T3 - Sleepers River**   Reach: **T3.05-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**81.07**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.80**	2.12 Substrate Composition		Bed:	**N/A** mm
2.3 Mean Depth (tf):	**2.93**	Bedrock:	**0.0 %**	Bar:	**80** mm
2.4 Floodprone Width (ft.):	**280.00**	Boulder:	**13.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.30**	Cobble:	**36.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**18.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**27.67**	Fine Gravel:	**27.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.45**	Sand:	**6.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.66**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**4.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**5**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**232.3**	Dominant:	**Deciduous**	**Herbaceous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**0.0**	**4.1**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**51-75**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**26-50**	**51-100**
W less than 25	**306**	**1,030**
Buffer Vegitation Type		
Dominant	**Shrubs/Sapling**	**Herbaceous**
Sub-Dominant	**Deciduous**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		**81.61**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**	Height		**15.0**
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**One**	**15.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **T3 - Sleepers River** Reach: **T3.05-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**None**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**1**
4.3 Flow Status:	**Low**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**0**	Impoundment Loc.:		Overland Flow:	**0**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**1**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**857**
Side:	**4**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**10**	**None**	**Yes**	Geomorphic Rating	**0.56**
7.2 Channel Aggradation	**12**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**11**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**12**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**45**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: T3 - Sleepers River
Reach: T3.06-0
Segment Length(ft): 1,773
Rain: Yes

SGAT Version: 4.56
Organization:
Observers: JHB,MPL,FEA
Completion Date: 7/17/2013
Qualtiy Control Status - Consultant: Provisional
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **From reach break immediately downstream of Goss Hollow Road crossing to the reach break just upstream of TH8 bridge.**

Step 5 - Notes: **Reach is located between a tight right valley wall and fully armored ~15' tall left bank to Goss Hollow Road. Reach is entrenched and has no access to floodplain on either bank. Minimal bar formation and plane bed bedform throughout reach, except for two large bedrock grade controls with cascade/pool. High incision ratio based on elevated bench on south side of channel (right bank); however prior to the road construction there may have been a bench or small floodplain on left bank that is now filled by roadway.**

Step 7 - Narrative: **The reach is deeply incised and entrenched due to the continuous encroachment from Goss Hollow Rd. The road embankment is heavily armored and elevated well above high water access. The right valley wall is tight to the channel throughout. Recent episodic floods likely scoured away any bed features leaving a flat plane bed stream with gravel and cobble. We selected modified stream type from Bc to F based on major encroachment from the road limiting any future restoration to B geometry.**

Step 1. Valley and Floodplain

1.1 Segmentation: None

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	1,498	15	269	13
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	390		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): 130
Width Determination: Measured
Confinement Type: NC
In Rock Gorge: No
Human Caused Change in Valley Width?: Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	12.0	7.0	Yes	
Ledge	Mid-segment	10.0	6.0	Yes	
Ledge	Mid-segment	3.0	1.0	Yes	

Stream: **T3 - Sleepers River** Reach: **T3.06-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**75.00**	2.11 Riffle/Step Spacing:	**260 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.60**	2.12 Substrate Composition		Bed:	**170** mm
2.3 Mean Depth (tf):	**1.90**	Bedrock:	**0.0 %**	Bar:	**N/A** mm
2.4 Floodprone Width (ft.):	**96.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.60**	Cobble:	**46.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**34.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**39.47**	Fine Gravel:	**6.0 %**	Subclass Slope:	
2.7 Entrenchment Ratio:	**1.28**	Sand:	**9.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.54**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**37**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**12.2**	**20.5**
Erosion Height (ft.):	**4.0**	**8.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**1,722.3**	**51.4**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Coniferous**
Sub-dominant:	**Shrubs/Sapling**	**Herbaceous**
Bank Canopy		
Canopy %:	**1-25**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**None**	**51-100**
W less than 25	**1,772**	**76**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**17.5**
Gullies	**None**	

	Left	Right
Mass Failures	**38.66**	**112.01**
Height	**20.0**	**15.0**
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **T3 - Sleepers River** Reach: **T3.06-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	66	Yes	No	Yes	Yes	Alignment
Bridge	60	Yes	No	Yes	Yes	Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **0** Side: **1**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Neck Cutoff: **0**
Avulsion: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **1,598**
5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	3	B to F	No
7.2 Channel Aggradation	11	None	No
7.3 Widening Channel	10	None	No
7.4 Change in Planforml	10	None	No
Total Score	34		

Geomorphic Rating **0.43**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: T3 - Sleepers River
Reach: T3.07-0
Segment Length(ft): 2,861
Rain: Yes

SGAT Version: 4.56
Organization:
Observers: JHB,MPL,FEA
Completion Date: 7/16/2013
Qualtiy Control Status - Consultant: Provisional
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **The reach begins at the reach break just upstream of the TH8 bridge and extends upstream to the reach break immediately upstream of the North Danville Rd bridge near Hawkins Rd.**

Step 5 - Notes: **Cross section was located at a representative riffle upstream of the large alluvial fan and immediately downstream of the tributary confluence. Channel is very wide and braided through large depositional areas. Large forested floodplain on right bank is elevated but accessible.**

Step 7 - Narrative: **This reach is a major depositional area and contains a large alluvial fan. The dominant adjustment process is widening as the stream braids through large cobble and gravel deposits; these adjustments would be expected in this setting, but are exacerbated by river corridor impacts. The left bank is armored along Goss Hollow Rd and the right bank shows evidence of recent scour and erosion. The stream is highly overwidened and contains numerous diagonal bars and mid channel bars braiding flow at all levels.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	1,232	13	708	15
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		299	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Flat
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **500**
Width Determination: **Measured**
Confinement Type: **BD**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	7.0	5.0	No	

Stream: **T3 - Sleepers River** Reach: **T3.07-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**106.00**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.60**	2.12 Substrate Composition		Bed:	**500 mm**
2.3 Mean Depth (tf):	**1.57**	Bedrock:	**0.0 %**	Bar:	**200 mm**
2.4 Floodprone Width (ft.):	**350.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.00**	Cobble:	**58.0 %**	Stream Type:	**D**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**25.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**67.52**	Fine Gravel:	**4.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.30**	Sand:	**7.0 %**	Bed Form:	**Braided**
2.8 Incision Ratio:	**1.67**	Silt and Smaller:	**1.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**112**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**110.2**	**327.8**
Erosion Height (ft.):	**3.9**	**5.4**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**1,289.4**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Coniferous**
Sub-dominant:	**Coniferous**	**Herbaceous**
Bank Canopy		
Canopy %:	**26-50**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**>100**	**51-100**
W less than 25	**1,311**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Coniferous**
Sub-Dominant	**Coniferous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **T3 - Sleepers River** Reach: **T3.07-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **1**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	60	Yes	No	No	Yes	Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **4** Point: **0** Side: **6**
Diagonal: **3** Delta: **1** Island: **0** Braiding: **1**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **1,245**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	11	None	Yes
7.2 Channel Aggradation	5	None	No
7.3 Widening Channel	4	None	No
7.4 Change in Planforml	12	None	No
Total Score	32		

Geomorphic Rating	**0.40**
Channel Evolution Model	**D**
Channel Evolution Stage	**IId**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **T3 - Sleepers River**
Reach: **T3.08-0**
Segment Length(ft): **5,011**
Rain: **No**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **7/30/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins just West of the intersection of North Danville Rd and Hawkins Rd. and continues upstream (Northwest) to the next reach break along North Danville Rd.**

Step 5 - Notes: **Widening is likely increased due to numerous natural and man-made (USGS weir and bed armoring) grade controls limiting vertical migration and interrupting sediment transport. A house located on the left bank in the upper portion of the reach is at major risk for flood damage. A neighbor said that a berm was constructed in 2010 to protect the house which failed during the 2011 floods.**
The last Grade Control in 1.6 TH8, HAW6 is a bed armoring site at the top of the reach. Large rip-rap was used to fill the channel along a major road damage site from recent floods.

Step 7 - Narrative: **Degradation is the dominant process for this reach. This reach contains numerous bedrock grade controls and an abandoned USGS weir. Grade controls may have arrested historic incision, with widening likely in near future. These features trap large volumes of sediment and may increase degradation downstream. The right valley wall is tight for most of the reach and the left bank is heavily armored in several stretches along North Danville Road, limited widening and increasing degradation.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft)	One Height	Both	Height
Berm:	234	5	0	
Road:	5,010	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	1,909		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **200**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Weir	Mid-segment	6.0	1.0	Yes	
Ledge	Mid-segment	1.0	0.0	Yes	
Ledge	Mid-segment	8.0	5.0	Yes	
Ledge	Mid-segment	10.0	6.0	Yes	
Ledge	Mid-segment	3.0	2.0	No	
Ledge	Mid-segment	3.0	1.0	No	
Ledge	Mid-segment	2.0	1.0	No	
Ledge	Mid-segment	8.0	6.0	Yes	

Stream: **T3 - Sleepers River**   Reach: **T3.08-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**54.00**	2.11 Riffle/Step Spacing:	**160 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.80**	2.12 Substrate Composition		Bed:	**600 mm**
2.3 Mean Depth (tf):	**2.01**	Bedrock:	**0.0 %**	Bar:	**300 mm**
2.4 Floodprone Width (ft.):	**86.00**	Boulder:	**9.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.10**	Cobble:	**44.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**19.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**26.87**	Fine Gravel:	**19.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**1.59**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.82**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**52**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**282.8**	**36.1**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Gravel**	**Gravel**	Erosion Height (ft.):	**4.8**	**5.0**	Sub-dominant:	**Herbaceous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**911.2**	**0.0**	Canopy %:	**51-75**	**51-75**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**51-100**	**51-100**
W less than 25	**2,561**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Shrubs/Sapling**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Commercial**	**Forest**	Mass Failures		**307.41**
Sub-dominant	**Residential**	**Shrubs/Sapling**	Height		**20.2**
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**22.5**	Gullies Length	**0**	
Gullies	**None**				

Phase 2 Segment Summary Report Lower Passumpsic

Stream: **T3 - Sleepers River** Reach: **T3.08-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **Small Run of River**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **4**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	80	Yes	No	No	No	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **7** Point: **6** Side: **8**
Diagonal: **2** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Head Cuts: **0**
Steep Riffles: **2**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	8	None	No
7.2 Channel Aggradation	10	None	No
7.3 Widening Channel	10	None	No
7.4 Change in Planforml	11	None	No
Total Score	39		

Geomorphic Rating	**0.49**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	T3 - Sleepers River	SGAT Version:	4.56
Reach:	T3.09-0	Organization:	
Segment Length(ft):	4,105	Observers:	EPF,JHB,MPL,FEA
Rain:	No	Completion Date:	7/30/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins at the valley wall constriction above T3.08 and extends upstream to the reach break immediately downstream of the timber crib dam.**

Step 5 - Notes: **Numerous right bank mass failures in reach, likely resulting from rip-rap along the left bank restricting lateral movement of channel. Deposition was limited to areas upstream of debris jams and a large depostional area upstream of a recent bed-armoring stretch mid-reach.**
Both of the grade controls in the reach are rip-rap bed armoring sites filling the channel along major road embankment repair sites.

Step 7 - Narrative: **The dominant adjustment processes in this reach are widening and deposition. Large deposits of cobbles occupy half of the channel in numerous locations and the channel is widening to accommodate the large sediment load. Mass failures were observed on several bends as the stream widens on the right bank. The left bank is armored along North Danville Rd for most of the reach. Two bed armoring sites were observed at pinch points where the stream was likely downcutting next to the road embankment.**

Step 1. Valley and Floodplain

1.1 Segmentation: None

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	97	4	0	
Road:	4,105	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	272		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	Mixed	Silt/Clay

1.5 Valley Features	
Valley Width (ft):	150
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	9.0	6.0	Yes	
Ledge	Mid-segment	7.0	6.0	Yes	

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **T3 - Sleepers River** Reach: **T3.09-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**53.43**	2.11 Riffle/Step Spacing:	**155 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.05**	2.12 Substrate Composition		Bed:	**650 mm**
2.3 Mean Depth (tf):	**1.71**	Bedrock:	**0.0 %**	Bar:	**500 mm**
2.4 Floodprone Width (ft.):	**120.00**	Boulder:	**15.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.65**	Cobble:	**39.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**24.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**31.25**	Fine Gravel:	**12.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**2.25**	Sand:	**10.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.85**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**57**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**137.0**	**0.0**
Erosion Height (ft.):	**4.6**	**0.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**1,351.3**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**1,306**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Mixed Trees**
Sub-Dominant	**Mixed Trees**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Commercial**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**17.5**
Gullies	**One**	**2.0**

	Left	Right
Mass Failures	**134.75**	**1374.07**
Height	**15.0**	**19.5**
Gullies Number	**1**	
Gullies Length	**100**	

Stream: **T3 - Sleepers River** Reach: **T3.09-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **5**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **3**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **4** Diagonal: **0**
Point: **3** Delta: **0**
Side: **7** Island: **0**
Braiding: **0**

5.2 Other Features
Flood chutes: **1** Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **2** Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**Yes**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**8**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**37**		

Geomorphic Rating	**0.46**
Channel Evolution Model	**F**
Channel Evolution Stage	**III**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	T3 - Sleepers River	SGAT Version:	4.56
Reach:	T3.10-0	Organization:	
Segment Length(ft):	607	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	7/30/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Very short reach that starts at the reach break just downstream of the timber crib dam east of Jamieson Rd crossing. This reach extends upstream to the confluence of Badger Brook and North Brook.**

Step 5 - Notes: **Large timber crib dam for a historic mill site influences bedform and sediment transport for entire reach. Channel is overwidened due to major retention of cobbles and gravel above the dam. Bankfull height was very low due to widened channel, leading to a low entrenchment ratio and a designation of F-type geometry. Road embankment on LB has led to a human caused changed in valley type from narrow to semi-confined. Combination of road encroachment and channel alterations due to dam sediment retention affect confinement/entrenchment leading to stream type departure.**

Step 7 - Narrative: **Channel adjustments are variable for this short reach that is strongly affected by the large timber crib dam at the bottom of the reach. The channel is attempting to reestablish planform through deep deposits of sand and gravel held by the dam. Narrow floodplain benches are forming on both sides and banks are relatively stable. Combination of adjustments suggests later stage of channel evolution - transitioning from stage III to IV.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	607	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	126		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Extr.Steep
Continuous w/ Bank:	Never	Always
Within 1 Bankfull W:	Sometimes	Always
Texture:	Sand	Silt/Clay

1.5 Valley Features

Valley Width (ft):	140
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Dam	Mid-segment	12.0	2.0	Yes	

Stream: **T3 - Sleepers River** Reach: **T3.10-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**60.00**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.10**	2.12 Substrate Composition		Bed:	**160 mm**
2.3 Mean Depth (tf):	**1.65**	Bedrock:	**0.0 %**	Bar:	**120 mm**
2.4 Floodprone Width (ft.):	**76.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.10**	Cobble:	**32.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**55.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**36.36**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.27**	Sand:	**6.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.48**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**8**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**151.1**	Dominant:	**Herbaceous**	**Deciduous**
Material Type:	**Gravel**	**Boulder/Cobble**	Erosion Height (ft.):	**0.0**	**2.0**	Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**116.1**	**0.0**	Canopy %:	**1-25**	**76-100**
Material Type:	**Gravel**	**Clay**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**>100**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**260**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Commercial**	**Forest**	Mass Failures		**38.17**
Sub-dominant	**Residential**	**Shrubs/Sapling**	Height		**10.0**
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**One**	**10.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **T3 - Sleepers River** Reach: **T3.10-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **1**

4.5 Flow Regulation Type **Large Run of River**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	40	Yes	No	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **1** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	4	B to F	No
7.2 Channel Aggradation	5	None	No
7.3 Widening Channel	7	None	No
7.4 Change in Planforml	10	None	No
Total Score	26		

Geomorphic Rating **0.32**
Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Poor**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	T3 - Sleepers River	SGAT Version:	4.56
Reach:	T3.11-0	Organization:	
Segment Length(ft):	5,661	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/27/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break at the bridge on Gadapee Rd and continues North upstream to the confluence with Pope Brook.**

Step 5 - Notes: **Major sand deposition was observed upstream of the USGS weir. Large floodplains with one or both sides accessible at high flows were consistent throughout the reach above the weir. Depositional features were limited to areas of debris jams and grade controls. Riffles and pools were slightly sedimented in lower reach, improving in upper reach. Banks were fairly stable throughout reach.**

Step 7 - Narrative: **The channel appears fairly stable throughout the reach. Some evidence of widening was observed in the lower reach along unbuffered agricultural fields. The remainder of the reach has stable vegetated banks, typical riffle pool sequences, and a slight increase in bar formation from gravel substrates working through the reach following recent episodic flooding. No direct evidence of historical channel straightening, but given agricultural fields in corridor some alterations were likely. Channel likely incised historically and has re-developed floodplain access and habitat with reforestation of banks and buffers.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	503	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	1,030		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	285
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	8.0	6.0	Yes	
Weir	Mid-segment	5.0	1.0	Yes	

Stream: **T3 - Sleepers River** Reach: **T3.11-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**21.40**	2.11 Riffle/Step Spacing:	**110 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.00**	2.12 Substrate Composition		Bed:	**300 mm**
2.3 Mean Depth (tf):	**2.46**	Bedrock:	**0.0 %**	Bar:	**100 mm**
2.4 Floodprone Width (ft.):	**75.00**	Boulder:	**10.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.75**	Cobble:	**34.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**37.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**8.70**	Fine Gravel:	**15.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.50**	Sand:	**4.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.25**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**4.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**101**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**97.0**
Erosion Height (ft.):	**0.0**	**2.4**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**54.6**	**353.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**952**	**2,545**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Coniferous**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **T3 - Sleepers River** Reach: **T3.11-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Abundant**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **10**

4.5 Flow Regulation Type **Small Run of River**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	16	Yes	No	Yes	Yes	Deposition Above,Deposition Below
Bridge	15	Yes	No	No	Yes	None
Bridge	25	Yes	No	No	No	None
Bridge	55	Yes	No	No	No	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: **0**
Mid: **5** Delta: **0**
Point: **14** Island: **0**
Side: **6** Braiding: **0**

5.2 Other Features Neck Cutoff: **0**
Flood chutes: **0** Avulsion: **0**
5.3 Steep Riffles and Head Cuts Head Cuts: **0**
Steep Riffles: **2** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**Yes**
7.3 Widening Channel	**14**	**None**	**No**
7.4 Change in Planforml	**13**	**None**	**No**
Total Score	**56**		

Geomorphic Rating	**0.70**
Channel Evolution Model	**F**
Channel Evolution Stage	**IV**
Geomorphic Condition	**Good**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Badger Brook**
Reach: **T3.10S1.01-0**
Segment Length(ft): **1,303**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **7/17/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This reach begins at the confluence of Badger Brook and the Sleepers River and extends upstream to the first USGS weir that occurs South of the intersection of Bruce Badger Memorial Highway and North Danville Road.**

Step 5 - Notes: **Major deposition was observed throughout the reach, especially below the USGS weir at the top of the reach. The stream appears to have substantially widened during recent flooding and is currently trying to re-establish a narrower channel through the formation of large bars occupying half of the channel. Upstream weir is a major interruption in sediment transport.**

Step 7 - Narrative: **This reach is deeply incised and is beginning to widen to attempt to regain access to elevated floodplains or redevelop new terraces. A large abandoned USGS weir is located at upstream reach break and is holding back a huge volume of cobble and gravel. This has likely starved channel of sediment and caused severe incision. Large deposits of cobble and gravel were observed on the margins throughout the reach and most bars were at or above bankfull. Sediment transferred into reach in recent floods. The banks indicated heavy scour on both sides and we observed numerous mass failures.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	208		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **150**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Badger Brook** Reach: **T3.10S1.01-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**58.00**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on			
2.2 Max Depth (ft.):	**2.40**	2.12 Substrate Composition			Bed:	**600**	**mm**
2.3 Mean Depth (tf):	**1.34**	Bedrock:	**0.0 %**		Bar:	**700**	**mm**
2.4 Floodprone Width (ft.):	**66.00**	Boulder:	**15.0 %**	2.14 Stream Type			
2.5 Aband. Floodpn (ft.):	**5.90**	Cobble:	**39.0 %**	Stream Type:	**F**		
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**		
2.6 Width/Depth Ratio:	**43.28**	Fine Gravel:	**20.0 %**	Subclass Slope:	**None**		
2.7 Entrenchment Ratio:	**1.14**	Sand:	**4.0 %**	Bed Form:	**Riffle-Pool**		
2.8 Incision Ratio:	**2.46**	Silt and Smaller:	**0.0 %**	Field Measured Slope:			
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type			
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:			
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**29**	Reference Bed Material:			
				Reference Subclass Slope:			
				Reference Bedform:			

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**0.0**	Dominant:	**Herbaceous**	**Coniferous**
Material Type:	**Boulder/Cobble**	**Gravel**	Erosion Height (ft.):	**0.0**	**0.0**	Sub-dominant:	**Coniferous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**85.9**	Canopy %:	**76-100**	**76-100**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Open**	
Consistency:	**Cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Coniferous**
Sub-Dominant	**Coniferous**	**Mixed Trees**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Commercial**	**Forest**	Mass Failures	**168.78**	**174.99**
Sub-dominant	**Forest**	**Shrubs/Sapling**	Height	**20.0**	**23.9**
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**17.5**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Badger Brook** Reach: **T3.10S1.01-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **3**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.: **Run-of-river Dam**

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**2**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:		**No**
Mid:	**3**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**	
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**	
Side:	**6**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**	

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type <u>Left</u> <u>Right</u>
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** <u>Score</u>	<u>STD</u>	<u>Historic</u>		
7.1 Channel Degradation	**5**	**B to F**	**No**	Geomorphic Rating	**0.34**
7.2 Channel Aggradation	**7**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**5**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**10**	**None**	**No**	Geomorphic Condition	**Poor**
Total Score	**27**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report   Lower Passumpsic

Stream:	Badger Brook	SGAT Version:	4.56
Reach:	T3.10S1.02-0	Organization:	
Segment Length(ft):	389	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	7/16/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional
		Why Not Assessed:	Other (to be explained in comments)

Step 0 - Location: **This reach begins at the reach break just upstream of USGS dam that is South of the intersection of Bruce Badge Memorial Highway and North Danville Road and extends upstream only 389 feet to the next reach break. See step 5 for comments on stream type adm**

Step 5 - Notes: **This reach is affected by a USGS weir for the entire length with large depositional features and lack of bankfull indicators. Administrative judgment for stream type.**

Step 7 - Narrative: **IId selected as administrative judgement based on grade control impacting entire reach and major deposition throughout.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Always	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	178
Width Determination:	Measured
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Weir	Mid-segment	6.0	1.0	Yes	

Stream: **Badger Brook** Reach: **T3.10S1.02-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):		2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):		Bedrock:	**%**	Bar:	
2.4 Floodprone Width (ft.):		Boulder:	**%**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):		Cobble:	**%**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**%**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**0.00**	Fine Gravel:	**%**	Subclass Slope:	
2.7 Entrenchment Ratio:	**0.00**	Sand:	**%**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**0.00**	Silt and Smaller:	**%**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:		# Large Woody Debris:	**3**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**236.5**	**0.0**	Dominant:	**Herbaceous**	**Deciduous**
Material Type:	**Mix**	**Mix**	Erosion Height (ft.):	**4.0**	**0.0**	Sub-dominant:	**Shrubs/Sapling**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**51-75**	**76-100**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**26-50**	**None**
W less than 25	**262**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Pasture**	**Forest**	Mass Failures		
Sub-dominant	**Residential**	**Shrubs/Sapling**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**None**		Gullies Length	**0**	
Gullies	**None**				

Stream: **Badger Brook** Reach: **T3.10S1.02-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **Small Run of River**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Diagonal: **0**
Point: **0** Delta: **0**
Side: **1** Island: **0**
Braiding: **0**

5.2 Other Features
Flood chutes: **0** Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0** Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score:
Habitat Rating:
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type <u>Left</u> <u>Right</u>
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type <u>Score</u> <u>STD</u> <u>Historic</u>
7.1 Channel Degradation
7.2 Channel Aggradation
7.3 Widening Channel
7.4 Change in Planforml
Total Score

Geomorphic Rating
Channel Evolution Model **D**
Channel Evolution Stage **IId**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: **Badger Brook**
Reach: **T3.10S1.03-0**
Segment Length(ft): **3,347**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **7/17/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **The reach begins at the reach break approximately 400' upstream of the USGS dam and continues upstream to the reach break immediately above the Bruce Badger Highway crossing.**

Step 5 - Notes: **Major widening on outer bends (valley wall mass failure and bank erosion) followed by deposition was observed throughout the reach. Flow was braided through large mid channel bars and steep riffles in the lower reach through the series of large grade controls. Large mass failures were likely triggered during recent floods. Most mass failures are now somewhat protected by tall cobble bars. A flood chute was observed at the top of the reach bypassing a large bed armoring site. A windrowed cobble berm immediately downstream of the bed armoring site cuts off access to a large left bank floodplain area. Uppermost grade control is a bed armoring site next to a major road embankment repair.**

Step 7 - Narrative: **This reach likely widened during recent episodic flooding events as indicated by scoured banks and numerous mass failures. The high sediment load following these events has produced large stable cobble/boulder/gravel bars along the channel margins for the entire reach. The bars are at or above bank full and have re-established a fairly stable channel geometry with small flood benches. A forested floodplain is typically accessible on one bank at high flows.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	197	5	0	
Road:	1,207	13	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	15		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	Mixed	Silt/Clay

1.5 Valley Features

Valley Width (ft): **160**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	6.0	4.0	Yes	
Ledge	Mid-segment	12.0	9.0	Yes	
Ledge	Mid-segment	7.0	5.0	Yes	

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **Badger Brook** Reach: **T3.10S1.03-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**31.00**	2.11 Riffle/Step Spacing:	**60 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.50**	2.12 Substrate Composition		Bed:	**450 mm**
2.3 Mean Depth (tf):	**1.52**	Bedrock:	**0.0 %**	Bar:	**300 mm**
2.4 Floodprone Width (ft.):	**112.00**	Boulder:	**12.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**54.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**19.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**20.39**	Fine Gravel:	**8.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**3.61**	Sand:	**7.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.64**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**6.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**101**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**275.1**	**73.0**
Erosion Height (ft.):	**8.4**	**7.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**365.6**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Coniferous**	**Coniferous**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**1,049**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Herbaceous**	**Mixed Trees**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**26.9**
Gullies	**Multiple**	**4.0**

	Left	Right
Mass Failures	**19.37**	**837.28**
Height	**20.0**	**31.2**
Gullies Number	**2**	
Gullies Length	**140**	

Stream: **Badger Brook** Reach: **T3.10S1.03-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **5**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch:
Road Ditch:
Other:
Tile Drain:
Overland Flow:
Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bedrock Outcrops	25	Yes	Yes	Yes	Yes	Deposition Above,Scour Below
Instream Culvert	8	Yes	No	Yes	Yes	Deposition Above,Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **8**
Point: **7**
Side: **7**
Diagonal: **1**
Delta: **0**
Island: **0**
Braiding: **1**

5.2 Other Features
Flood chutes: **3**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **2**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

	Left	Right
6.8 Bank Stability:		
6.9 Bank Vegetation Protection		
6.10 Riparian Veg. Zone Width:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined		
	Score	STD	Historic
7.1 Channel Degradation	12	None	No
7.2 Channel Aggradation	13	None	No
7.3 Widening Channel	10	None	No
7.4 Change in Planforml	12	None	No
Total Score	47		

Geomorphic Rating	**0.59**
Channel Evolution Model	**F**
Channel Evolution Stage	**IV**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.01-A	Organization:	
Segment Length(ft):	979	Observers:	JHB, MPL, FEA
Rain:	Yes	Completion Date:	7/17/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This segment extends from the confluence with Sleepers River upstream to the segment break above the alluvial fan and below the short gorge where the valley walls narrow.**

Step 5 - Notes:

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	777	6	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	331		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Very Steep
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	320
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Stream: **Whiteman Brook** Reach: **T3.7S1.01-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):		2.11 Riffle/Step Spacing:	**80 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):		Bedrock:	**%**	Bar:	
2.4 Floodprone Width (ft.):		Boulder:	**%**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):		Cobble:	**%**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**%**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**0.00**	Fine Gravel:	**%**	Subclass Slope:	
2.7 Entrenchment Ratio:	**0.00**	Sand:	**%**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**0.00**	Silt and Smaller:	**%**	Field Measured Slope:	**0.75**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**107**	Reference Bed Material:	**Gravel**
				Reference Subclass Slope:	
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope:

Bank Texture	Left	Right
Upper		
Material Type:		
Consistency:		
Lower		
Material Type:		
Consistency:		

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:		
Sub-dominant:		
Bank Canopy		
Canopy %:		
Mid-Channel Canopy:		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-Dominant		
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant		
Sub-Dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
(Legacy)	Amount	Mean Hieght
Failures	**One**	**10.0**
Gullies	**None**	

	Left	Right
Mass Failures		**35.08**
Height		**10.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:

4.2 Adjacent Wetlands:

4.3 Flow Status:

4.4 # of Debris Jams: **3**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch: Road Ditch:

Other: Tile Drain:

Overland Flow: Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	15	Yes	No	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **3** Point: **6** Side: **2**

Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **2**

Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **1**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **None**

Straightening Length (ft.): **0**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score:

Habitat Rating:

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type Score STD Historic

7.1 Channel Degradation

7.2 Channel Aggradation

7.3 Widening Channel

7.4 Change in Planforml

Total Score

Geomorphic Rating

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.01-B	Organization:	
Segment Length(ft):	2,668	Observers:	JHB, MPL, FEA
Rain:	Yes	Completion Date:	7/17/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Segment begins at the segment break immediately downstream of a small gorge and continues upstream to the reach break upstream of the end of Roy Rd.**

Step 5 - Notes: **A short and steep bedrock gorge section was observed above the alluvial fan. The cross-section was located at a representative riffle indicating widened B-type geometry with large bar formation re-filling the channel. Large mid channel bars were observed upstream of grade controls and debris jams. Revetments on LB are 530ft of stacked stone wall in two locations adjacent to Roy Rd, the remaining armoring is rip-rap.**

Step 7 - Narrative: **This reach contained huge depositional features from recent episodic flood events. Many banks along the outer bends corresponding to mass failures have been scoured back ~10-40' during these events and have since been replaced with large cobble/boulder/gravel side bars throughout the reach. Steep riffles were indexed where the stream is sharply downcutting through deep aggraded sediments in the channel. Many of these bars are well above bankfull and occupy more than half of the channel. Large mass failures were observed along the right bank and the left bank was heavily armored along Roy Rd for a portion of the reach. We selected stage 3 due to the instability of the large depositional features and moderate incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: Valley Width

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	2,300	6	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	407		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Very Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	130
Width Determination:	Measured
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	16.0	13.0	Yes	
Ledge	Mid-segment	12.0	10.0	Yes	
Ledge	Mid-segment	6.0	5.0	No	
Ledge	Mid-segment	8.0	4.0	Yes	
Ledge	Mid-segment	3.0	2.0	Yes	
Weir	Mid-segment	4.0	4.0	Yes	

Stream: **Whiteman Brook** Reach: **T3.7S1.01-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**35.90**	2.11 Riffle/Step Spacing:	**70 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.00**	2.12 Substrate Composition		Bed:	**700** mm
2.3 Mean Depth (tf):	**1.06**	Bedrock:	**0.0 %**	Bar:	**150** mm
2.4 Floodprone Width (ft.):	**74.00**	Boulder:	**6.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.95**	Cobble:	**47.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**33.87**	Fine Gravel:	**17.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**2.06**	Sand:	**8.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.48**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**3.5**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**220**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**Multiple**	**None**
Revetment Length:	**765.5**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Coniferous**
Sub-dominant:	**Deciduous**	**Herbaceous**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**450**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Residential**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**22.2**
Gullies	**None**	

	Left	Right
Mass Failures		**373.47**
Height		**29.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.01-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **3**

4.5 Flow Regulation Type **Small Run of River**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bedrock Outcrops	12	Yes	No	No	No	Deposition Below,Scour Below
Bridge	16	Yes	No	Yes	Yes	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **3** Point: **5** Side: **2**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Head Cuts: **0**
Steep Riffles: **1**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type — Left — Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**No**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**7**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**37**		

Geomorphic Rating	**0.46**
Channel Evolution Model	**F**
Channel Evolution Stage	**III**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.02-0	Organization:	
Segment Length(ft):	2,105	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/6/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins at the reach break at the end of Roy Rd and continues upstream to the next reach break immediately northwest of Route 2**

Step 5 - Notes: **Lower banks were scoured out during recently flooding. Major deposition of cobbles have reestablished a somewhat stable meandering channel through these large depositional features. Left floodplain was elevated but accessible throughout reach. The right bank was typically tight the valley wall and had numerous large mass failures. Heavy deposition of cobbles and boulders within the channel have filled in the step-pool bedform resulting in long riffles and short unstable steep riffles (due to erosion through aggraded sediment from recent flooding).**

Step 7 - Narrative: **Lower banks appear to have been scoured back during recent episodic floods followed by major deposition of cobbles, gravel, and boulders throughout the reach. The reach is only moderately incised and has a very low W/D ratio due to large cobble deposits along the margins that typically fill over half of the channel. We selected degradation as the primary adjustment process due to the numerous steep riffles (caused by erosion cutting through aggraded material at channel nickpoints) we observed at the stream tries to re-establish riffle pool sequences through the deep cobble deposits. Channel will likely widen and redevelop planform in the future as flood related sediment is worked through the reach and downstream.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	143	6	0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	Gravel	Silt/Clay

1.5 Valley Features

Valley Width (ft):	205
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

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Stream: **Whiteman Brook** Reach: **T3.7S1.02-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**22.00**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.25**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**1.92**	Bedrock:	**0.0 %**	Bar:	**350 mm**
2.4 Floodprone Width (ft.):	**48.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.25**	Cobble:	**32.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**37.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**11.46**	Fine Gravel:	**19.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**2.18**	Sand:	**7.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.31**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**4.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**81**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**
Lower		
Material Type:	**Gravel**	**Clay**
Consistency:	**Non-cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**401.8**	**32.1**
Erosion Height (ft.):	**8.7**	**6.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**487.9**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Herbaceous**
Sub-dominant:	**Herbaceous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**None**	**26-50**
W less than 25	**45**	**419**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Shrubs/Sapling**
Sub-Dominant	**Herbaceous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Commercial**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**19.4**
Gullies	**Multiple**	**2.0**

	Left	Right
Mass Failures	**49.49**	**406.61**
Height	**12.0**	**20.1**
Gullies Number	**2**	
Gullies Length	**160**	

Stream: **Whiteman Brook** Reach: **T3.7S1.02-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**10**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**2**	Delta:	**0**	Flood chutes:	**3**	Avulsion:	**1**	5.5 Straightening:	**Straightening**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**563**
Side:	**7**	Braiding:	**0**	Steep Riffles:	**5**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined**	Score	STD	Historic		
7.1 Channel Degradation		**10**	**None**	**No**	Geomorphic Rating	**0.57**
7.2 Channel Aggradation		**11**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel		**12**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml		**13**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score		**46**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.03-0	Organization:	
Segment Length(ft):	2,521	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/6/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins at the second reach break southwest of the end of Roy Rd and continues upstream to the reach break just north of the first Rt2 crossing.**

Step 5 - Notes: **Cross-section was located at a representative channel location at the top of the reach to minimize backwater from the numerous beaver dams and debris jams in the lower and mid reach. Typical E-type stream with low slope, large sand point bars, and beaver activity. Banks were densely vegetated and showed some signs of slumping.**

Step 7 - Narrative: **Reach is stable and has minor incision. Active beaver dams and lodges have removed all trees reducing rooting strength of banks. Some bank slumping and a few recent avulsions were observed. Beaver dams are trapping sediment through most of reach and limiting riffle formation. Based on review of historical imagery that shows agricultural fields in the corridor we assumed this reach was likely manipulated historically but maintained connection to the floodplain.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	563	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Flat	Flat
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft):	490
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream: **Whiteman Brook** Reach: **T3.7S1.03-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**17.83**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.60**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**2.17**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**490.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.60**	Cobble:	**0.0 %**	Stream Type:	**E**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**0.0 %**	Bed Material:	**Sand**
2.6 Width/Depth Ratio:	**8.22**	Fine Gravel:	**10.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**27.48**	Sand:	**90.0 %**	Bed Form:	**Dune-Ripple**
2.8 Incision Ratio:	**1.28**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**8.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Not Applicable**	# Large Woody Debris:	**47**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**50.1**	**82.3**
Erosion Height (ft.):	**3.2**	**3.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**1-25**	**1-25**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**8.0**
Gullies	**None**	

	Left	Right
Mass Failures		**47.97**
Height		**8.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.03-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Abundant**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**4**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**4**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**800**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**2**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**1**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**8**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**9**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**15**	**None**	**Yes**	Geomorphic Rating	**0.75**
7.2 Channel Aggradation	**15**	**None**	**Yes**	Channel Evolution Model	**F**
7.3 Widening Channel	**17**	**None**	**Yes**	Channel Evolution Stage	**I**
7.4 Change in Planforml	**13**	**None**	**No**	Geomorphic Condition	**Good**
Total Score	**60**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report   Lower Passumpsic

Stream: Whiteman Brook
Reach: T3.7S1.04-0
Segment Length(ft): 4,147
Rain: No

SGAT Version: 4.56
Organization:
Observers: JHB,MPL,FEA
Completion Date: 8/6/2013
Qualtiy Control Status - Consultant: Provisional
Qualtiy Control Status - Staff: Provisional

Step 0 - Location: **This reach begins at the reach break immediately downstream of the Route 2 crossing and then extends up to the reach break just East of the Trestle road crossing.**

Step 5 - Notes: **The cross-section was located in a representative riffle in the upper reach. A short stretch of increased incision and possible straightening was observed immediately upstream of the Parker Rd Bridge, otherwise the reach was consistently E-type. This reach was more active than the downstream reach, showing increased bank slumping (not indexed as erosion), channel migration features, depositional areas, and debris jams. A small alluvial fan was observed at the top end of the reach. The channel was braided through a large gravel bar system located at the slope change and valley wall opening. This alluvial fan was approximately 100ft long and 50ft wide, it is likely due to large volumes of sediment and debris from recent floods and is not a permanent feature.**

Step 7 - Narrative: **This reach appears to have widened slightly during recent episodic flooding. Banks now appear stable for most of the reach. Channel is exhibiting lateral movement and is in stage IV. We observed slumping banks and increased scour on outside bends (due to low severity and scale these features were not indexed as erosion). A small alluvial fan at the top of the reach and increased gravel and sand deposition throughout indicate that increased bedload from recent episodic flooding events may still be working through the reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: None
1.2 Alluvial Fan: Yes
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	867	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Flat	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Sand	Sand

1.5 Valley Features
Valley Width (ft): 450
Width Determination: Measured
Confinement Type: VB
In Rock Gorge: No
Human Caused Change in Valley Width?: No

1.6 Grade Controls: None

Stream: **Whiteman Brook** Reach: **T3.7S1.04-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**19.30**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.90**	2.12 Substrate Composition		Bed:	**60 mm**
2.3 Mean Depth (tf):	**1.78**	Bedrock:	**0.0 %**	Bar:	**40 mm**
2.4 Floodprone Width (ft.):	**570.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.50**	Cobble:	**4.0 %**	Stream Type:	**E**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**73.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**10.84**	Fine Gravel:	**9.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**29.53**	Sand:	**14.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.55**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**4.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**57**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**96.2**	**264.8**
Erosion Height (ft.):	**3.3**	**3.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**26-50**	**26-50**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**26-50**	**51-100**
W less than 25	**563**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Shrubs/Sapling**
Sub-Dominant	**Coniferous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.04-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Abundant**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **7**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch: Road Ditch:

Other: Tile Drain:

Overland Flow: Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	12	Yes	No	Yes	Yes	Deposition Above,Deposition Below
Instream Culvert	18	Yes	No	No	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: **1**

Mid: **11** Delta: **0**

Point: **11** Island: **0**

Side: **11** Braiding: **0**

5.2 Other Features

Flood chutes: **1**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

Neck Cutoff: **1**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **192**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**12**	**None**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**12**	**None**	**No**
7.4 Change in Planforml	**12**	**None**	**No**
Total Score	**48**		

Geomorphic Rating **0.60**

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.05-0	Organization:	
Segment Length(ft):	3,246	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/7/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This reach begins at the reach break just east of Trestle Rd and continues upstream to the next reach break due south of Parker Rd.**

Step 5 - Notes: **Reach was heavily impacted by widening and subsequent deposition during the 2011 flooding events. Lower bank terraces were scoured and upper banks show major sings of erosion in form of mass failures. A narrow (40') elevated floodplain terrace was typically present on one side of the stream, but was always inaccessible. Large unstable bars filling 75% of the channel. Major areas of deposition were observed upstream of large debris jams. Numerous fresh mass failures throughout reach are contributing large volumes of fine sediment. An active construction site was observed immediately upstream of the cross-section. Contractors were filling in the valley and armoring a fill slope to create abutments for a VAST bridge.**

Step 7 - Narrative: **This reach widened during recent episodic flood events heavily scouring away lower banks. Major cobble and gravel deposits have since formed within the channel creating a low W/D, very high incision, and deep entrenchment. The stream appears to be cutting down through these deposits and further incising. These features are FIT'd as steep riffles and headcuts, but they are all due to degradation. Forested floodplain exists on one or both banks throughout the reach but is inaccessible. The incision could increase if the channel cuts deep enough to reduce access to the small floodplain areas over the cobble bars within the widened banks.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	90
Width Determination:	Measured
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream: **Whiteman Brook** Reach: **T3.7S1.05-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**25.20**	2.11 Riffle/Step Spacing:	**90 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.00**	2.12 Substrate Composition		Bed:	**750 mm**
2.3 Mean Depth (tf):	**1.39**	Bedrock:	**0.0 %**	Bar:	**230 mm**
2.4 Floodprone Width (ft.):	**27.50**	Boulder:	**12.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.00**	Cobble:	**33.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**29.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**18.13**	Fine Gravel:	**8.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.09**	Sand:	**18.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**2.00**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**141**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Clay**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**121.7**	**253.7**
Erosion Height (ft.):	**3.7**	**4.2**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**55.9**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Coniferous**	**Coniferous**
Bank Canopy		
Canopy %:	**51-75**	**76-100**

Mid-Channel Canopy: **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**11.0**
Gullies	**None**	

	Left	Right
Mass Failures	**248.09**	**62.26**
Height	**10.0**	**17.1**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.05-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **9**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	8.5	Yes	No	Yes	Yes	Deposition Above,Deposition Below,Scour Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **3** Point: **3** Side: **11**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **3**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **1**
Head Cuts: **2**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	5	B to F	No
7.2 Channel Aggradation	9	None	No
7.3 Widening Channel	5	None	No
7.4 Change in Planforml	9	None	No
Total Score	28		

Geomorphic Rating	**0.35**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.06-A	Organization:	
Segment Length(ft):	1,566	Observers:	JHB,MPL,FEA
Rain:	No	Completion Date:	8/7/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **This segment begins at the reach break where the valley opens and the stream flows through a meadow and then continues upstream to the segment break where the stream enters a wooded valley.**

Step 5 - Notes: **Short segment with deeply incised E-type geometry. Segment flowed through a hayfield and had some evidence of historic armoring and straightening. Floodplain was very wide but inaccessible except during extreme events. Slopes on both segments are lower than Ph1 estimated slope - this is due to increased sinuosity and likely inaccurate elevation data near the top of the reach from the elevated road bed for Rt2.**

Step 7 - Narrative: **This segment is deeply incised due to the presence of historic armoring and straightening along the field edges. Visible rip-rap was indexed, it is likely that further armoring was present under slumping banks.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Flat	Flat
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	220
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream: **Whiteman Brook**   Reach: **T3.7S1.06-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**11.13**	2.11 Riffle/Step Spacing:	**100 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.10**	2.12 Substrate Composition		Bed:	**70 mm**
2.3 Mean Depth (tf):	**2.40**	Bedrock:	**0.0 %**	Bar:	**50 mm**
2.4 Floodprone Width (ft.):	**500.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.40**	Cobble:	**1.0 %**	Stream Type:	**E**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**58.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**4.64**	Fine Gravel:	**19.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**44.92**	Sand:	**22.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.74**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**0.75**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**6.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**48**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**147.6**	**91.9**
Erosion Height (ft.):	**3.0**	**3.8**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**56.6**	**212.2**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**1-25**	**1-25**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**1,061**	**1,233**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Hay**	**Hay**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Whiteman Brook** Reach: **T3.7S1.06-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **None**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **1**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **1**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**15**	**Yes**	**No**	**Yes**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **4** Point: **3** Side: **4**

Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **0**

Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **453**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**8**	**Other**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**12**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**42**		

Geomorphic Rating **0.52**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Whiteman Brook**
Reach: **T3.7S1.06-B**
Segment Length(ft): **2,679**
Rain: **No**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **8/7/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **This segment begins at the reach break about 200 ft upstream from where the larger tributary that crosses Parker Road enters the brook and continues up to the reach break immediately downstream of Rt2 near Parker Rd.**

Step 5 - Notes: **Some evidence of recent incision throughout reach. One floodplain is accessible and shows evidence of recent access and deposition. Typically the opposite bank is very high and slumping. The double stone culvert under the VAST trail is failing and causing a major interruption in sediment transport. Some type of blockage (debris jam or beaver) upslope has recently failed or been cleared. The resulting area upstream of the VAST culvert is approximately 400' of deeply incised channel with the entire valley filled with 6-8 feet of sand. The channel rapidly cut through this deposition leaving raw vertical sand banks on both sides. This reach is highly unstable and represents a major sediment source. Slopes on both segments are lower than Ph1 estimated slope - this is due to increased sinuosity and likely inaccurate elevation data near the top of the reach from the elevated road bed for Rt2.**

Step 7 - Narrative: **The channel adjustments in this segment are driven by the huge amount of sediment trapped behind the failing stone culvert near the middle of the segment. Floodplain is accessible on one side below the culvert and has a high failing bank to an inaccessible terrace on the other side. Above the culvert, a deeply incised channel is carving through loose sand and gravel deposits that have been stored above the culvert. The stream is trying to re-establish planform by carving out meanders above the culvert and to a lesser extent, below the culvert. Major adjustments would likely occur if the stone culvert were repaired or replaced.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft): **202**
Width Determination: **Measured**
Confinement Type: **VB**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Whiteman Brook** Reach: **T3.7S1.06-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**18.50**	2.11 Riffle/Step Spacing:	**90 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.90**	2.12 Substrate Composition		Bed:	**50 mm**
2.3 Mean Depth (tf):	**1.19**	Bedrock:	**0.0 %**	Bar:	**30 mm**
2.4 Floodprone Width (ft.):	**93.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.40**	Cobble:	**0.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**45.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**15.55**	Fine Gravel:	**35.0 %**	Subclass Slope:	
2.7 Entrenchment Ratio:	**5.03**	Sand:	**20.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.26**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**1.25**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**150**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**327.5**	**361.4**
Erosion Height (ft.):	**7.7**	**7.4**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Herbaceous**
Sub-dominant:	**Coniferous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Whiteman Brook** Reach: **T3.7S1.06-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **12**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	20	No	No	Yes	Yes	Deposition Below
Instream Culvert	8	Yes	No	Yes	Yes	Deposition Above,Deposition Below,Scour Above,Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **7** Point: **3** Side: **11**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	12	None	Yes
7.2 Channel Aggradation	7	None	No
7.3 Widening Channel	8	None	No
7.4 Change in Planforml	8	None	No
Total Score	35		

Geomorphic Rating	**0.44**
Channel Evolution Model	**F**
Channel Evolution Stage	**III**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report   Lower Passumpsic

Stream:	Whiteman Brook	SGAT Version:	4.56
Reach:	T3.7S1.07-0	Organization:	
Segment Length(ft):	4,545	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	8/27/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Begins at the reach break Southeast of Rt 2 and continues upstream to the reach break West of Cormier Rd**

Step 5 - Notes: **Reach indicated widening during recent flooding followed by major deposition throughout. Bank scour and flood chutes were observed on bends and lower banks were scoured out for most of the reach. Large unstable deposits of sand, gravel, and cobble were observed throughout the reach, especially upstream of the numerous debris jams. An undersized culvert at the top of the reach appears to have caused major scour down stream and deposition upstream. A huge debris jam above this culvert is holding a large volume of sediment and debris which could eventually work downstream.**

Step 7 - Narrative: **This reach was scoured during recent episodic flooding events followed by major deposition of gravel and sand. Large mass failures were observed at the top of the reach and have increased bedload of fine material that continues to work through the reach. Three undersized culverts within the reach likely increased deposition during flooding events. Tall deposits of gravel were observed along the margins and at bends in the channel throughout the reach. The relatively fine substrates coupled with the higher slope of the reach created several headcuts through the poorly sorted channel material. Degradation and aggradation adjustments are both present, but degradation is the dominant adjustment process as the stream cuts through deposits of finer material aggraded during floods.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	225	25	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	623		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft):	205
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls: **None**

Stream: **Whiteman Brook** Reach: **T3.7S1.07-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**18.50**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on			
2.2 Max Depth (ft.):	**1.45**	2.12 Substrate Composition			Bed:	**400**	**mm**
2.3 Mean Depth (tf):	**1.07**	Bedrock:	**0.0 %**		Bar:	**250**	**mm**
2.4 Floodprone Width (ft.):	**30.00**	Boulder:	**3.0 %**	2.14 Stream Type			
2.5 Aband. Floodpn (ft.):	**2.05**	Cobble:	**23.0 %**	Stream Type:	**B**		
Human Elev FloodPln (ft.):	**0.00**	Coarse Gravel:	**50.0 %**	Bed Material:	**Gravel**		
2.6 Width/Depth Ratio:	**17.29**	Fine Gravel:	**10.0 %**	Subclass Slope:	**None**		
2.7 Entrenchment Ratio:	**1.62**	Sand:	**14.0 %**	Bed Form:	**Riffle-Pool**		
2.8 Incision Ratio:	**1.41**	Silt and Smaller:	**0.0 %**	Field Measured Slope:			
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type			
2.9 Sinuosity:	**Moderate**	Detritus:	**3.0 %**	Reference Stream Type:			
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**174**	Reference Bed Material:			
				Reference Subclass Slope:			
				Reference Bedform:			

