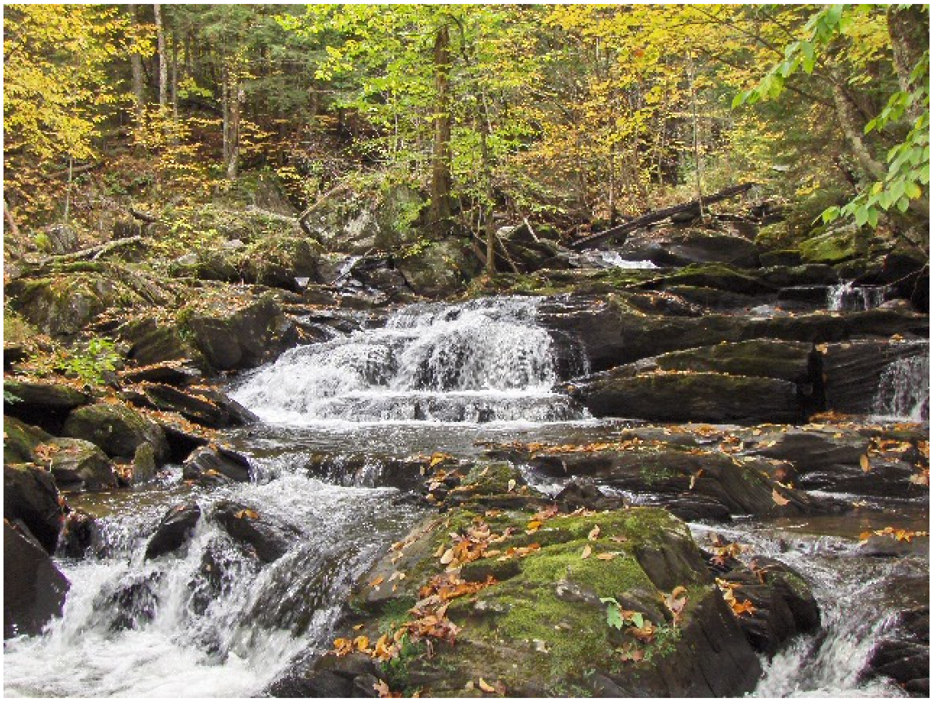
Pekin Brook Corridor Plan

Calais, Vermont

June 2, 2010



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Pekin Brook Corridor Plan
Calais, Vermont

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Pekin Brook Corridor Plan
Calais, Vermont

1.0 EXECUTIVE SUMMARY

The River Corridor Planning effort for Pekin Brook in 2009-2010 is sponsored by the Central Vermont Regional Planning Commission (CVRPC) with funding provided through a grant from the Federal Emergency Management Agency (FEMA). The Vermont Department of Environmental Conservation (DEC) River Management Program provided technical expertise and shared quality control/quality assurance responsibilities with Bear Creek Environmental, LLC (BCE). The River Corridor Plan (RCP) followed the Vermont Agency of Natural Resources River Corridor Planning Guide. Information for the RCP came from the DEC, the Vermont Center for Geographic Information (VCGI), and field data collected by BCE and CVRPC. This corridor plan is an addendum to the River Corridor Plan for the Kingsbury Branch of the Winooski River Watershed prepared by BCE, Friends of the Winooski River (FWR) and CVRPC dated October 2008.

The primary objective of the RCP is to use stream geomorphic assessment data to identify and prioritize river corridor protection and restoration projects within the Pekin Brook watershed in the Town of Calais. The stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use alter the physical processes and habitat of rivers. The Vermont Stream Geomorphic Assessment Protocol includes three phases:

1. Phase 1- Remote sensing and cursory field assessment;
2. Phase 2 – Rapid habitat and rapid geomorphic assessment to provide field data to characterize the current physical condition of a river; and
3. Phase 3 – Detailed survey information for designing "active" channel management projects.