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**99.5**	**193.0**	Dominant:	**Coniferous**	**Herbaceous**
Material Type:	**Mix**	**Gravel**	Erosion Height (ft.):	**3.0**	**5.1**	Sub-dominant:	**Herbaceous**	**Coniferous**
Consistency:	**Cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**205.7**	**331.1**	Canopy %:	**51-75**	**51-75**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**381**	**646**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures	**39.01**	
Sub-dominant	**Commercial**	**Residential**	Height	**15.0**	
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**One**	**15.0**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Whiteman Brook** Reach: **T3.7S1.07-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Low**

4.4 # of Debris Jams: **16**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **2** Road Ditch: **1**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	7	No	No	Yes	Yes	Deposition Above
Instream Culvert	8	Yes	No	Yes	Yes	Deposition Above,Scour Below
Instream Culvert	7	Yes	No	Yes	Yes	Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types Diagonal: **2**

Mid: **14** Delta: **0**

Point: **13** Island: **0**

Side: **18** Braiding: **0**

5.2 Other Features Neck Cutoff: **0**

Flood chutes: **3** Avulsion: **0**

5.3 Steep Riffles and Head Cuts Head Cuts: **2**

Steep Riffles: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **125**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	5	C to B	No
7.2 Channel Aggradation	10	None	No
7.3 Widening Channel	11	None	No
7.4 Change in Planforml	10	None	No
Total Score	36		

Geomorphic Rating **0.45**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	**Sheldon Brook**	SGAT Version:	**4.56**
Reach:	**T4.01-0**	Organization:	
Segment Length(ft):	**3,783**	Observers:	**EPF,JHB,MPL,FEA**
Rain:	**Yes**	Completion Date:	**6/18/2013**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **From confluence with Passumpsic to reach break upstream of Severance Hill Rd**

Step 5 - Notes: **This reach is highly incised (1.8) and exhibits impacts associated with historic straightening and armoring along agricultural fields. Armoring and/or bank erosion were observed along every bend in the reach. A wide floodplain is accessible on one or both sides at very high flows. Moderate gravel and sand deposition was observed throughout the reach.**

Step 7 - Narrative: **This reach has been historically straightened and armored through the agricultural fields on both sides. The channel is deeply incised and it starting to widen in the areas that are less armored or bermed. Degradation is the dominant process due to controls on channel migration.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**659**	**3**	**0**	
Road:	**588**	**10**	**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**740**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Hilly**	**Hilly**
Continuous w/ Bank:	**Sometimes**	**Never**
Within 1 Bankfull W:	**Never**	**Never**
Texture:	**Mixed**	**Mixed**

1.5 Valley Features

Valley Width (ft):	**445**
Width Determination:	**Measured**
Confinement Type:	**VB**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	**Mid-segment**	**7.0**	**6.0**	**Yes**	

Stream: **Sheldon Brook** Reach: **T4.01-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**37.50**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.90**	2.12 Substrate Composition		Bed:	**450 mm**
2.3 Mean Depth (tf):	**1.98**	Bedrock:	**0.0 %**	Bar:	**90 mm**
2.4 Floodprone Width (ft.):	**320.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.10**	Cobble:	**46.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**5.50**	Coarse Gravel:	**34.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**18.94**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**8.53**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.76**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**1.90**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**17**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**429.6**	**0.0**
Erosion Height (ft.):	**4.4**	**0.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**316.5**	**414.2**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Herbaceous**
Sub-dominant:	**Herbaceous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**26-50**
Sub-Dominant	**26-50**	**0-25**
W less than 25	**2,002**	**1,387**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Hay**	**Hay**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**One**	**2.0**

	Left	Right
Mass Failures		
Height		
Gullies Number	**1**	
Gullies Length	**15**	

Stream: **Sheldon Brook** Reach: **T4.01-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Abundant**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **2**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	32	Yes	No	Yes	No	Deposition Above,Deposition Below
Bridge	36	Yes	No	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **5** Point: **8** Side: **1**

Diagonal: **1** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **1**

Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **3**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **2,665**

5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**	**None**	**No**
7.4 Change in Planforml	**10**	**None**	**No**
Total Score	**48**		

Geomorphic Rating **0.60**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Sheldon Brook	SGAT Version:	4.56
Reach:	T4.02-0	Organization:	
Segment Length(ft):	2,653	Observers:	EPF,JHB,MPL,FEA
Rain:	Yes	Completion Date:	6/18/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From reach break upstream of Severance Hill Rd along Red Village Rd to reach break upstream of Red Village Road Crossing and confluence with Sheldon Bk (T4.2S1.01)**

Step 5 - Notes: **This reach widened during recent flood events scouring lower terraces and banks. Multiple large mass failures through lacustrine deposits were observed throughout the reach, mainly along the left bank. Fine sediments deposits were also observed throughout the reach.**

Step 7 - Narrative: **Lower banks were scoured back and the channel slightly over-widened during recent episodic flood events. Cobble deposition along the margins is rebuilding these lower banks and vegetated upper banks are stable. The close proximity of Red Village Road decreases floodprone width through most of the reach and increases entrenchment. A forested floodplain bench is present through most of the reach and is accessible at most high flows. Some erosion was observed on outside bends indicating that minor planform adjustments are ongoing.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	2,231	5	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	1,568		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Sometimes
Texture:	Silt/Clay	Sand

1.5 Valley Features	
Valley Width (ft):	110
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	2.0	2.0	Yes	

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Sheldon Brook** Reach: **T4.02-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**42.00**	2.11 Riffle/Step Spacing:	**270 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.50**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**1.86**	Bedrock:	**0.0 %**	Bar:	**160 mm**
2.4 Floodprone Width (ft.):	**62.00**	Boulder:	**4.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.50**	Cobble:	**42.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**33.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**22.58**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.48**	Sand:	**14.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.00**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**30**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**187.6**	**0.0**
Erosion Height (ft.):	**6.3**	**0.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**198.5**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Deciduous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**26-50**
Sub-Dominant	**51-100**	**0-25**
W less than 25	**0**	**442**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Mixed Trees**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**22.5**
Gullies	**One**	**3.0**

	Left	Right
Mass Failures	**502.18**	**35.26**
Height	**22.9**	**10.0**
Gullies Number	**1**	
Gullies Length	**250**	

Phase 2 Segment Summary Report   Lower Passumpsic

Stream: **Sheldon Brook**   Reach: **T4.02-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**	
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:	
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:	
4.4 # of Debris Jams:	**3**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:	
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:		**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):		**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**7**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**2**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**2**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**					
Habitat Stream Condition:						

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**14**	**None**	**No**	Geomorphic Rating	**0.65**
7.2 Channel Aggradation	**11**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**13**	**None**	**No**	Channel Evolution Stage	**I**
7.4 Change in Planforml	**14**	**None**	**No**	Geomorphic Condition	**Good**
Total Score	**52**			Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Sheldon Brook (South Branch)	SGAT Version:	4.56
Reach:	T4.2S1.01-0	Organization:	
Segment Length(ft):	1,980	Observers:	EPF, FEA
Rain:	Yes	Completion Date:	6/18/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From confluence with Hawkins Brook to reach break approximately 1200ft upstream of Sheldon Brook Rd crossing**

Step 5 - Notes:

Step 7 - Narrative: **No evidence of significant adjustments. No bedrock grade controls but larger substrate in lower reach may control degradation. Minor impacts from adjacent property and armoring along Sheldon Brook Road.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	302		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Gravel	Gravel

1.5 Valley Features

Valley Width (ft):	50
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream: **Sheldon Brook (South Branch)** Reach: **T4.2S1.01-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**14.50**	2.11 Riffle/Step Spacing:	**50 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.80**	2.12 Substrate Composition		Bed:	**320 mm**
2.3 Mean Depth (tf):	**1.17**	Bedrock:	**0.0 %**	Bar:	**60 mm**
2.4 Floodprone Width (ft.):	**28.00**	Boulder:	**15.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.10**	Cobble:	**28.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**21.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**12.39**	Fine Gravel:	**6.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.93**	Sand:	**30.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.17**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**19**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**74.3**	**53.2**
Erosion Height (ft.):	**10.0**	**6.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**192.8**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**51-100**
Sub-Dominant	**26-50**	**>100**
W less than 25	**305**	**210**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Mixed Trees**	**Mixed Trees**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Hay**	**Hay**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**20.0**
Gullies	**None**	

	Left	Right
Mass Failures	**96.28**	**10.87**
Height	**23.9**	**15.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Sheldon Brook (South Branch)** Reach: **T4.2S1.01-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Low**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	13	Yes	No	Yes	Yes	Deposition Above,Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **7** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**

Neck Cutoff: **0**
Avulsion: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **157**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Confined Score	STD	Historic
7.1 Channel Degradation	15	None	No
7.2 Channel Aggradation	13	None	No
7.3 Widening Channel	15	None	No
7.4 Change in Planforml	13	None	No
Total Score	56		

Geomorphic Rating	**0.70**
Channel Evolution Model	**F**
Channel Evolution Stage	**I**
Geomorphic Condition	**Good**
Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: **Sheldon Brook**
Reach: **T4.03-A**
Segment Length(ft): **2,514**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **EPF,JHB,MPL,FEA**
Completion Date: **6/19/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From reach break at confluence with Sheldon Brook to segment break immediately downstream of second Red Village Rd crossing**

Step 5 - Notes: **This segment likely incised during recent storm events. Banks were scoured but typically stable, except for several large mass failures on sharps bends. A huge mass failure was observed in the middle of the reach with raw vertical banks comprised of varved silt/clay deposits. This mass failure was exacerbated by a large debris jam downstream leading to the formation of a large cobble bar, directing additional flow into the failing bank. Two newly constructed cobble berm were observed along the edge of a property on the left bank near the top of the segment. The downstream berm was tall and locally increased incision to approximately 2, however no increased bed degradation was observed.**

Step 7 - Narrative: **Lower banks were scoured out during recent episodic flood events followed by major deposition of cobble and gravel through most of the segment. The segment is moderately incised as the stream cuts down through these deposits. Large mass failures were observed at most bends in the channel, however these mass failures are now mostly protected by large cobble side bars. Newly constructed cobble berms near the top of the segment are limiting floodplain access and could contribute to further degradation downstream.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	235	7	0	
Road:	891	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	203		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Flat	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft): **400**
Width Determination: **Measured**
Confinement Type: **VB**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	2.0	1.0	No	

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **Sheldon Brook** Reach: **T4.03-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**33.20**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.40**	2.12 Substrate Composition		Bed:	**250 mm**
2.3 Mean Depth (tf):	**1.47**	Bedrock:	**0.0 %**	Bar:	**160 mm**
2.4 Floodprone Width (ft.):	**155.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**51.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**36.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**22.59**	Fine Gravel:	**4.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**4.67**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.71**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**1.5**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**Yes**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**55**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**None**
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks — Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**29.5**	**0.0**
Erosion Height (ft.):	**5.0**	**0.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**371.3**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Coniferous**	**Coniferous**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**51-100**
W less than 25	**59**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Hay**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**30.0**
Gullies	**None**	

	Left	Right
Mass Failures	**37.49**	**223.64**
Height	**20.0**	**40.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Sheldon Brook** Reach: **T4.03-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **3**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch: Road Ditch:

Other: Tile Drain:

Overland Flow: Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	27	Yes	Yes	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **8** Point: **4** Side: **1**

Diagonal: **1** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **1**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **1**

Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **None**

Straightening Length (ft.): **0**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	12	None	No
7.2 Channel Aggradation	11	None	No
7.3 Widening Channel	11	None	No
7.4 Change in Planforml	11	None	No
Total Score	45		

Geomorphic Rating **0.56**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **Sheldon Brook**
Reach: **T4.03-B**
Segment Length(ft): **3,083**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **EPF,JHB,MPL,FEA**
Completion Date: **6/19/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From segment break downstream of second Red Village Rd crossing to reach break at VW opening along farm upstream of His Hill Rd crossing.**

Step 5 - Notes: **This segment indicated some scour of lower banks/terraces followed by significant deposition. Large vegetated and unvegetated bars were present throughout reach. Moderate incision and entrenchment were observed. A large raw mass failure near the top of the reach continues to contribute large volumes of fine sediment to the stream.**

Step 7 - Narrative: **Lower banks were scoured out during recent episodic flood events followed by major deposition of cobble and gravel throughout the segment. The segment appears to be transitioning from degradation to widening with fresh bank erosion visible on many bends as the stream re-establishes planform through the large flood deposits. The segment is moderately incised but does retain access to narrow floodplain benches at high flows.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Valley Width**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	498		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Sometimes
Texture:	Sand	Sand

1.5 Valley Features

Valley Width (ft): **160**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Sheldon Brook** Reach: **T4.03-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**36.80**	2.11 Riffle/Step Spacing:	**170 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.15**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**1.75**	Bedrock:	**0.0 %**	Bar:	**100 mm**
2.4 Floodprone Width (ft.):	**75.00**	Boulder:	**2.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.15**	Cobble:	**53.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**32.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**21.03**	Fine Gravel:	**5.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**2.04**	Sand:	**8.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.47**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**2**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**79**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**196.9**	**217.5**
Erosion Height (ft.):	**7.4**	**7.8**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**67.8**	**18.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Deciduous**
Sub-dominant:	**Deciduous**	**Herbaceous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**51-100**	**26-50**
W less than 25	**417**	**502**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**32.0**
Gullies	**None**	

	Left	Right
Mass Failures	**332.82**	**81.55**
Height	**76.6**	**4.3**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Sheldon Brook** Reach: **T4.03-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **5**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch:

Road Ditch:

Other:

Tile Drain:

Overland Flow:

Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**20**	**Yes**	**No**	**Yes**	**Yes**	**Deposition Above,Scour Below**
Bridge	**20**	**Yes**	**No**	**Yes**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **8**

Point: **5**

Side: **8**

Diagonal: **2**

Delta: **0**

Island: **0**

Braiding: **0**

5.2 Other Features

Flood chutes: **1**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

Neck Cutoff: **0**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **None**

Straightening Length (ft.): **0**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**8**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**41**		

Geomorphic Rating	**0.51**
Channel Evolution Model	**F**
Channel Evolution Stage	**III**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream:	Sheldon Brook	SGAT Version:	4.56
Reach:	T4.04-0	Organization:	
Segment Length(ft):	4,700	Observers:	EPF,MPL,FEA
Rain:	Yes	Completion Date:	6/19/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From reach break upstream of His Hill Rd crossing to reach break upstream of Sugar Maple Rd**

Step 5 - Notes: **Area of historic and current migration downstream of Red Village Road. Appears to have be an ongoing conflict with adjacent farm land use due to historical and recent armoring. This area of floodplain stores large volume of sediment and could be a good candidate for floodplain/corridor protection.**

Step 7 - Narrative: **Majority of reach has minor to moderate incision with limited widening and bank erosion. Lower reach has a short stretch showing signs of planform adjustments and stage III or IV of channel evolution. This area is likely responding to past channel straightening.**

Step 1. Valley and Floodplain

1.1 Segmentation: None

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	274	10	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	508		481	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features	
Valley Width (ft):	400
Width Determination:	Measured
Confinement Type:	VB
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: None

Stream: **Sheldon Brook** Reach: **T4.04-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**33.50**	2.11 Riffle/Step Spacing:	**230 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.70**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**1.89**	Bedrock:	**0.0 %**	Bar:	**120 mm**
2.4 Floodprone Width (ft.):	**75.00**	Boulder:	**16.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.80**	Cobble:	**42.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**20.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**17.72**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**2.24**	Sand:	**15.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.41**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**55**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Silt**	**Silt**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**134.7**
Erosion Height (ft.):	**0.0**	**4.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**63.7**	**235.2**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**51-100**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**535**	**676**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Mixed Trees**	**Mixed Trees**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Hay**	**Crop**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**12.0**
Gullies	**None**	

	Left	Right
Mass Failures	**70.65**	
Height	**12.0**	
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Sheldon Brook**   Reach: **T4.04-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **4**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	26	No	No	Yes	Yes	None
Bridge	19	Yes	No	Yes	Yes	Deposition Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **4**   Point: **9**   Side: **6**
Diagonal: **1**   Delta: **0**   Island: **0**   Braiding: **0**

5.2 Other Features
Flood chutes: **0**   Neck Cutoff: **1**   Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**   Head Cuts: **0**   Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **999**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type   Left   Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined Score	STD	Historic
7.1 Channel Degradation	13	None	Yes
7.2 Channel Aggradation	14	None	No
7.3 Widening Channel	12	None	No
7.4 Change in Planforml	11	None	No
Total Score	50		

Geomorphic Rating	0.63
Channel Evolution Model	F
Channel Evolution Stage	III
Geomorphic Condition	Fair
Stream Sensitivity	High

Phase 2 Segment Summary Report   Lower Passumpsic

Stream:	Wheelock Brook	SGAT Version:	4.56
Reach:	T5.01-0	Organization:	
Segment Length(ft):	2,101	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	6/19/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Confluence with the Passumpsic River to reach break upstream of the Schoolhouse Covered Bridge**

Step 5 - Notes: **Nearly entire reach is straightened and deeply entrenched. Lower reach (below highway) is against the left valley wall, and the right bank is armored and approximately 6ft above bankfull. The upper reach is channel that was blasted out during highway construction lined with steep bedrock on both sides. Channel geometry indicates a slight left floodplain bench and entrenchment is 1.7, however, this reach is significantly narrowed and has no true floodplain access. Therefore we assessed this as an F-type channel.**

Step 7 - Narrative: **Entrenchment ration of 1.68 is high due to narrow channel from bedrock on both banks. Channel appears to have been blasted through bedrock during highway construction. F type plane bed was selected based on field observations. Incision is the dominant process with aggradation, widening, and planform all very limited due to straightening and armoring throughout reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	807	20	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	205		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Hilly
Continuous w/ Bank:	Always	Sometimes
Within 1 Bankfull W:	Always	Sometimes
Texture:	Bedrock	Sand

1.5 Valley Features	
Valley Width (ft):	80
Width Determination:	Measured
Confinement Type:	NC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls: **None**

Stream: **Wheelock Brook** Reach: **T5.01-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**28.50**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.55**	2.12 Substrate Composition		Bed:	**250** mm
2.3 Mean Depth (tf):	**2.82**	Bedrock:	**0.0 %**	Bar:	**N/A** mm
2.4 Floodprone Width (ft.):	**48.00**	Boulder:	**3.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.35**	Cobble:	**22.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**47.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**10.11**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.68**	Sand:	**22.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.23**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**12**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Bedrock**	**Bedrock**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**12.7**	**0.0**
Erosion Height (ft.):	**3.0**	**0.0**
Revetment Type:	**Multiple**	**Multiple**
Revetment Length:	**1,145.3**	**1,168.5**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Herbaceous**
Sub-dominant:	**Herbaceous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**212**	**737**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Commercial**
Sub-dominant	**Commercial**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**10.0**
Gullies	**None**	

	Left	Right
Mass Failures	**20.39**	
Height	**10.0**	
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Wheelock Brook** Reach: **T5.01-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **None**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **3**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **1**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	32	Yes	No	No	No	None
Instream Culvert	30	Yes	No	Yes	No	Scour Below
Instream Culvert	30	Yes	No	Yes	Yes	None
Bedrock Outcrops	30	Yes	No	Yes	Yes	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **1** Point: **1** Side: **0**

Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **0**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

Neck Cutoff: **0**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **1,528**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type — Left — Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Unconfined	Score	STD	Historic
7.1 Channel Degradation		5	C to F	Yes
7.2 Channel Aggradation		8	None	No
7.3 Widening Channel		12	None	No
7.4 Change in Planforml		10	None	No
Total Score		35		

Geomorphic Rating	**0.44**
Channel Evolution Model	**F**
Channel Evolution Stage	**II**
Geomorphic Condition	**Fair**
Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report   Lower Passumpsic

Stream:	Wheelock Brook	SGAT Version:	4.56
Reach:	T5.02-0	Organization:	
Segment Length(ft):	2,341	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	6/20/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From reach break upstream of the Schoolhouse Covered Bridge to reach break above cascade at Chamberlain Covered Bridge**

Step 5 - Notes: **This reach is highly incised and entrenched due to historic armoring to protect agricultural fields and roads. Some slumping and erosion was observed in the lower reach, but banks were relatively stable throughout. Bar formation was minimal within the narrow channel, indicating sediment transport through the reach. Revetments are primarily rip-rap. stacked stone hard bank armoring was observed on the right and left banks along a house foundations, old mill abutment, and the abutments for the Chamberlain covered bridge. Total hard bank armoring length is approximately 180 feet.**

Step 7 - Narrative: **Incision is the dominant process throughout reach. Historic armoring was observed on one or both banks for much of reach. Access to the large floodplain in the lower reach was very limited, upper reach typically only had a small floodplain on the left bank which was also elevated.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	165	2	0	
Road:	325	20	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	1,139		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Sand	Gravel

1.5 Valley Features

Valley Width (ft):	270
Width Determination:	Measured
Confinement Type:	BD
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	15.0	9.0	Yes	
Ledge	Mid-segment	18.0	15.0	Yes	

Stream: **Wheelock Brook**　　Reach: **T5.02-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**37.00**	2.11 Riffle/Step Spacing:	**150 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.75**	2.12 Substrate Composition		Bed:	**170** mm
2.3 Mean Depth (tf):	**2.26**	Bedrock:	**0.0 %**	Bar:	**80** mm
2.4 Floodprone Width (ft.):	**50.00**	Boulder:	**1.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.05**	Cobble:	**8.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**43.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**16.37**	Fine Gravel:	**34.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.35**	Sand:	**14.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.20**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**33**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks　　Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**88.8**	**0.0**	Dominant:	**Herbaceous**	**Herbaceous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**4.3**	**0.0**	Sub-dominant:	**Deciduous**	**Shrubs/Sapling**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Multiple**	**Multiple**	Bank Canopy		
Lower			Revetment Length:	**550.1**	**605.5**	Canopy %:	**26-50**	**26-50**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**26-50**
Sub-Dominant	**26-50**	**0-25**
W less than 25	**643**	**675**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Shrubs/Sapling**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Commercial**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report — Lower Passumpsic

Stream: **Wheelock Brook** Reach: **T5.02-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **6**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	30	Yes	No	Yes	Yes	None
Bridge	25	Yes	No	Yes	Yes	Deposition Below
Bridge	60	Yes	No	No	No	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **2** Point: **4** Side: **1**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **487**
5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type — Left — Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	5	C to F	Yes
7.2 Channel Aggradation	13	None	No
7.3 Widening Channel	13	None	No
7.4 Change in Planforml	12	None	No
Total Score	43		

Geomorphic Rating **0.54**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	Wheelock Brook	SGAT Version:	4.56
Reach:	T5.03-0	Organization:	
Segment Length(ft):	3,303	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	6/20/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From reach break upstream of Chamberlain Covered Bridge along Wheelock Road to reach break at valley wall opening approximately 700ft downstream from farm on left bank.**

Step 5 - Notes: **This reach indicated some recent widening and incision within the deeply entrenched and incised channel. The stream has likely incised historically due to the frequent close proximity to South Wheelock road and subsequent bank armoring. Floodplains are inaccessible throughout the reach.**

Step 7 - Narrative: **Incision is transitioning to widening as the dominant process in this reach due to historic and likely recent downcutting during flood events leading to a B->F STD. Some widening and aggradation was observed throughout the reach in areas of bank failure. We selected a B reference stream type due to the natural valley confinement.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	1,667	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	930		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Hilly
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Sand

1.5 Valley Features	
Valley Width (ft):	140
Width Determination:	Measured
Confinement Type:	SC
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	4.0	0.0	Yes	
Ledge	Mid-segment	6.0	2.0	Yes	

Phase 2 Segment Summary Report   Lower Passumpsic

Stream: **Wheelock Brook**   Reach: **T5.03-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**50.00**	2.11 Riffle/Step Spacing:	**150 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.90**	2.12 Substrate Composition		Bed:	**300 mm**
2.3 Mean Depth (tf):	**2.00**	Bedrock:	**0.0 %**	Bar:	**190 mm**
2.4 Floodprone Width (ft.):	**60.00**	Boulder:	**2.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.70**	Cobble:	**60.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**23.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**25.00**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.20**	Sand:	**9.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.97**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**56**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**180.3**	**82.5**	Dominant:	**Coniferous**	**Shrubs/Sapling**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**5.7**	**5.7**	Sub-dominant:	**Shrubs/Sapling**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**1,294.9**	**0.0**	Canopy %:	**26-50**	**76-100**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**51-100**	**26-50**
W less than 25	**1,382**	**263**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Herbaceous**
Sub-Dominant	**Herbaceous**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Commercial**	**Forest**
Sub-dominant	**Residential**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**21.5**
Gullies	**None**	

	Left	Right
Mass Failures	**132.37**	
Height	**22.8**	
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Wheelock Brook** Reach: **T5.03-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**2**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**1**	Impoundment Loc.:		Overland Flow:	**0**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Old Abutment	30	Yes	No	Yes	Yes	Deposition Above,Deposition Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**4**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**4**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**4**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**B to F**	**No**	Geomorphic Rating	**0.54**
7.2 Channel Aggradation	**13**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**11**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**14**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**43**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Wheelock Brook**
Reach: **T5.04-0**
Segment Length(ft): **2,324**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **6/20/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From reach break approximately 700ft downstream from farm on left bank to reach break near large house on left bank at valley wall constriction.**

Step 5 - Notes: **Channel geometry was variable throughout reach. Typically the channel was incised with scoured but stable banks leading to a somewhat accessible floodplain. Several areas of widened channel with large side bars were also observed throughout the reach. Well vegetated and naturally armored banks (stony soils) are likely limiting widening processes and leading to moderate incision.**

Step 7 - Narrative: **Channel was typically incised but retained access to floodplains on one or both banks for larger events. Some evidence of recent widening through bank scour, however banks appear to be stable. Reach is likely transitioning to stage III after flood deposits work through.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	592	0	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	400		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Sand	Mixed

1.5 Valley Features

Valley Width (ft): **230**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	7.0	4.0	Yes	
Ledge	Mid-segment	5.0	2.0	Yes	
Ledge	Mid-segment	5.0	2.0	Yes	

Stream: **Wheelock Brook**   Reach: **T5.04-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**42.00**	2.11 Riffle/Step Spacing:	**170 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.80**	2.12 Substrate Composition		Bed:	**300 mm**
2.3 Mean Depth (tf):	**2.34**	Bedrock:	**0.0 %**	Bar:	**70 mm**
2.4 Floodprone Width (ft.):	**85.00**	Boulder:	**11.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.25**	Cobble:	**33.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**41.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**17.95**	Fine Gravel:	**9.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**2.02**	Sand:	**6.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.52**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**94**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**103.9**	**172.2**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Gravel**	**Gravel**	Erosion Height (ft.):	**3.9**	**2.0**	Sub-dominant:	**Herbaceous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**None**	Bank Canopy		
Lower			Revetment Length:	**409.0**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**400**	**167**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Deciduous**
Sub-Dominant	**Deciduous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures	**69.86**	**14.1**
Sub-dominant	**Shrubs/Sapling**	**Shrubs/Sapling**	Height	**18.0**	**8.0**
(Legacy)	Amount	Mean Hieght	Gullies Number	**3**	
Failures	**Multiple**	**13.0**	Gullies Length	**180**	
Gullies	**Multiple**	**2.0**			

Stream: **Wheelock Brook** Reach: **T5.04-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bedrock Outcrops	20	Yes	Yes	Yes	Yes	Deposition Above,Deposition Below,Scour Below

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **6** Point: **7** Side: **7**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score: **0**
Habitat Rating: **0.00**
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**	**None**	**No**
7.4 Change in Planforml	**14**	**None**	**No**
Total Score	**55**		

Geomorphic Rating **0.69**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream:	Wheelock Brook	SGAT Version:	4.56
Reach:	T5.05-A	Organization:	
Segment Length(ft):	2,756	Observers:	JHB,MPL,FEA
Rain:	Yes	Completion Date:	6/25/2013
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **From reach break at valley constriction upstream of large house on left bank to segment break at valley wall opening upstream of large farm on left bank.**

Step 5 - Notes: **This segment typically had a tight valley wall on one bank and an elevated inaccessible terrace on the other bank. Numerous bedrock grade controls were observed throughout the reach. The segment may have been historically straightened and armored along the left bank to protect the agricultural fields in the upper segment, and is pinned between a tight valley wall and South Wheelock Road in the lower segment. Sediment storage is limited to sand deposition above and below grade controls.**

Step 7 - Narrative: **Incision is the dominant adjustment process following recent flood events. Channel was scoured out removing most bed features. These feature are starting to reform as sediment moves out of the channel and is deposited along the margins. Bedrock grade controls limit the severity of channel incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: Subreach

1.2 Alluvial Fan: None

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	435		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Always
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	190
Width Determination:	Measured
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	Yes

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	6.0	2.0	Yes	
Ledge	Mid-segment	7.0	4.0	Yes	
Ledge	Mid-segment	4.0	2.0	Yes	
Ledge	Mid-segment	2.0	0.0	Yes	
Ledge	Mid-segment	1.0	0.0	Yes	
Ledge	Mid-segment	1.0	0.0	No	

Stream: **Wheelock Brook** Reach: **T5.05-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**39.00**	2.11 Riffle/Step Spacing:	**180 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.35**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**2.15**	Bedrock:	**0.0 %**	Bar:	**140 mm**
2.4 Floodprone Width (ft.):	**51.00**	Boulder:	**9.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.85**	Cobble:	**34.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**31.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**18.14**	Fine Gravel:	**18.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**1.31**	Sand:	**8.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.45**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**1**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	**B**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**46**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**c**
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**170.6**	**111.0**
Erosion Height (ft.):	**2.6**	**6.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**159.6**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Coniferous**
Sub-dominant:	**Coniferous**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**26-50**
Sub-Dominant	**0-25**	**>100**
W less than 25	**858**	**750**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Commercial**	**Forest**
Sub-dominant	**Forest**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Wheelock Brook** Reach: **T5.05-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**

4.2 Adjacent Wetlands: **None**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **1**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bedrock Outcrops	40	Yes	Yes	No	Yes	Deposition Above

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **1** Diagonal: **0**

Point: **3** Delta: **0**

Side: **6** Island: **0**

Braiding: **0**

5.2 Other Features

Flood chutes: **0**

Neck Cutoff: **0**

Avulsion: **0**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **559**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type | Left | Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	8	None	No
7.2 Channel Aggradation	11	None	No
7.3 Widening Channel	13	None	No
7.4 Change in Planforml	14	None	No
Total Score	46		

Geomorphic Rating	0.57
Channel Evolution Model	F
Channel Evolution Stage	II
Geomorphic Condition	Fair
Stream Sensitivity	Very High

Phase 2 Segment Summary Report **Lower Passumpsic**

Stream: **Wheelock Brook**
Reach: **T5.05-B**
Segment Length(ft): **1,963**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **6/25/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From segment break upstream of large farm at valley wall opening to reach break immediately downstream of Cold Hill Rd crossing.**

Step 5 - Notes: **This reach indicates some bank scour during recent flooding events, however banks are generally very stable. Fairly wide floodplains are typically present on one bank and are accessible for larger events. A narrow (~20') terrace was typically present on the opposite bank at a higher elevation. Sediment deposition remained limited in this segment but had increased bar formation compared to the segment A.**

Step 7 - Narrative: **Channel adjustments were variable throughout the segment. Recent minor widening followed by aggradation are likely the dominant processes with evidence of lower bank scour from recent episodic flooding events. Some bed features were also likely scoured during these events reducing the number and size of bed features. Recent depositional features along the channel margins indicate that the channel is beginning to aggrade and reestablish lower bank features, possibly transitioning to stage IV.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	810	6	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	245		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Steep
Continuous w/ Bank:	Sometimes	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Gravel	Sand

1.5 Valley Features
Valley Width (ft): **240**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	8.0	5.0	Yes	

Stream: **Wheelock Brook**   Reach: **T5.05-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**44.20**	2.11 Riffle/Step Spacing:	**250 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.70**	2.12 Substrate Composition		Bed:	**600 mm**
2.3 Mean Depth (tf):	**2.00**	Bedrock:	**0.0 %**	Bar:	**50 mm**
2.4 Floodprone Width (ft.):	**200.00**	Boulder:	**2.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.05**	Cobble:	**45.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**41.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**22.10**	Fine Gravel:	**4.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**4.52**	Sand:	**8.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.50**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	**0.9**
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**28**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks   Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**0.0**	Dominant:	**Coniferous**	**Coniferous**
Material Type:	**Sand**	**Sand**	Erosion Height (ft.):	**0.0**	**0.0**	Sub-dominant:	**Herbaceous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**>100**	**None**
W less than 25	**267**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures	**26.08**	
Sub-dominant	**Commercial**	**None**	Height	**7.6**	
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**Multiple**	**7.5**	Gullies Length	**0**	
Gullies	**None**				

Stream: **Wheelock Brook**   Reach: **T5.05-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Low**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**2**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**1**	Delta:	**0**	Flood chutes:	**1**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**6**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**7**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:		Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:		6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:		6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:		6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**					
Habitat Stream Condition:						

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**13**	**None**	**Yes**	Geomorphic Rating	**0.65**
7.2 Channel Aggradation	**14**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**12**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**13**	**None**	**No**	Geomorphic Condition	**Good**
Total Score	**52**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: **Wheelock Brook**
Reach: **T5.06-0**
Segment Length(ft): **3,648**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **6/25/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From reach break downstream of Cold Hill Road to reach break approximately 750ft upstream of Wheelock Rd crossing**

Step 5 - Notes: **This reach indicates some bank scour on the lower banks during recent flooding events, however banks are generally very stable. Wide terraces (not recently abandoned floodplains) extend out on one side of the valley. Smaller benches are typically present on one bank and are somewhat accessible (IR ~1.5 on average). Numerous large bedrock grade controls were found throughout the reach.**

Step 7 - Narrative: **Numerous bedrock grade controls were present in the reach. Riffles between these grade controls were sedimented (with coarse sediment) and poorly formed. Coarse sediment stored above the bedrock features resulted in long poorly formed riffles for most of the reach. Large and deep pools were found below the grade controls and aggradation of fine sediment was limited through most of the reach. Degradation is likely historic given limited bank erosion. Aggradation appears to be the dominant process. Stage IV CEM was selected for the reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	1,448	3	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	587		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Steep
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **220**
Width Determination: **Measured**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	4.0	1.0	Yes	
Ledge	Mid-segment	5.0	1.0	Yes	
Ledge	Mid-segment	7.0	4.0	Yes	
Ledge	Mid-segment	9.0	5.0	Yes	
Ledge	Mid-segment	8.0	3.0	Yes	

Stream: **Wheelock Brook** Reach: **T5.06-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**34.50**	2.11 Riffle/Step Spacing:	**300 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.90**	2.12 Substrate Composition		Bed:	**300 mm**
2.3 Mean Depth (tf):	**2.26**	Bedrock:	**0.0 %**	Bar:	**70 mm**
2.4 Floodprone Width (ft.):	**70.00**	Boulder:	**6.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.90**	Cobble:	**27.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**45.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**15.27**	Fine Gravel:	**14.0 %**	Subclass Slope:	**c**
2.7 Entrenchment Ratio:	**2.03**	Sand:	**8.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.69**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**1.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**95**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Sand**	**Sand**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**81.0**	**25.2**
Erosion Height (ft.):	**4.6**	**4.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**76.8**	**184.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Coniferous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**51-100**	**>100**
Sub-Dominant	**26-50**	**51-100**
W less than 25	**714**	**393**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Pasture**	**Shrubs/Sapling**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**15.0**
Gullies	**None**	

	Left	Right
Mass Failures		**81.77**
Height		**15.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Wheelock Brook** Reach: **T5.06-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**2**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**3**	Impoundment Loc.:		Overland Flow:	**0**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bedrock Outcrops	**30**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Below**
Bridge	**25**	**Yes**	**No**	**Yes**	**Yes**	**Deposition Above,Scour Above,Scour Below**
Bridge	**17**	**Yes**	**No**	**Yes**	**Yes**	**Scour Above**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**2**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**6**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**7**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:		6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:		6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:		6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	**0**	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:	**0.00**				
Habitat Stream Condition:					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic		
7.1 Channel Degradation	**13**	**None**	**Yes**	Geomorphic Rating	**0.63**
7.2 Channel Aggradation	**11**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**13**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml	**13**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**50**			Stream Sensitivity	**Very High**

Phase 2 Segment Summary Report Lower Passumpsic

Stream: **Wheelock Brook**
Reach: **T5.07-0**
Segment Length(ft): **5,403**
Rain: **Yes**

SGAT Version: **4.56**
Organization:
Observers: **JHB,MPL,FEA**
Completion Date: **7/16/2013**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Begins at the reach break Southeast of the intersection of South Wheelock road and Vermont Drive and extends upstream to the next reach break west of the same intersection**

Step 5 - Notes: **This reach contained numerous large grade controls affecting approximately 10% of the reach. The areas outside of this bedrock influence exhibited recent widening and deposition. The cross-section was located at a representative riffle in the upper reach with slightly elevated but accessible floodplain on both banks. The large pasture area mid reach contained historic armoring and recent windrowed cobble berms. Historic imagery indicates that a ~400' stretch immediately upstream of the house and farm was straightened and then blew out during recent floods. This area was very wide ~100' and was reestablishing meander geometry.**

Step 7 - Narrative: **Widening from a recent episodic flooding event is the dominant process in this reach. The lower reach contains numerous large bedrock cascades and indicated some widening through scoured lower banks. The upper reach had several locations with major widening. Several large diagonal bars and mid channel bars were observed in the upper reach.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	131	2	209	1
Road:	1,348	7	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	1,528		388	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Sometimes	Never
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **320**
Width Determination: **Measured**
Confinement Type: **BD**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	4.0	1.0	No	
Ledge	Mid-segment	6.0	3.0	Yes	
Ledge	Mid-segment	2.0	0.0	Yes	
Ledge	Mid-segment	12.0	10.0	Yes	
Ledge	Mid-segment	8.0	6.0	Yes	
Ledge	Mid-segment	6.0	3.0	Yes	
Ledge	Mid-segment	9.0	5.0	Yes	
Ledge	Mid-segment	3.0	0.0	Yes	

Stream: **Wheelock Brook** Reach: **T5.07-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**47.00**	2.11 Riffle/Step Spacing:	**150 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.60**	2.12 Substrate Composition		Bed:	**400 mm**
2.3 Mean Depth (tf):	**1.60**	Bedrock:	**0.0 %**	Bar:	**240 mm**
2.4 Floodprone Width (ft.):	**179.00**	Boulder:	**2.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**50.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**34.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**29.38**	Fine Gravel:	**10.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.81**	Sand:	**3.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.58**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**111**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**219.8**	**284.4**
Erosion Height (ft.):	**5.7**	**4.9**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**87.1**	**298.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**0-25**	**51-100**
W less than 25	**337**	**3,771**
Buffer Vegitation Type		
Dominant	**Herbaceous**	**Herbaceous**
Sub-Dominant	**Deciduous**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Pasture**	**Residential**
Sub-dominant	**Forest**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Wheelock Brook** Reach: **T5.07-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **None**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **4**

4.5 Flow Regulation Type **Small Withdrawal**

Flow Reg. Use: **Drinking**

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **None**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs

Field Ditch: **0** Road Ditch: **2**

Other: **0** Tile Drain: **0**

Overland Flow: **0** Urb Strm Wtr Pipe: **0**

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	26	Yes	No	Yes	Yes	Deposition Above
Bedrock Outcrops	30	Yes	Yes	Yes	Yes	Deposition Above,Scour Below
Bridge	40	Yes	No	No	No	None

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **7** Point: **9** Side: **6**

Diagonal: **1** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features

Flood chutes: **1**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **1**

Neck Cutoff: **0**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **582**

5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:

6.2 Pool Substrate:

6.3 Pool Variability:

Total Score: **0**

Habitat Rating: **0.00**

Habitat Stream Condition:

6.4 Sediment Deposition:

6.5 Channel Flow Status:

6.6 Channel Alteration:

6.7 Channel Sinuosity:

Stream Gradiant Type Left Right

6.8 Bank Stability:

6.9 Bank Vegetation Protection

6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**10**	**None**	**No**
7.4 Change in Planforml	**13**	**None**	**No**
Total Score	**47**		

Geomorphic Rating **0.59**

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

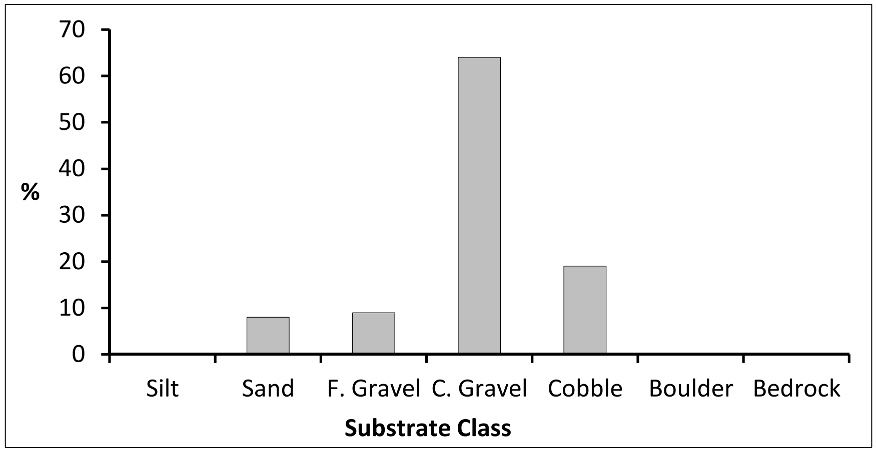
Stream Sensitivity **High**

APPENDIX C

REACH HABITAT DATA SUMMARY SHEETS

Reach/Segment Information

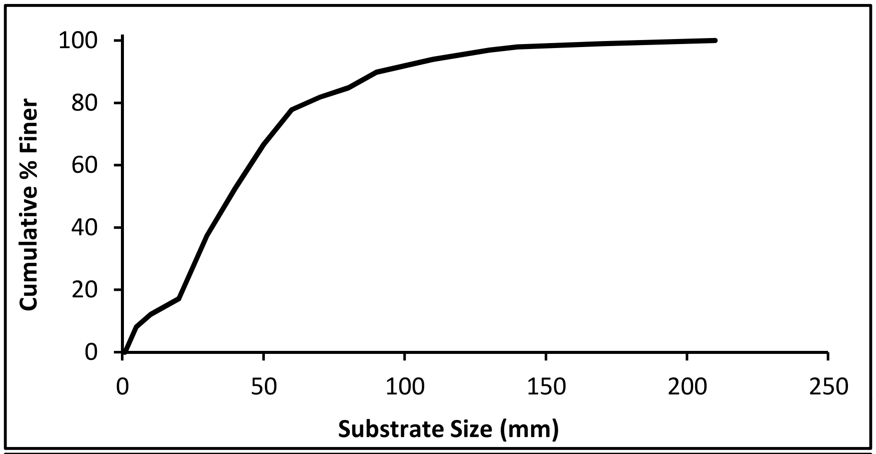
SGA ID:	T2.07
Length (ft):	4,113
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	96
RHA Percentage:	60%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	9
C. Gravel	16 - 64	64
Cobble	64 - 256	19
Boulder	256 - 4096	0
Bedrock	> 4096	0

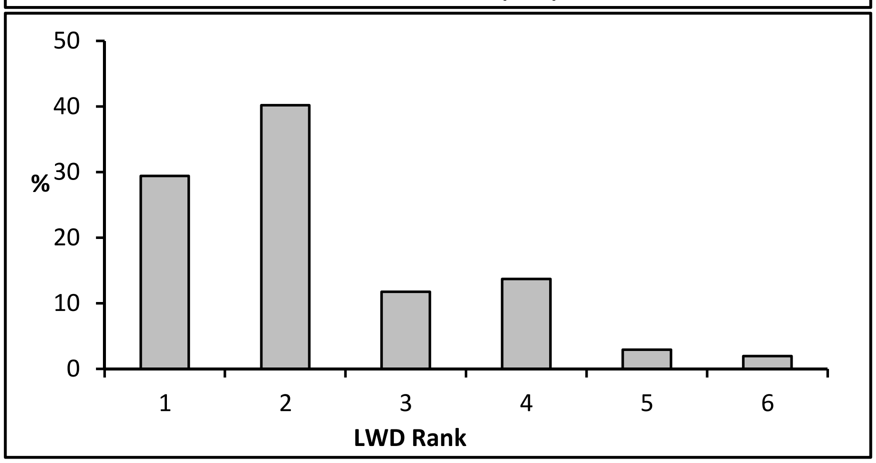
Median Substrate Size:	30	mm
Avg. Largest Particle (Bar):	130	mm
Riffle Stability Index (RSI):	97	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	30
2	0.5 ≤ D < 1.0	≥ 0.5	41
3	1.0 ≤ D < 2.0	< 0.5	12
4	1.0 ≤ D < 2.0	≥ 0.5	14
5	D ≥ 2.0	< 0.5	3
6	D ≥ 2.0	≥ 0.5	2

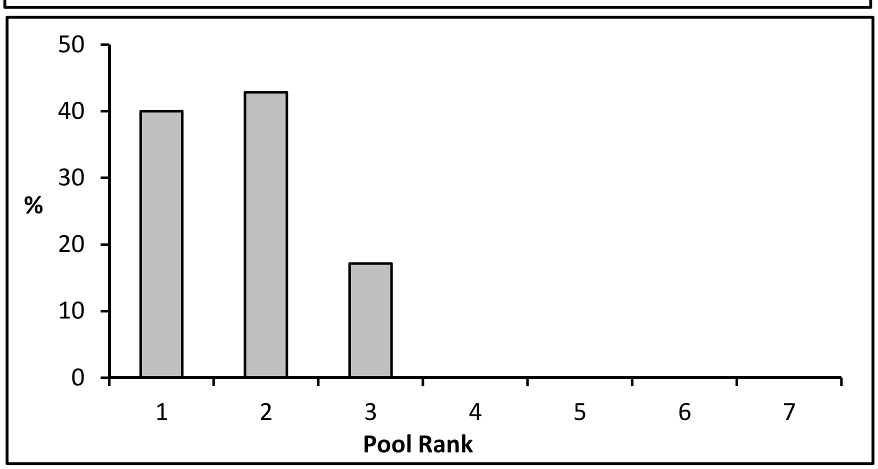
 # LWDs/mile: 131



Pools

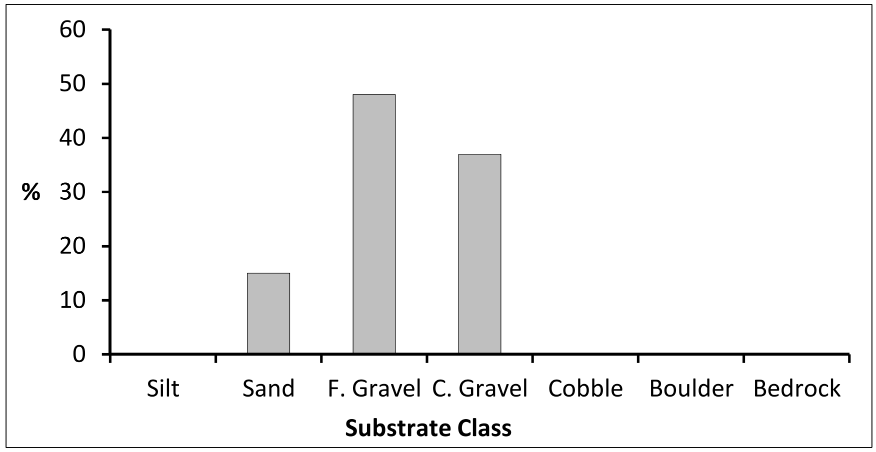
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	14
2	1.0 ≤ D < 2.0	≥ 0.5	15
3	2.0 ≤ D < 3.0	< 0.5	6
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 45



Reach/Segment Information

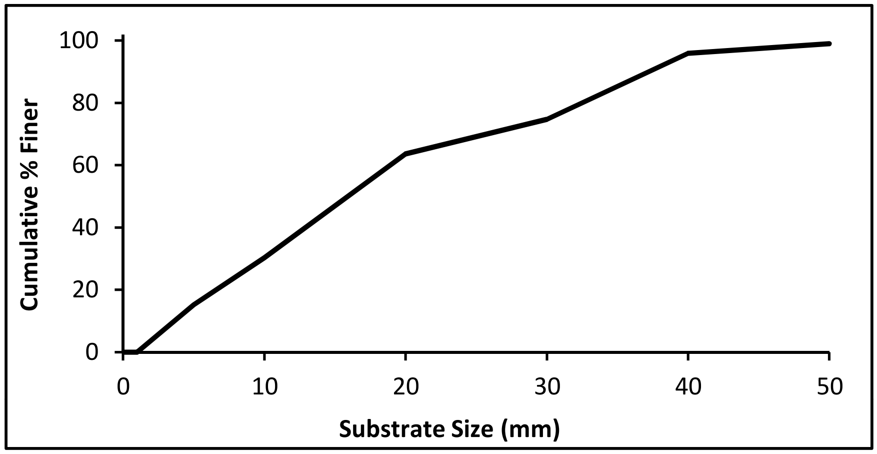
SGA ID:	T2.08A
Length (ft):	1,922
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	97
RHA Percentage:	61%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	15
F. Gravel	2 - 16	48
C. Gravel	16 - 64	37
Cobble	64 - 256	0
Boulder	256 - 4096	0
Bedrock	> 4096	0

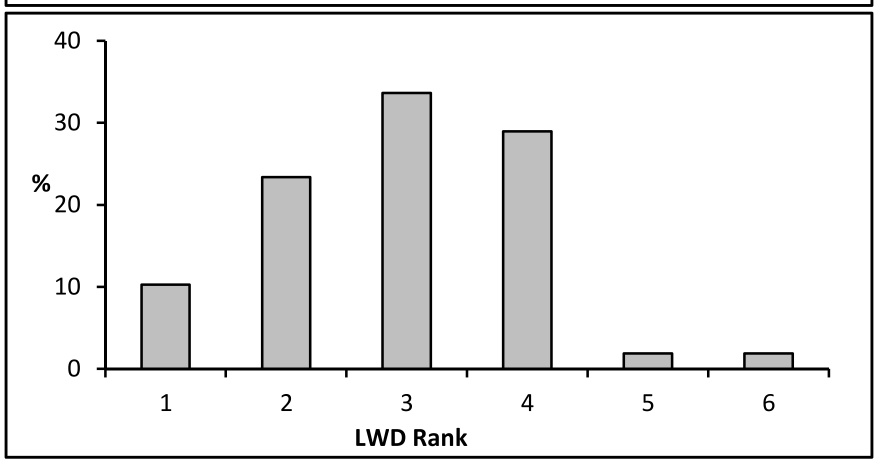
Median Substrate Size:	10	mm
Avg. Largest Particle (Bar):	40	mm
Riffle Stability Index (RSI):	97	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	11
2	0.5 ≤ D < 1.0	≥ 0.5	25
3	1.0 ≤ D < 2.0	< 0.5	36
4	1.0 ≤ D < 2.0	≥ 0.5	31
5	D ≥ 2.0	< 0.5	2
6	D ≥ 2.0	≥ 0.5	2

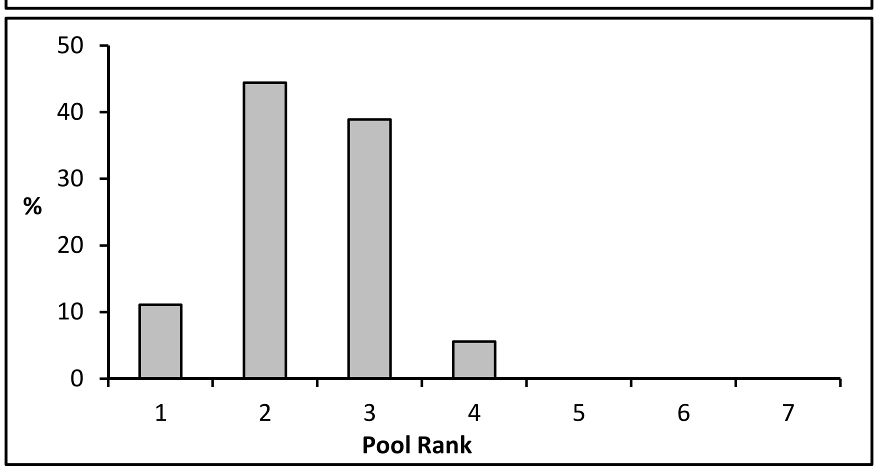
 # LWDs/mile: 293

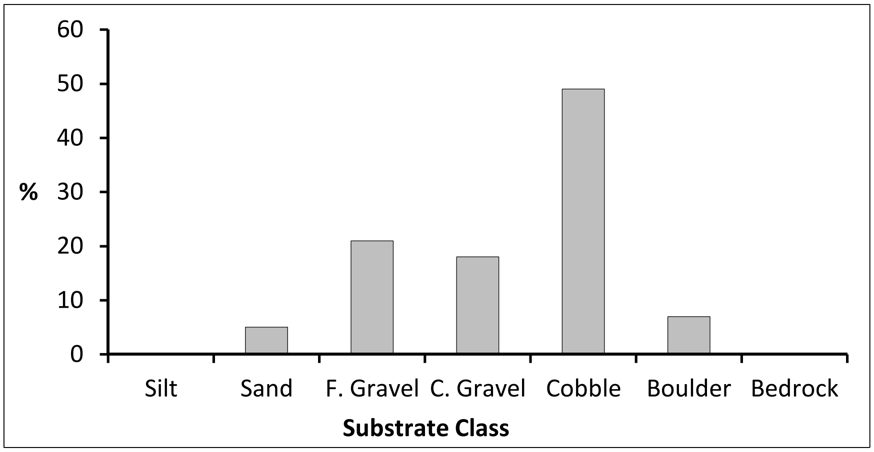


Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	2
2	1.0 ≤ D < 2.0	≥ 0.5	8
3	2.0 ≤ D < 3.0	< 0.5	7
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

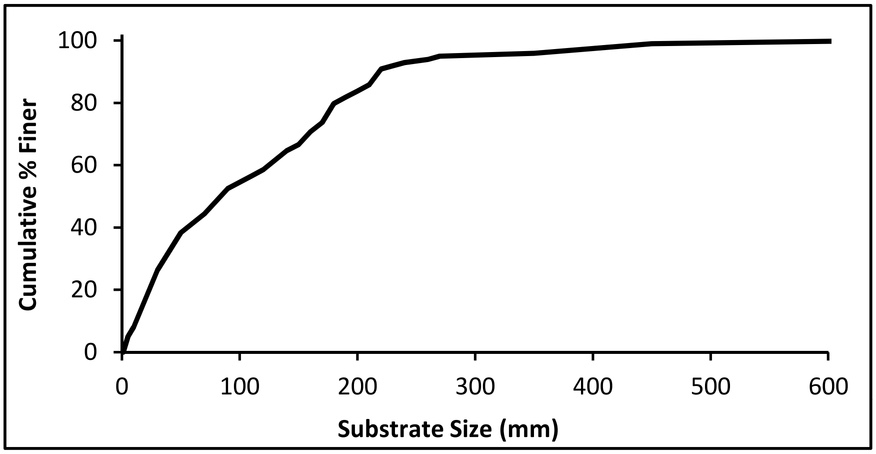
 # Pools/mile: 49





Reach/Segment Information

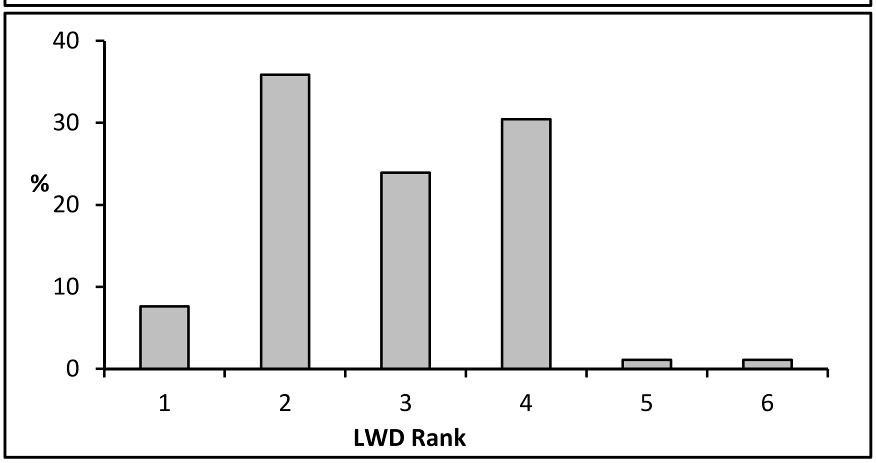
SGA ID:	T2.08B
Length (ft):	1,896
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	105
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	5
F. Gravel	2 - 16	21
C. Gravel	16 - 64	18
Cobble	64 - 256	49
Boulder	256 - 4096	7
Bedrock	> 4096	0

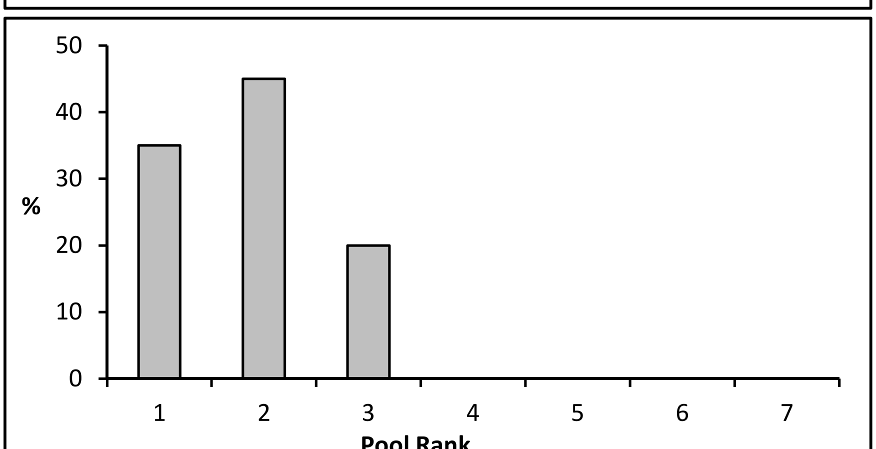
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	180	mm
Riffle Stability Index (RSI):	80	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	7
2	0.5 ≤ D < 1.0	≥ 0.5	33
3	1.0 ≤ D < 2.0	< 0.5	22
4	1.0 ≤ D < 2.0	≥ 0.5	28
5	D ≥ 2.0	< 0.5	1
6	D ≥ 2.0	≥ 0.5	1

 # LWDs/mile: 256



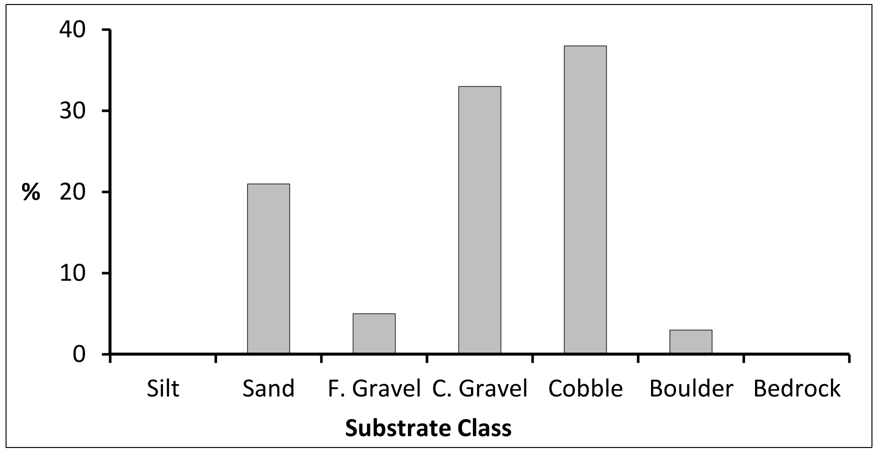
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	7
2	1.0 ≤ D < 2.0	≥ 0.5	9
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 56

Reach/Segment Information

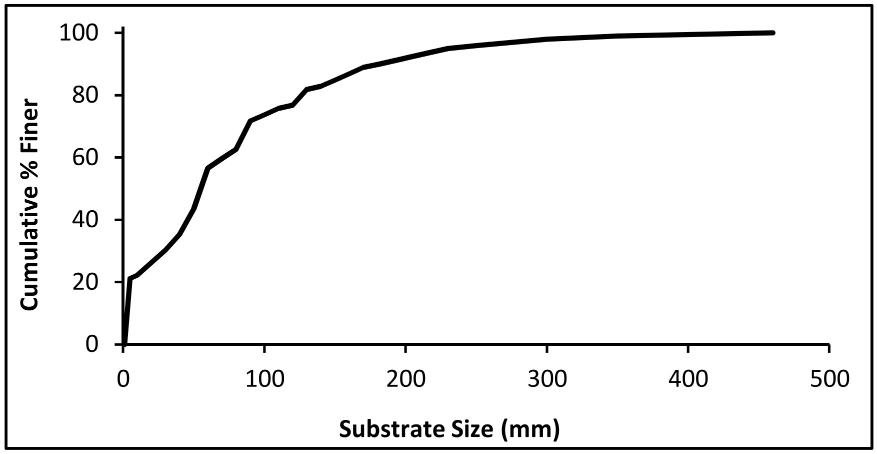
SGA ID:	T2.09
Length (ft):	6,499
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	107
RHA Percentage:	67%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	21
F. Gravel	2 - 16	5
C. Gravel	16 - 64	33
Cobble	64 - 256	38
Boulder	256 - 4096	3
Bedrock	> 4096	0

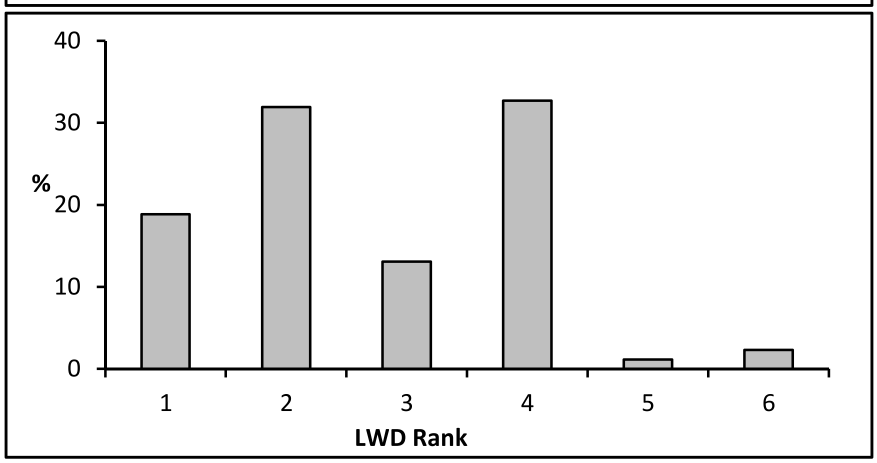
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	80	mm
Riffle Stability Index (RSI):	63	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	49
2	0.5 ≤ D < 1.0	≥ 0.5	83
3	1.0 ≤ D < 2.0	< 0.5	34
4	1.0 ≤ D < 2.0	≥ 0.5	85
5	D ≥ 2.0	< 0.5	3
6	D ≥ 2.0	≥ 0.5	6

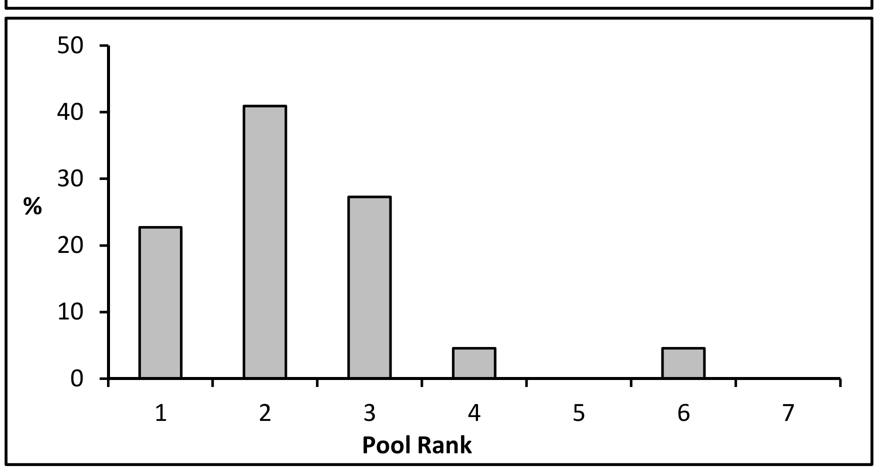
 # LWDs/mile: 211



Pools

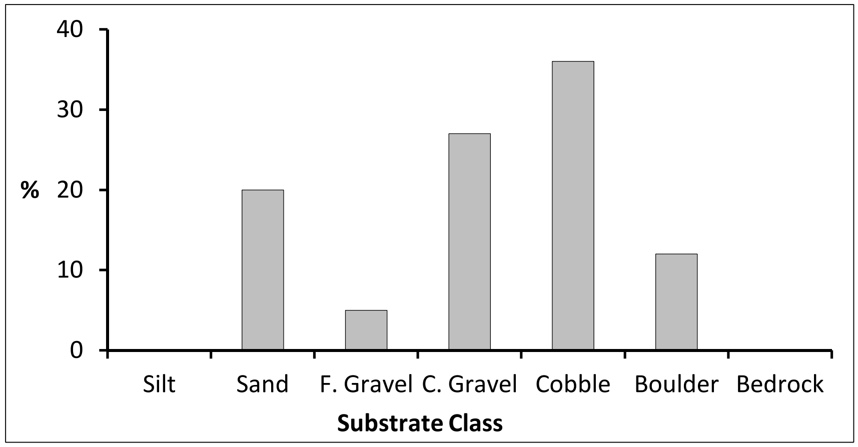
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	9
3	2.0 ≤ D < 3.0	< 0.5	6
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 18



Reach/Segment Information

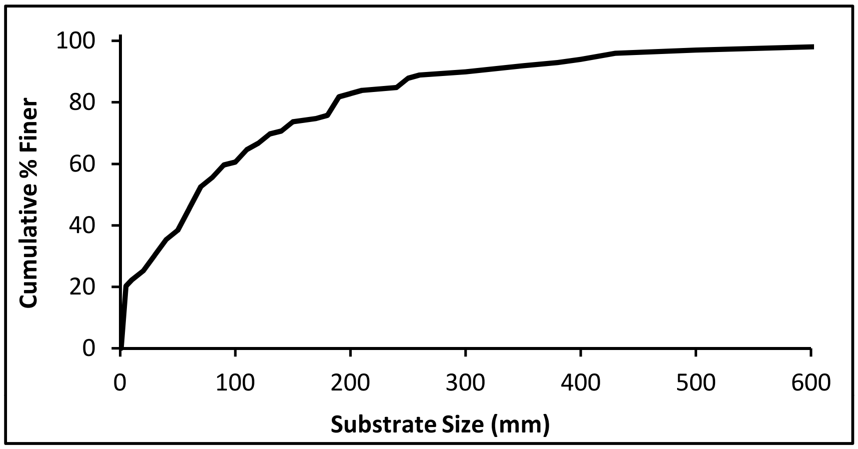
SGA ID:	T2.10
Length (ft):	3,423
Reference Bedform Type:	Step-Pool
Total RHA Score:	94
RHA Percentage:	59%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	20
F. Gravel	2 - 16	5
C. Gravel	16 - 64	27
Cobble	64 - 256	36
Boulder	256 - 4096	12
Bedrock	> 4096	0

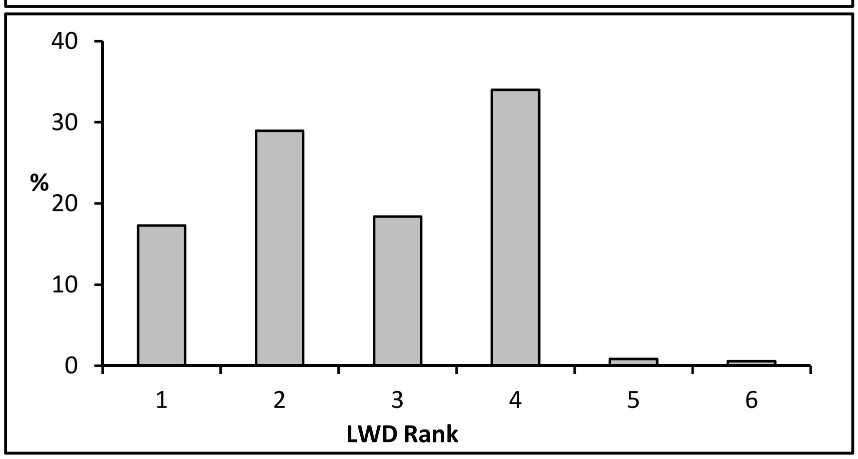
Median Substrate Size:	60	mm
Avg. Largest Particle (Bar):	150	mm
Riffle Stability Index (RSI):	74	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	62
2	0.5 ≤ D < 1.0	≥ 0.5	104
3	1.0 ≤ D < 2.0	< 0.5	66
4	1.0 ≤ D < 2.0	≥ 0.5	122
5	D ≥ 2.0	< 0.5	3
6	D ≥ 2.0	≥ 0.5	2

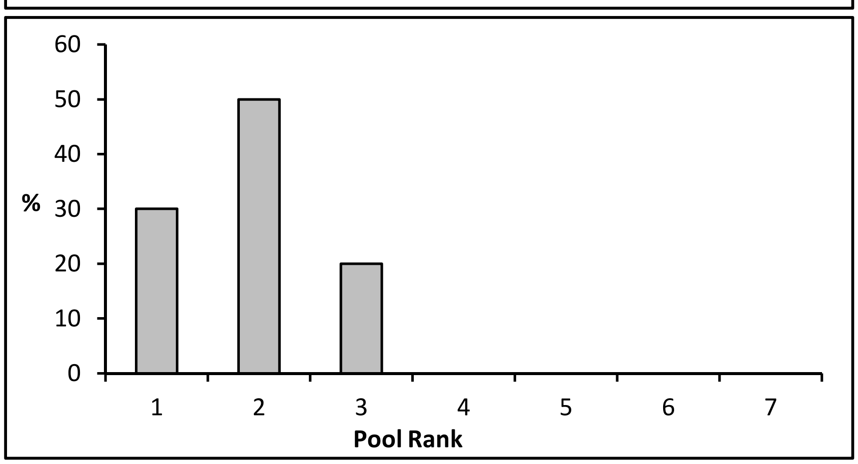
 # LWDs/mile: 554



Pools

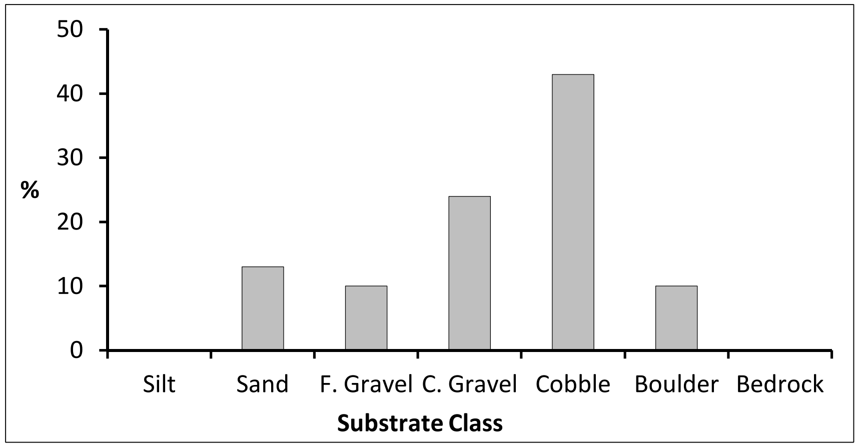
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	5
3	2.0 ≤ D < 3.0	< 0.5	2
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 15



Reach/Segment Information

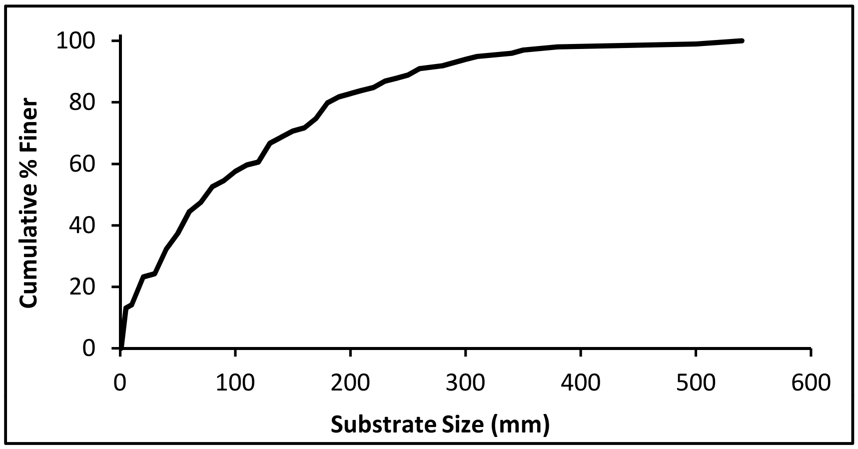
SGA ID:	T2.11A
Length (ft):	3,714
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	105
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	13
F. Gravel	2 - 16	10
C. Gravel	16 - 64	24
Cobble	64 - 256	43
Boulder	256 - 4096	10
Bedrock	> 4096	0

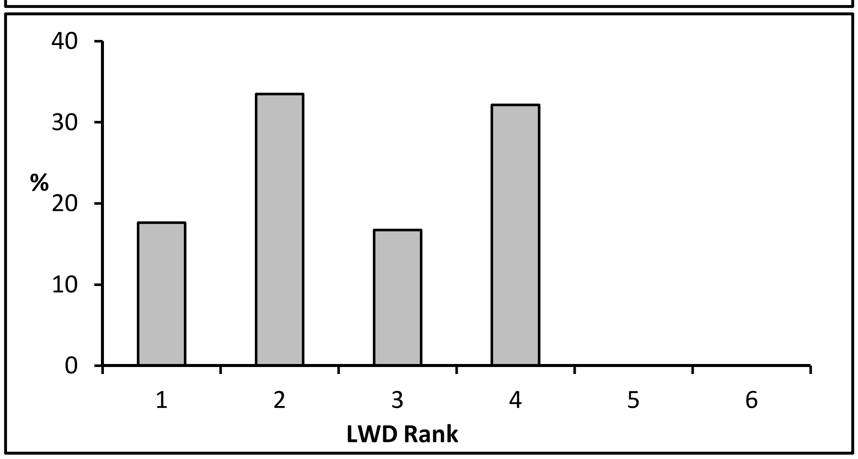
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	80	mm
Riffle Stability Index (RSI):	53	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	40
2	0.5 ≤ D < 1.0	≥ 0.5	76
3	1.0 ≤ D < 2.0	< 0.5	38
4	1.0 ≤ D < 2.0	≥ 0.5	73
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

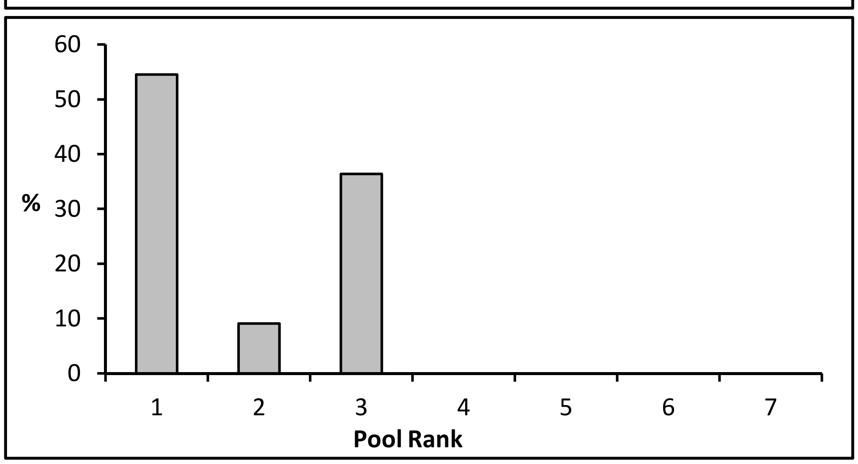
 # LWDs/mile: 323

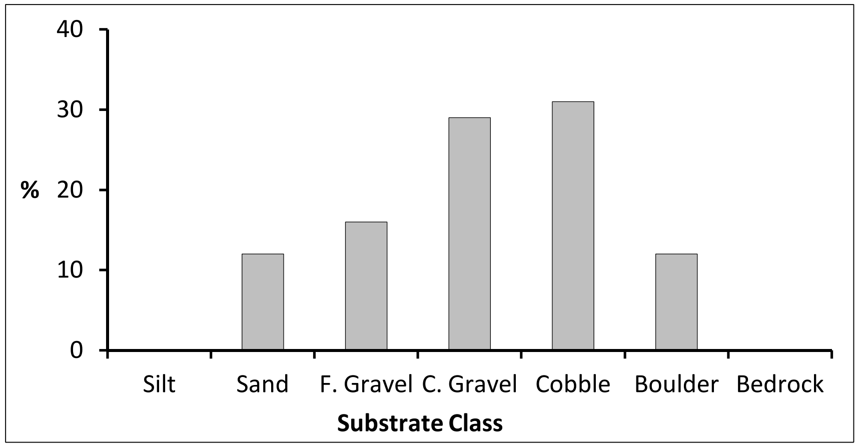


Pools

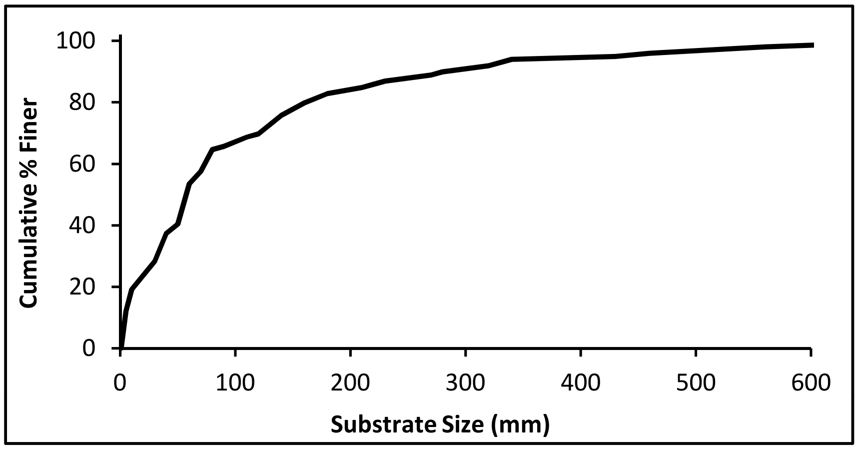
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	6
2	1.0 ≤ D < 2.0	≥ 0.5	1
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 16





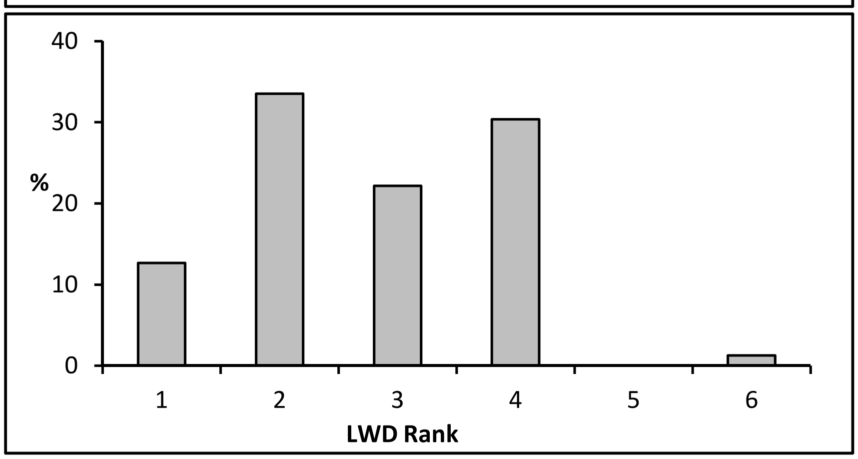
Reach/Segment Information	
SGA ID:	T2.11B
Length (ft):	3,500
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	106
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	12
F. Gravel	2 - 16	16
C. Gravel	16 - 64	29
Cobble	64 - 256	31
Boulder	256 - 4096	12
Bedrock	> 4096	0

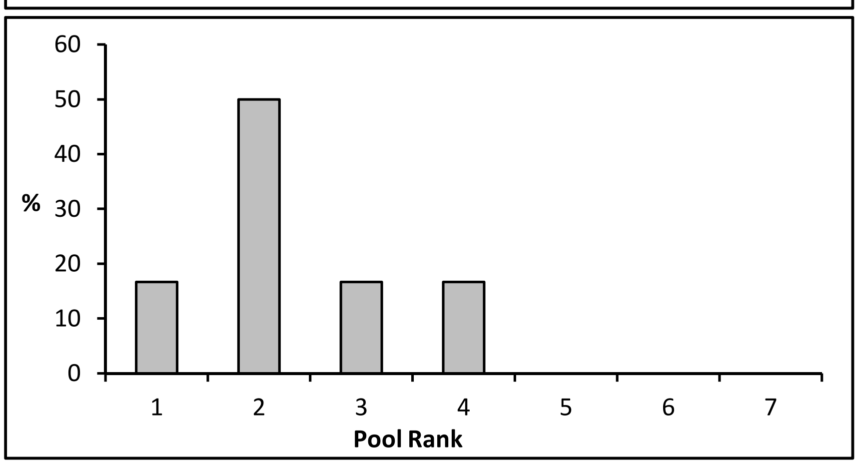
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	320	mm
Riffle Stability Index (RSI):	92	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	20
2	0.5 ≤ D < 1.0	≥ 0.5	53
3	1.0 ≤ D < 2.0	< 0.5	35
4	1.0 ≤ D < 2.0	≥ 0.5	48
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	2

 # LWDs/mile: 238



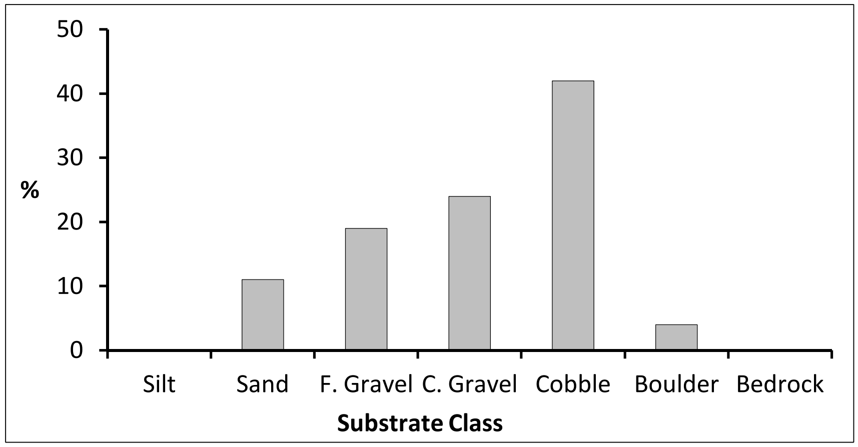
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	1
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 9

Reach/Segment Information

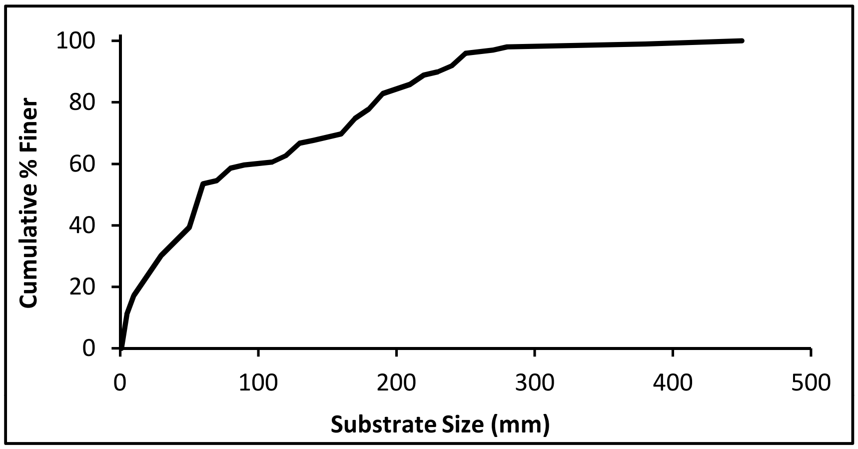
SGA ID:	T2.12A
Length (ft):	1,291
Reference Bedform Type:	Step-Pool
Total RHA Score:	84
RHA Percentage:	53%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	11
F. Gravel	2 - 16	19
C. Gravel	16 - 64	24
Cobble	64 - 256	42
Boulder	256 - 4096	4
Bedrock	> 4096	0

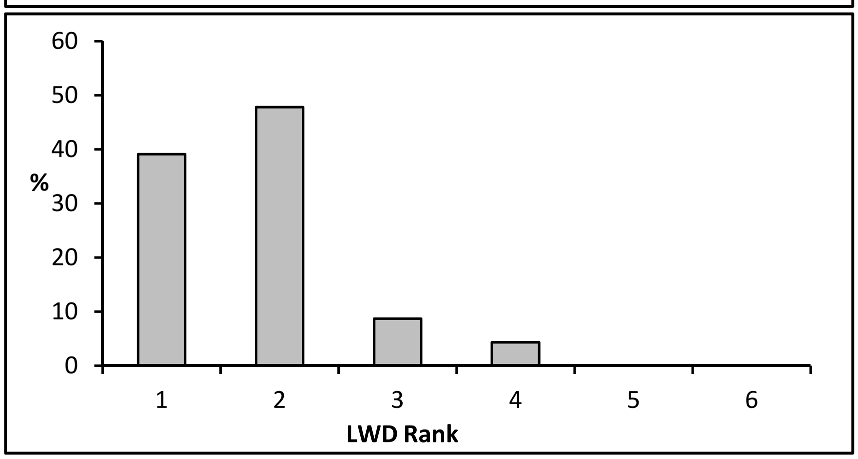
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	250	mm
Riffle Stability Index (RSI):	96	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	9
2	0.5 ≤ D < 1.0	≥ 0.5	11
3	1.0 ≤ D < 2.0	< 0.5	2
4	1.0 ≤ D < 2.0	≥ 0.5	1
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

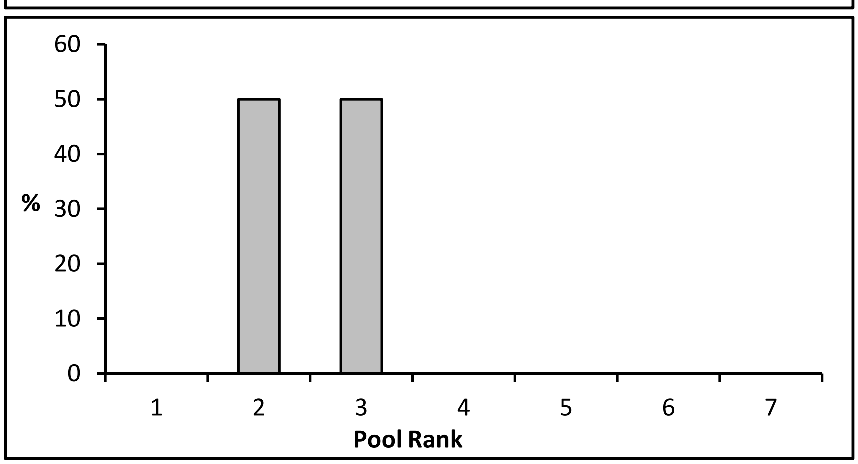
 # LWDs/mile: 94



Pools

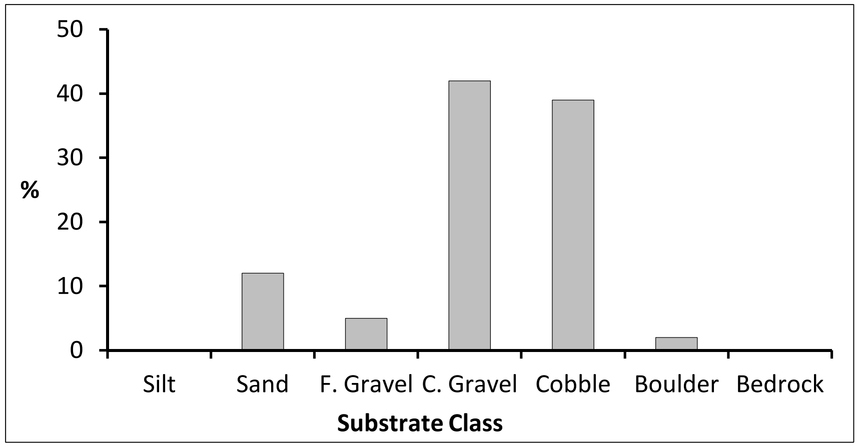
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	0
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	2
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 16



Reach/Segment Information

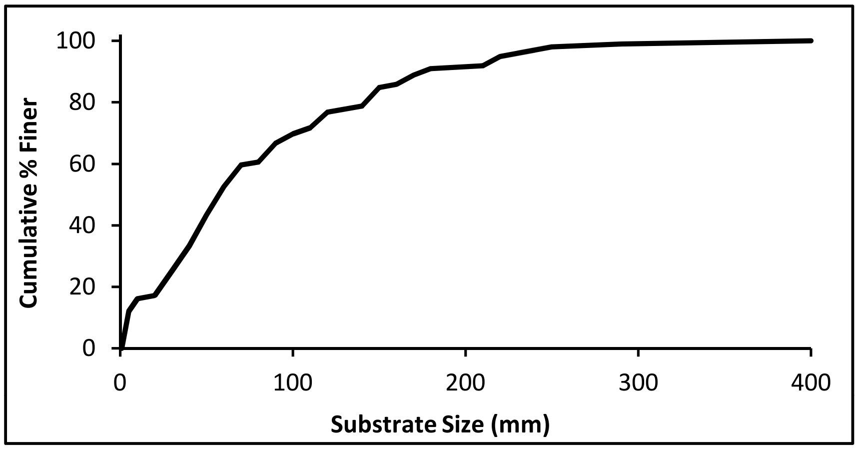
SGA ID:	T2.12B
Length (ft):	3,344
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	82
RHA Percentage:	51%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	12
F. Gravel	2 - 16	5
C. Gravel	16 - 64	42
Cobble	64 - 256	39
Boulder	256 - 4096	2
Bedrock	> 4096	0

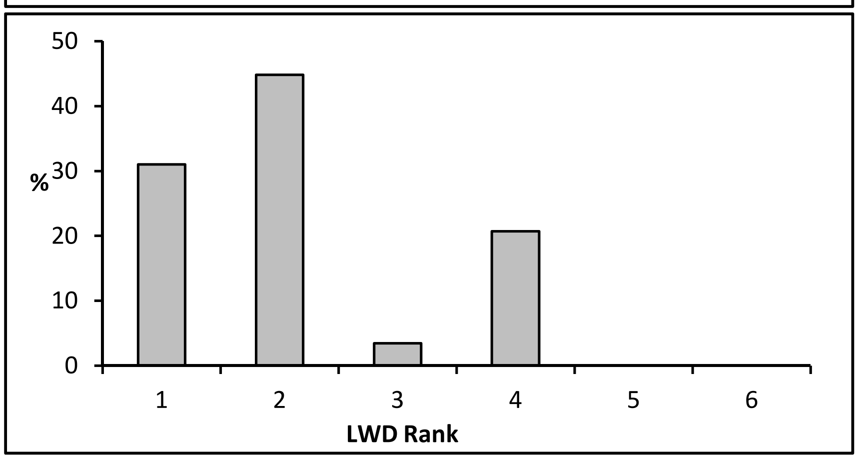
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	50	mm
Riffle Stability Index (RSI):	43	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	9
2	0.5 ≤ D < 1.0	≥ 0.5	13
3	1.0 ≤ D < 2.0	< 0.5	1
4	1.0 ≤ D < 2.0	≥ 0.5	6
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

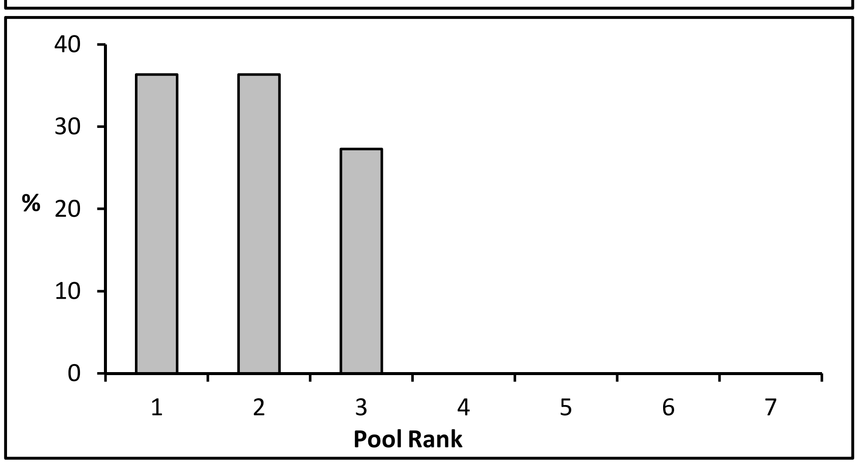
 # LWDs/mile: 46



Pools

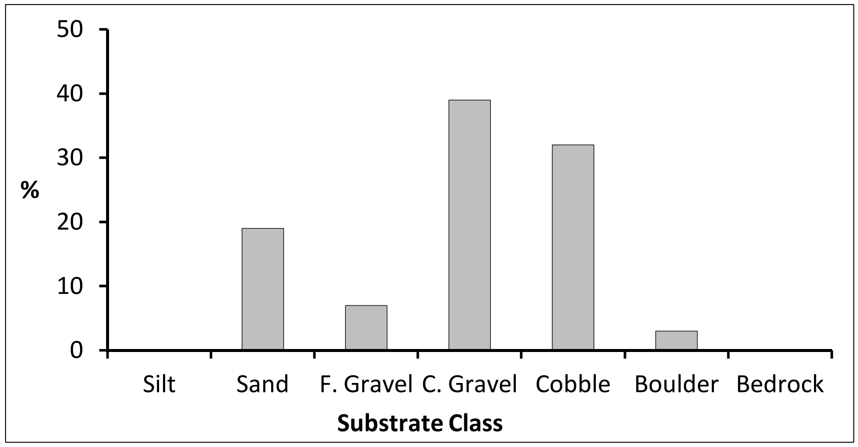
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	4
2	1.0 ≤ D < 2.0	≥ 0.5	4
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 17



Reach/Segment Information

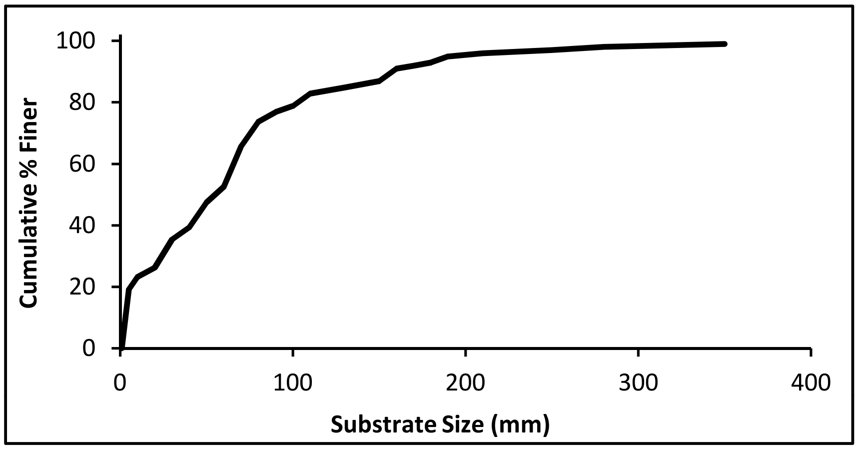
SGA ID:	T3.04
Length (ft):	3,988
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	56
RHA Percentage:	35%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	19
F. Gravel	2 - 16	7
C. Gravel	16 - 64	39
Cobble	64 - 256	32
Boulder	256 - 4096	3
Bedrock	> 4096	0

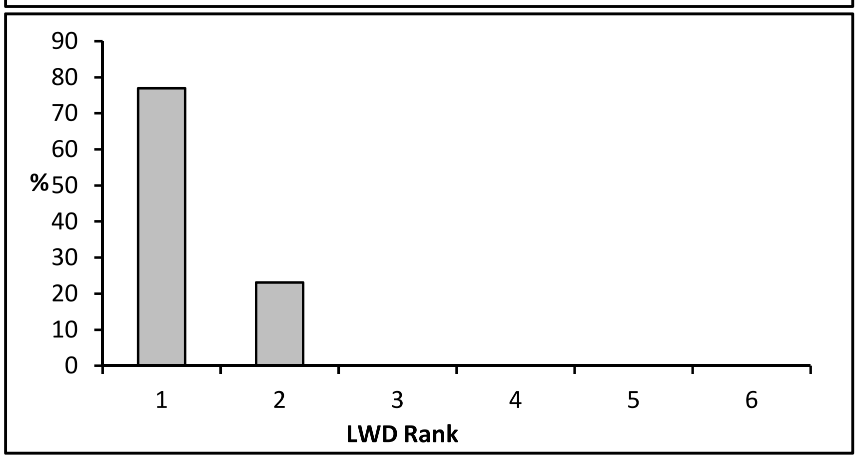
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	100	mm
Riffle Stability Index (RSI):	79	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	10
2	0.5 ≤ D < 1.0	≥ 0.5	3
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

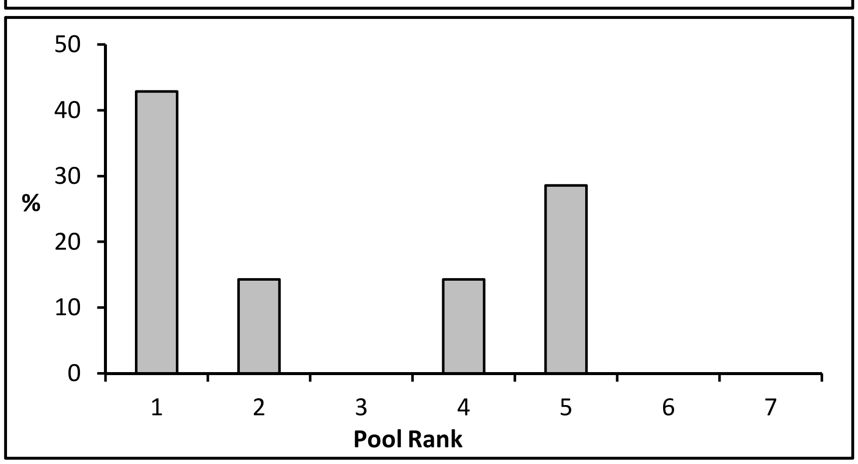
 # LWDs/mile: 17



Pools

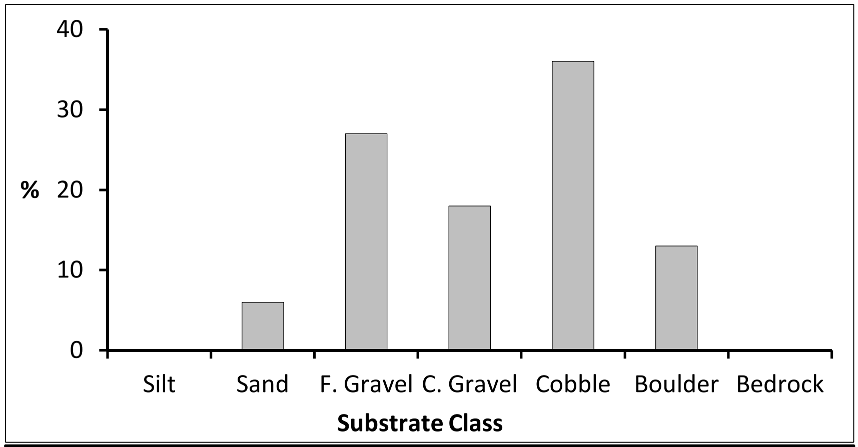
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	1
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	2
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 9



Reach/Segment Information

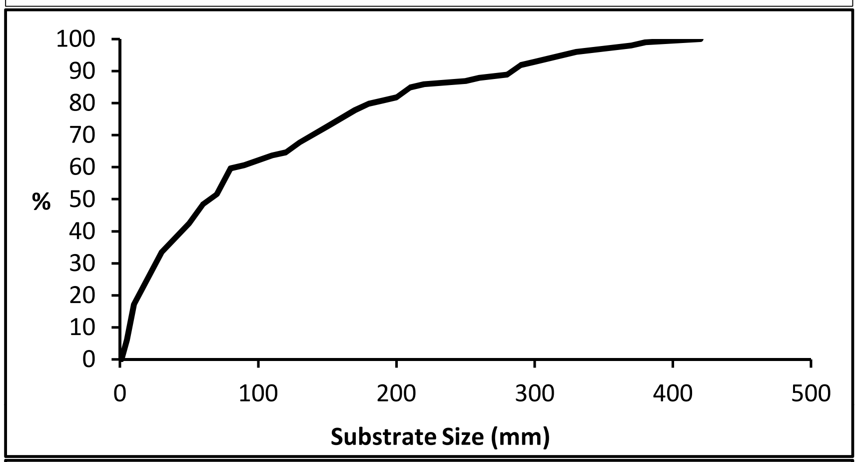
SGA ID:	T3.05
Length (ft):	1,946
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	79
RHA Percentage:	49%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	6
F. Gravel	2 - 16	27
C. Gravel	16 - 64	18
Cobble	64 - 256	36
Boulder	256 - 4096	13
Bedrock	> 4096	0