A Phase 1 Stream Geomorphic Assessment following Agency of Natural Resources Protocols was completed for Pekin Brook watershed by FWR, the Winooski Natural Resources Conservation District (WNRCD) and CVRPC as part of the Kingsbury Branch Phase 1 project. A Phase 2 Stream Geomorphic Assessment following Agency of Natural Resources Protocols was completed for the Kingsbury Branch and the lower section of Pekin Brook from the confluence with the Kingsbury Branch to Kent Hill Road during summer 2007. For the Phase 2 field work in 2007, approximately 4.5 miles of Pekin Brook were assessed. To have a more complete picture of the geomorphic stability and habitat condition of Pekin Brook, a Phase 2 Stream Geomorphic Assessment was conducted by BCE and CVRPC on portions of Pekin Brook, Dugar Brook (a tributary to Pekin Brook), and an unnamed tributary to Pekin Brook during the summer of 2009. The combined length of the stream reaches assessed during the

2009 Phase 2 study is approximately 2 ½ miles. Approximately 2 miles of Pekin Brook were not assessed due to lack of landowner permission, but administrative judgments were conducted to provide a geomorphic condition and stream type. Bridge and culvert data were collected by BCE during the Phase 2 assessment to identify structures that have the potential to fail because of channel adjustments, are having a geomorphic impact on the stream, or are impeding aquatic organism passage.

The major problems observed within the Pekin Brook watershed include lack of riparian buffer, road encroachment, and channel straightening. Undersized structures are contributing to the unstable geomorphic condition in some reaches. Four mass failures (two on Pekin Brook, one on the unnamed tributary to Pekin Brook, and one on Dugar Brook) were observed during the Phase 2 assessment. Alteration of the stream channel has caused major channel degradation resulting in aggradation, widening, and often major planform adjustment in many reaches. The channel modification, straightening, floodplain encroachment, and the buildup of sediment have all decreased the quality of habitat in the Pekin Brook watershed.

As the river works toward a more stable equilibrium, the community of Calais has the opportunity to provide long-term protection to the river corridor and encourage the reestablishment of floodplain vegetation and healthy instream habitat. At the reach and site level, potential restoration and protection projects that would be compatible with geomorphic adjustments and managing the stream toward equilibrium conditions were identified. A list of 18 potential restoration and conservation projects was developed during project identification and is provided in Table 7 on pages 56 to 60 of this report. Types of projects include: river corridor protection through corridor easements and conservation efforts, replacing undersized structures causing localized channel instability, improving riparian buffers, and alternative analyses for removing dams.

2.0 LOCAL PLANNING PROGRAM OVERVIEW

2.1 River Corridor Planning Team

The river corridor planning team for the Pekin Brook watershed is comprised of the Central Vermont Regional Planning Commission, the Agency of Natural Resources, Bear Creek Environmental, LLC, local municipalities and landowners. This planning effort is sponsored by the Central Vermont Regional Planning Commission. Funding for the project is provided through a grant from the FEMA. Sacha Pealer from the Vermont River Management Section of the Vermont Agency of Natural Resources (VANR) provided technical guidance for this project.

2.2 Goals and Objectives of the Project

The primary objective of the River Corridor Management Plan is to use the Phase 1 and 2 Stream Geomorphic Assessment data to identify and prioritize river corridor protection and restoration projects within the Pekin Brook watershed. The State of Vermont's River Management Program has set out several goals and objectives that are supportive of the local initiative in the Pekin Brook watershed. The state management goal 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" (Vermont Agency of Natural Resources, 2007b). The objectives of the Program include fluvial erosion hazard mitigation and sediment and nutrient load reduction as well as aquatic and riparian habitat protection and restoration. The Program seeks to conduct river corridor planning in an effort to remediate the geomorphic instability that is largely responsible for problems in a majority of Vermont's rivers. Additionally, the Vermont River Management Program has set out to provide funding and technical assistance to facilitate an understanding of river instability and the establishment of well developed and appropriately scaled strategies to protect and restore river equilibrium.