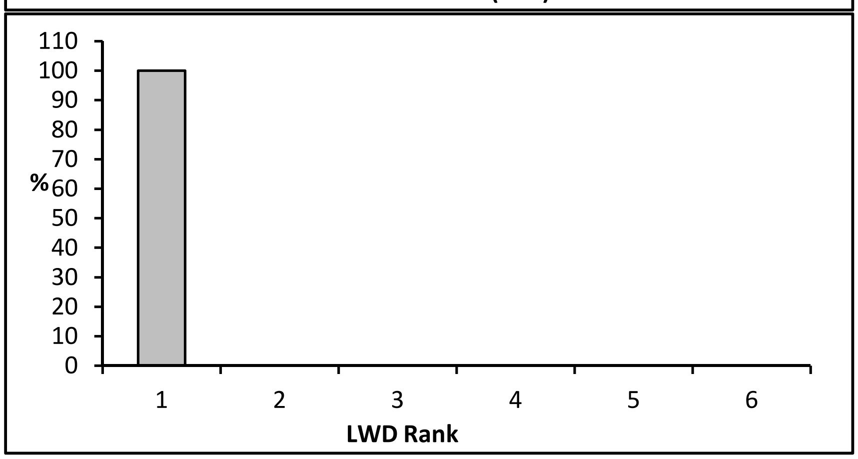
Median Substrate Size:	60	mm
Avg. Largest Particle (Bar):	80	mm
Riffle Stability Index (RSI):	60	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	5
2	0.5 ≤ D < 1.0	≥ 0.5	0
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

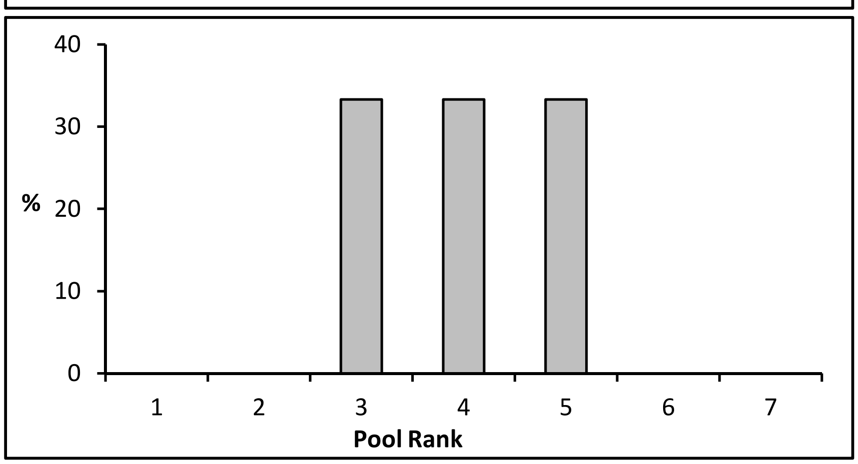
 # LWDs/mile: 14



Pools

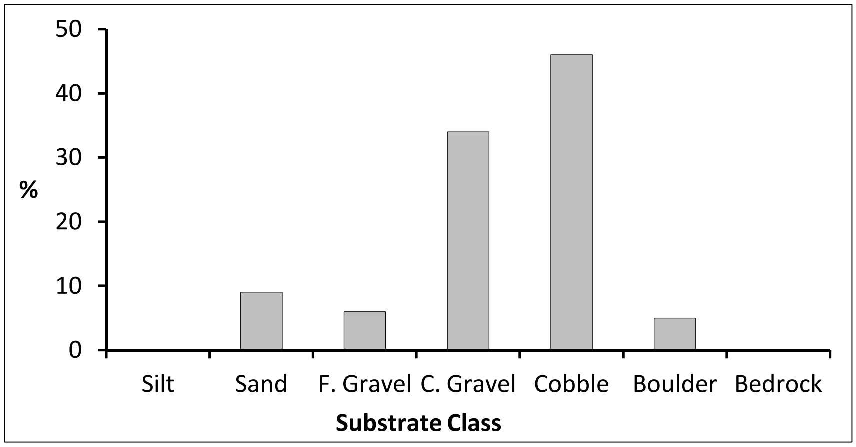
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	0
2	1.0 ≤ D < 2.0	≥ 0.5	0
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	1
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 8



Reach/Segment Information

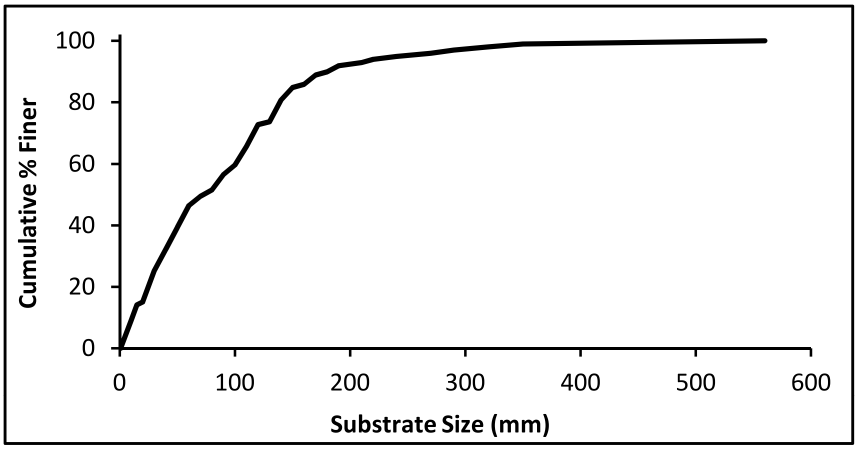
SGA ID:	T3.06
Length (ft):	1,773
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	74
RHA Percentage:	46%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	9
F. Gravel	2 - 16	6
C. Gravel	16 - 64	34
Cobble	64 - 256	46
Boulder	256 - 4096	5
Bedrock	> 4096	0

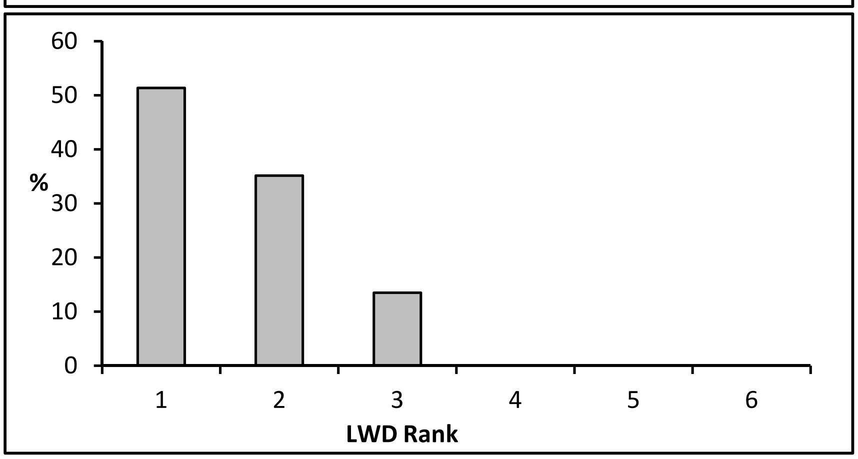
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	NA	mm
Riffle Stability Index (RSI):	NA	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	19
2	0.5 ≤ D < 1.0	≥ 0.5	13
3	1.0 ≤ D < 2.0	< 0.5	5
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

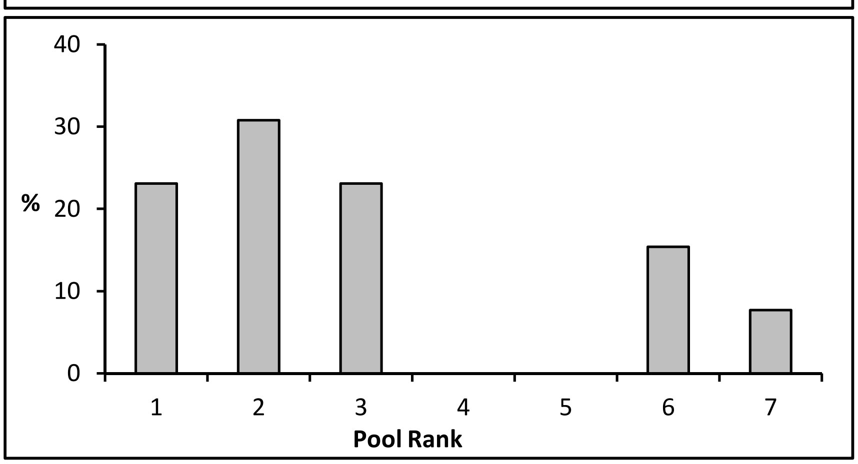
 # LWDs/mile: 110



Pools

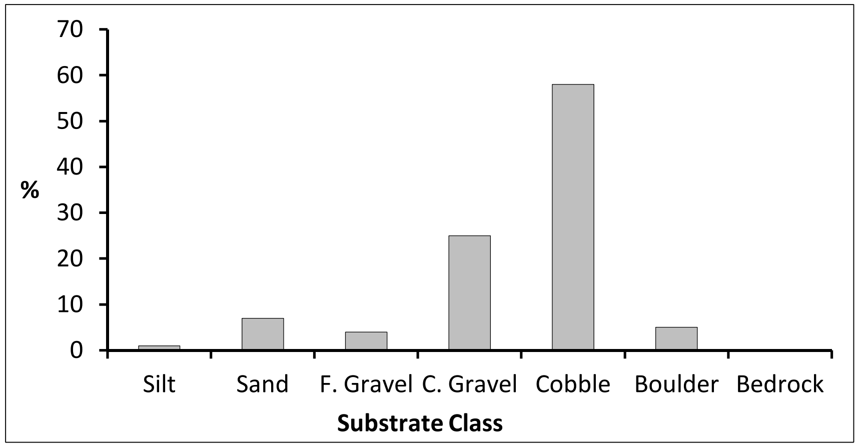
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	4
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	2
7	D ≥ 3.0	≥ 1.0	1

 # Pools/mile: 39



Reach/Segment Information

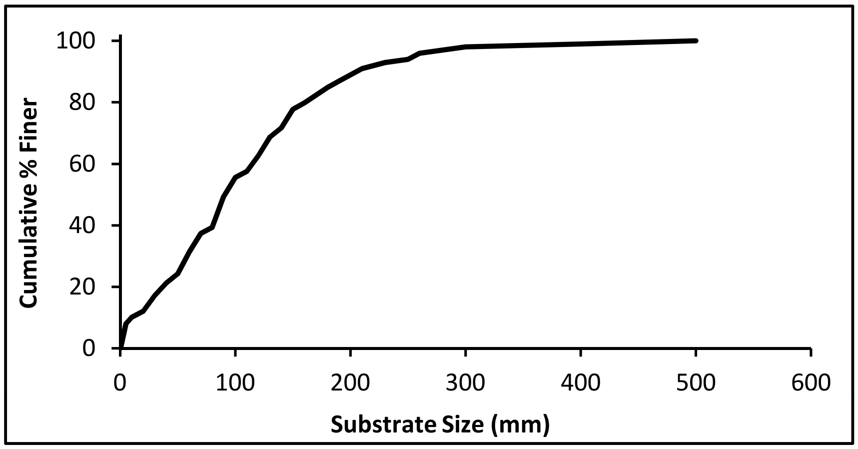
SGA ID:	T3.07
Length (ft):	2,861
Reference Bedform Type:	Braided
Total RHA Score:	81
RHA Percentage:	51%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	1
Sand	0.06 - 2	7
F. Gravel	2 - 16	4
C. Gravel	16 - 64	25
Cobble	64 - 256	58
Boulder	256 - 4096	5
Bedrock	> 4096	0

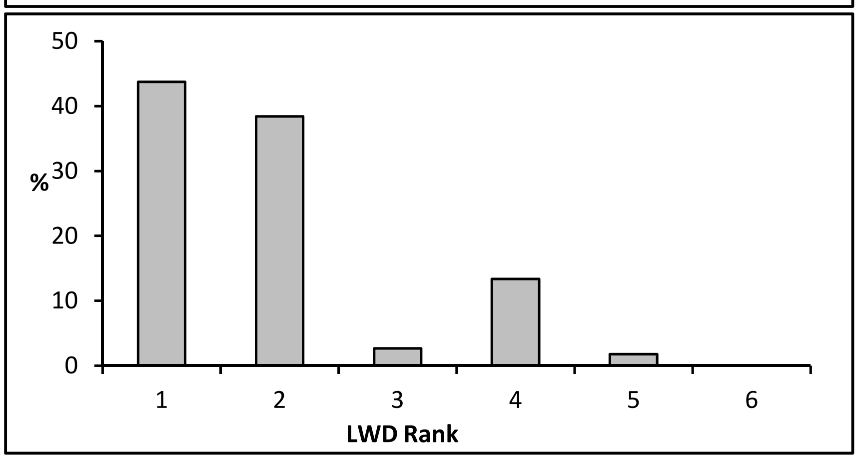
Median Substrate Size:	90	mm
Avg. Largest Particle (Bar):	200	mm
Riffle Stability Index (RSI):	86	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	49
2	0.5 ≤ D < 1.0	≥ 0.5	43
3	1.0 ≤ D < 2.0	< 0.5	3
4	1.0 ≤ D < 2.0	≥ 0.5	15
5	D ≥ 2.0	< 0.5	2
6	D ≥ 2.0	≥ 0.5	0

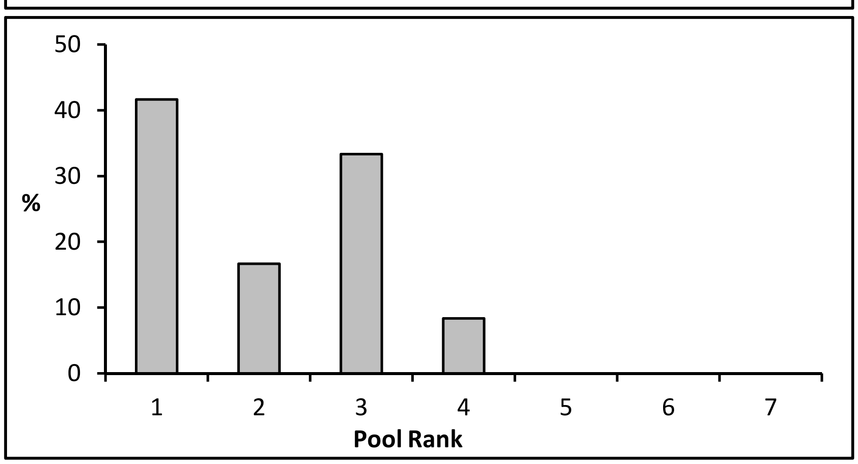
 # LWDs/mile: 207



Pools

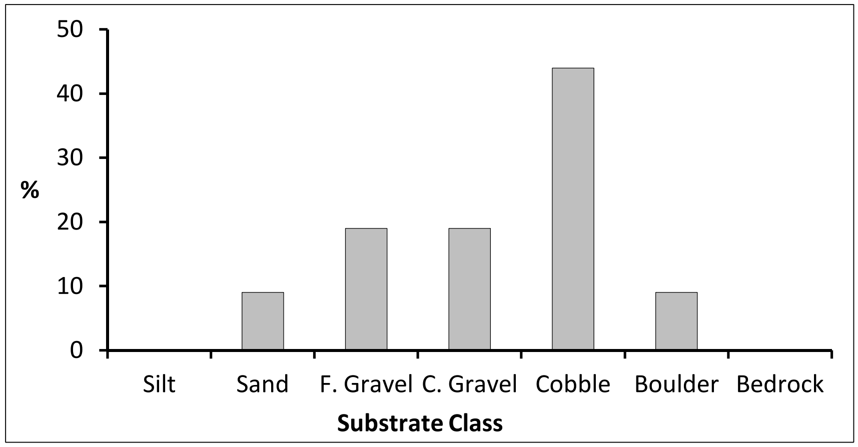
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 22



Reach/Segment Information

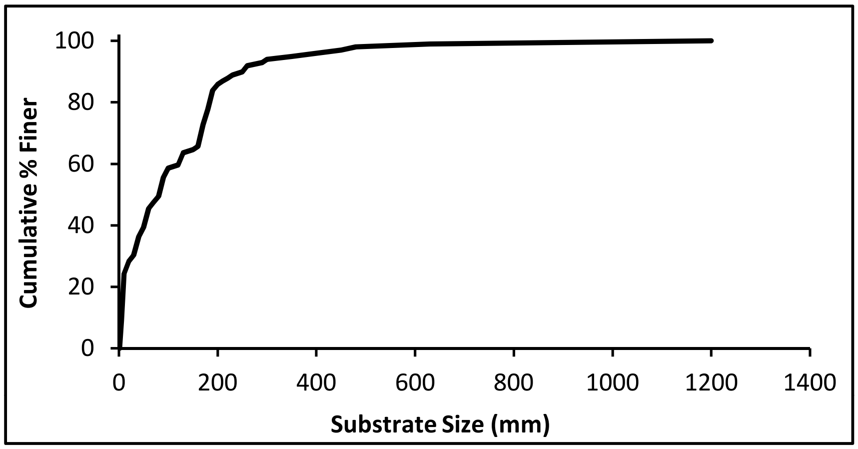
SGA ID:	T3.08
Length (ft):	5,010
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	76
RHA Percentage:	48%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	9
F. Gravel	2 - 16	19
C. Gravel	16 - 64	19
Cobble	64 - 256	44
Boulder	256 - 4096	9
Bedrock	> 4096	0

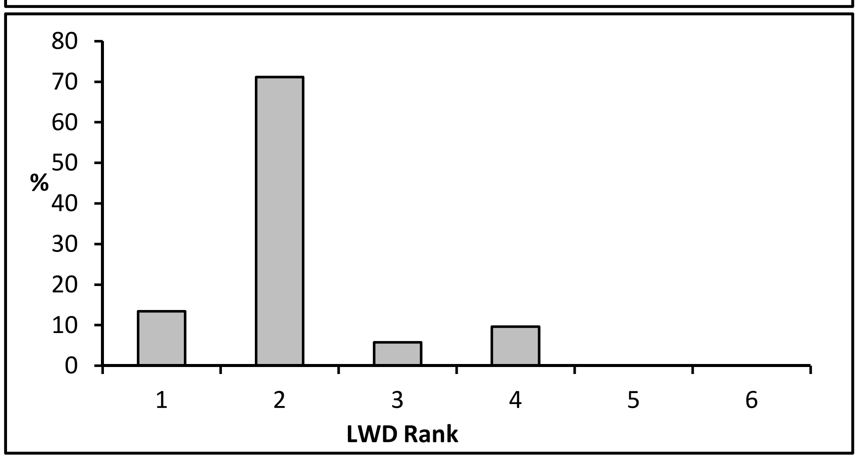
Median Substrate Size:	80	mm
Avg. Largest Particle (Bar):	300	mm
Riffle Stability Index (RSI):	94	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	7
2	0.5 ≤ D < 1.0	≥ 0.5	37
3	1.0 ≤ D < 2.0	< 0.5	3
4	1.0 ≤ D < 2.0	≥ 0.5	5
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

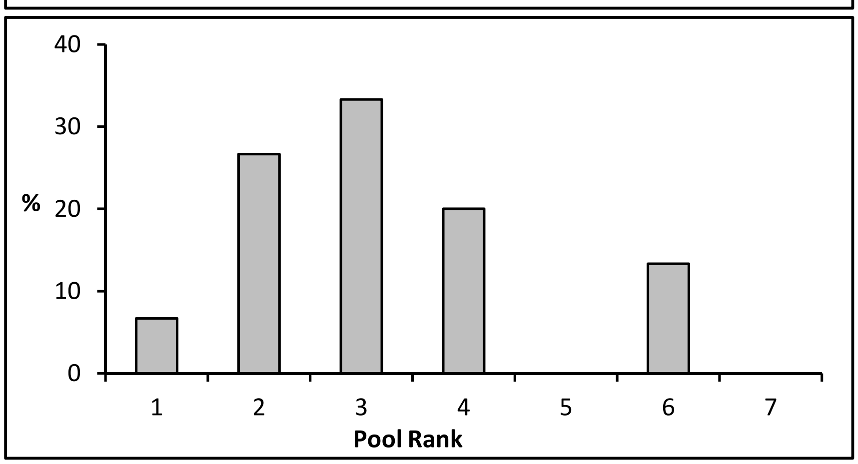
 # LWDs/mile: 55



Pools

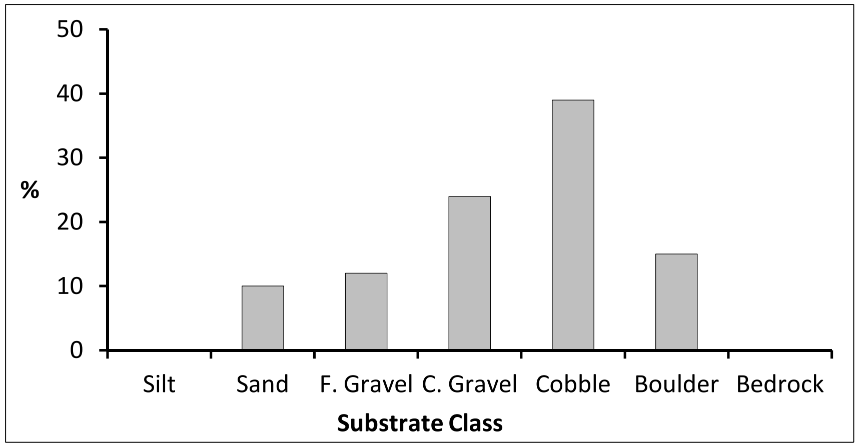
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	1
2	1.0 ≤ D < 2.0	≥ 0.5	4
3	2.0 ≤ D < 3.0	< 0.5	5
4	2.0 ≤ D < 3.0	≥ 0.5	3
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	2
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 16



Reach/Segment Information

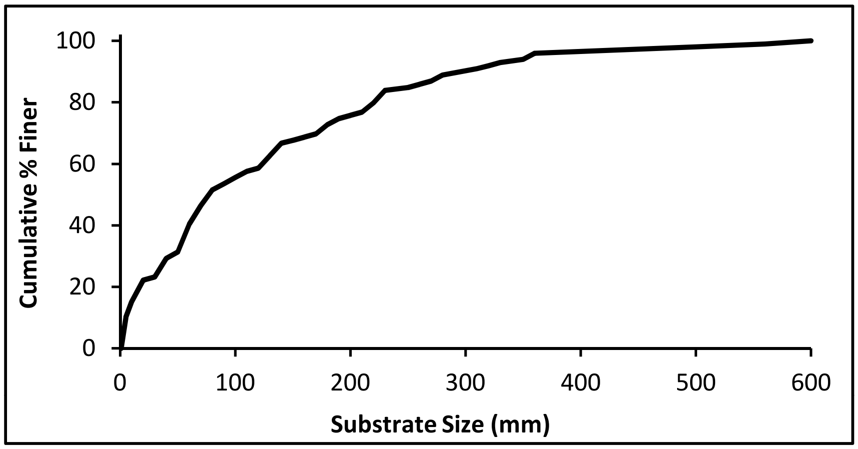
SGA ID:	T3.09
Length (ft):	4,105
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	86
RHA Percentage:	54%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	10
F. Gravel	2 - 16	12
C. Gravel	16 - 64	24
Cobble	64 - 256	39
Boulder	256 - 4096	15
Bedrock	> 4096	0

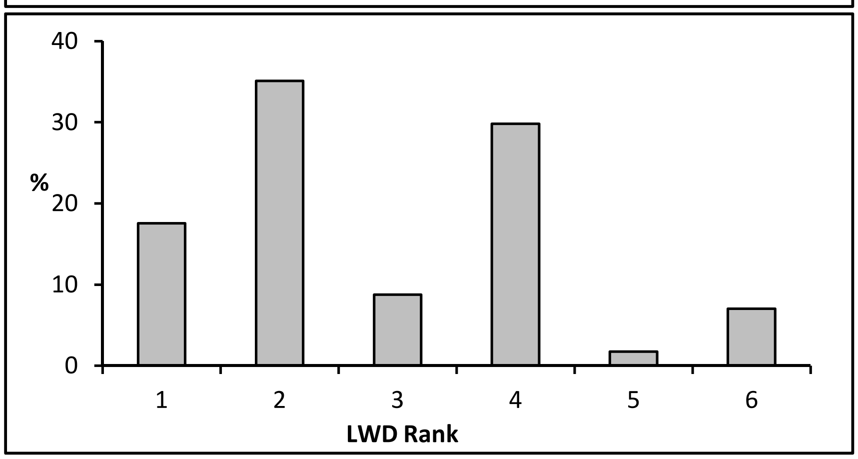
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	500	mm
Riffle Stability Index (RSI):	98	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	10
2	0.5 ≤ D < 1.0	≥ 0.5	20
3	1.0 ≤ D < 2.0	< 0.5	5
4	1.0 ≤ D < 2.0	≥ 0.5	17
5	D ≥ 2.0	< 0.5	1
6	D ≥ 2.0	≥ 0.5	4

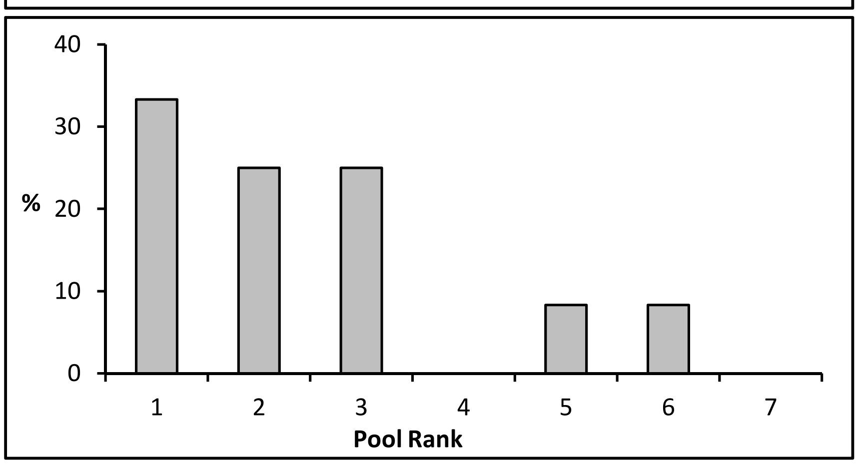
 # LWDs/mile: 73



Pools

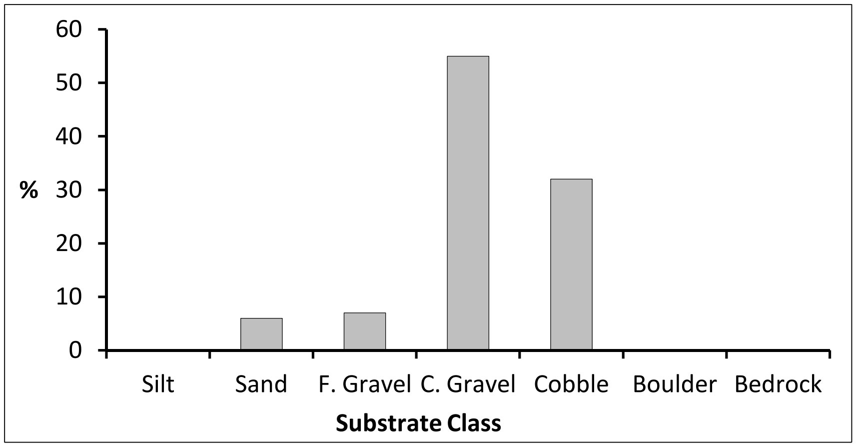
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	4
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	1
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 15



Reach/Segment Information

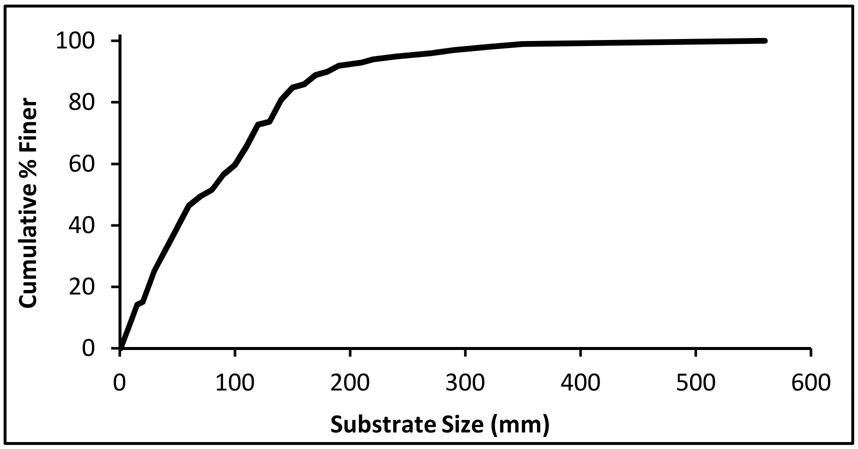
SGA ID:	T3.10
Length (ft):	607
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	67
RHA Percentage:	42%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	6
F. Gravel	2 - 16	7
C. Gravel	16 - 64	55
Cobble	64 - 256	32
Boulder	256 - 4096	0
Bedrock	> 4096	0

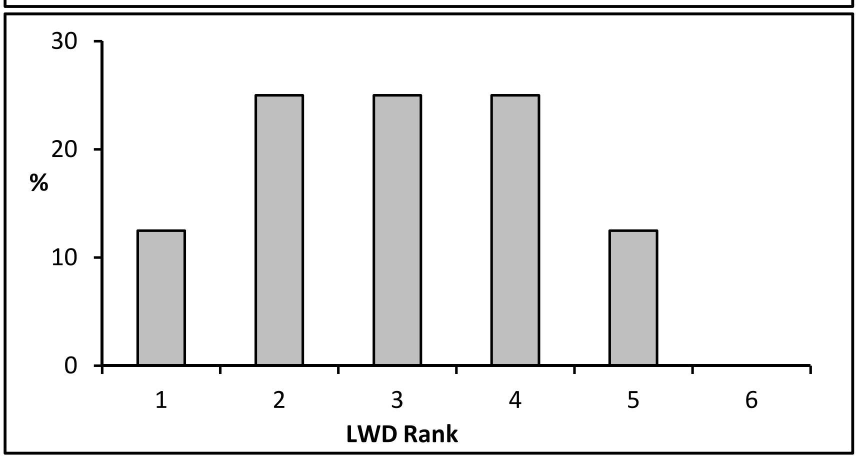
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	120	mm
Riffle Stability Index (RSI):	73	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	1
2	0.5 ≤ D < 1.0	≥ 0.5	2
3	1.0 ≤ D < 2.0	< 0.5	2
4	1.0 ≤ D < 2.0	≥ 0.5	2
5	D ≥ 2.0	< 0.5	1
6	D ≥ 2.0	≥ 0.5	0

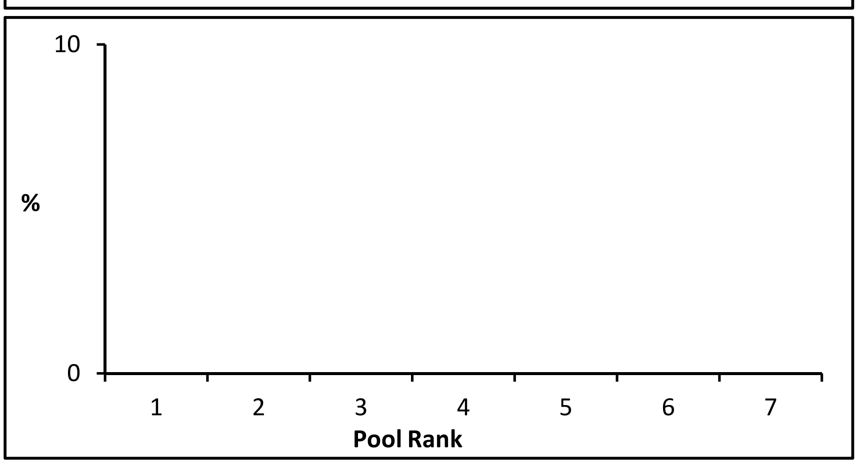
 # LWDs/mile: 70



Pools

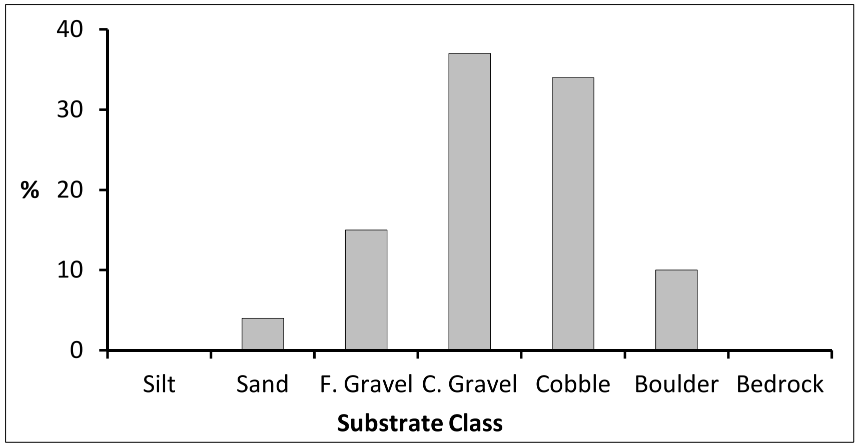
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	0
2	1.0 ≤ D < 2.0	≥ 0.5	0
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 0



Reach/Segment Information

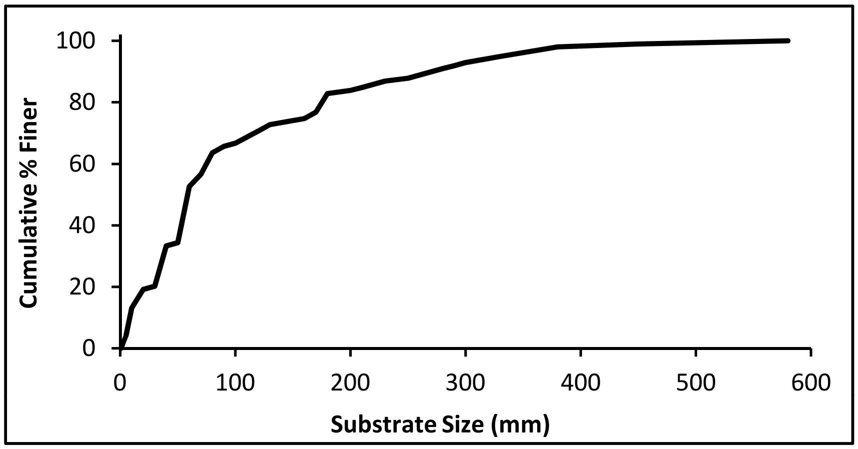
SGA ID:	T3.11
Length (ft):	5,661
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	104
RHA Percentage:	65%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	4
F. Gravel	2 - 16	15
C. Gravel	16 - 64	37
Cobble	64 - 256	34
Boulder	256 - 4096	10
Bedrock	> 4096	0

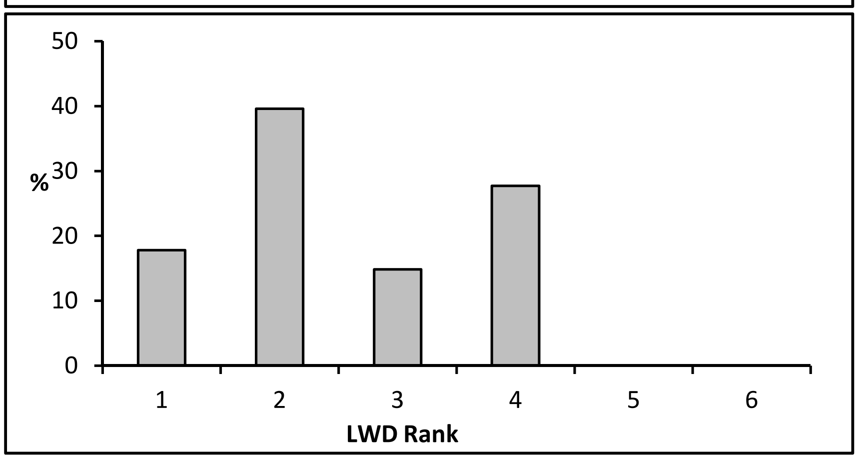
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	100	mm
Riffle Stability Index (RSI):	67	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	18
2	0.5 ≤ D < 1.0	≥ 0.5	40
3	1.0 ≤ D < 2.0	< 0.5	15
4	1.0 ≤ D < 2.0	≥ 0.5	28
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

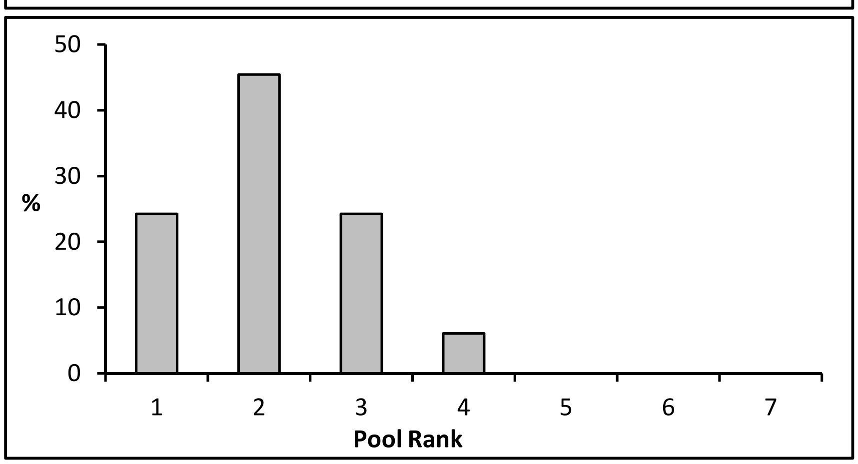
 # LWDs/mile: 94

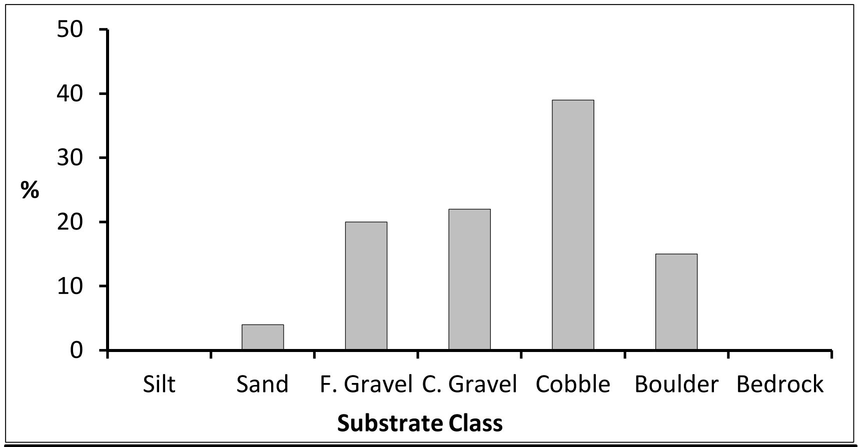


Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	8
2	1.0 ≤ D < 2.0	≥ 0.5	15
3	2.0 ≤ D < 3.0	< 0.5	8
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 31



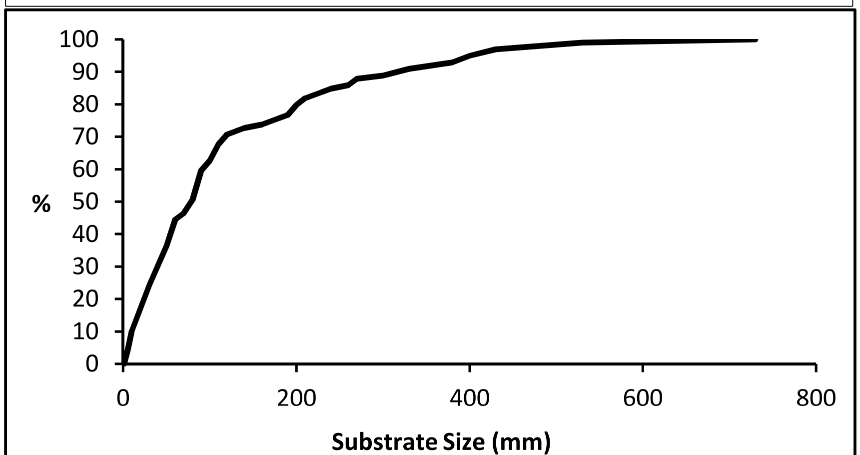


Reach/Segment Information	
SGA ID:	T3.10S1.01
Length (ft):	1,303
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	83
RHA Percentage:	82%
Overall Habitat Condition:	Fair

Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	4
F. Gravel	2 - 16	20
C. Gravel	16 - 64	22
Cobble	64 - 256	39
Boulder	256 - 4096	15
Bedrock	> 4096	0

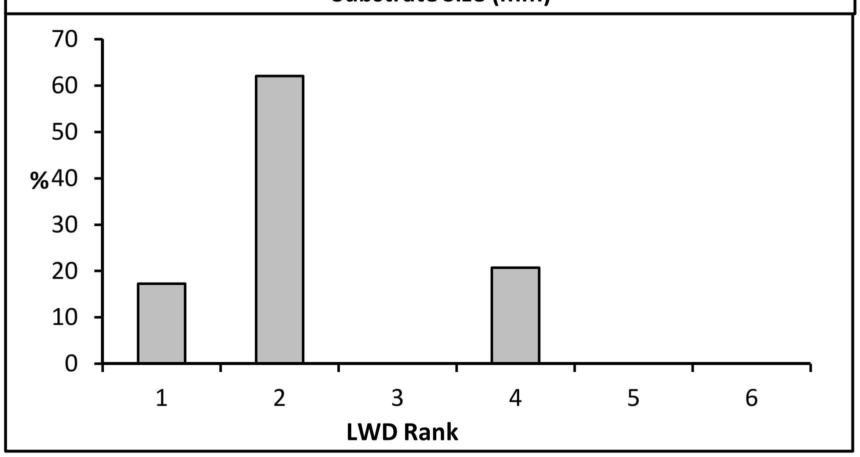
Median Substrate Size:	75	mm
Avg. Largest Particle (Bar):	600	mm
Riffle Stability Index (RSI):	99	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	5
2	0.5 ≤ D < 1.0	≥ 0.5	18
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	6
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

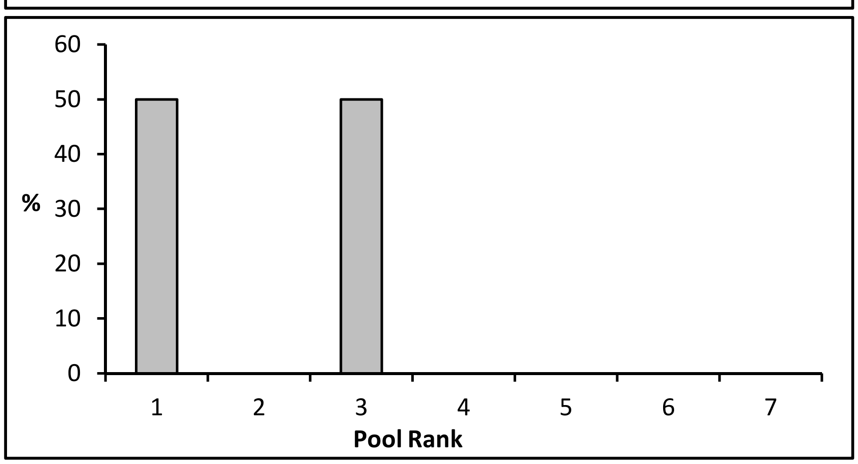
 # LWDs/mile: 118



Pools

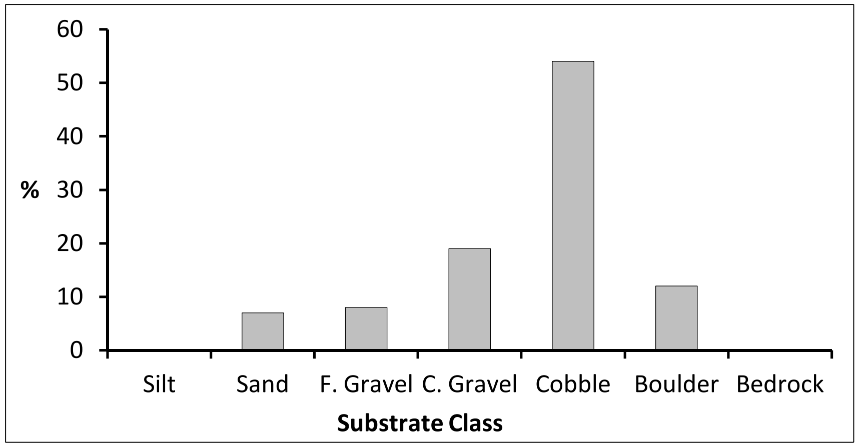
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	1
2	1.0 ≤ D < 2.0	≥ 0.5	0
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 8



Reach/Segment Information

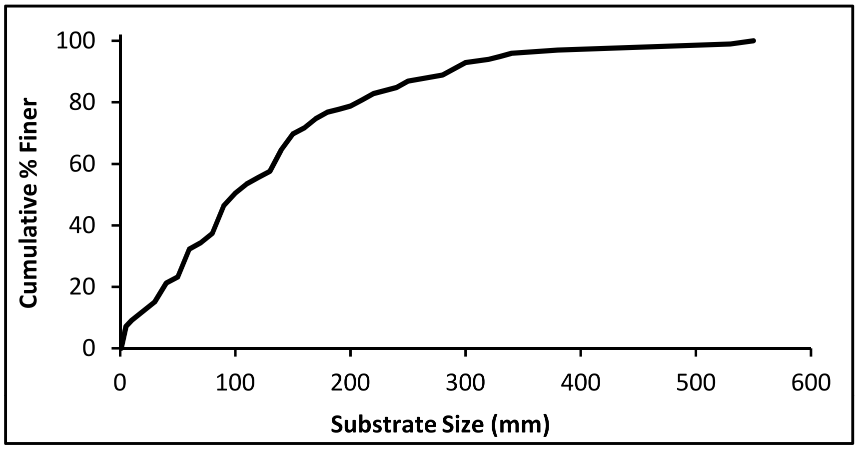
SGA ID:	T3.10S1.03
Length (ft):	3,347
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	94
RHA Percentage:	59%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	7
F. Gravel	2 - 16	8
C. Gravel	16 - 64	19
Cobble	64 - 256	54
Boulder	256 - 4096	12
Bedrock	> 4096	0

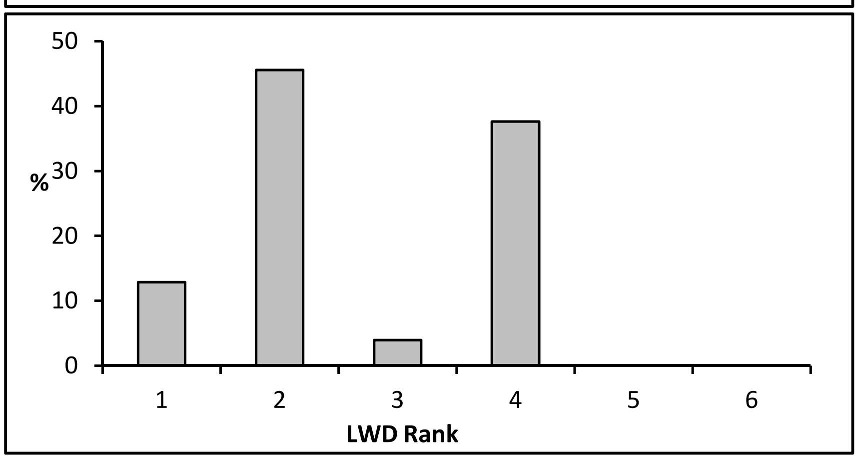
Median Substrate Size:	95	mm
Avg. Largest Particle (Bar):	300	mm
Riffle Stability Index (RSI):	93	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	13
2	0.5 ≤ D < 1.0	≥ 0.5	46
3	1.0 ≤ D < 2.0	< 0.5	4
4	1.0 ≤ D < 2.0	≥ 0.5	38
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

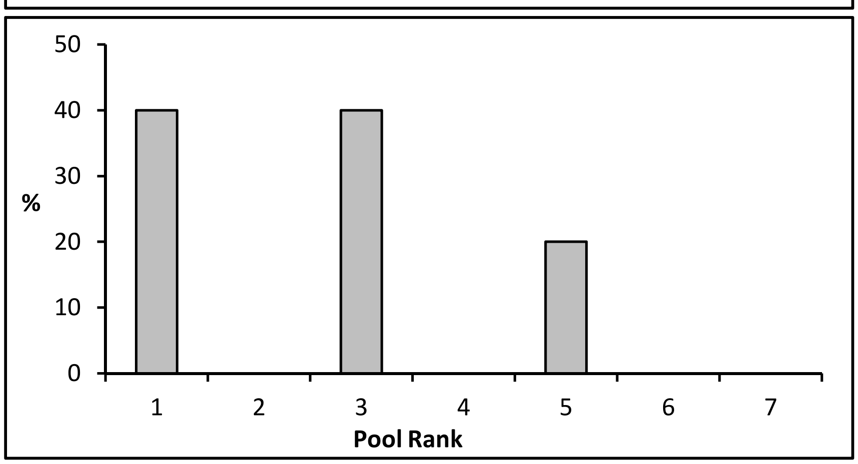
 # LWDs/mile: 159



Pools

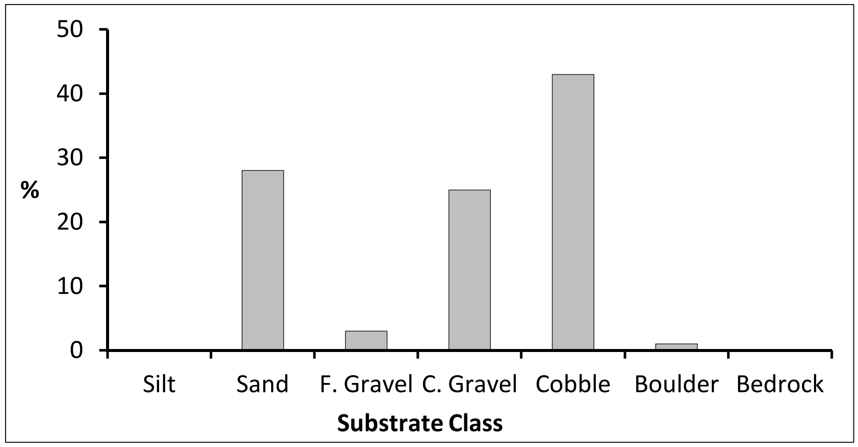
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	2
2	1.0 ≤ D < 2.0	≥ 0.5	0
3	2.0 ≤ D < 3.0	< 0.5	2
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	1
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 8