3.0 BACKGROUND WATERSHED INFORMATION

3.1 Geographic Setting

Please refer to the Kingsbury Branch of the Winooski River Watershed: River Corridor Plan (BCE, FWR and CVRPC, 2009) for a summary of the geographic setting. A project location map is provided below for reference (Figure 3.1).

3.2 Geologic Setting

Please refer to the Kingsbury Branch of the Winooski River Watershed: River Corridor Plan (BCE, FWR and CVRPC, 2009) for a description of the geologic setting.

3.3 Geomorphic Setting

A Phase 1 Stream Geomorphic Assessment was conducted on 36 reaches in the Pekin Brook Watershed in 2007. Each reach represents a similar section of the stream based on physical attributes such as valley confinement, slope, sinuosity, bed material, dominant bedform, land use, and other hydrologic characteristics. Each point represents the downstream end of the reach. The 2007 Phase 2 study included 4.5 miles of Pekin Brook from the confluence with the Kingsbury Branch upstream to Kent Hill Road (near the former Calais town hall). The Phase 2 study conducted in 2009 focused on two stream reaches on the main stem of Pekin Brook, one reach on an unnamed tributary to Pekin Brook, and four reaches on Dugar Brook within the Town of Calais. In 2009, one mile on Pekin Brook, 1.2 miles on Dugar Brook, and one-quarter mile of an unnamed tributary to Pekin Brook were assessed for Phase 2 by BCE and CVRPC (Figure 3.2).