Reach/Segment Information

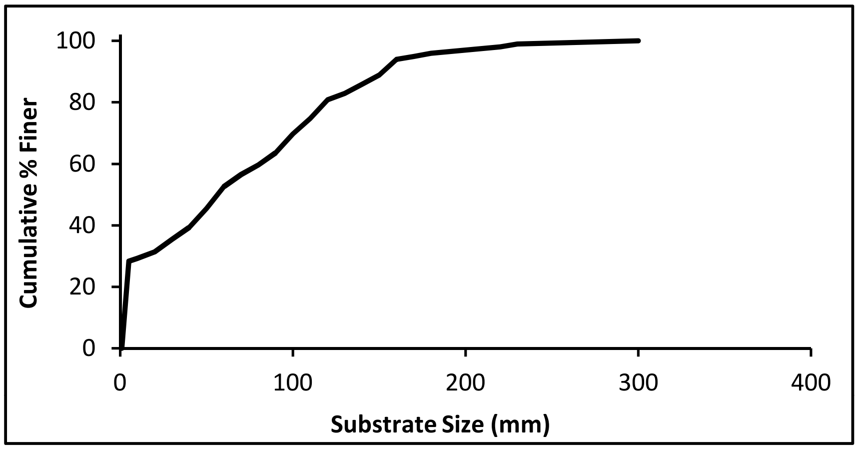
SGA ID:	T3.7S1.01A
Length (ft):	979
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	104
RHA Percentage:	65%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	28
F. Gravel	2 - 16	3
C. Gravel	16 - 64	25
Cobble	64 - 256	43
Boulder	256 - 4096	1
Bedrock	> 4096	0

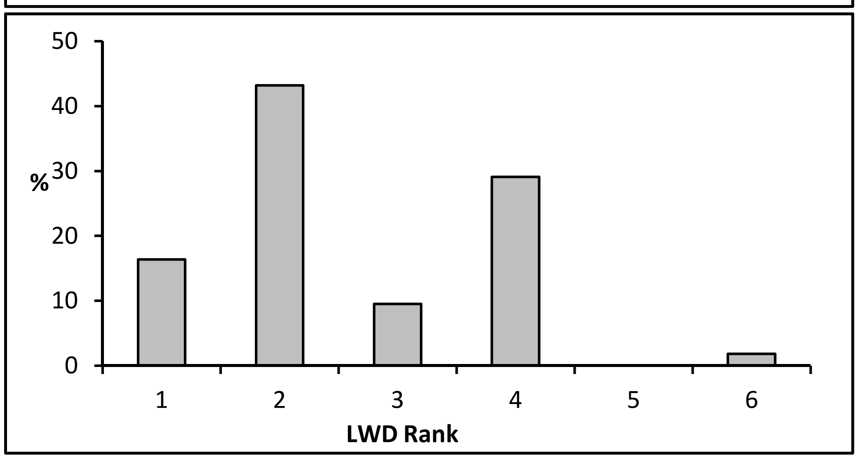
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	90	mm
Riffle Stability Index (RSI):	64	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	18
2	0.5 ≤ D < 1.0	≥ 0.5	42
3	1.0 ≤ D < 2.0	< 0.5	13
4	1.0 ≤ D < 2.0	≥ 0.5	33
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	1

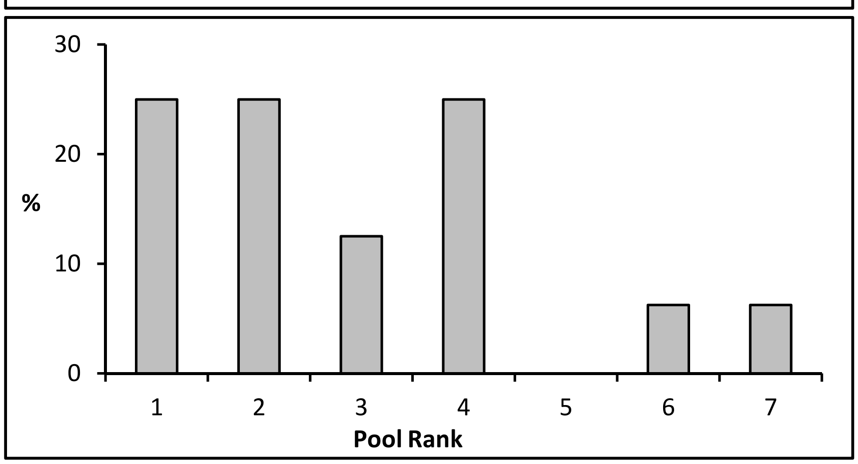
 # LWDs/mile: 577



Pools

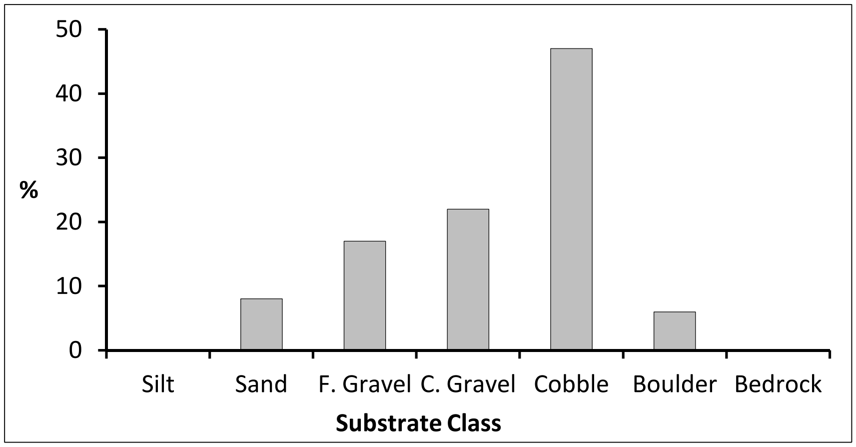
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	1
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 32



Reach/Segment Information

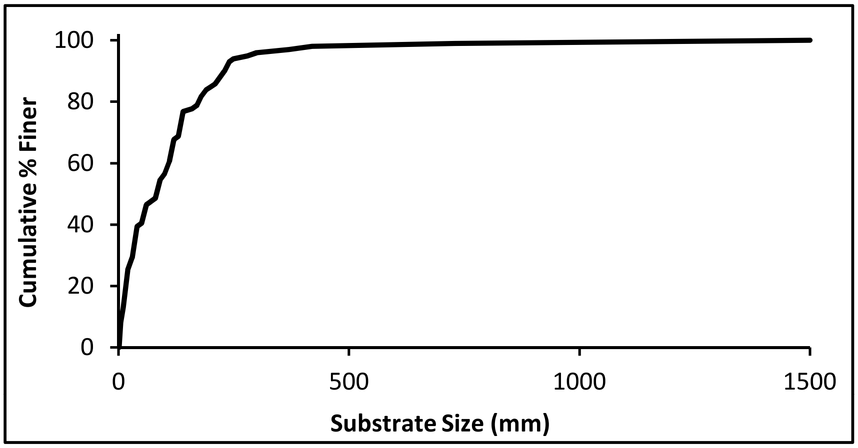
SGA ID:	T3.7S1.01B
Length (ft):	2,668
Reference Bedform Type:	Step-Pool
Total RHA Score:	81
RHA Percentage:	51%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	17
C. Gravel	16 - 64	22
Cobble	64 - 256	47
Boulder	256 - 4096	6
Bedrock	> 4096	0

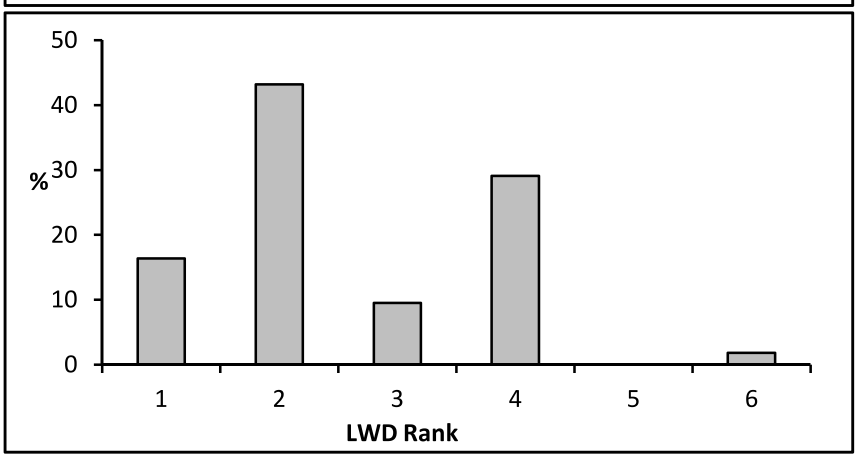
Median Substrate Size:	80	mm
Avg. Largest Particle (Bar):	150	mm
Riffle Stability Index (RSI):	77	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	18
2	0.5 ≤ D < 1.0	≥ 0.5	53
3	1.0 ≤ D < 2.0	< 0.5	8
4	1.0 ≤ D < 2.0	≥ 0.5	31
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	3

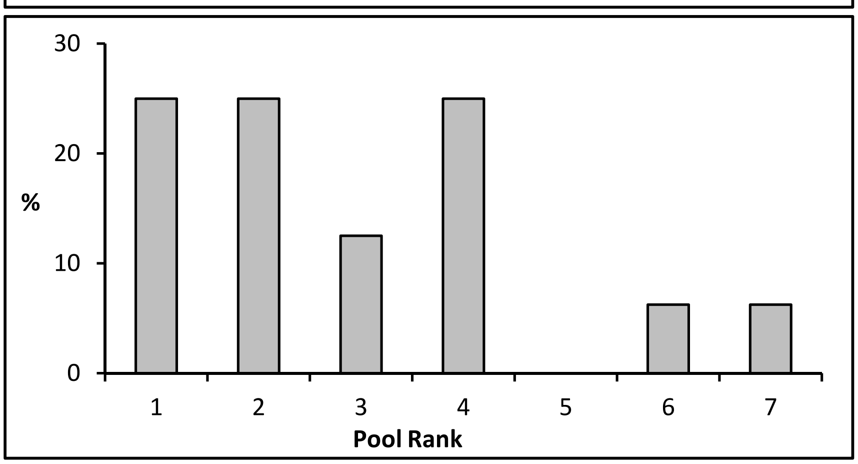
 # LWDs/mile: 224



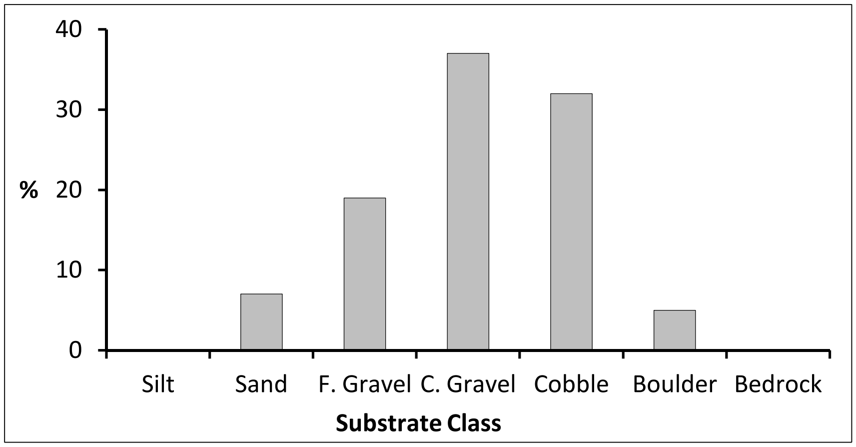
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	1

 # Pools/mile: 20



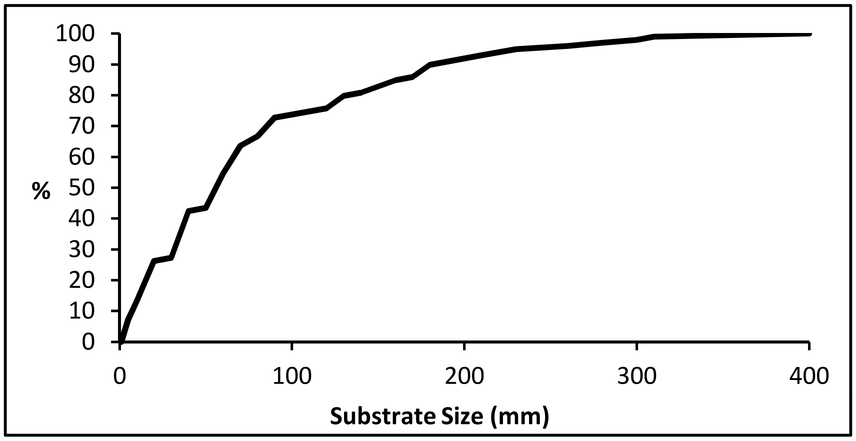
Reach/Segment Information	
SGA ID:	T3.7S1.02
Length (ft):	2,105
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	106
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	7
F. Gravel	2 - 16	19
C. Gravel	16 - 64	37
Cobble	64 - 256	32
Boulder	256 - 4096	5
Bedrock	> 4096	0

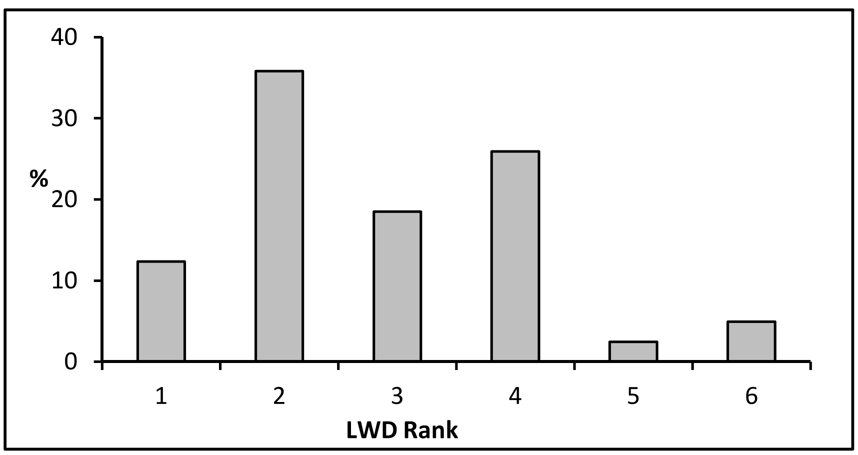
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	350	mm
Riffle Stability Index (RSI):	99	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	10
2	0.5 ≤ D < 1.0	≥ 0.5	29
3	1.0 ≤ D < 2.0	< 0.5	15
4	1.0 ≤ D < 2.0	≥ 0.5	21
5	D ≥ 2.0	< 0.5	2
6	D ≥ 2.0	≥ 0.5	4

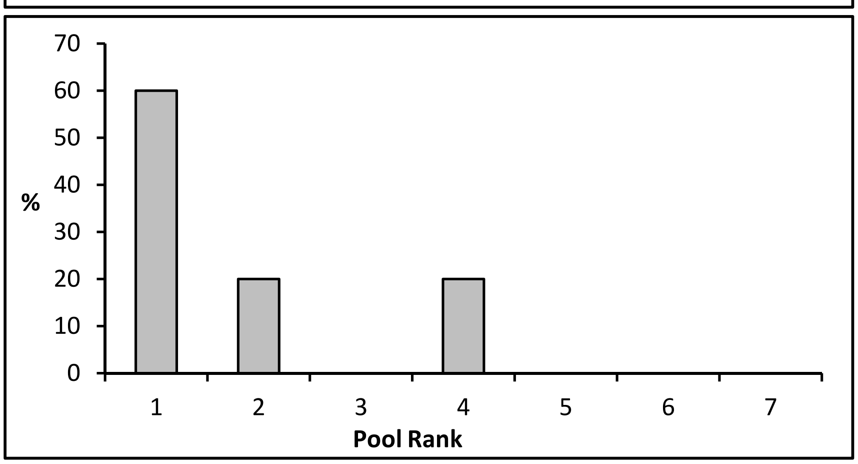
 # LWDs/mile: 203

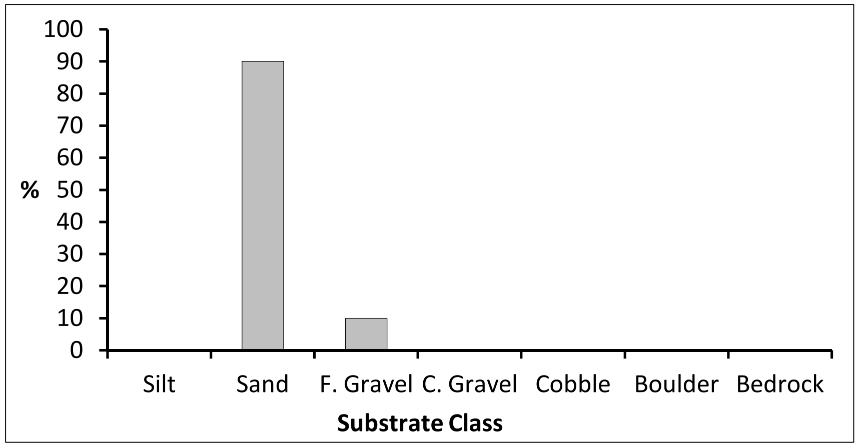


Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	1
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 13





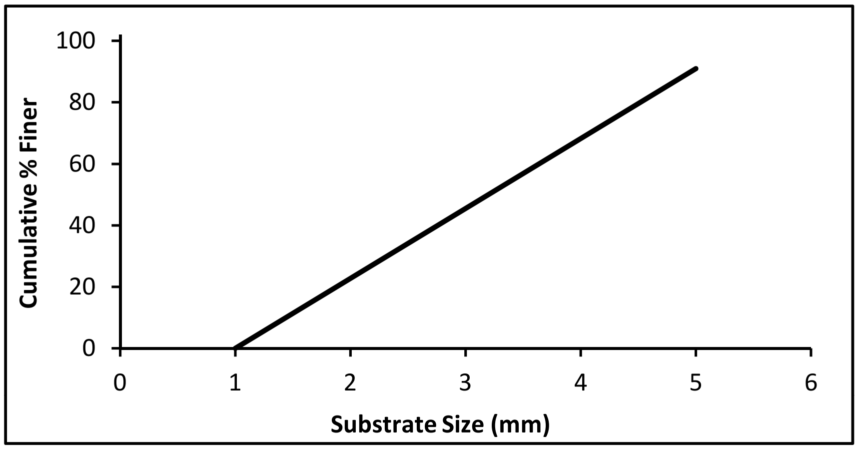
Reach/Segment Information

SGA ID:	T3.7S1.03
Length (ft):	2,521
Reference Bedform Type:	Dune-Ripple
Total RHA Score:	111
RHA Percentage:	69%
Overall Habitat Condition:	Good

Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	90
F. Gravel	2 - 16	10
C. Gravel	16 - 64	0
Cobble	64 - 256	0
Boulder	256 - 4096	0
Bedrock	> 4096	0

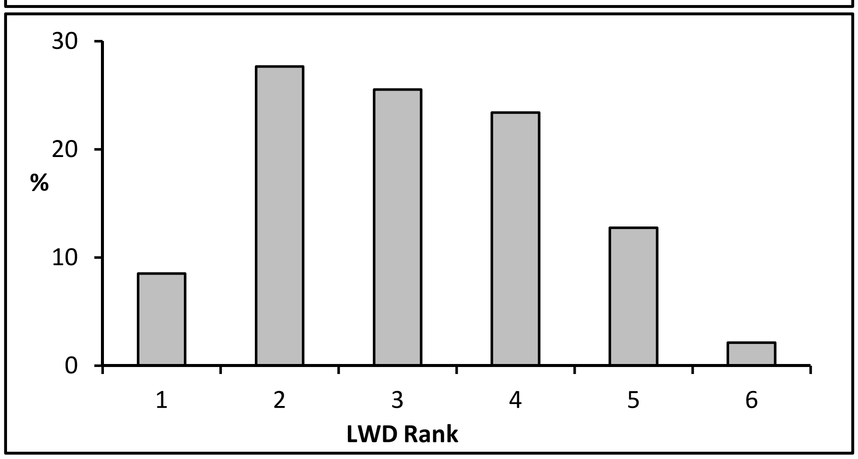
Median Substrate Size:	1	mm
Avg. Largest Particle (Bar):	1	mm
Riffle Stability Index (RSI):	0	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	4
2	0.5 ≤ D < 1.0	≥ 0.5	13
3	1.0 ≤ D < 2.0	< 0.5	12
4	1.0 ≤ D < 2.0	≥ 0.5	11
5	D ≥ 2.0	< 0.5	6
6	D ≥ 2.0	≥ 0.5	1

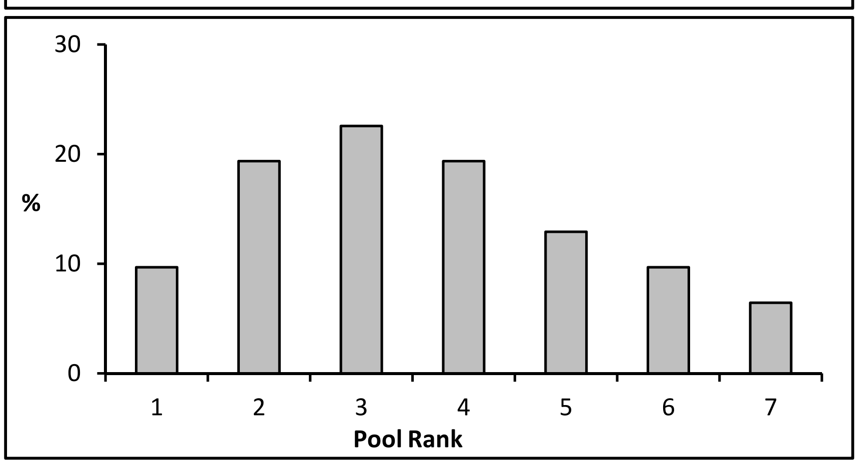
 # LWDs/mile: 98



Pools

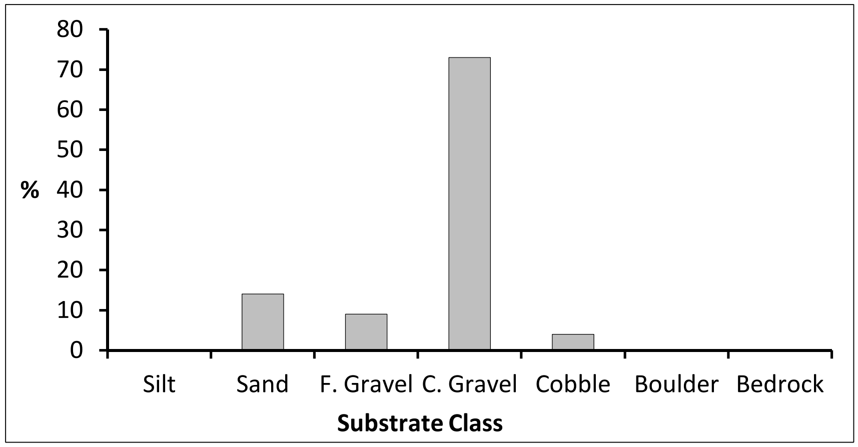
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	3
2	1.0 ≤ D < 2.0	≥ 0.5	6
3	2.0 ≤ D < 3.0	< 0.5	7
4	2.0 ≤ D < 3.0	≥ 0.5	6
5	D ≥ 3.0	< 0.5	4
6	D ≥ 3.0	≥ 0.5	3
7	D ≥ 3.0	≥ 1.0	2

 # Pools/mile: 65



Reach/Segment Information

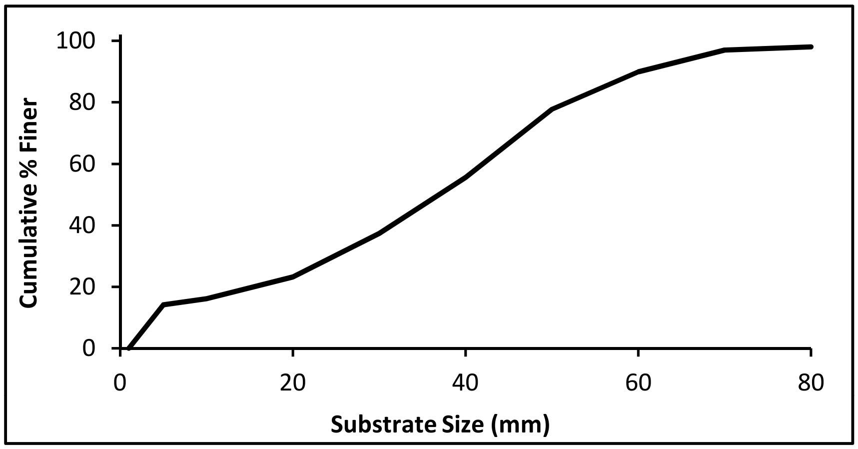
SGA ID:	T3.7S1.04
Length (ft):	4,147
Reference Bedform Type:	Dune-Ripple
Total RHA Score:	105
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	14
F. Gravel	2 - 16	9
C. Gravel	16 - 64	73
Cobble	64 - 256	4
Boulder	256 - 4096	0
Bedrock	> 4096	0

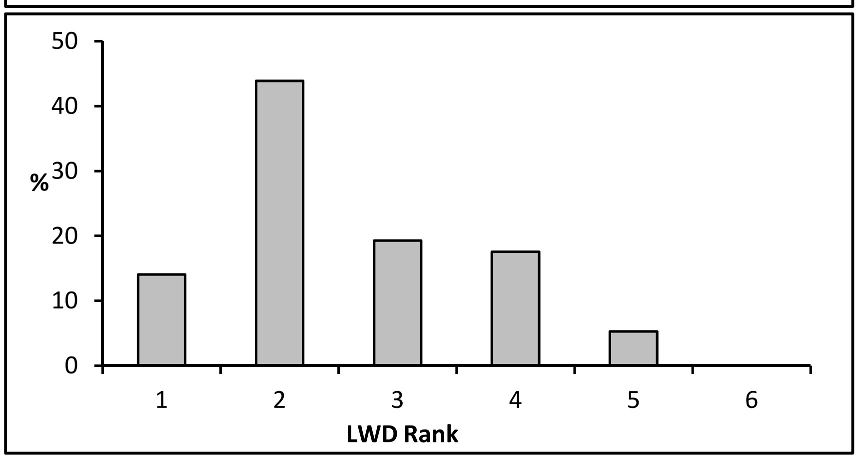
Median Substrate Size:	30	mm
Avg. Largest Particle (Bar):	40	mm
Riffle Stability Index (RSI):	56	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	8
2	0.5 ≤ D < 1.0	≥ 0.5	25
3	1.0 ≤ D < 2.0	< 0.5	11
4	1.0 ≤ D < 2.0	≥ 0.5	10
5	D ≥ 2.0	< 0.5	3
6	D ≥ 2.0	≥ 0.5	0

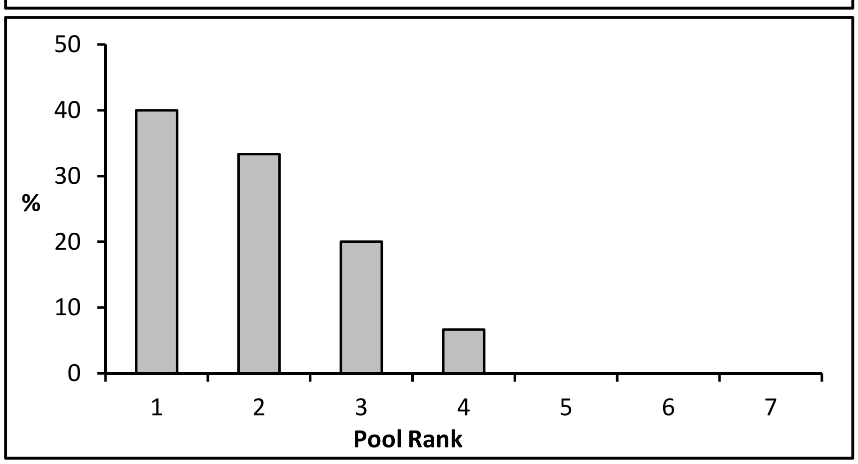
 # LWDs/mile: 73



Pools

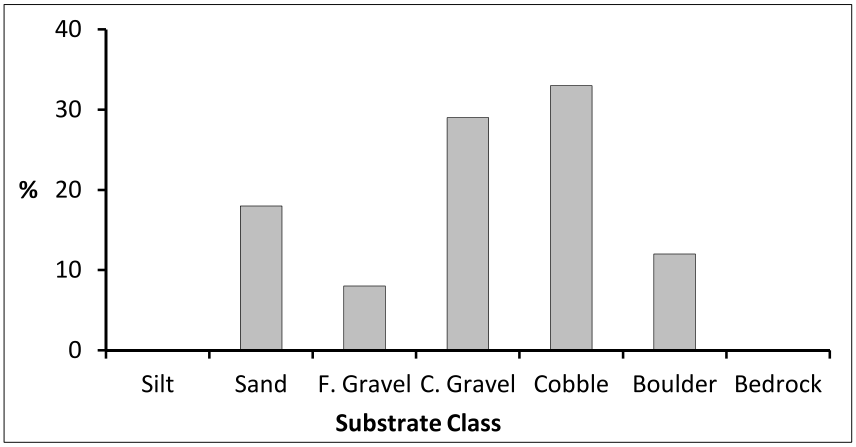
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	6
2	1.0 ≤ D < 2.0	≥ 0.5	5
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 19



Reach/Segment Information

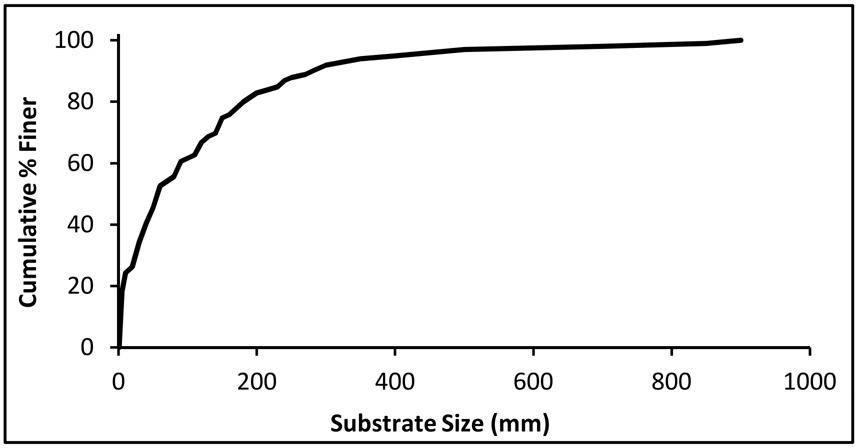
SGA ID:	T3.7S1.05
Length (ft):	3,245
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	98
RHA Percentage:	61%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	18
F. Gravel	2 - 16	8
C. Gravel	16 - 64	29
Cobble	64 - 256	33
Boulder	256 - 4096	12
Bedrock	> 4096	0

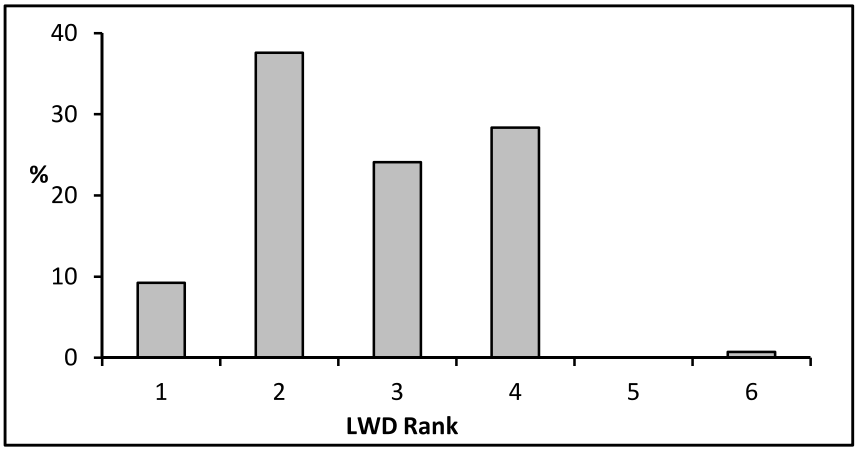
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	230	mm
Riffle Stability Index (RSI):	85	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	13
2	0.5 ≤ D < 1.0	≥ 0.5	53
3	1.0 ≤ D < 2.0	< 0.5	34
4	1.0 ≤ D < 2.0	≥ 0.5	40
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	1

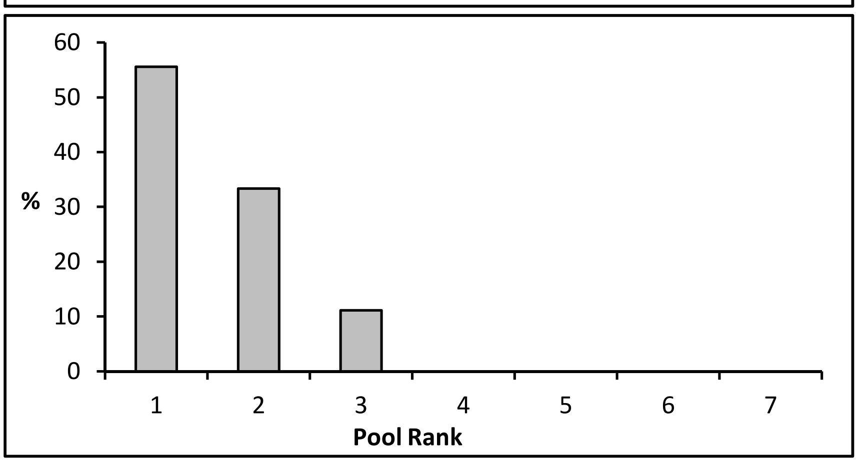
 # LWDs/mile: 229



Pools

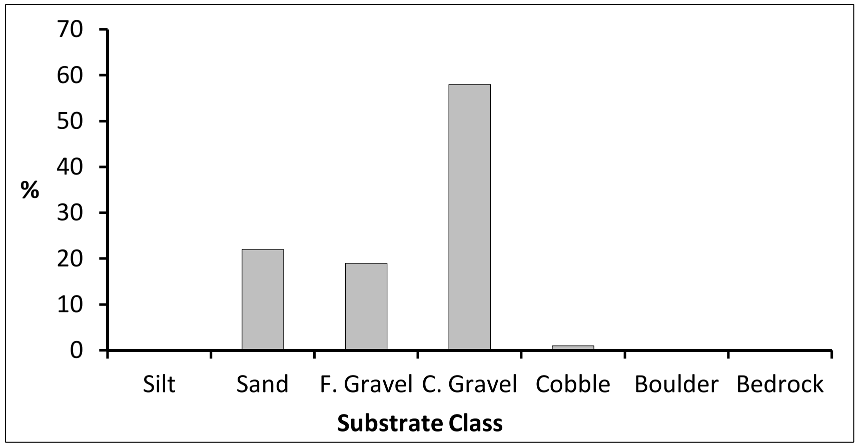
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 15



Reach/Segment Information

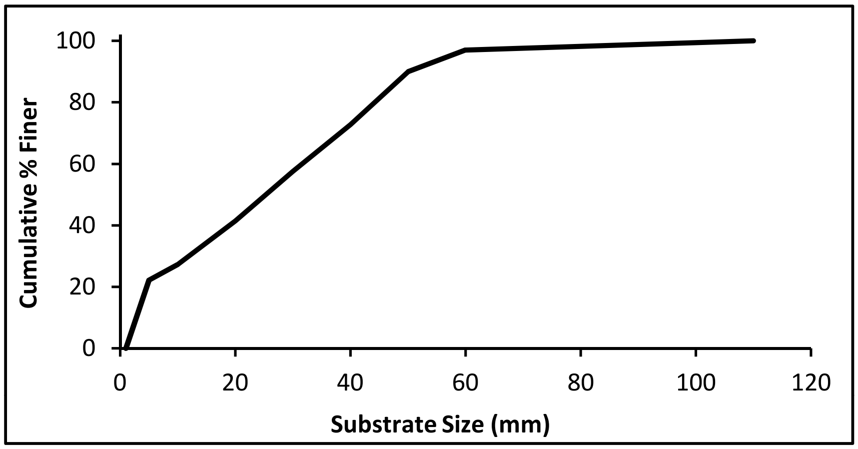
SGA ID:	T3.7S1.06A
Length (ft):	1,566
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	75
RHA Percentage:	47%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	22
F. Gravel	2 - 16	19
C. Gravel	16 - 64	58
Cobble	64 - 256	1
Boulder	256 - 4096	0
Bedrock	> 4096	0

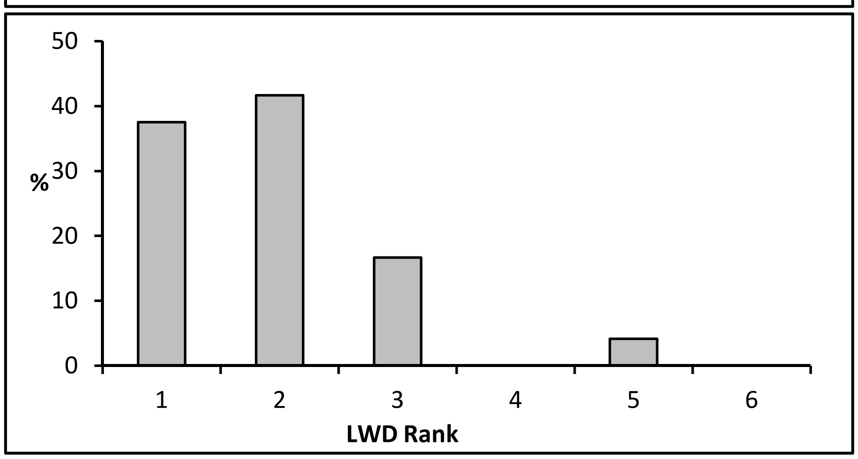
Median Substrate Size:	20	mm
Avg. Largest Particle (Bar):	50	mm
Riffle Stability Index (RSI):	90	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	18
2	0.5 ≤ D < 1.0	≥ 0.5	20
3	1.0 ≤ D < 2.0	< 0.5	8
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	2
6	D ≥ 2.0	≥ 0.5	0

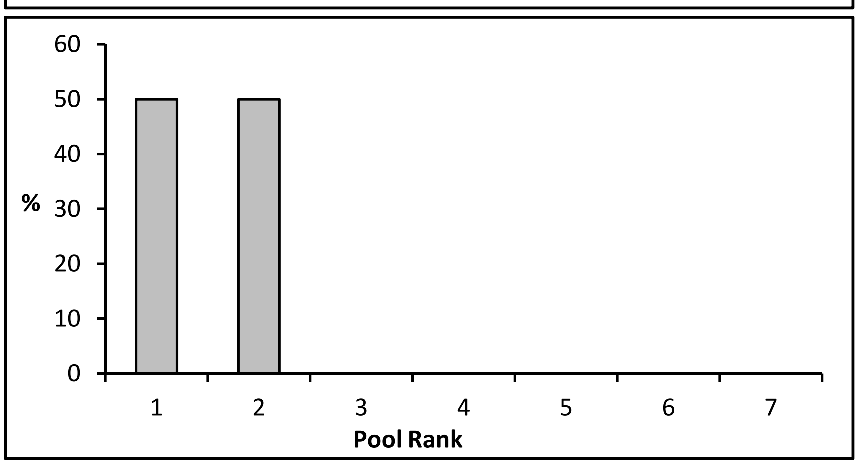
 # LWDs/mile: 162

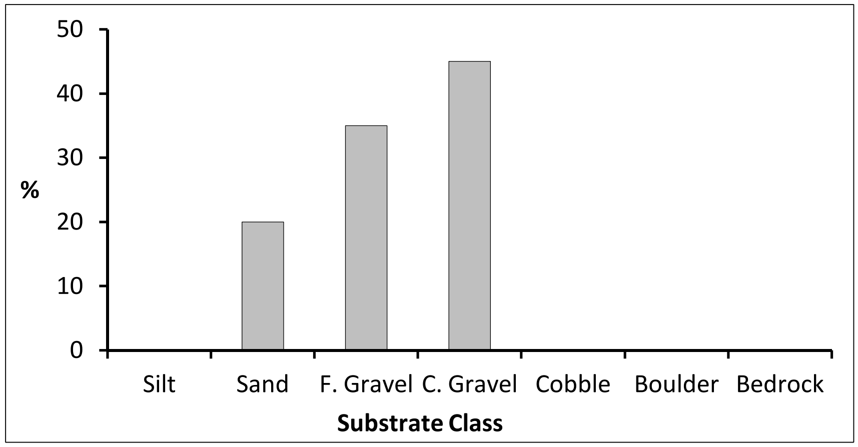


Pools

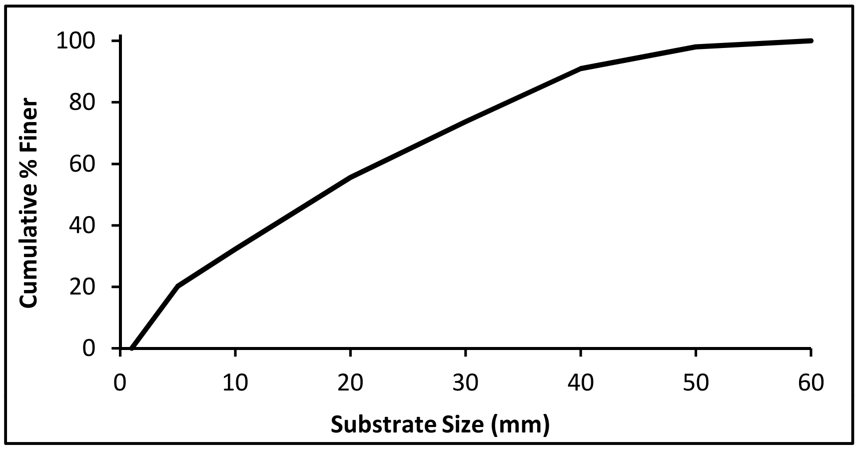
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	8
2	1.0 ≤ D < 2.0	≥ 0.5	8
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 54





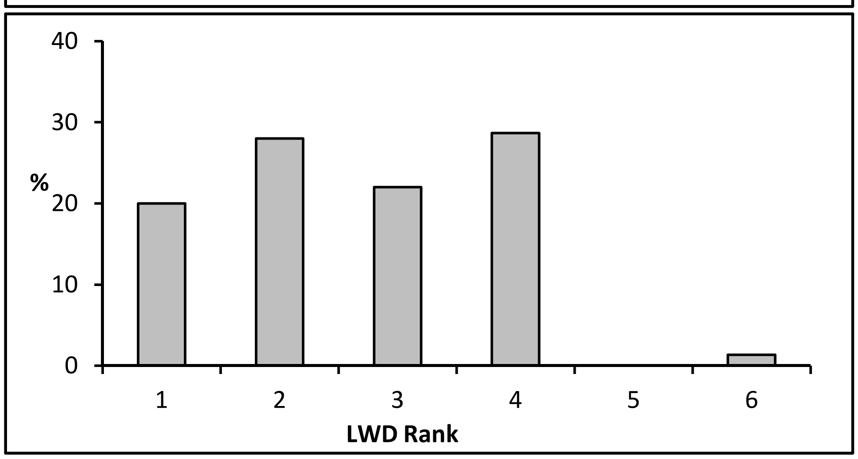
Reach/Segment Information	
SGA ID:	T3.7S1.06B
Length (ft):	2,679
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	82
RHA Percentage:	51%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	20
F. Gravel	2 - 16	35
C. Gravel	16 - 64	45
Cobble	64 - 256	0
Boulder	256 - 4096	0
Bedrock	> 4096	0

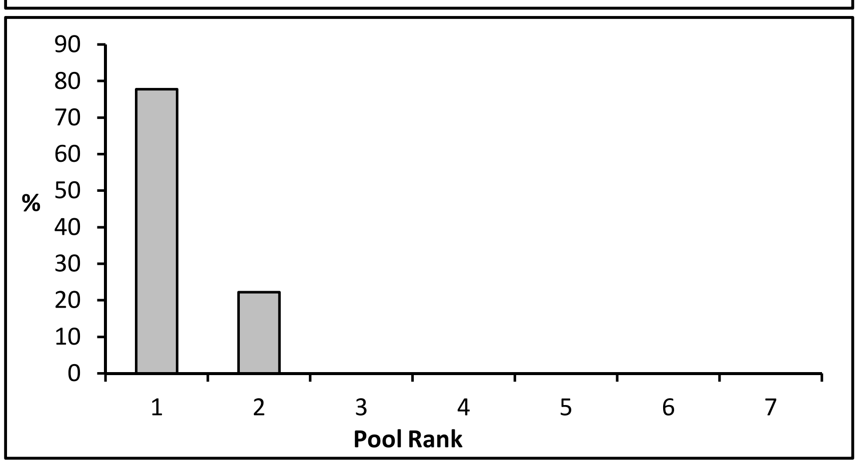
Median Substrate Size:	10	mm
Avg. Largest Particle (Bar):	30	mm
Riffle Stability Index (RSI):	74	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	30
2	0.5 ≤ D < 1.0	≥ 0.5	42
3	1.0 ≤ D < 2.0	< 0.5	33
4	1.0 ≤ D < 2.0	≥ 0.5	43
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	2

 # LWDs/mile: 296



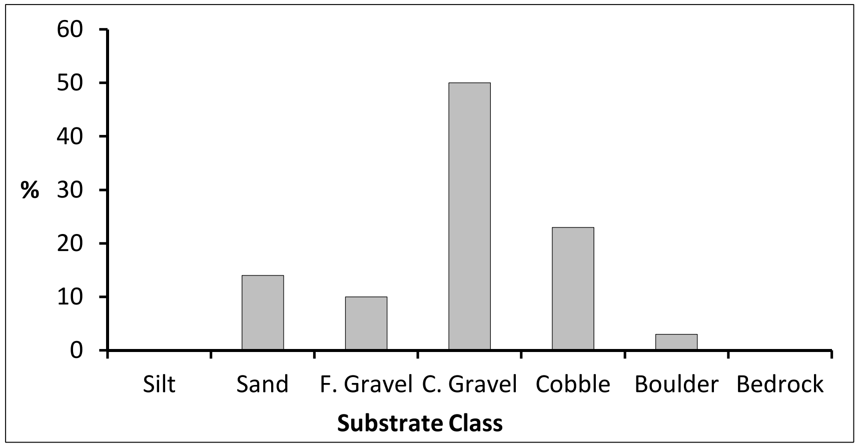
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	7
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 18

Reach/Segment Information

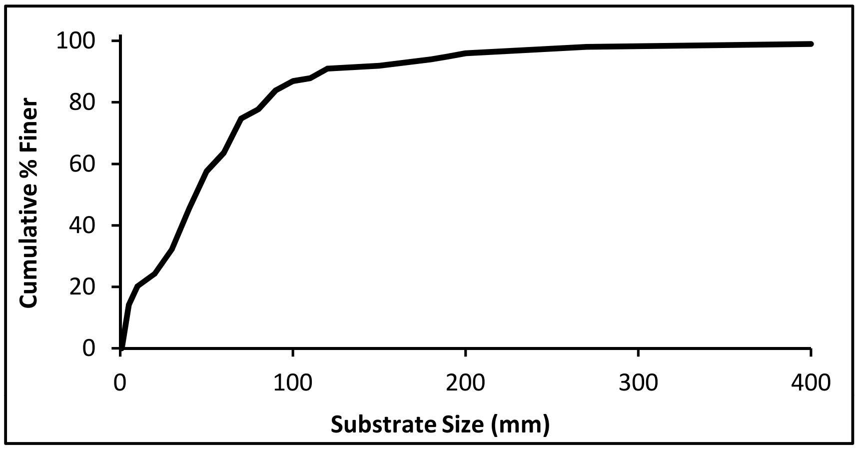
SGA ID:	T3.7S1.07
Length (ft):	4,545
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	101
RHA Percentage:	63%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	14
F. Gravel	2 - 16	10
C. Gravel	16 - 64	50
Cobble	64 - 256	23
Boulder	256 - 4096	3
Bedrock	> 4096	0

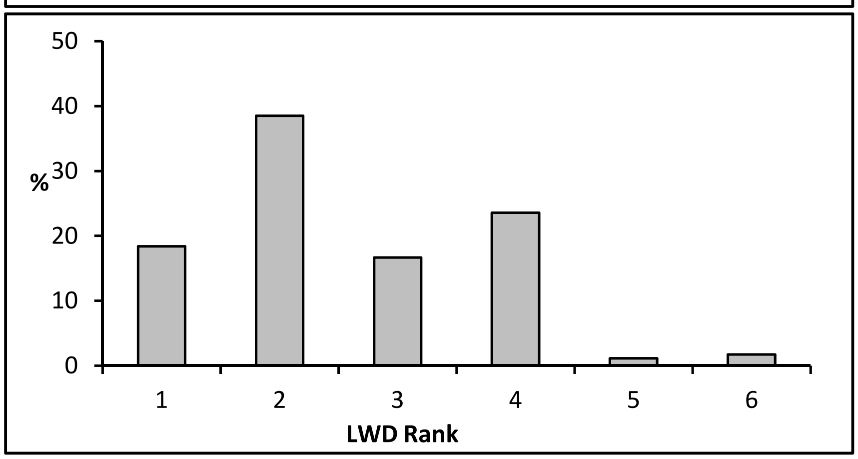
Median Substrate Size:	40	mm
Avg. Largest Particle (Bar):	250	mm
Riffle Stability Index (RSI):	97	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	32
2	0.5 ≤ D < 1.0	≥ 0.5	67
3	1.0 ≤ D < 2.0	< 0.5	29
4	1.0 ≤ D < 2.0	≥ 0.5	41
5	D ≥ 2.0	< 0.5	2
6	D ≥ 2.0	≥ 0.5	3