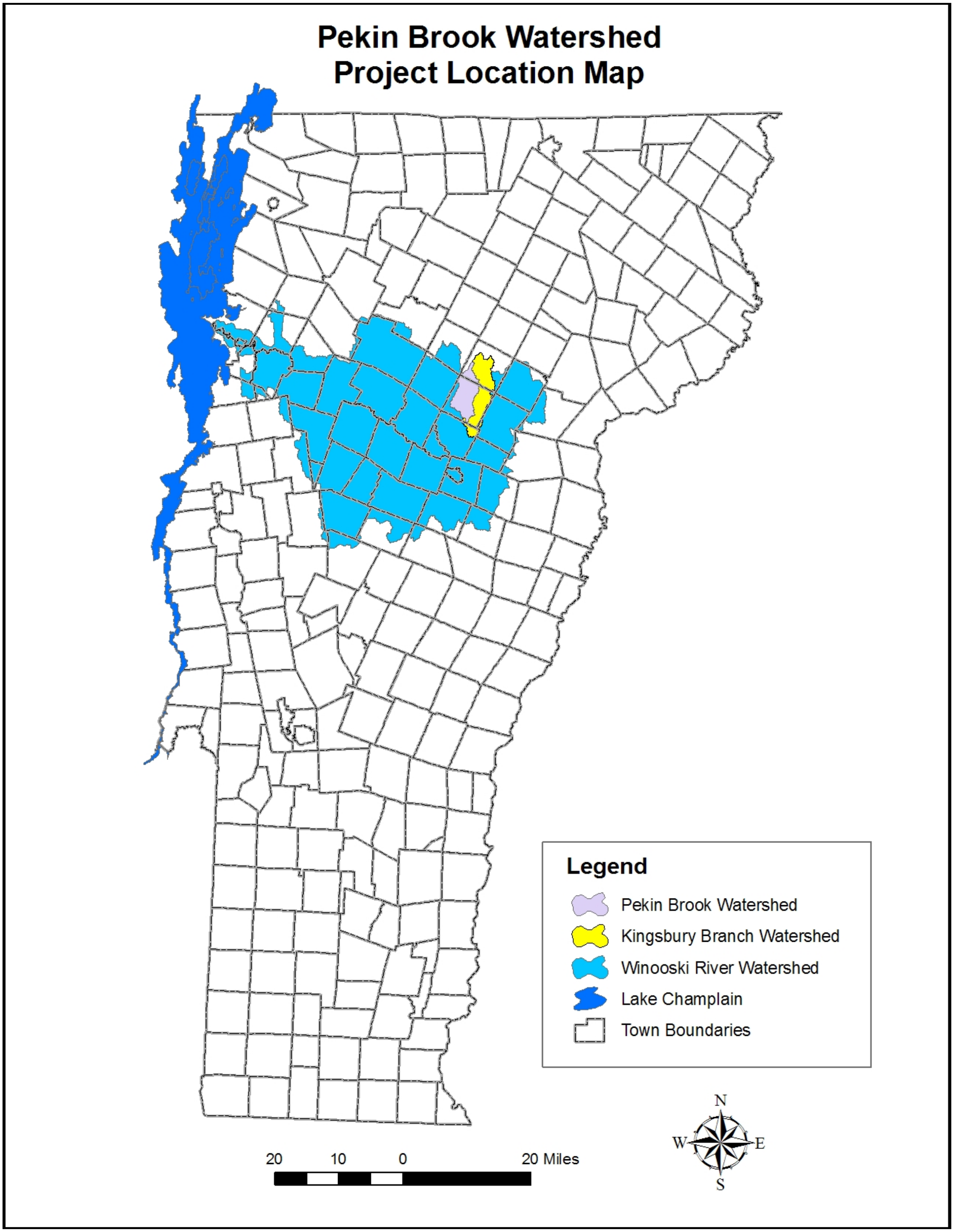

Figure 3.1 Project Location Map

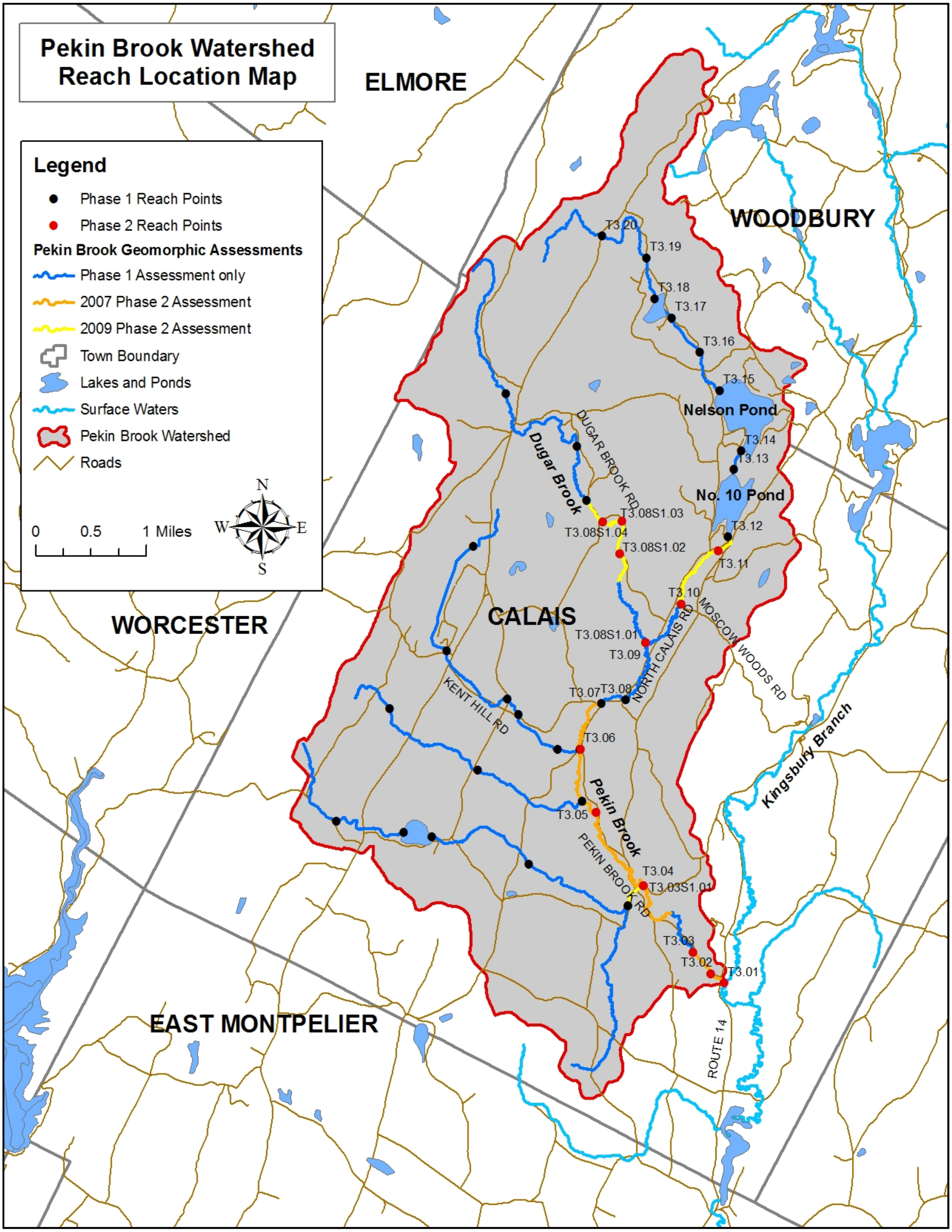

Figure 3.2 Pekin Brook Watershed Reach Location Map

Reference stream types are based on the valley type, geology and climate of a region and describe what the channel would look like in the absence of human-related changes to the channel, floodplain, and/or watershed. Stream and valley characteristics including valley confinement, and slope were determined from digital USGS topographic maps. The reference reach characteristics were refined during the windshield survey and Phase 2 Assessment. Reference reach typing was based on both the Rosgen (1996) and the Montgomery and Buffington (1997) classification systems. Table 1 shows the typical characteristics used to determine reference stream types (Vermont Agency of Natural Resources, 2007b).

Reference stream types for the assessed reaches are listed in Table 2. Reference stream types are variable for reaches assessed for Phase 2 in 2009. Three reaches (one on Pekin Brook, one on Dugar Brook, and one on the unnamed tributary to Pekin Brook) have a reference stream type of "C". Reference "C" channels have unconfined valleys with moderate to gentle valley slopes and moderate to high width to depth ratios and sinuosity. On Dugar Brook, two reaches have a reference stream type of "E". Reference "E" channels have unconfined valleys and moderate to gentle valley slopes, but have lower width to depth ratios and are generally more sinuous than "C" channels. The rest of the reaches are "B" channels by reference (Figure 3.3). "B" channels have moderate to steep slopes and have narrower valleys than C channels.

Table 1: Reference Stream Type

Stream Type	Confinement	Valley Slope	Bed Form
A	Narrowly Confined	Very steep > 6.5 %	Cascade
A	Confined	Very steep 4.0 - 6.5 %	Step-Pool
B	Confined or Semi-confined	Steep 3.0 – 4.0 %	Step-Pool
B	Confined, Semi-confined or Narrow	Moderate to Steep 2.0 – 3.0 %	Plane Bed
C or E	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <2.0 %	Riffle-Pool or Dune-Ripple
D	Unconfined (Narrow, Broad or Very Broad)	Moderate to Gentle <4.0 %	Braided Channel