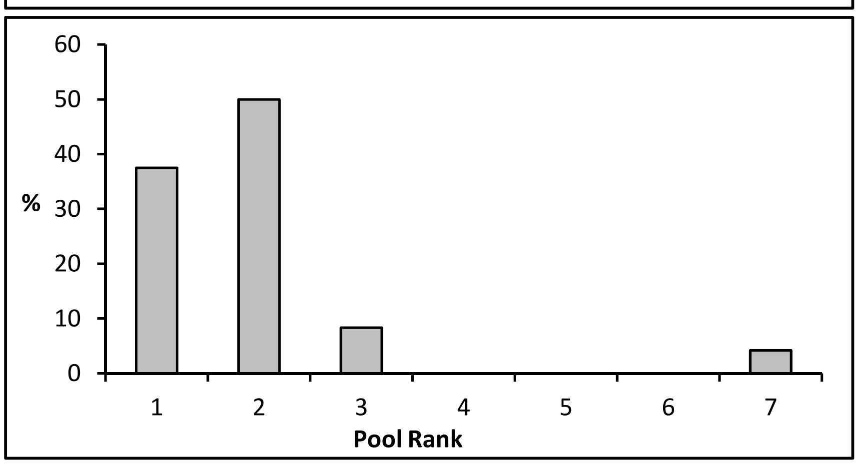
 # LWDs/mile: 202



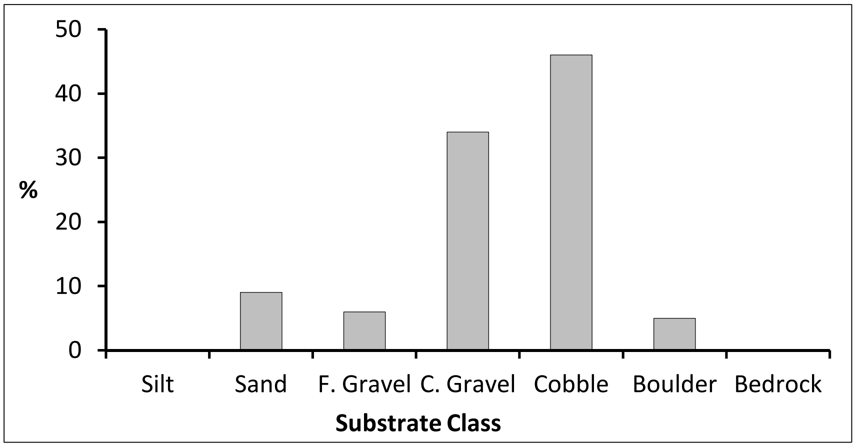
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	9
2	1.0 ≤ D < 2.0	≥ 0.5	12
3	2.0 ≤ D < 3.0	< 0.5	2
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	1

 # Pools/mile: 28



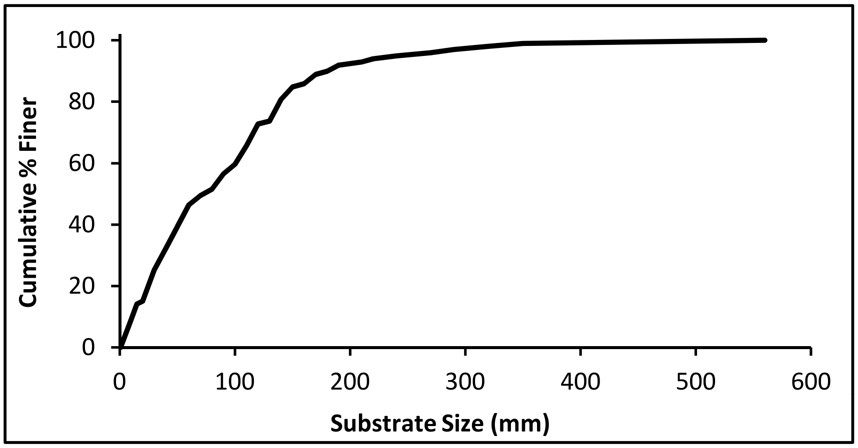
Reach/Segment Information	
SGA ID:	T4.01
Length (ft):	3,783
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	91
RHA Percentage:	57%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	9
F. Gravel	2 - 16	6
C. Gravel	16 - 64	34
Cobble	64 - 256	46
Boulder	256 - 4096	5
Bedrock	> 4096	0

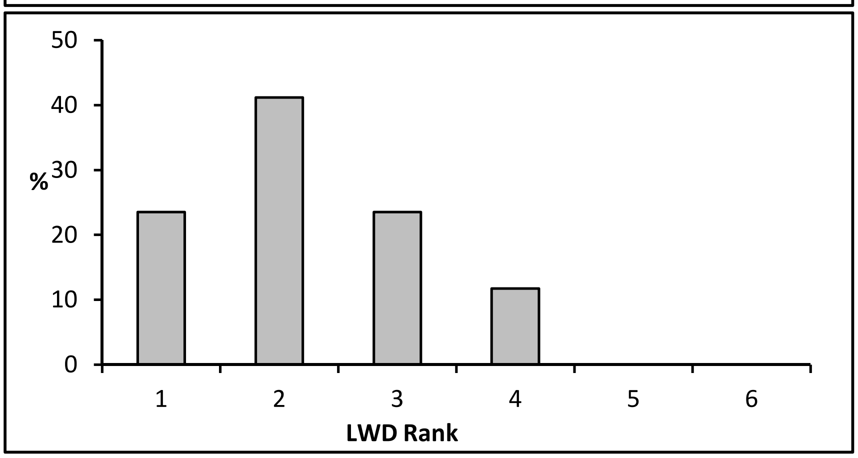
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	90	mm
Riffle Stability Index (RSI):	57	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	4
2	0.5 ≤ D < 1.0	≥ 0.5	7
3	1.0 ≤ D < 2.0	< 0.5	4
4	1.0 ≤ D < 2.0	≥ 0.5	2
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

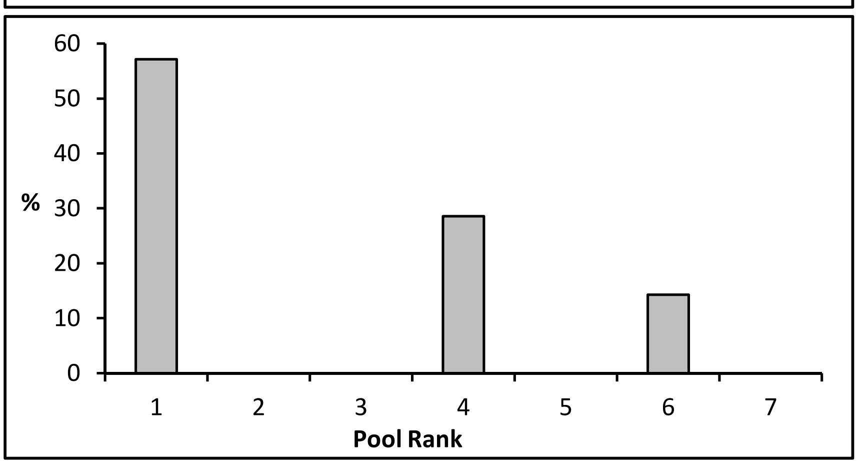
 # LWDs/mile: 24



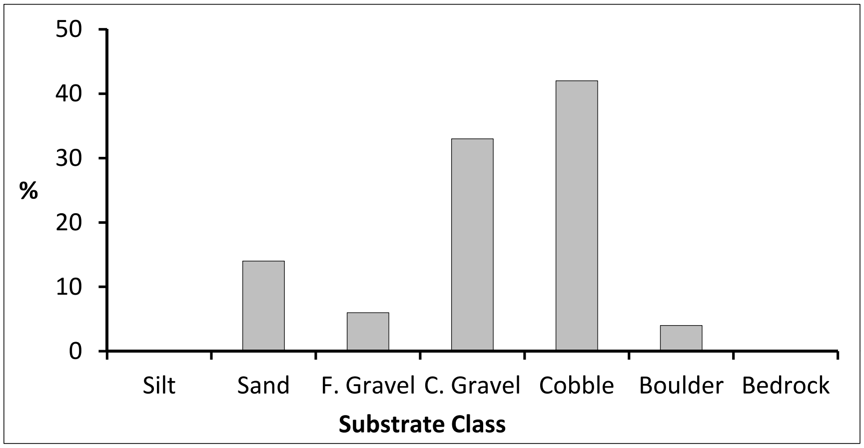
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	4
2	1.0 ≤ D < 2.0	≥ 0.5	0
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 10



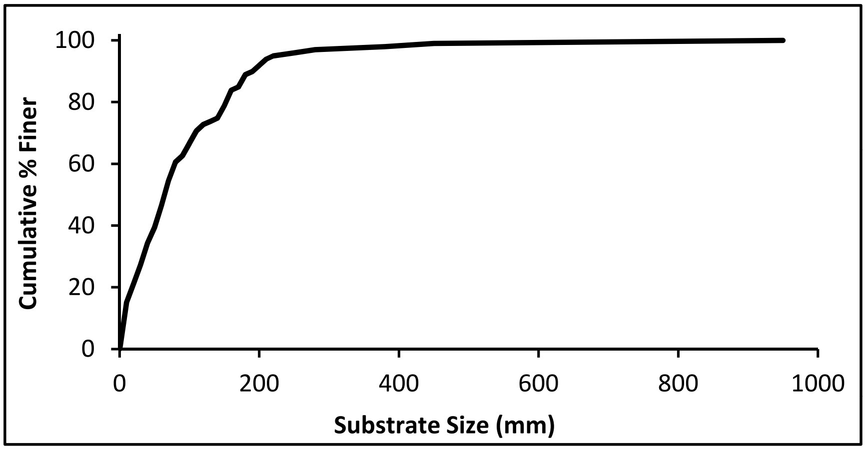
Reach/Segment Information	
SGA ID:	T4.02
Length (ft):	2,653
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	105
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	14
F. Gravel	2 - 16	6
C. Gravel	16 - 64	33
Cobble	64 - 256	42
Boulder	256 - 4096	4
Bedrock	> 4096	0

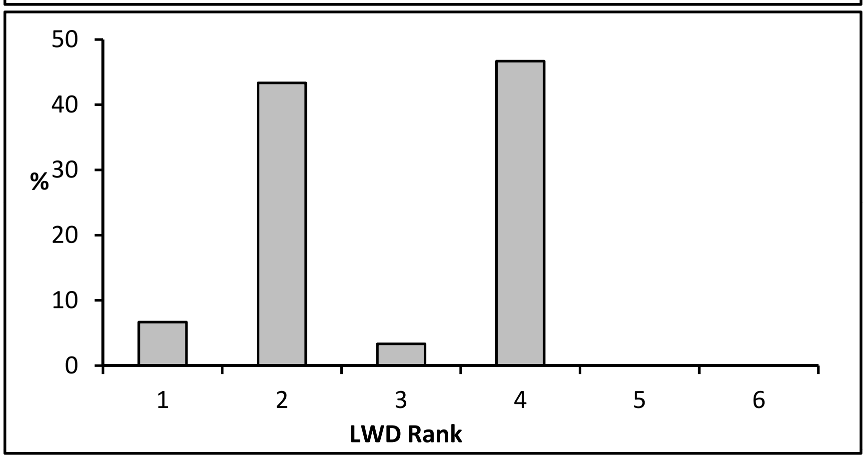
Median Substrate Size:	60	mm
Avg. Largest Particle (Bar):	160	mm
Riffle Stability Index (RSI):	84	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	2
2	0.5 ≤ D < 1.0	≥ 0.5	13
3	1.0 ≤ D < 2.0	< 0.5	1
4	1.0 ≤ D < 2.0	≥ 0.5	14
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

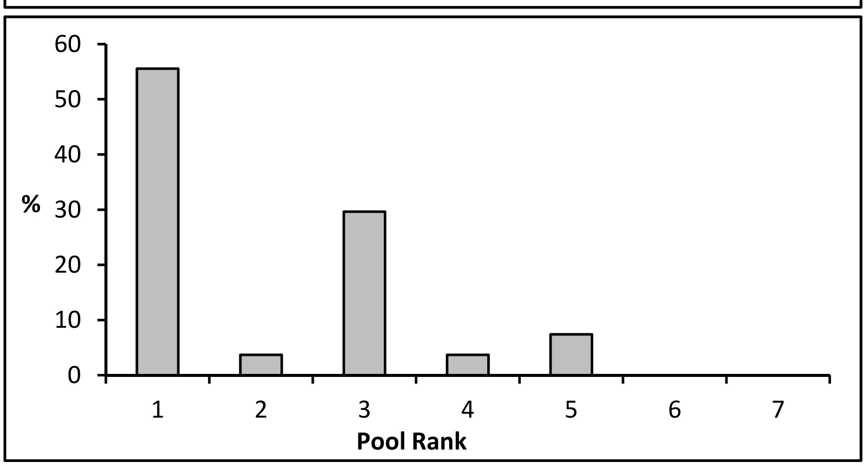
 # LWDs/mile: 60



Pools

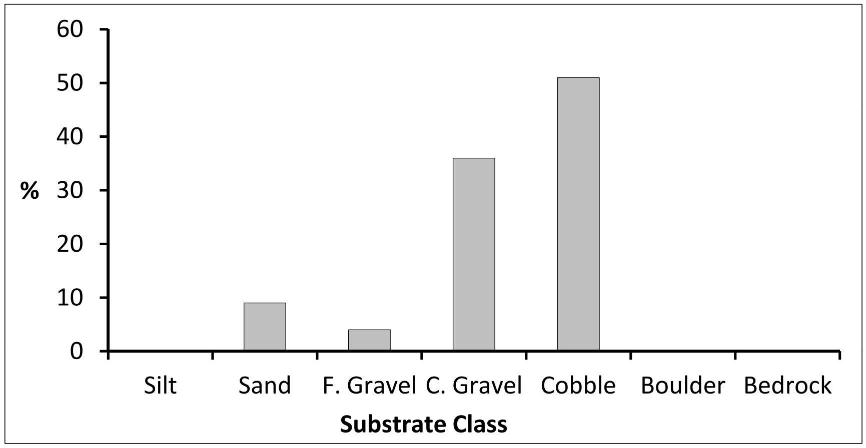
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	15
2	1.0 ≤ D < 2.0	≥ 0.5	1
3	2.0 ≤ D < 3.0	< 0.5	8
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	2
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 54



Reach/Segment Information

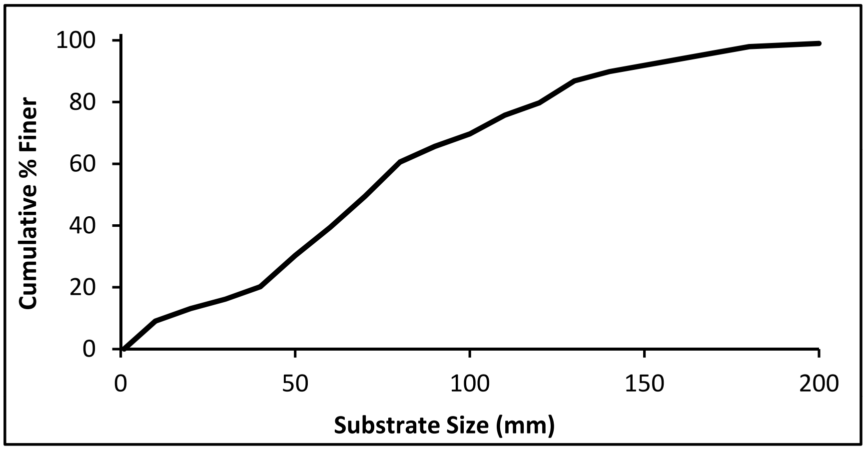
SGA ID:	T4.03A
Length (ft):	2,514
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	102
RHA Percentage:	64%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	9
F. Gravel	2 - 16	4
C. Gravel	16 - 64	36
Cobble	64 - 256	51
Boulder	256 - 4096	0
Bedrock	> 4096	0

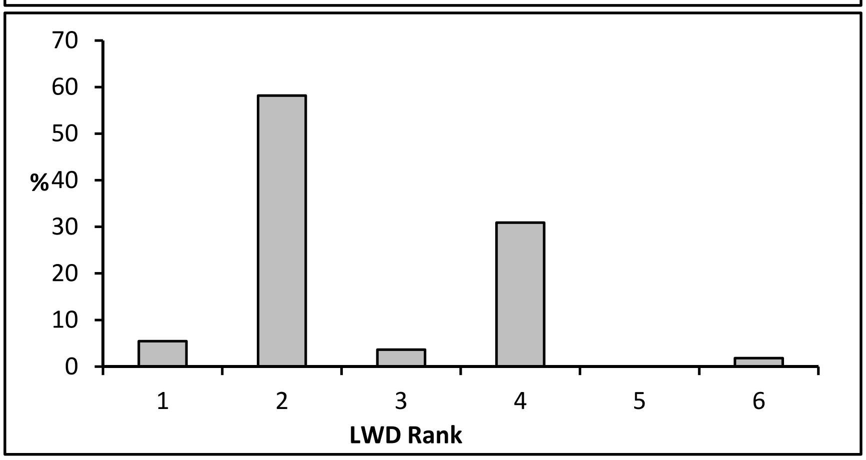
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	160	mm
Riffle Stability Index (RSI):	94	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	3
2	0.5 ≤ D < 1.0	≥ 0.5	32
3	1.0 ≤ D < 2.0	< 0.5	2
4	1.0 ≤ D < 2.0	≥ 0.5	17
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	1

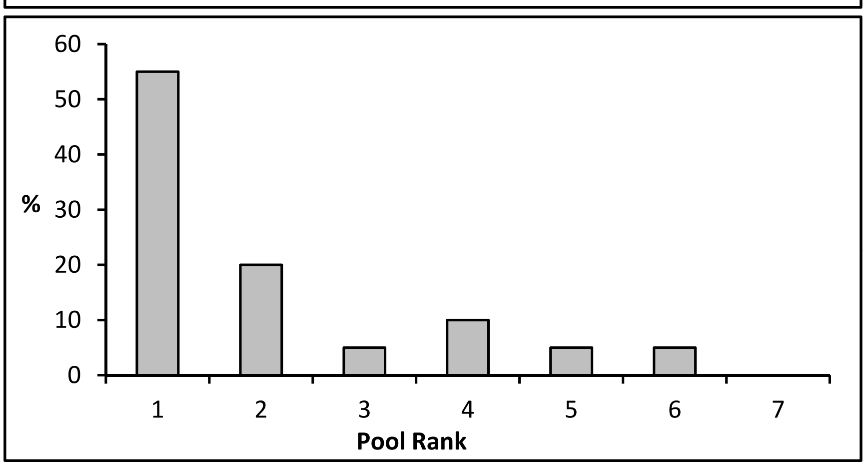
 # LWDs/mile: 116



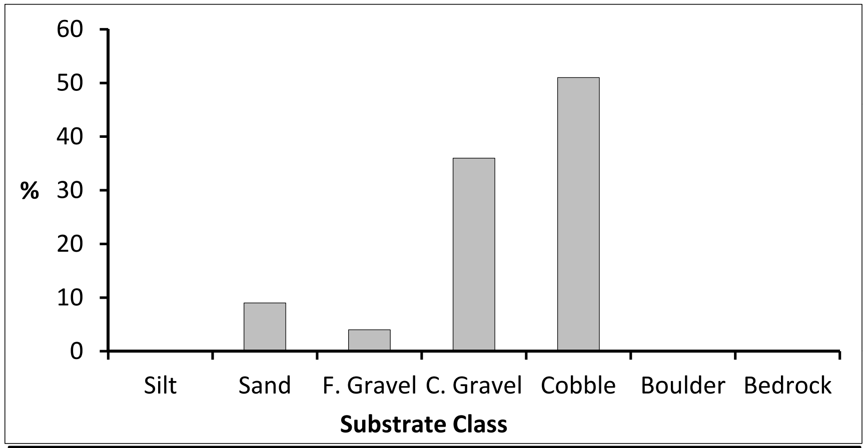
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	11
2	1.0 ≤ D < 2.0	≥ 0.5	4
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	1
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 42



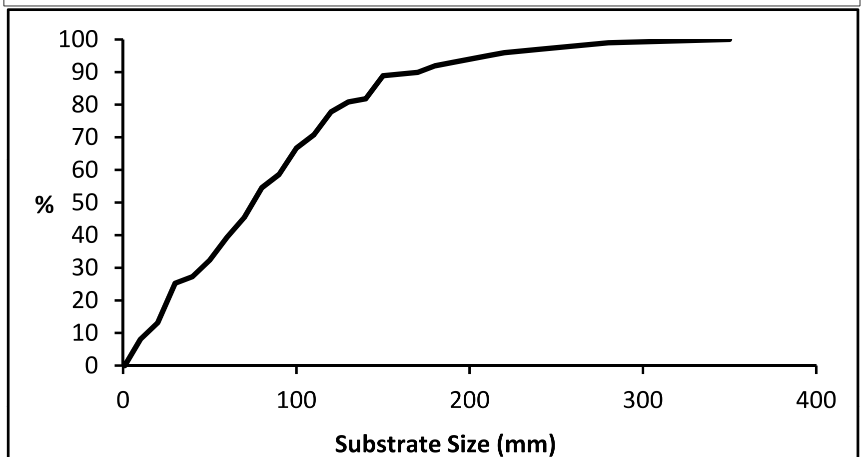
Reach/Segment Information	
SGA ID:	T4.03B
Length (ft):	3,083
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	105
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	5
C. Gravel	16 - 64	32
Cobble	64 - 256	53
Boulder	256 - 4096	2
Bedrock	> 4096	0

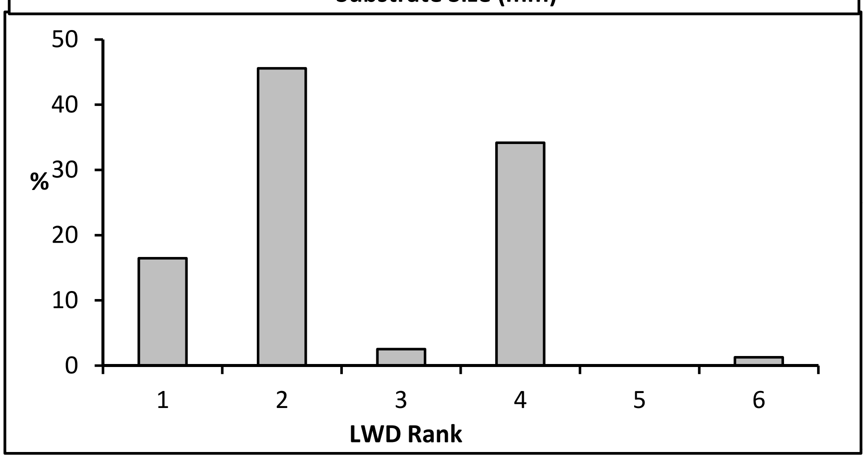
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	100	mm
Riffle Stability Index (RSI):	67	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	13
2	0.5 ≤ D < 1.0	≥ 0.5	36
3	1.0 ≤ D < 2.0	< 0.5	2
4	1.0 ≤ D < 2.0	≥ 0.5	27
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	1

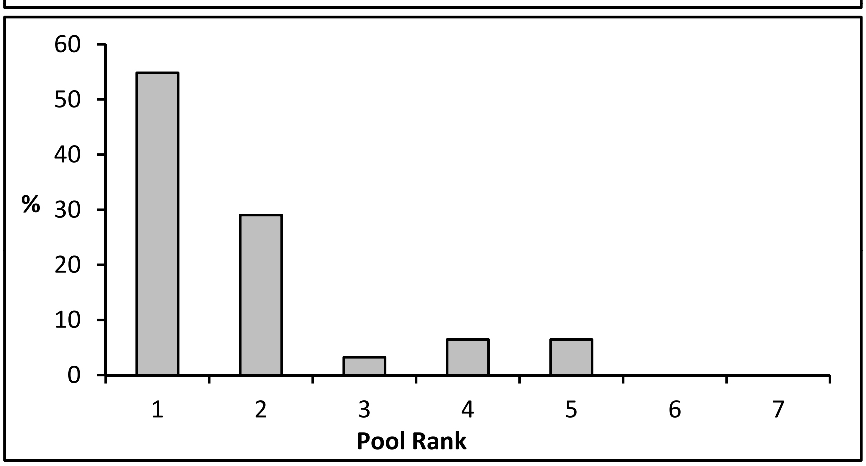
 # LWDs/mile: 135

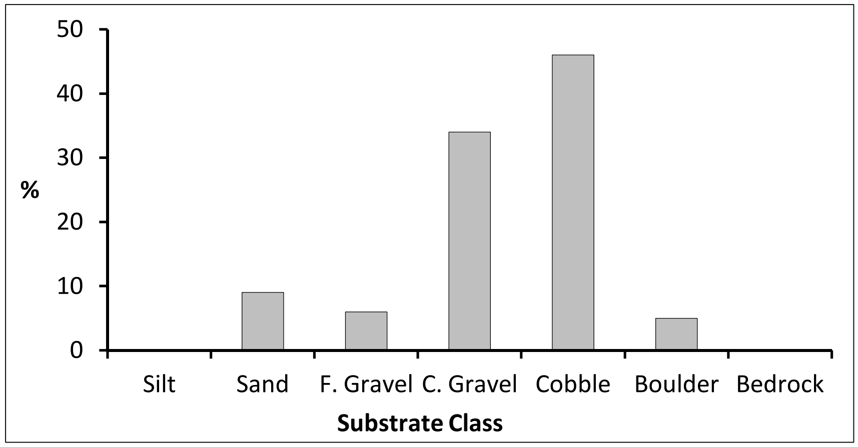


Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	17
2	1.0 ≤ D < 2.0	≥ 0.5	9
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	2
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

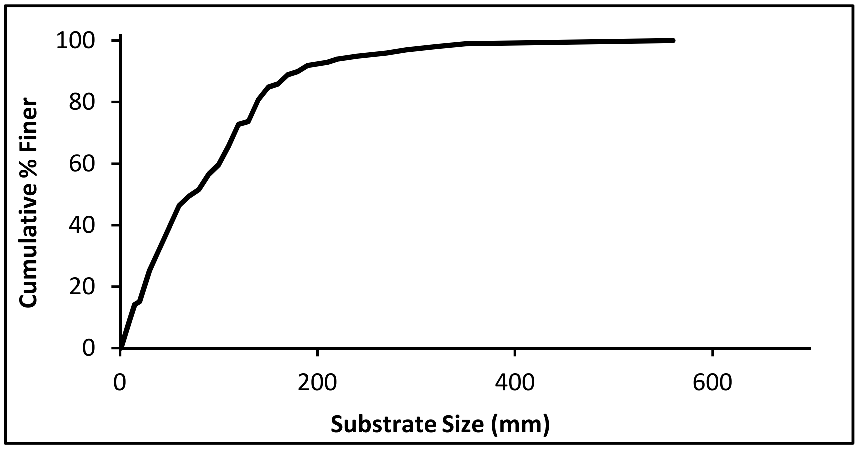
 # Pools/mile: 53





Reach/Segment Information

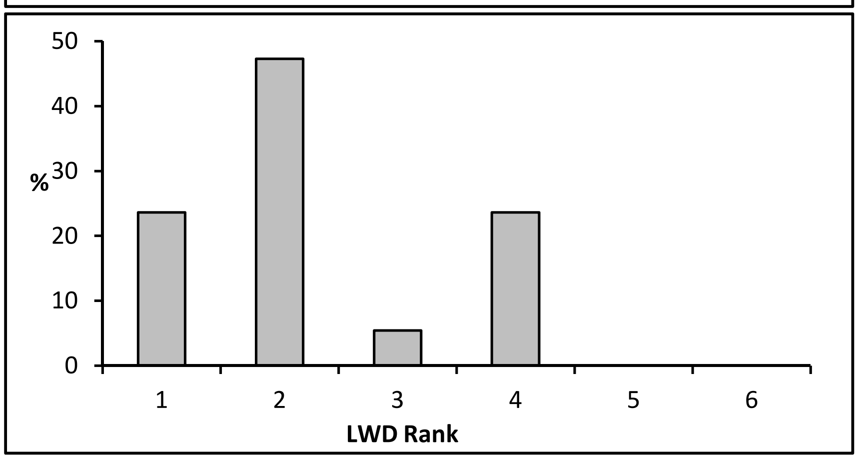
SGA ID:	T4.04
Length (ft):	4,700
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	106
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	15
F. Gravel	2 - 16	7
C. Gravel	16 - 64	20
Cobble	64 - 256	42
Boulder	256 - 4096	16
Bedrock	> 4096	0

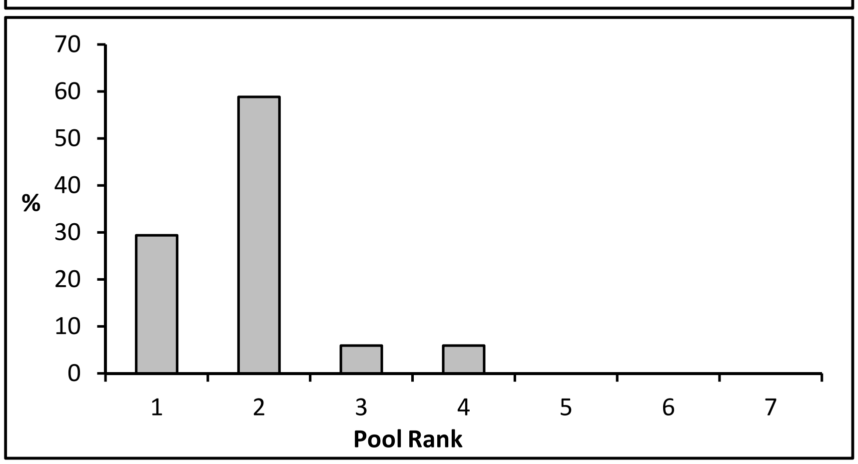
Median Substrate Size:	90	mm
Avg. Largest Particle (Bar):	120	mm
Riffle Stability Index (RSI):	60	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	13
2	0.5 ≤ D < 1.0	≥ 0.5	26
3	1.0 ≤ D < 2.0	< 0.5	3
4	1.0 ≤ D < 2.0	≥ 0.5	13
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

 # LWDs/mile: 62



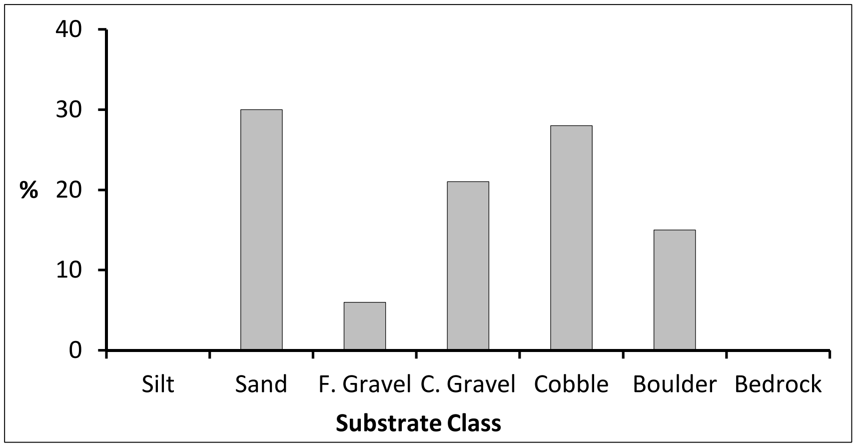
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	10
3	2.0 ≤ D < 3.0	< 0.5	1
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 19

Reach/Segment Information

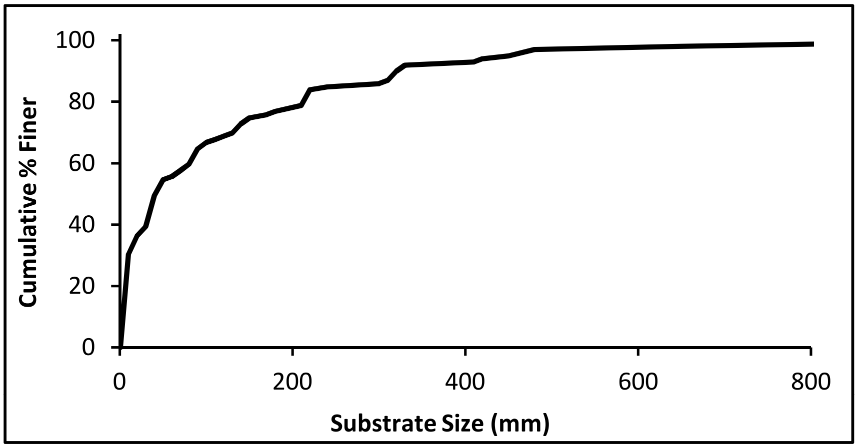
SGA ID:	T4.2S1.01
Length (ft):	1,980
Reference Bedform Type:	Step-Pool
Total RHA Score:	85
RHA Percentage:	53%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	30
F. Gravel	2 - 16	6
C. Gravel	16 - 64	21
Cobble	64 - 256	28
Boulder	256 - 4096	15
Bedrock	> 4096	0

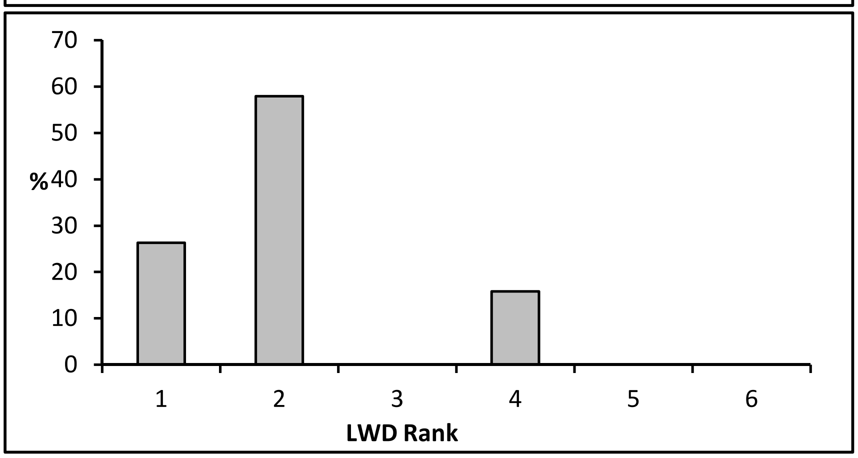
Median Substrate Size:	40	mm
Avg. Largest Particle (Bar):	60	mm
Riffle Stability Index (RSI):	56	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	5
2	0.5 ≤ D < 1.0	≥ 0.5	11
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	3
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

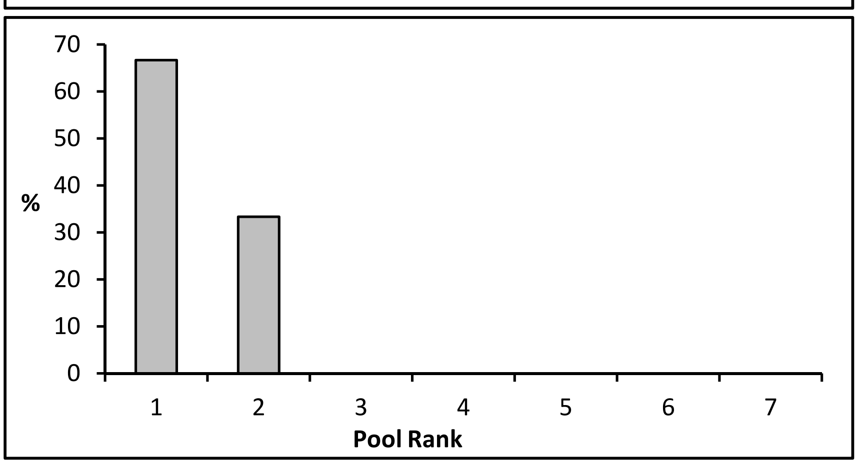
 # LWDs/mile: 51

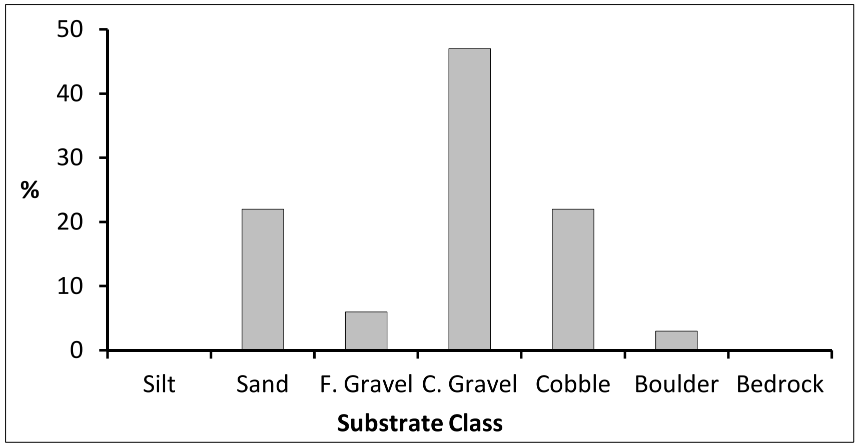


Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	6
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	0
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

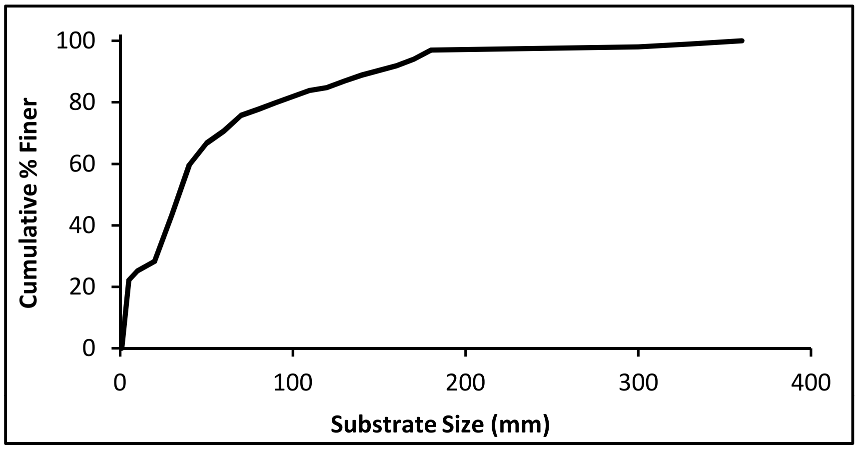
 # Pools/mile: 24





Reach/Segment Information

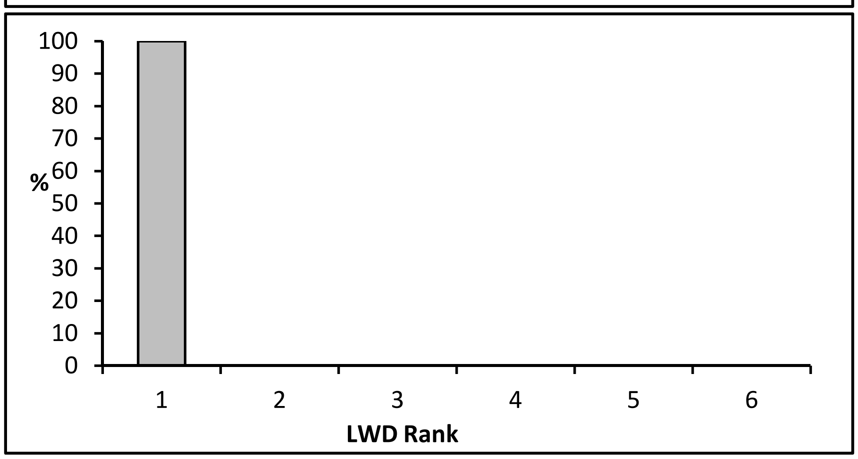
SGA ID:	T5.01
Length (ft):	2,101
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	55
RHA Percentage:	34%
Overall Habitat Condition:	Poor



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	22
F. Gravel	2 - 16	6
C. Gravel	16 - 64	47
Cobble	64 - 256	22
Boulder	256 - 4096	3
Bedrock	> 4096	0

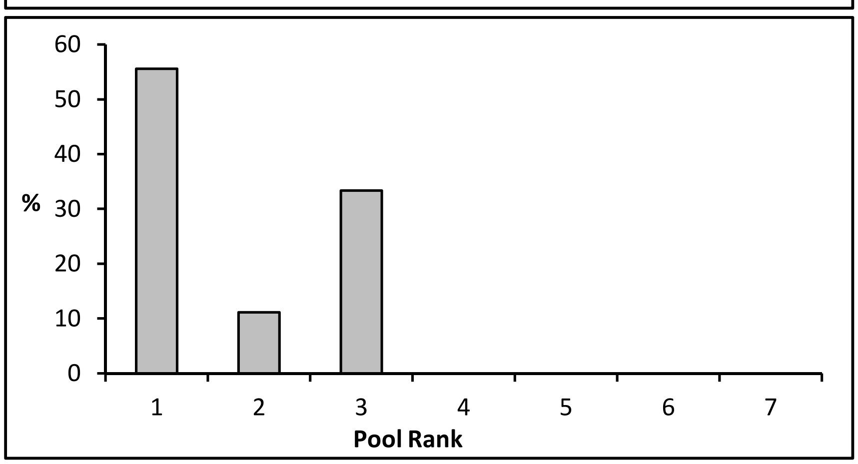
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	NA	mm
Riffle Stability Index (RSI):	NA	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	12
2	0.5 ≤ D < 1.0	≥ 0.5	0
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

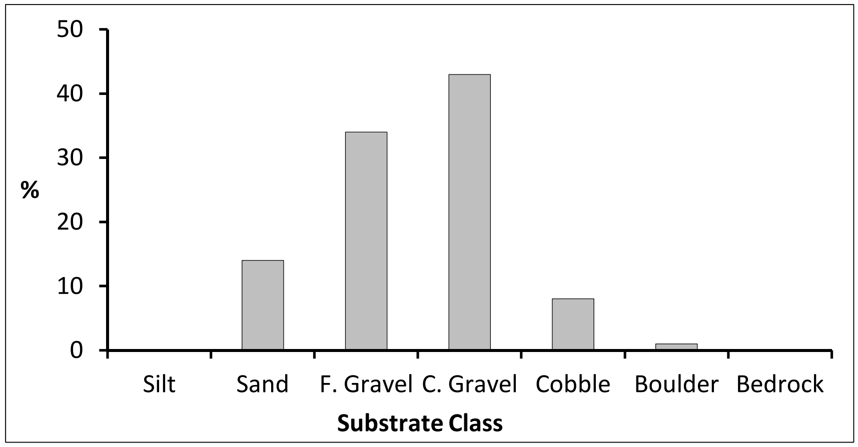
 # LWDs/mile: 30



Pools

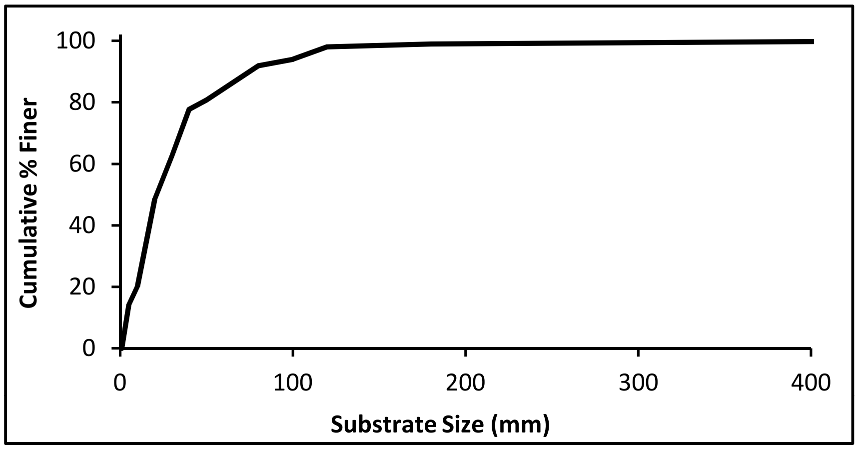
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	1
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 23



Reach/Segment Information

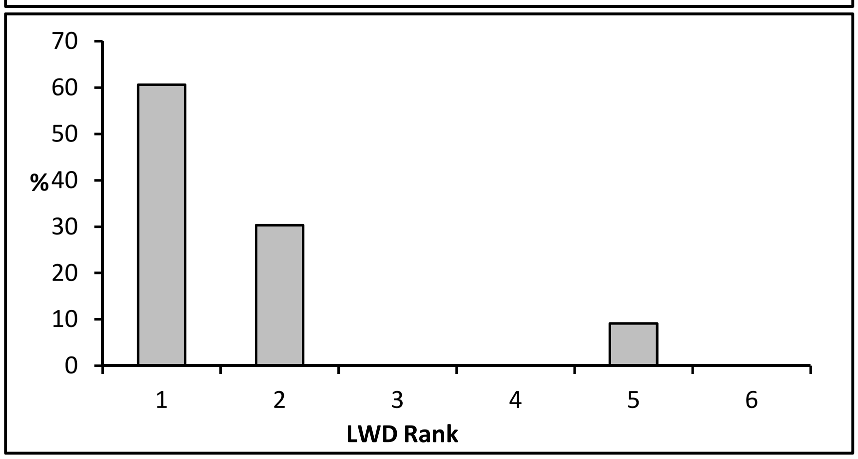
SGA ID:	T5.02
Length (ft):	2,341
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	67
RHA Percentage:	42%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	14
F. Gravel	2 - 16	34
C. Gravel	16 - 64	43
Cobble	64 - 256	8
Boulder	256 - 4096	1
Bedrock	> 4096	0

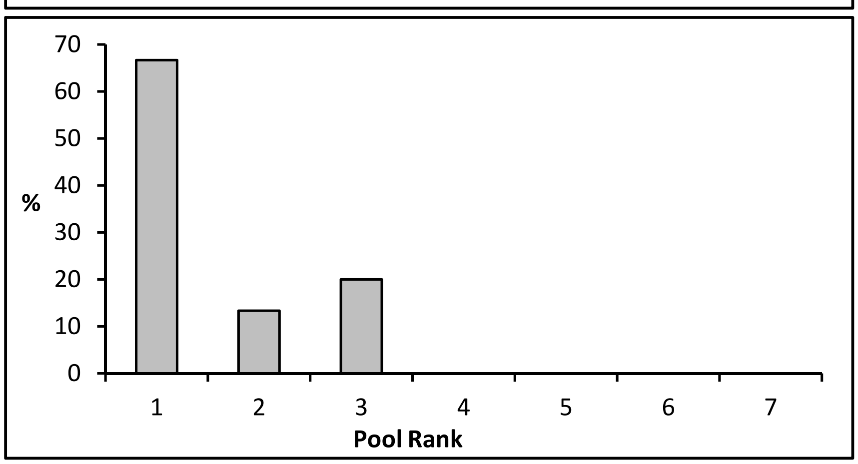
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	80	mm
Riffle Stability Index (RSI):	92	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	20
2	0.5 ≤ D < 1.0	≥ 0.5	10
3	1.0 ≤ D < 2.0	< 0.5	0
4	1.0 ≤ D < 2.0	≥ 0.5	0
5	D ≥ 2.0	< 0.5	3
6	D ≥ 2.0	≥ 0.5	0

 # LWDs/mile: 74



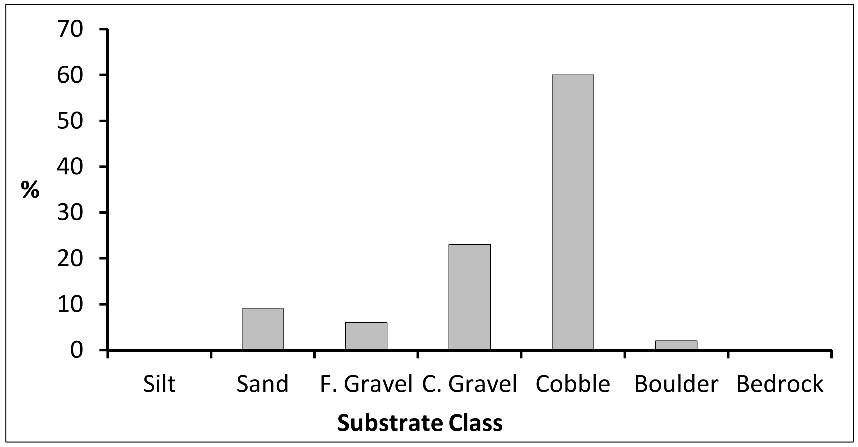
Pools

Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	10
2	1.0 ≤ D < 2.0	≥ 0.5	2
3	2.0 ≤ D < 3.0	< 0.5	3
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 34

Reach/Segment Information

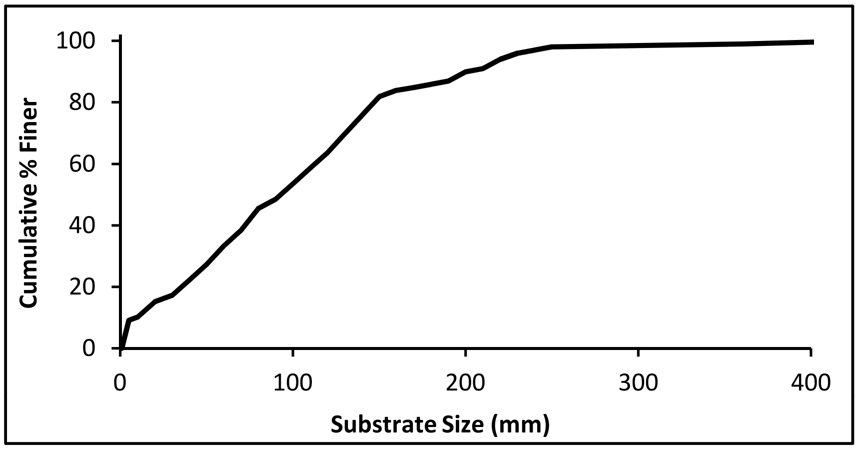
SGA ID:	T5.03
Length (ft):	3,303
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	88
RHA Percentage:	55%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	9
F. Gravel	2 - 16	6
C. Gravel	16 - 64	23
Cobble	64 - 256	60
Boulder	256 - 4096	2
Bedrock	> 4096	0

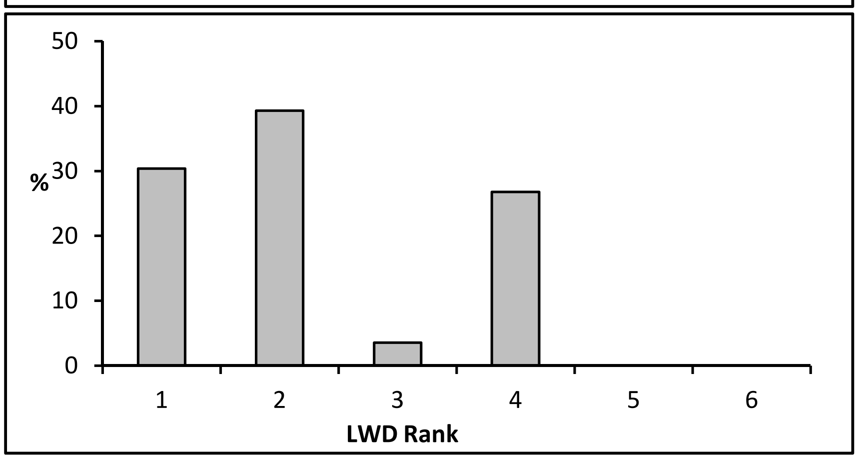
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	190	mm
Riffle Stability Index (RSI):	87	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	17
2	0.5 ≤ D < 1.0	≥ 0.5	22
3	1.0 ≤ D < 2.0	< 0.5	2
4	1.0 ≤ D < 2.0	≥ 0.5	15
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

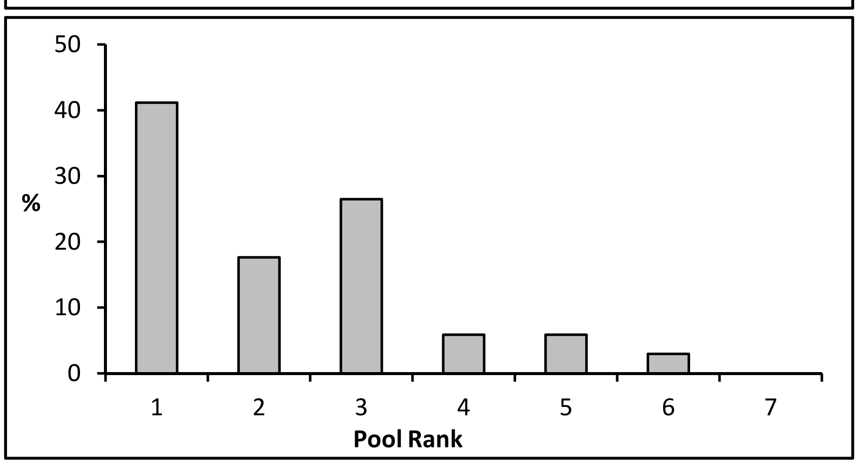
 # LWDs/mile: 90



Pools

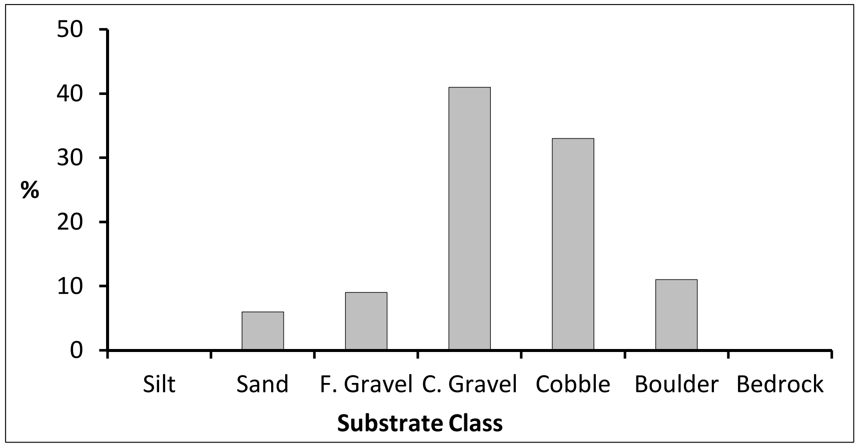
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	14
2	1.0 ≤ D < 2.0	≥ 0.5	6
3	2.0 ≤ D < 3.0	< 0.5	9
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	2
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 54



Reach/Segment Information

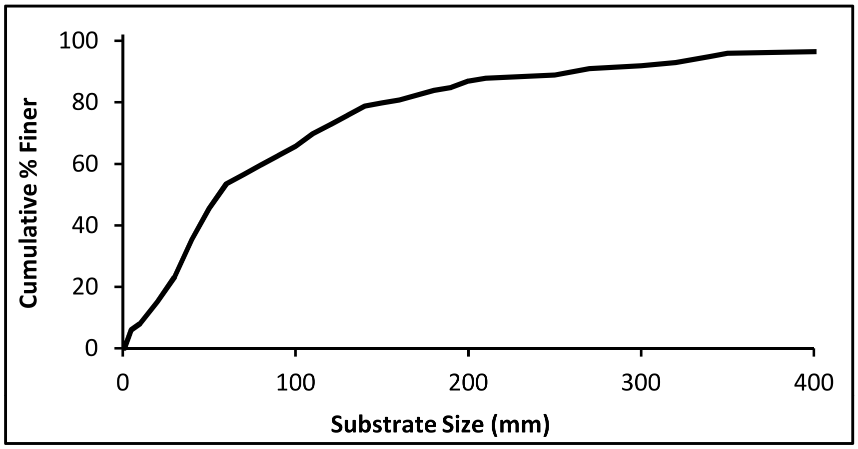
SGA ID:	T5.04
Length (ft):	2,324
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	106
RHA Percentage:	66%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	6
F. Gravel	2 - 16	9
C. Gravel	16 - 64	41
Cobble	64 - 256	33
Boulder	256 - 4096	11
Bedrock	> 4096	0

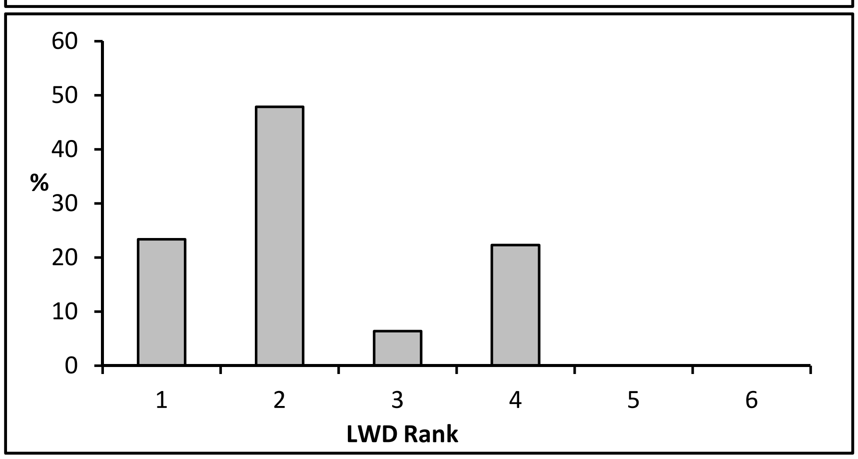
Median Substrate Size:	50	mm
Avg. Largest Particle (Bar):	70	mm
Riffle Stability Index (RSI):	57	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	22
2	0.5 ≤ D < 1.0	≥ 0.5	45
3	1.0 ≤ D < 2.0	< 0.5	6
4	1.0 ≤ D < 2.0	≥ 0.5	21
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

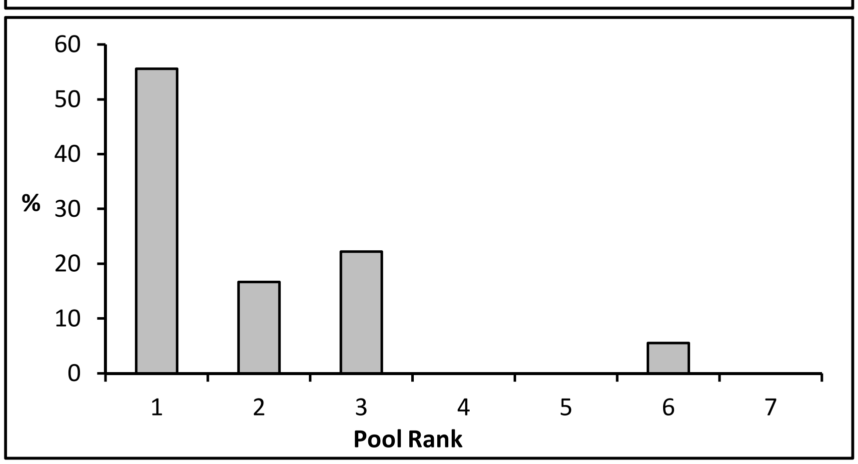
 # LWDs/mile: 214



Pools

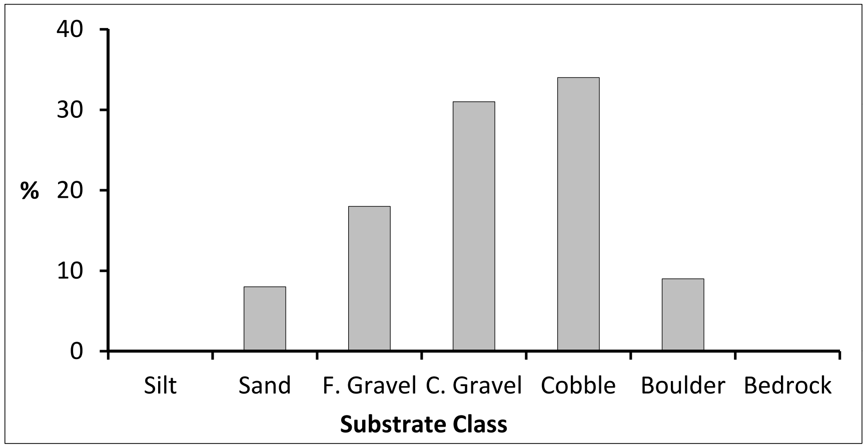
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	10
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 41



Reach/Segment Information

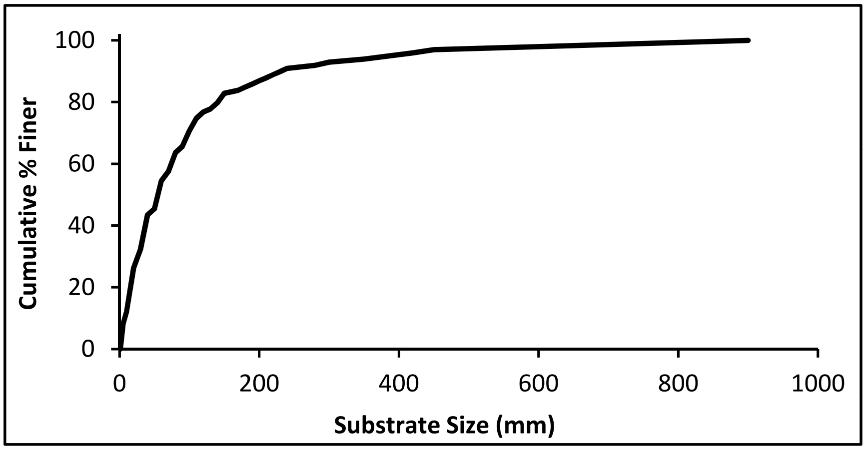
SGA ID:	T5.05A
Length (ft):	2,756
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	94
RHA Percentage:	59%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	18
C. Gravel	16 - 64	31
Cobble	64 - 256	34
Boulder	256 - 4096	9
Bedrock	> 4096	0

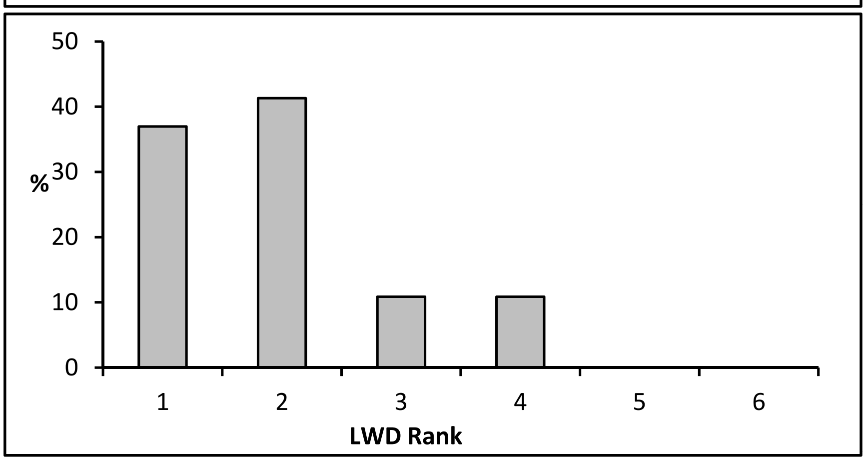
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	140	mm
Riffle Stability Index (RSI):	79	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	17
2	0.5 ≤ D < 1.0	≥ 0.5	19
3	1.0 ≤ D < 2.0	< 0.5	5
4	1.0 ≤ D < 2.0	≥ 0.5	5
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

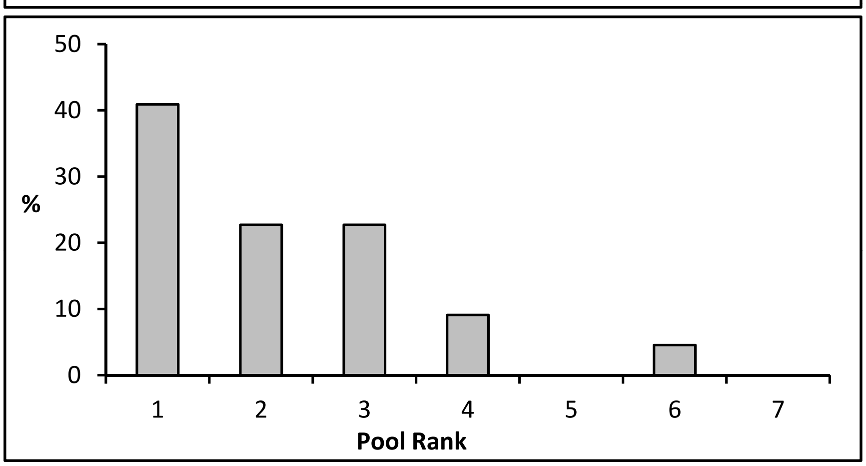
 # LWDs/mile: 88



Pools

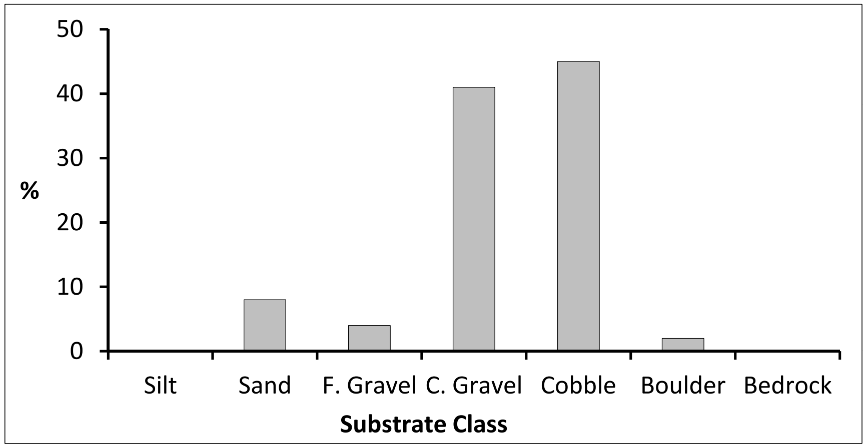
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	9
2	1.0 ≤ D < 2.0	≥ 0.5	5
3	2.0 ≤ D < 3.0	< 0.5	5
4	2.0 ≤ D < 3.0	≥ 0.5	2
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 42



Reach/Segment Information

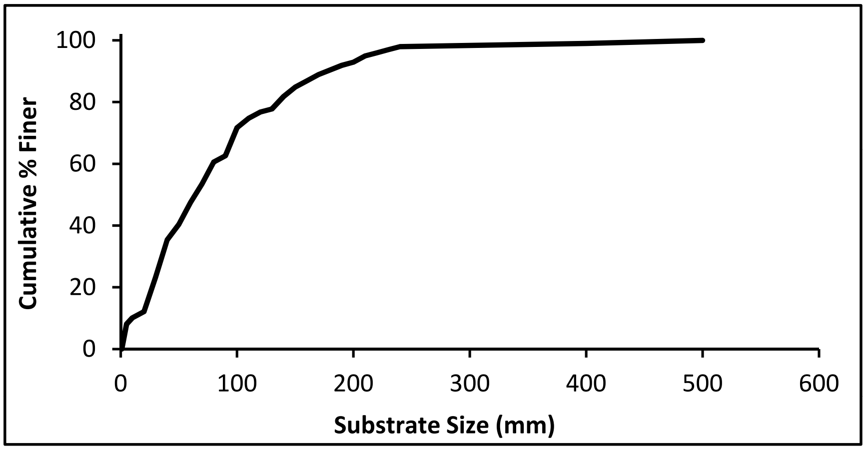
SGA ID:	T5.05B
Length (ft):	1,963
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	107
RHA Percentage:	67%
Overall Habitat Condition:	Good



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	4
C. Gravel	16 - 64	41
Cobble	64 - 256	45
Boulder	256 - 4096	2
Bedrock	> 4096	0

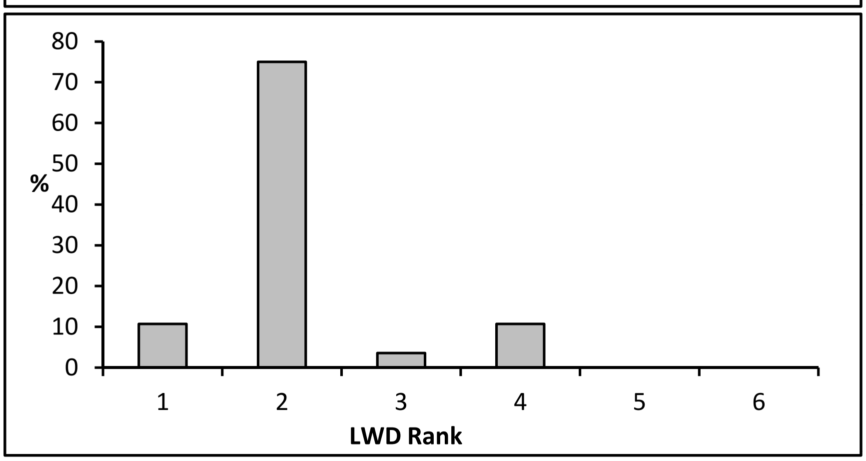
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	50	mm
Riffle Stability Index (RSI):	40	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	3
2	0.5 ≤ D < 1.0	≥ 0.5	21
3	1.0 ≤ D < 2.0	< 0.5	1
4	1.0 ≤ D < 2.0	≥ 0.5	3
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	0

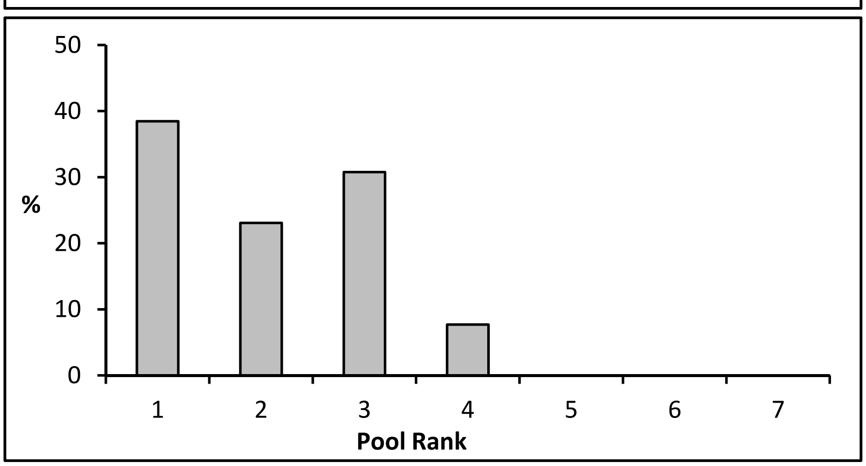
 # LWDs/mile: 75



Pools

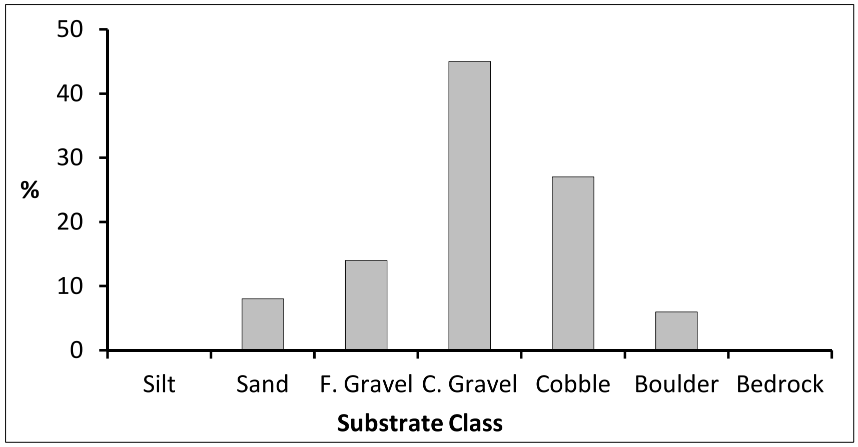
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	5
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	0
6	D ≥ 3.0	≥ 0.5	0
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 35



Reach/Segment Information

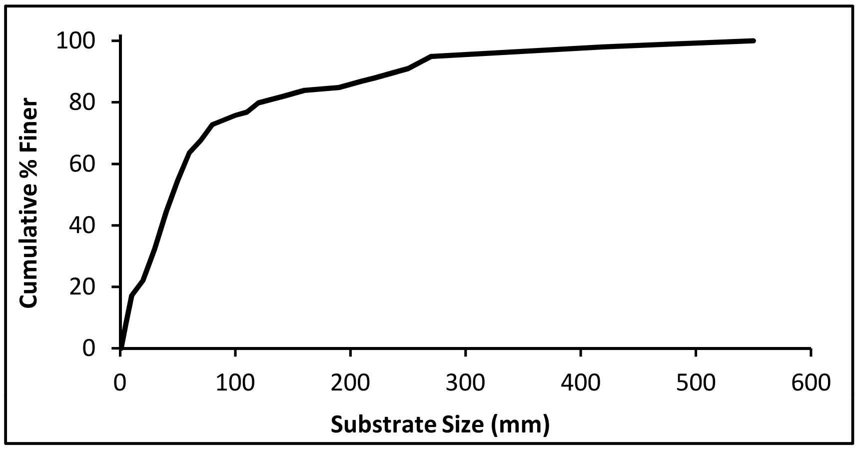
SGA ID:	T5.06
Length (ft):	3,648
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	103
RHA Percentage:	64%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	8
F. Gravel	2 - 16	14
C. Gravel	16 - 64	45
Cobble	64 - 256	27
Boulder	256 - 4096	6
Bedrock	> 4096	0

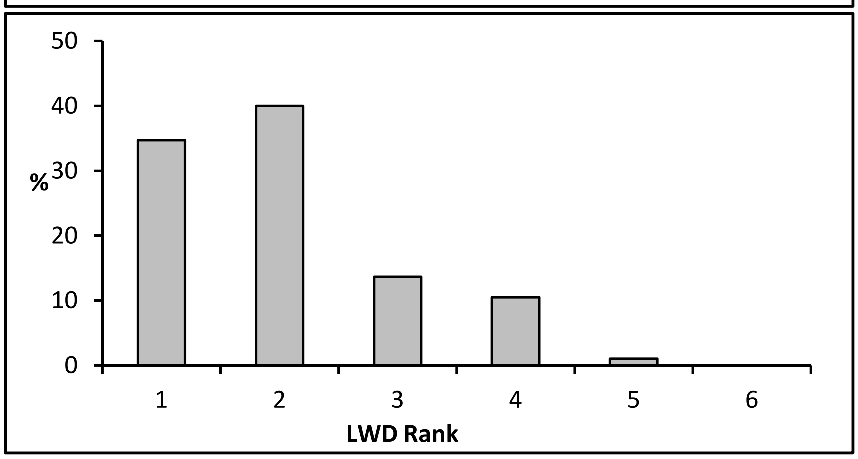
Median Substrate Size:	40	mm
Avg. Largest Particle (Bar):	70	mm
Riffle Stability Index (RSI):	67	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	33
2	0.5 ≤ D < 1.0	≥ 0.5	38
3	1.0 ≤ D < 2.0	< 0.5	13
4	1.0 ≤ D < 2.0	≥ 0.5	10
5	D ≥ 2.0	< 0.5	1
6	D ≥ 2.0	≥ 0.5	0

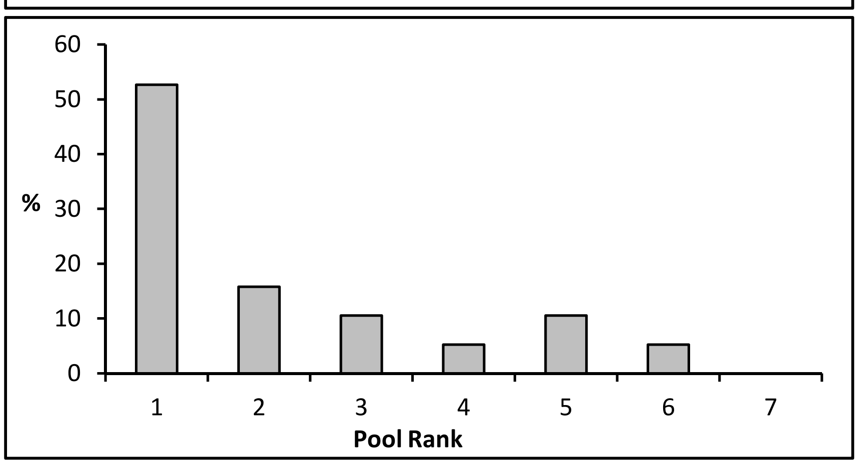
 # LWDs/mile: 138



Pools

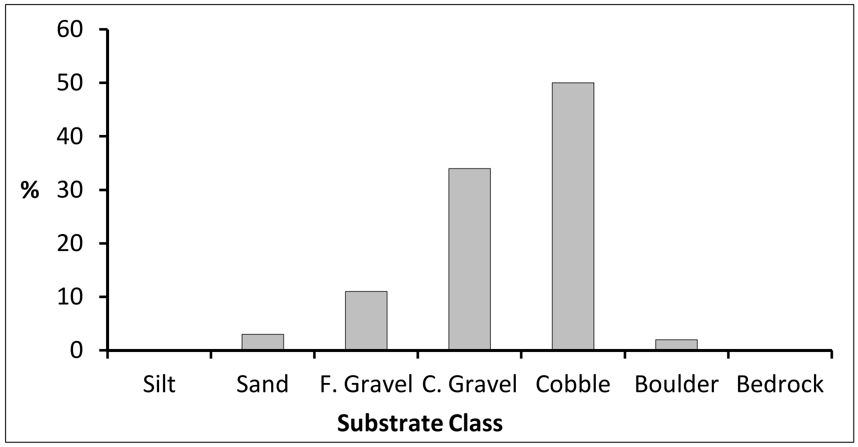
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	10
2	1.0 ≤ D < 2.0	≥ 0.5	3
3	2.0 ≤ D < 3.0	< 0.5	2
4	2.0 ≤ D < 3.0	≥ 0.5	1
5	D ≥ 3.0	< 0.5	2
6	D ≥ 3.0	≥ 0.5	1
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 28



Reach/Segment Information

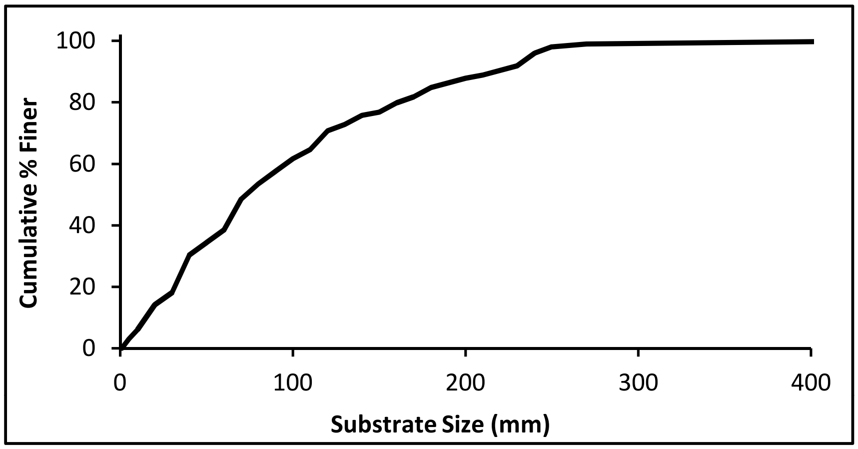
SGA ID:	T5.07
Length (ft):	5,403
Reference Bedform Type:	Riffle-Pool
Total RHA Score:	87
RHA Percentage:	54%
Overall Habitat Condition:	Fair



Sediment Composition and Mobility

Class	Range (mm)	Percent
Silt	< 0.06	0
Sand	0.06 - 2	3
F. Gravel	2 - 16	10
C. Gravel	16 - 64	34
Cobble	64 - 256	50
Boulder	256 - 4096	2
Bedrock	> 4096	0

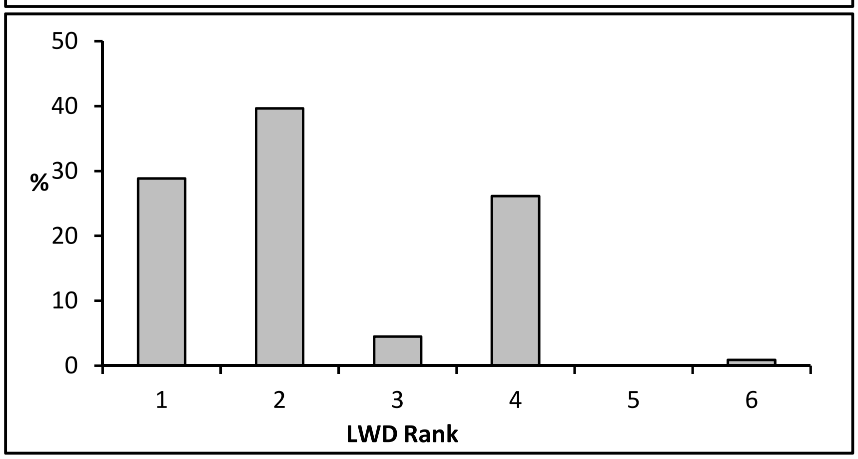
Median Substrate Size:	70	mm
Avg. Largest Particle (Bar):	240	mm
Riffle Stability Index (RSI):	96	%



Large Woody Debris (LWD)

Rank	Diameter (ft)	L (W_{bkf})	#
1	0.5 ≤ D < 1.0	< 0.5	32
2	0.5 ≤ D < 1.0	≥ 0.5	44
3	1.0 ≤ D < 2.0	< 0.5	5
4	1.0 ≤ D < 2.0	≥ 0.5	29
5	D ≥ 2.0	< 0.5	0
6	D ≥ 2.0	≥ 0.5	1

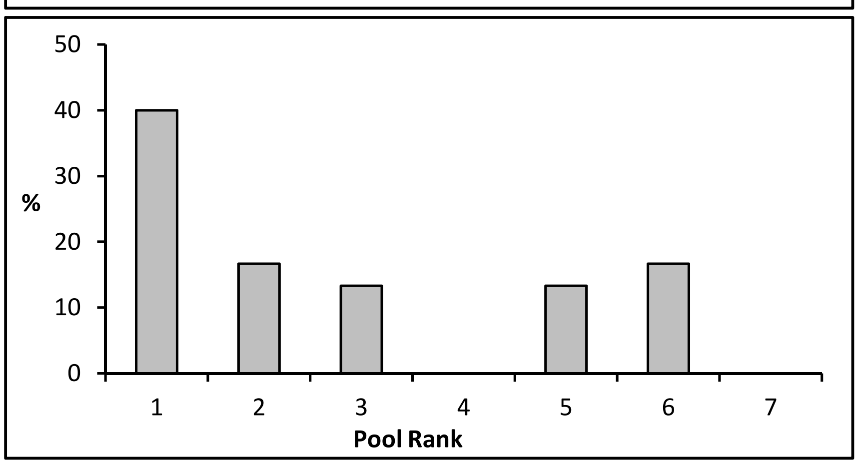
 # LWDs/mile: 108



Pools

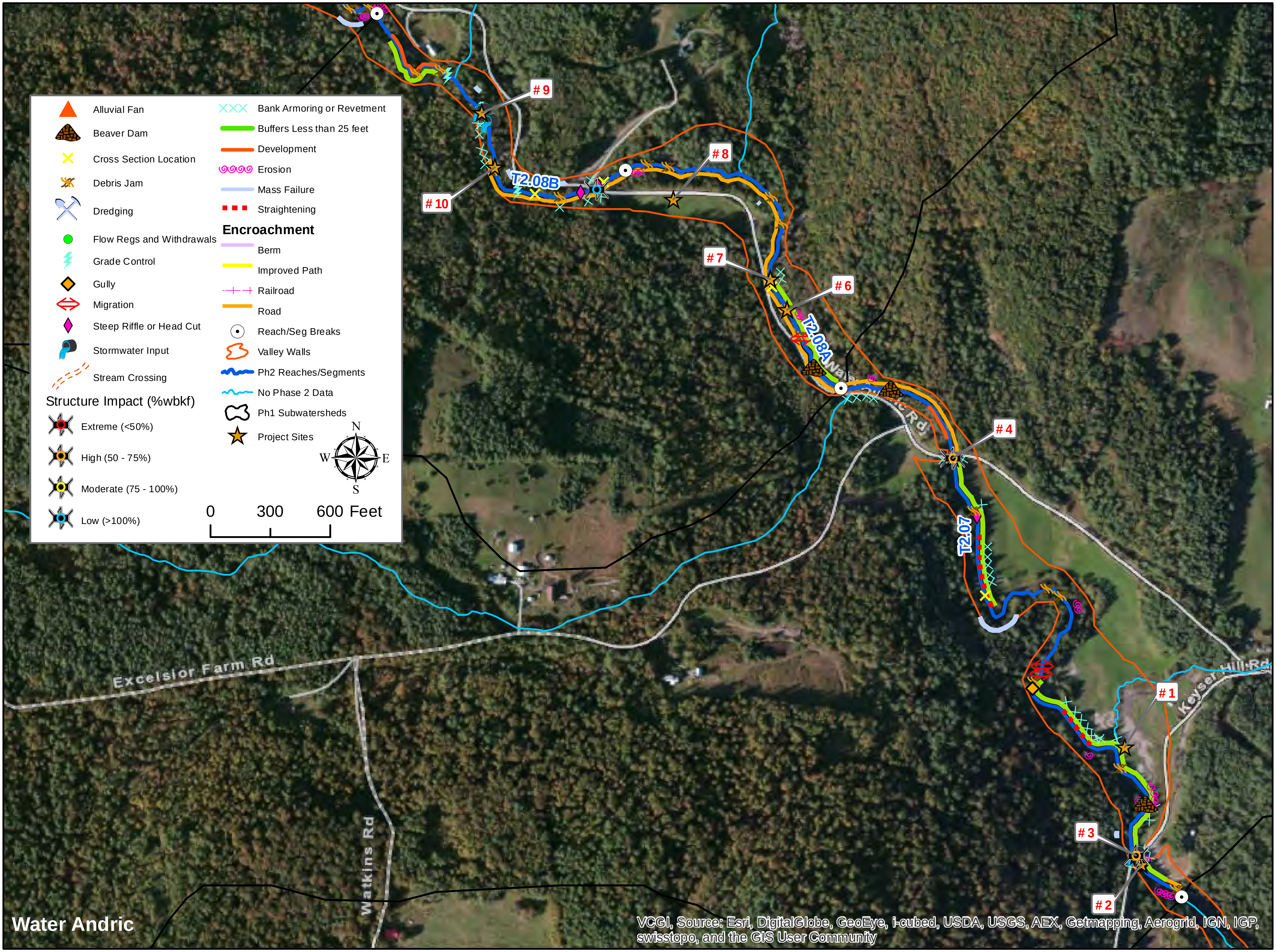
Rank	Depth (ft)	L (W_{bkf})	#
1	1.0 ≤ D < 2.0	< 0.5	12
2	1.0 ≤ D < 2.0	≥ 0.5	5
3	2.0 ≤ D < 3.0	< 0.5	4
4	2.0 ≤ D < 3.0	≥ 0.5	0
5	D ≥ 3.0	< 0.5	4
6	D ≥ 3.0	≥ 0.5	5
7	D ≥ 3.0	≥ 1.0	0

 # Pools/mile: 29

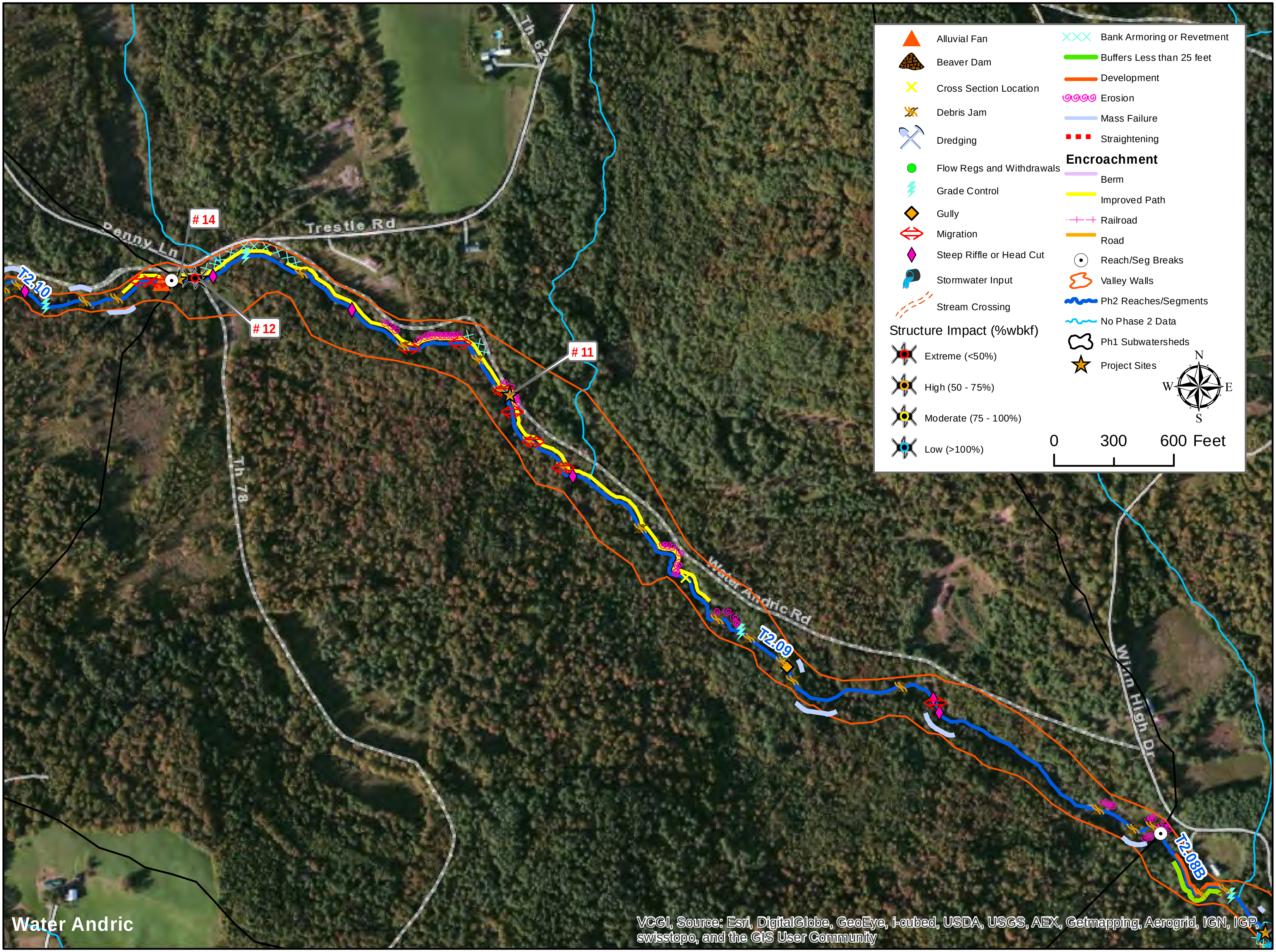


APPENDIX D

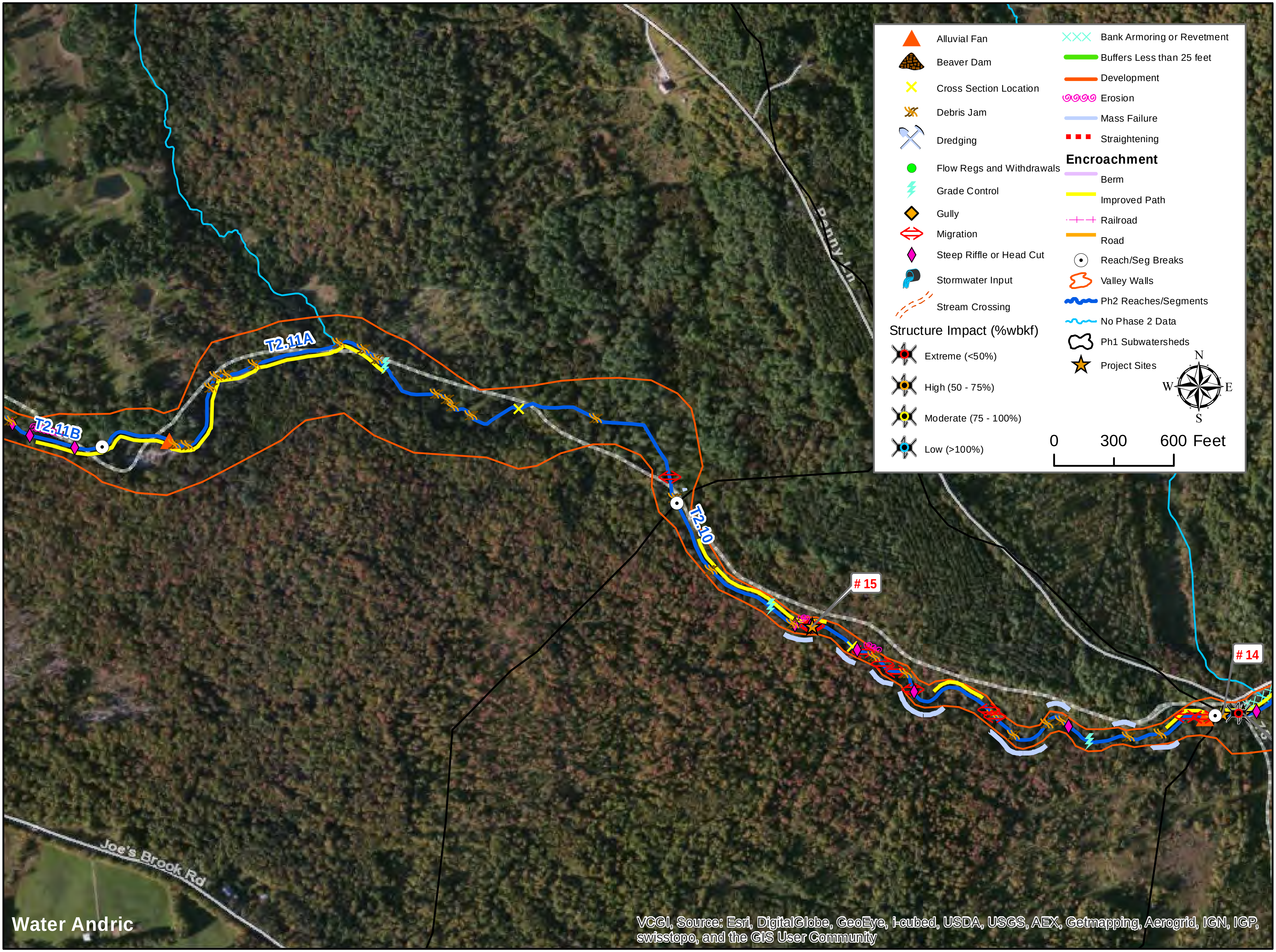
REACH STRESSOR AND PROJECT IDENTIFICATION MAPS

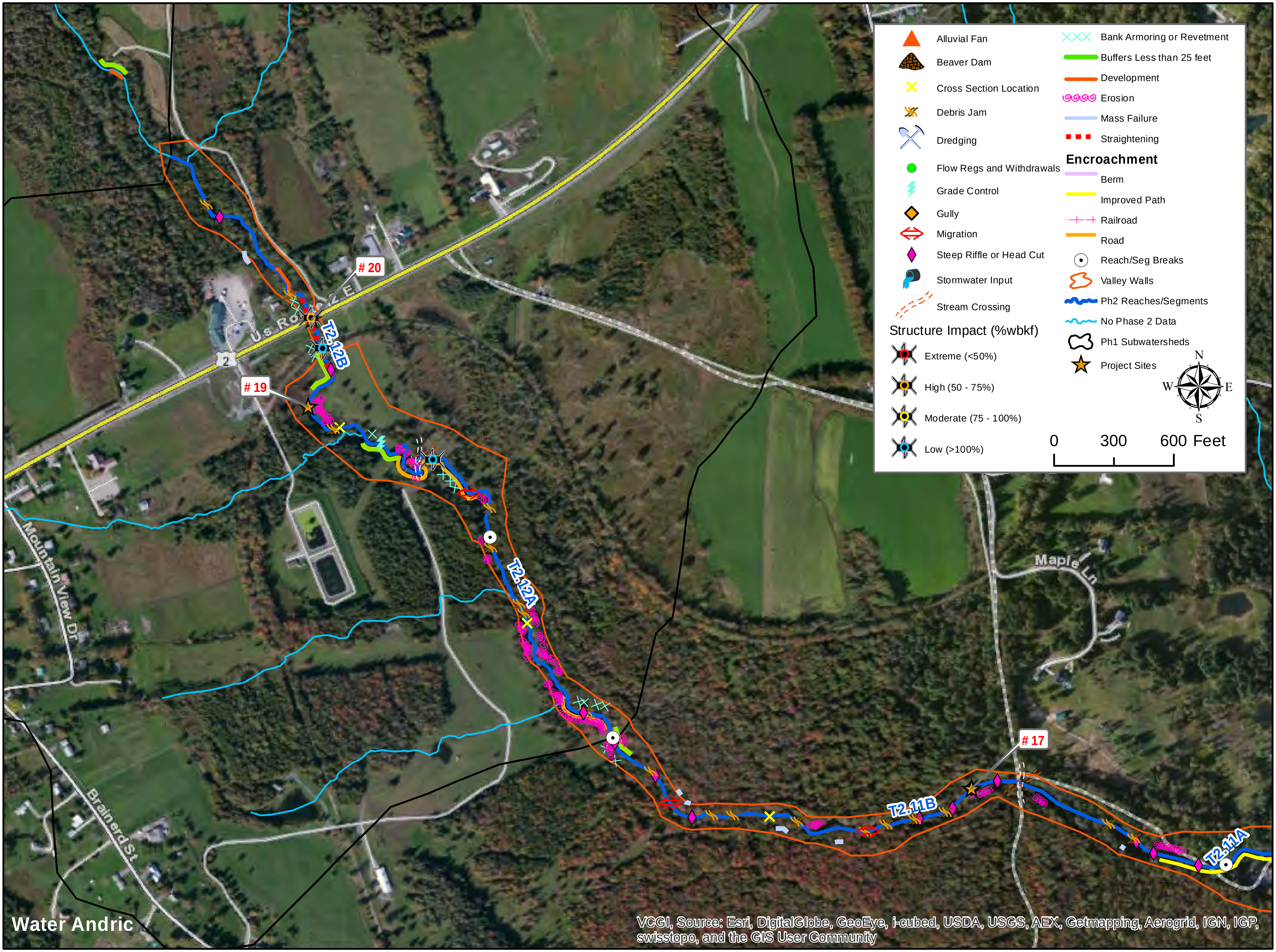


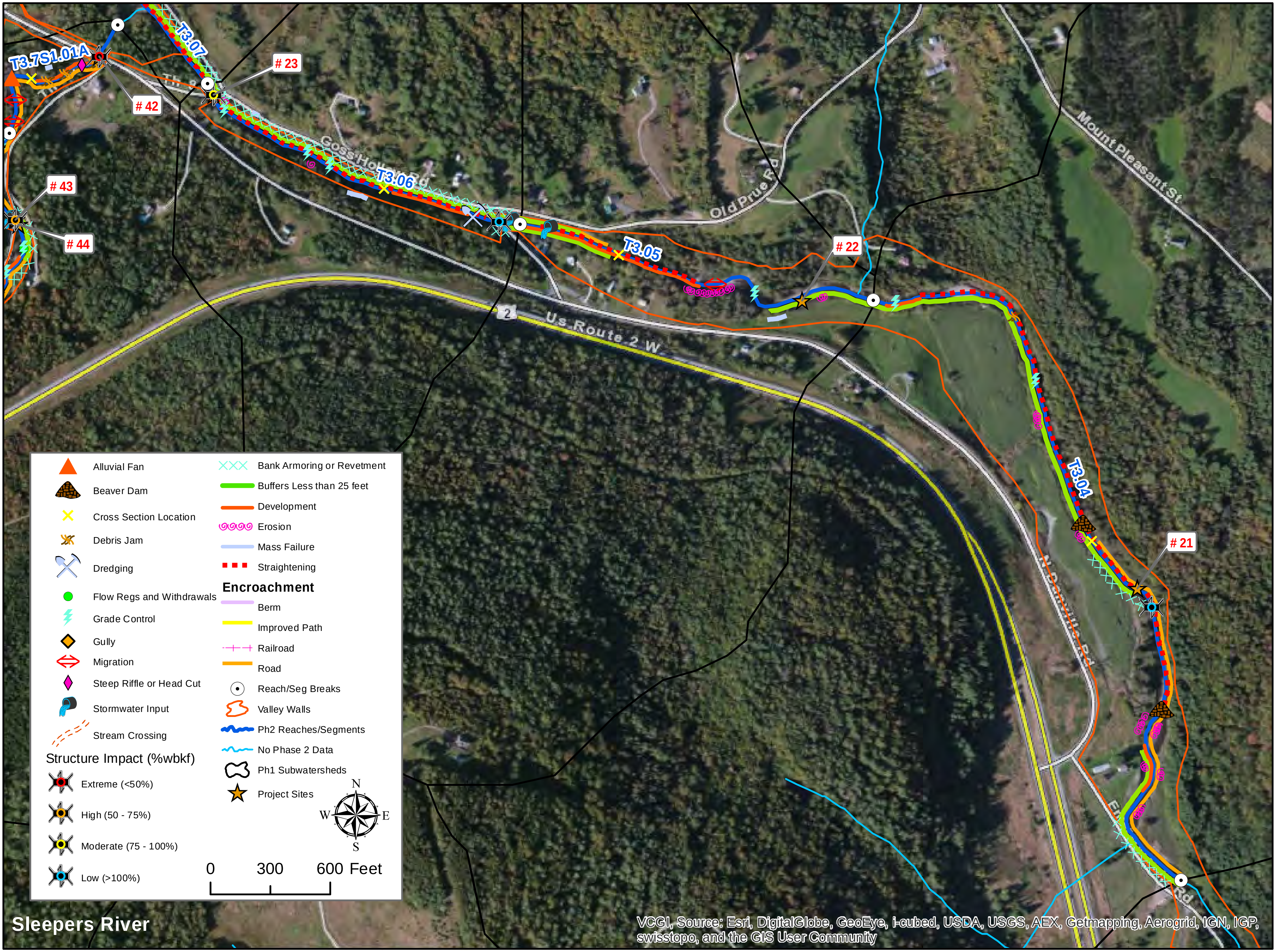
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
1
2
3
4
6
7
8
9
10
T2.08B
T2.08A
T2.07
Excelsior Farm Rd
Watkins Rd
Keyser Hill Rd
Water Andric
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

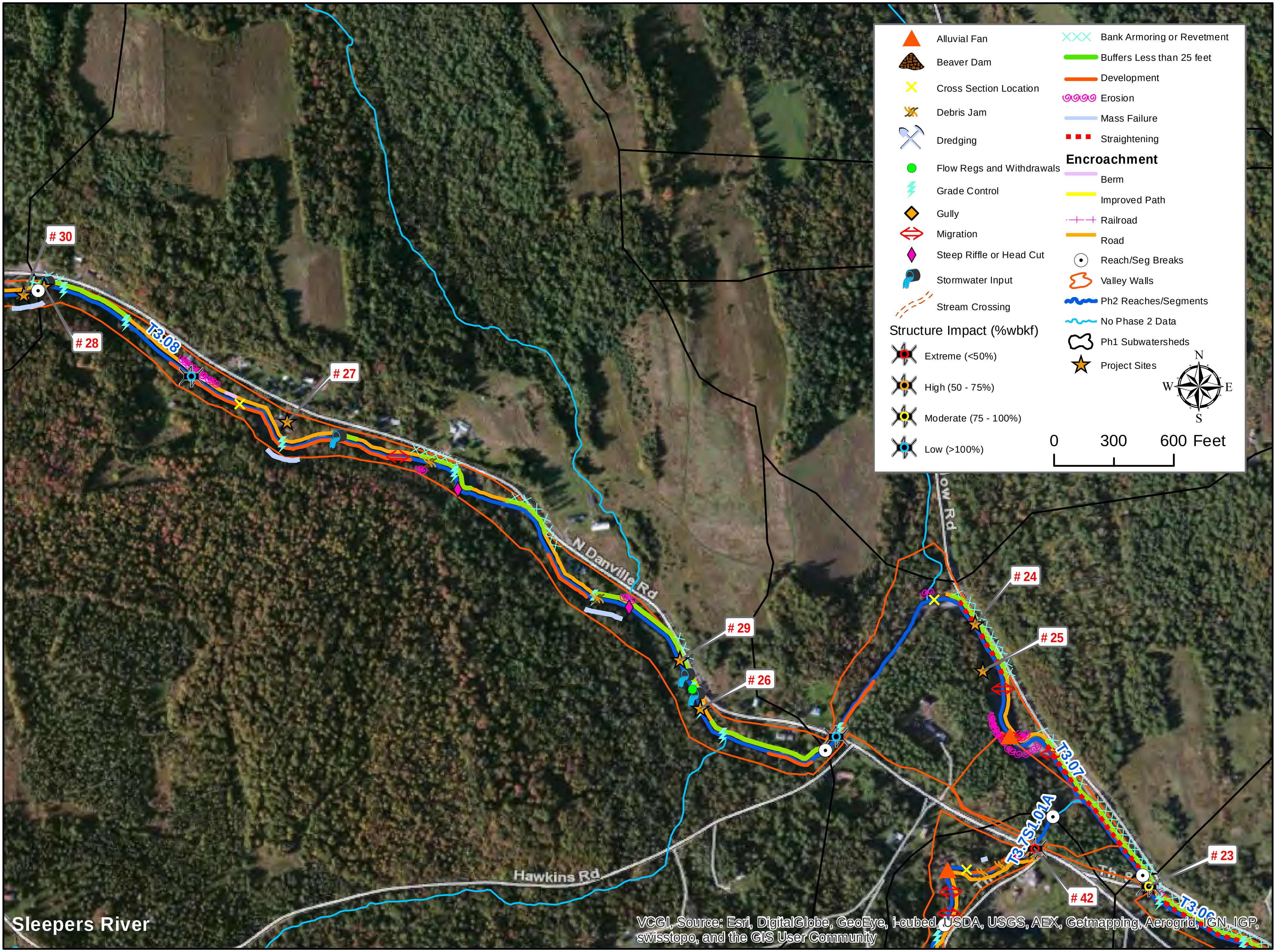


Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
14
12
11
T2.10
T2.09
T2.08B
Trestle Rd
Penny Ln
Th 62
Th 78
Water Andric Rd
Water Andric
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

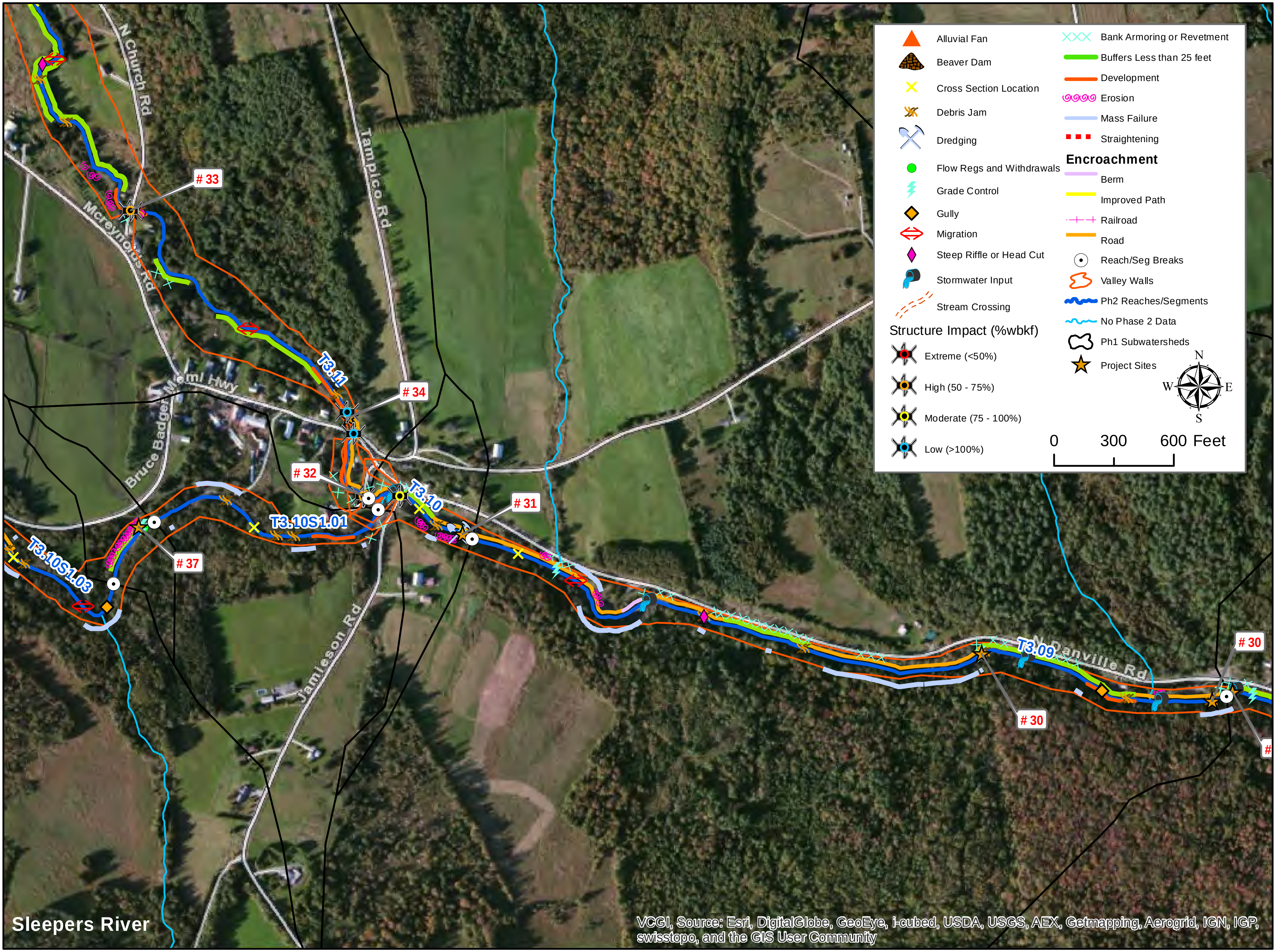

T2.11A
T2.11B
T2.10
15
14
Penny Ln
Joe's Brook Rd
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
E
S
W
0
300
600 Feet
Water Andric
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
20
19
17
T2.12B
T2.12A
T2.11B
T2.11A
Us Route 2 E
2
Mountain View Dr
Brainerd St
Maple Ln
Water Andric
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

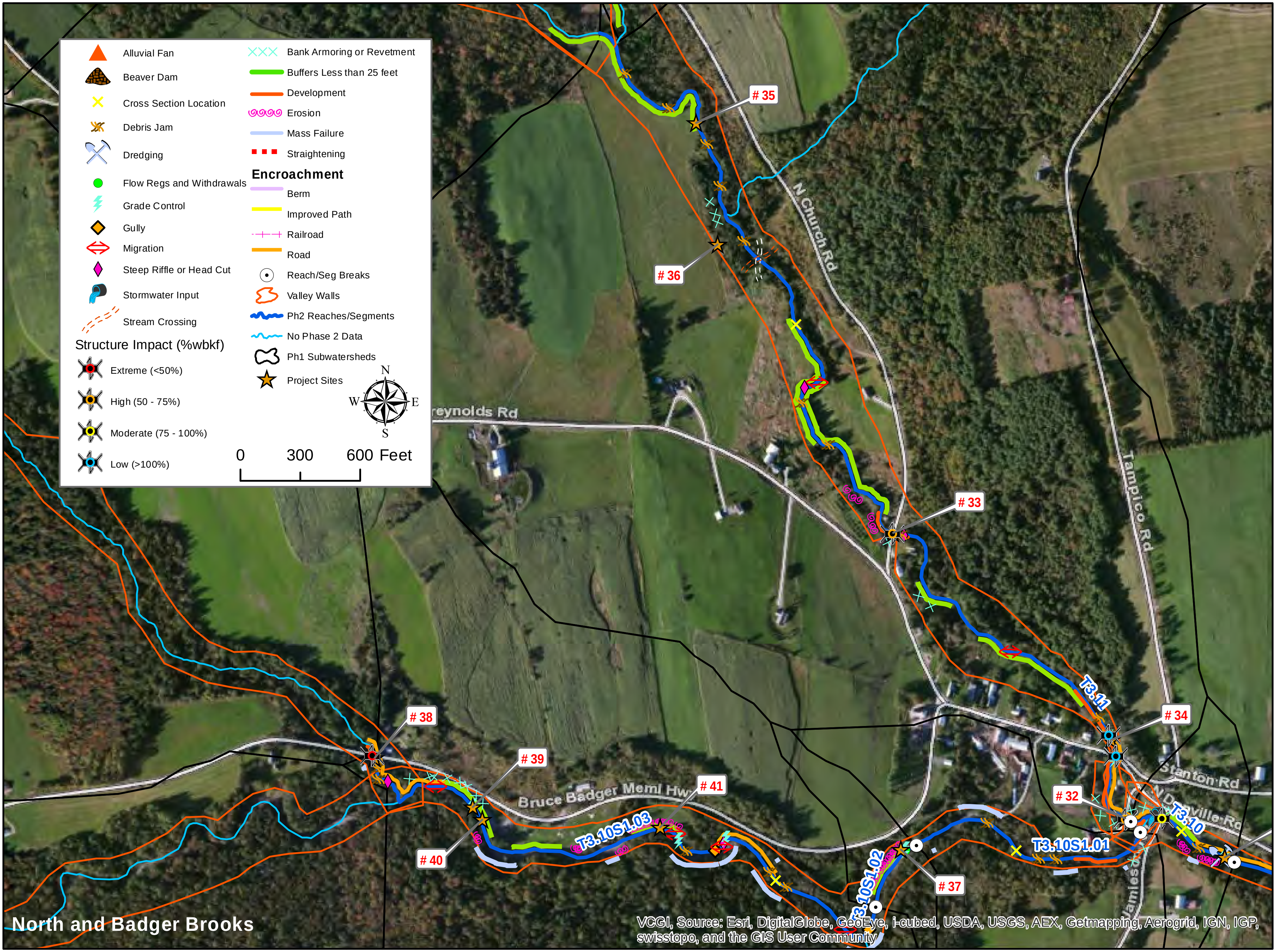

T3.7S1.01A
T3.07
T3.06
T3.05
T3.04
23
42
43
44
22
21
Goss Hollow Rd
Old Prue Rd
Mount Pleasant St
Us Route 2 W
2
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
Sleepers River
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

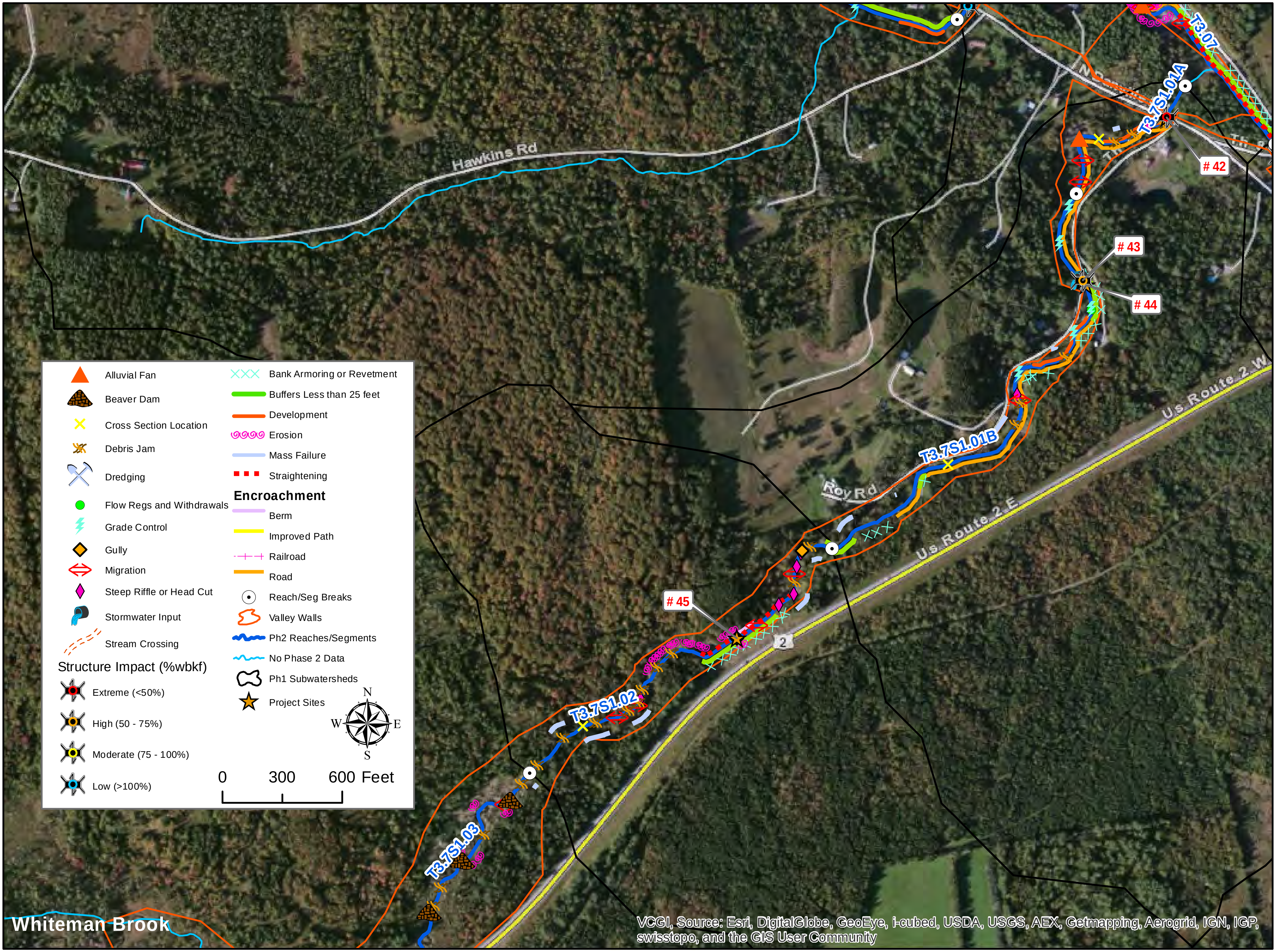


Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
30
28
27
29
26
24
25
23
42
T3.08
T3.07
T3.06
T3.7S1.01A
N Danville Rd
Hawkins Rd
Sleepers River
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

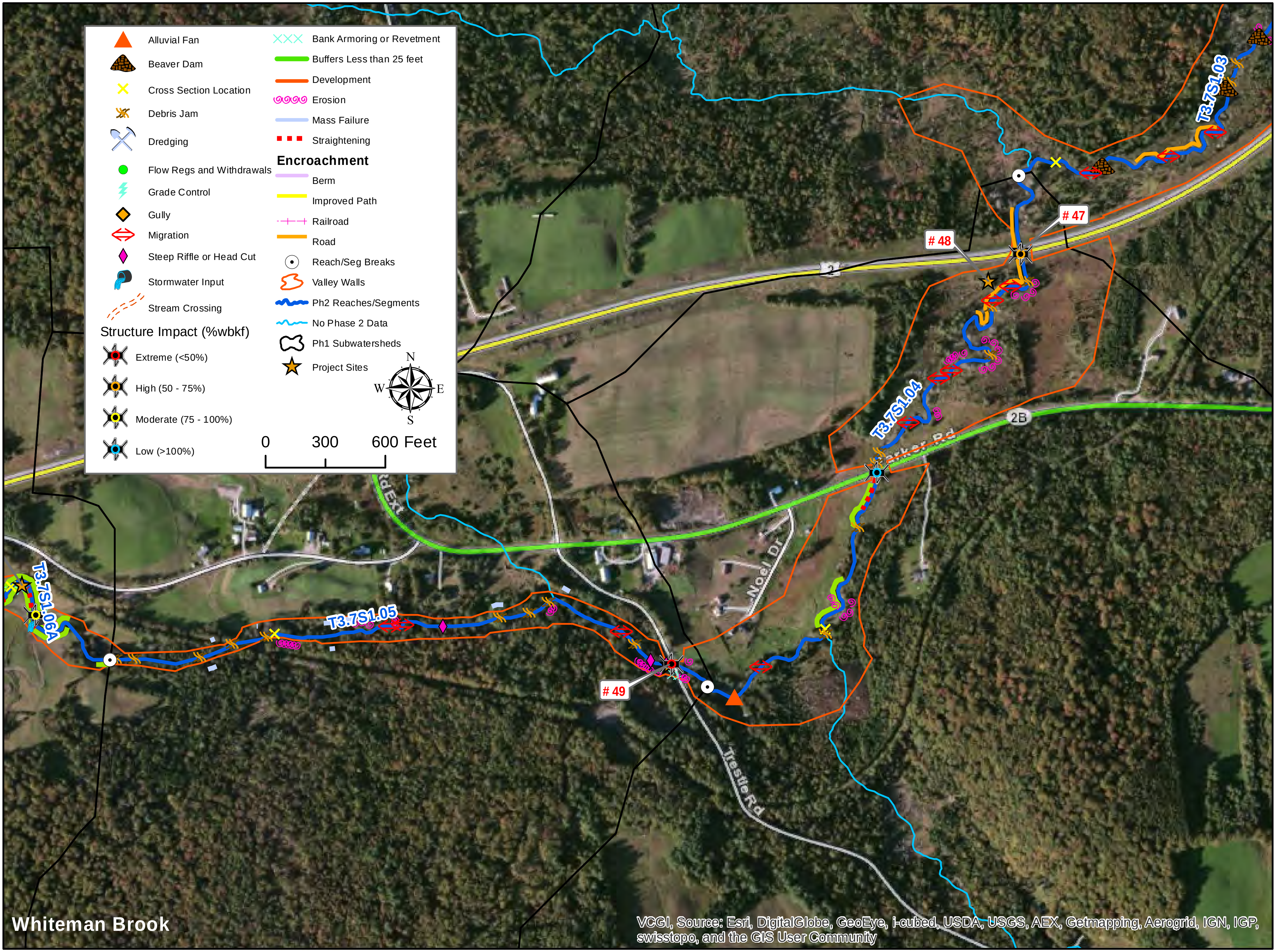


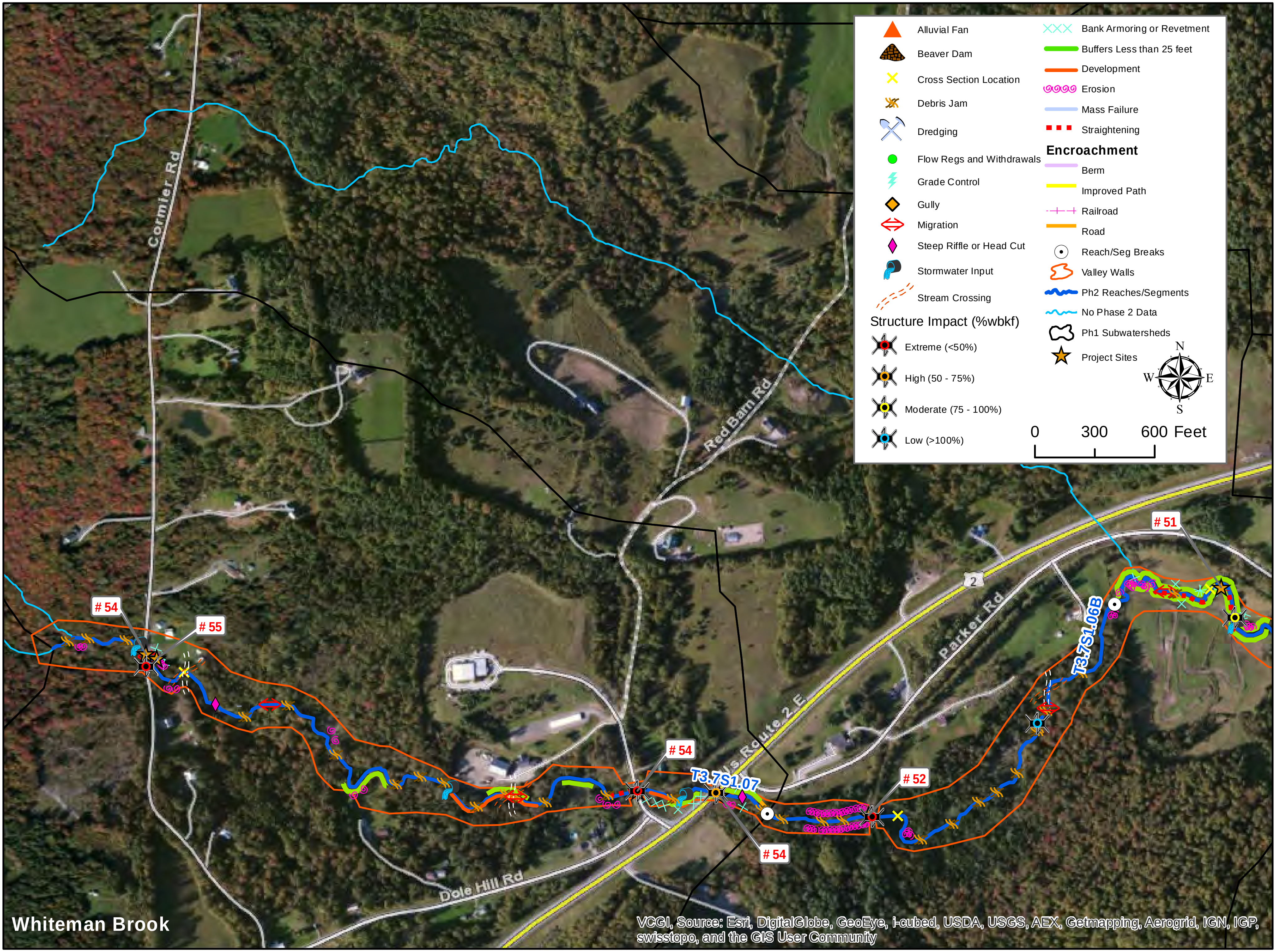
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
N Church Rd
Tampico Rd
Mcreynolds Rd
Miami Hwy
Bruce Badger Rd
Jamieson Rd
N Danville Rd
T3.11
T3.10
T3.10S1.01
T3.10S1.03
T3.09
33
34
32
31
37
30
30
Sleepers River
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

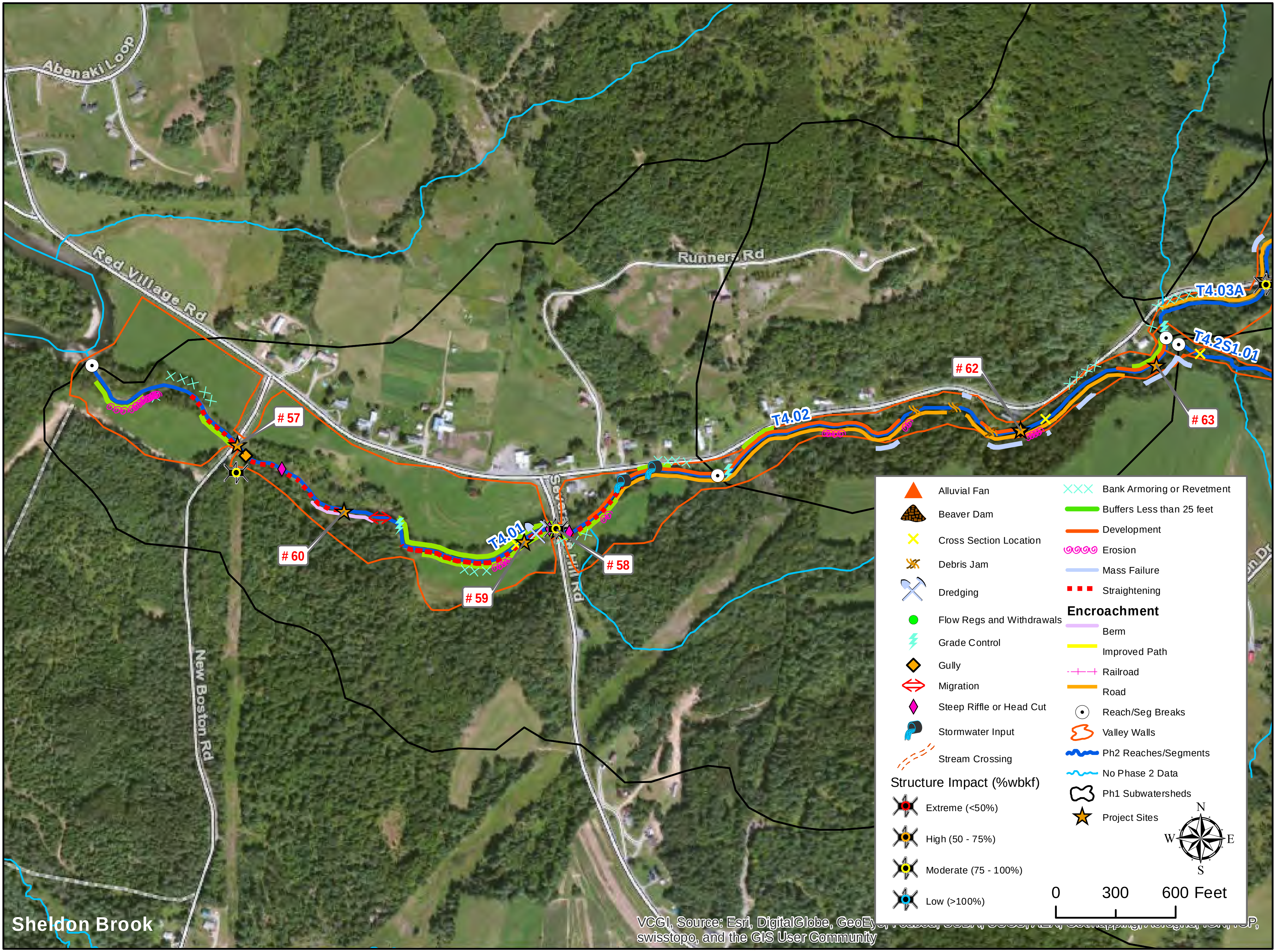

Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0 300 600 Feet
35
36
33
34
32
38
39
40
41
37
N Church Rd
Reynolds Rd
Tampico Rd
Stanton Rd
Bruce Badger Meml Hwy
T3.11
T3.10
T3.10S1.03
T3.10S1.02
T3.10S1.01
North and Badger Brooks
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Hawkins Rd
Roy Rd
Us Route 2 W
Us Route 2 E
2
T3.07
T3.7S1.01A
T3.7S1.01B
T3.7S1.02
T3.7S1.03
42
43
44
45
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
Whiteman Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
T3.7S1.03
47
48
T3.7S1.04
2B
T3.7S1.05
T3.7S1.06A
49
Noel Dr
Trestle Rd
Whiteman Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
Dredging
Flow Regs and Withdrawals
Grade Control
Gully
Migration
Steep Riffle or Head Cut
Stormwater Input
Stream Crossing
Structure Impact (%wbkf)
Extreme (<50%)
High (50 - 75%)
Moderate (75 - 100%)
Low (>100%)
Bank Armoring or Revetment
Buffers Less than 25 feet
Development
Erosion
Mass Failure
Straightening
Encroachment
Berm
Improved Path
Railroad
Road
Reach/Seg Breaks
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
Cormier Rd
Red Barn Rd
Parker Rd
Dole Hill Rd
US Route 2 E
2
51
52
54
54
54
55
T3.7S1.06B
T3.7S1.07
Whiteman Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Abenaki Loop
Red Village Rd
Runners Rd
New Boston Rd
T4.01
T4.02
T4.03A
T4.2S1.01
57
58
59
60
62
63
Alluvial Fan
Beaver Dam
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Debris Jam
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Gully
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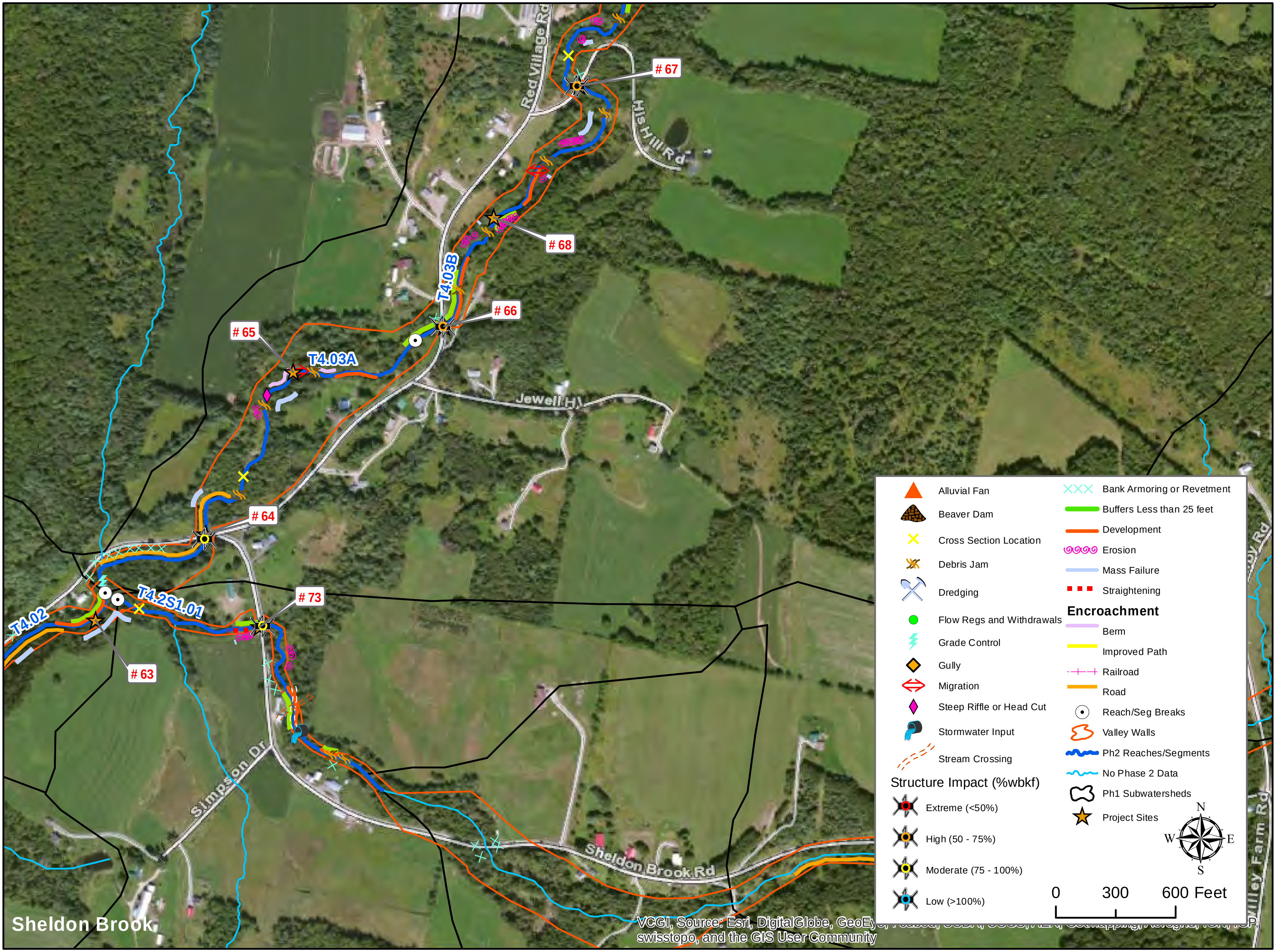
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
Sheldon Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Red Village Rd
His Hill Rd
Jewell Hl
Simpson Dr
Sheldon Brook Rd
Valley Farm Rd
67
68
66
65
64
73
63
T4.03B
T4.03A
T4.2S1.01
T4.02
Alluvial Fan
Beaver Dam
Cross Section Location
Debris Jam
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Gully
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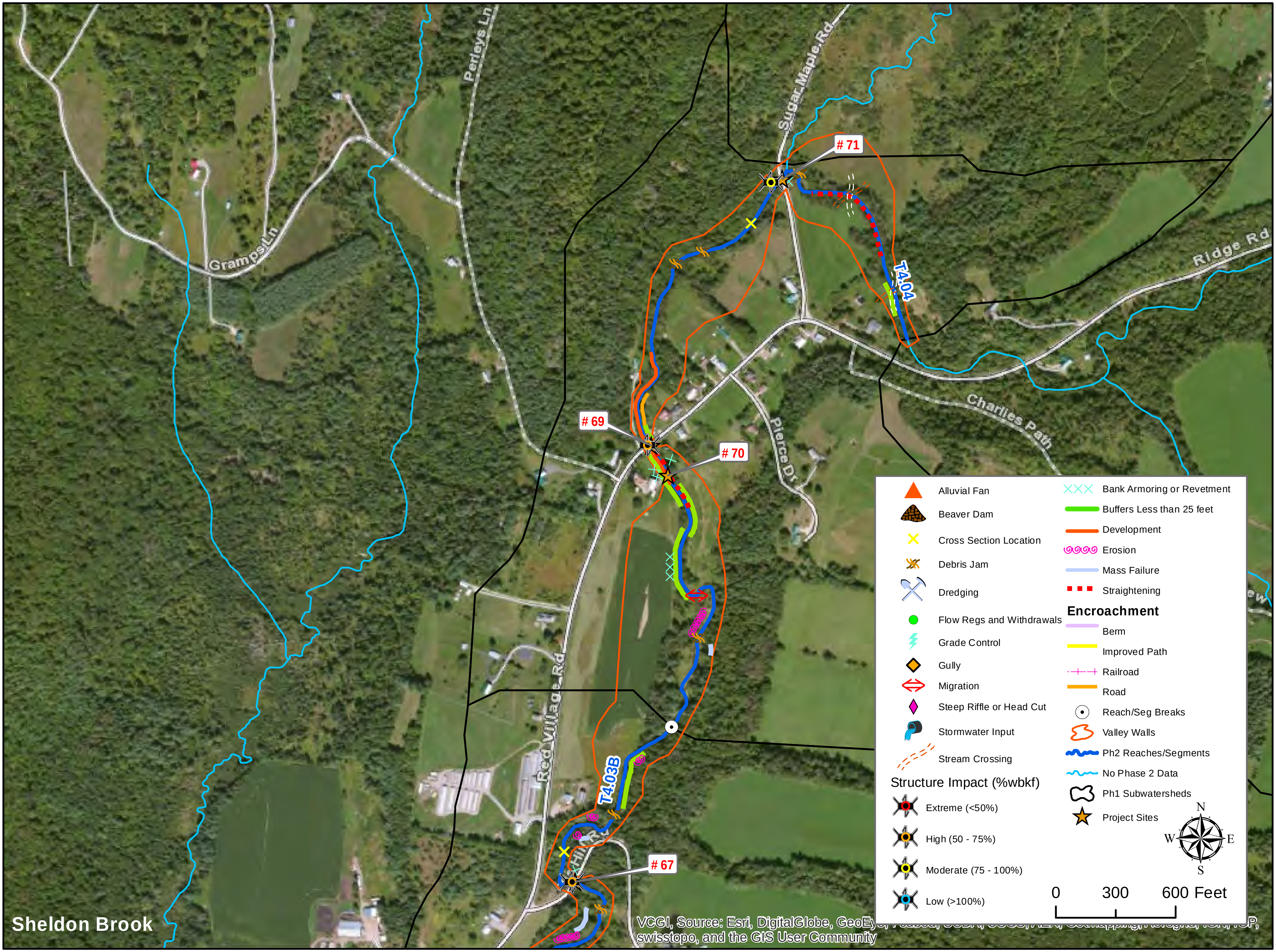
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
Sheldon Brook
swisstopo, and the GIS User Community


Perleys Ln
Sugar Maple Rd
Gramps Ln
Ridge Rd
Charlies Path
Pierce Dr
Red Village Rd
71
69
70
67
T4.04
T4.03B
Sheldon Brook
Alluvial Fan
Beaver Dam
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Debris Jam
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Grade Control
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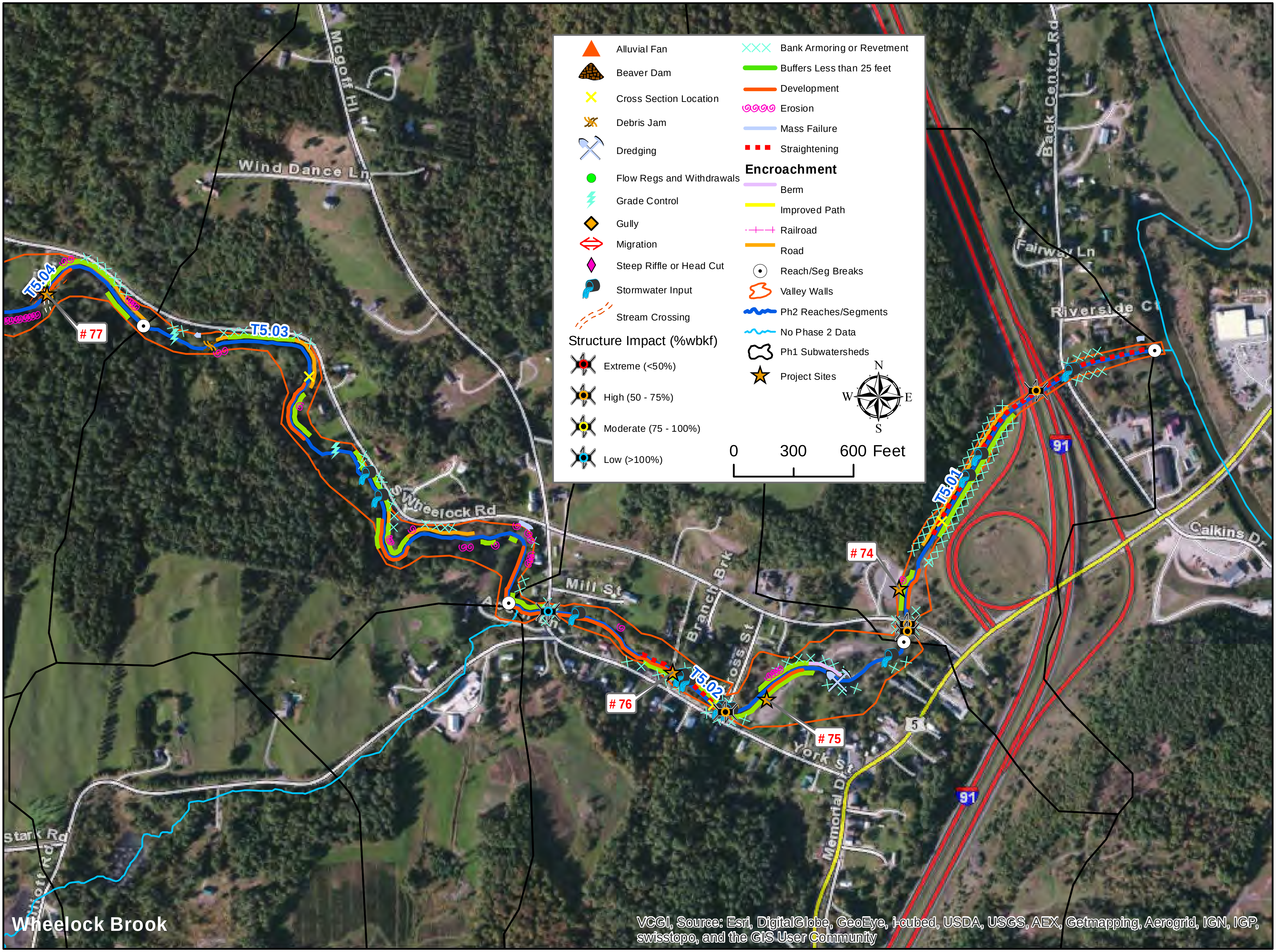
Valley Walls
Ph2 Reaches/Segments
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet



Alluvial Fan
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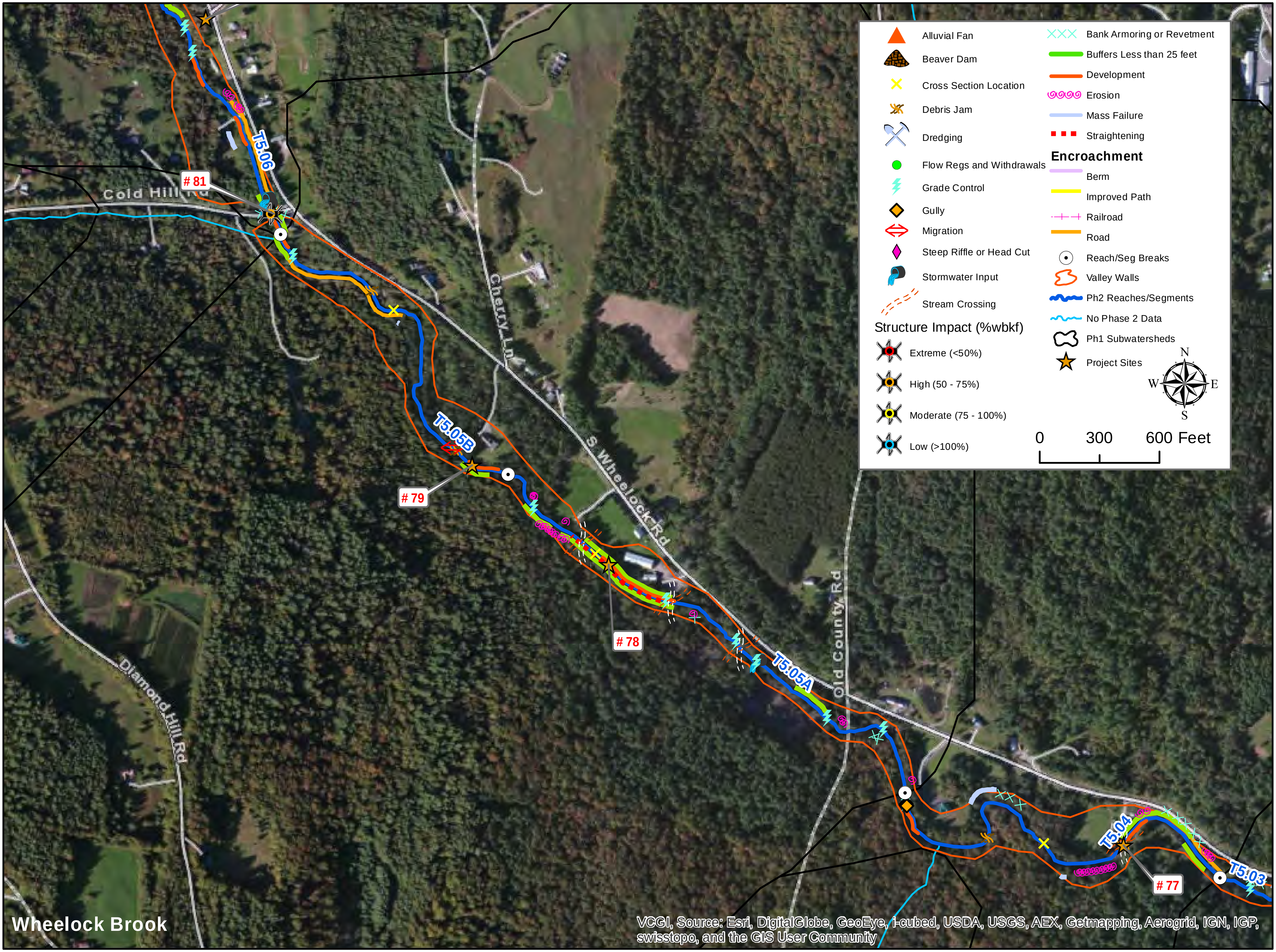
No Phase 2 Data
Ph1 Subwatersheds
Project Sites
N
W
E
S
0
300
600 Feet
T5.04
T5.03
T5.02
T5.01
77
76
75
74
Wind Dance Ln
Mcgoff Hl
S Wheelock Rd
Mill St
Branch Brk
Cross St
York St
Memorial Dr
Back Center Rd
Fairway Ln
Riverside Ct
Calkins Dr
Stark Rd
91
5
Wheelock Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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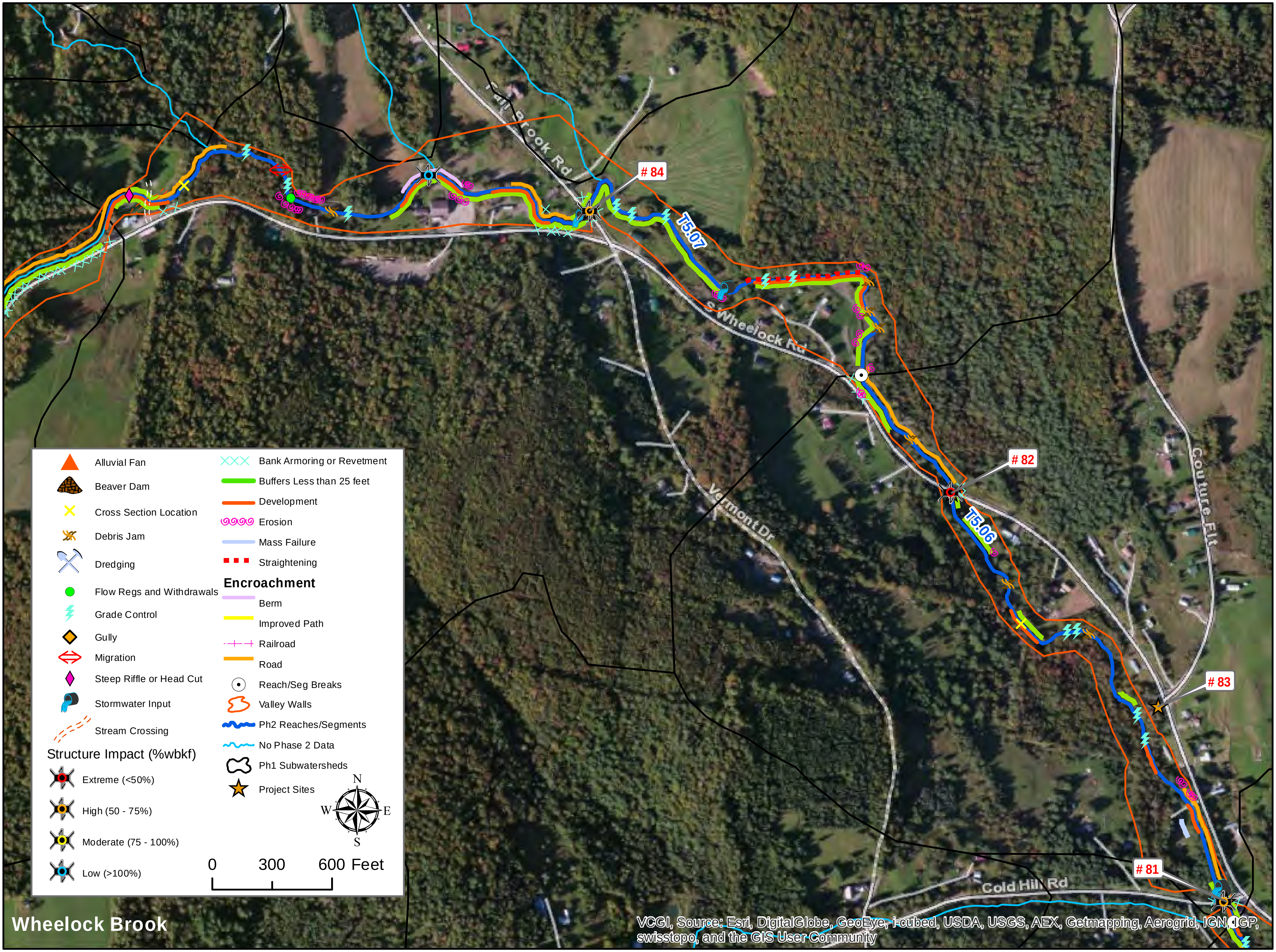
Project Sites
N
W
E
S
0
300
600 Feet
T5.06
81
Cold Hill Rd
Cherry Ln
T5.05B
79
S Wheelock Rd
78
T5.05A
Old County Rd
Diamond Hill Rd
T5.04
77
T5.03
Wheelock Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



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Project Sites
N
W
E
S
0
300
600 Feet
84
82
83
81
T5.07
T5.06
Wheelock Rd
Vermont Dr
Couture Flt
Cold Hill Rd
Wheelock Brook
VCGI, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community