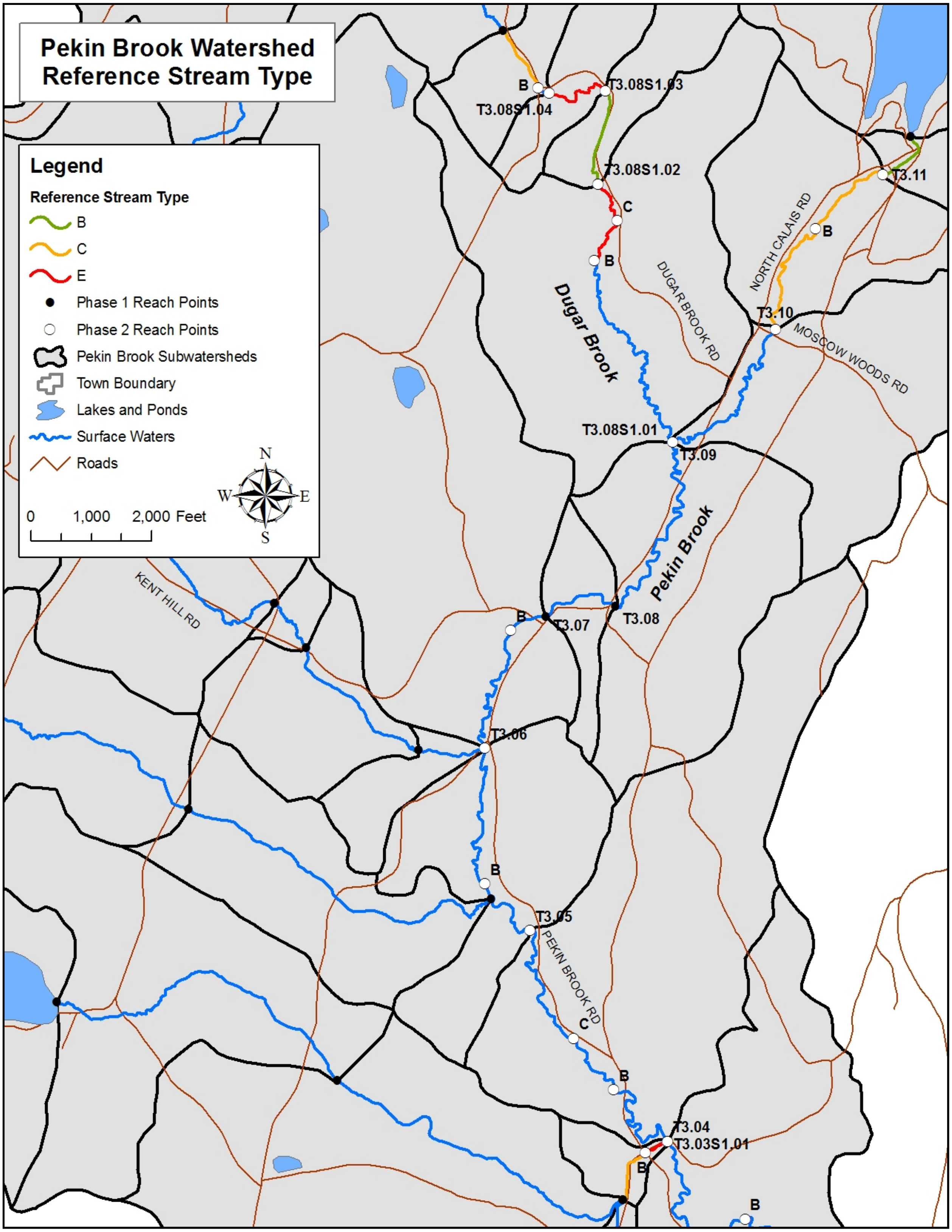

Figure 3.3 Reference Stream Type in Pekin Brook Watershed (2009 Study Area)

Table 2: Geomorphic Setting of Assessed Reaches

Stream	Reach ID	Reference Stream Type	Confinement	Valley Slope	Bedform
Tributary to Pekin Brook	T3.03S1.01	C	Very Broad	0.65	Riffle-Pool
Dugar Brook	T3.08S1.01	E	Very Broad	0.79	Riffle-Pool
	T3.08S1.02	B	Semi-Confined	2.31	Riffle-Pool
	T3.08S1.03	E	Very Broad	3.47	Riffle-Pool
	T3.08S1.04	C	Broad	3.47	Riffle-Pool
Pekin Brook	T3.10	C	Very Broad	1.99	Riffle-Pool
	T3.11	B	Broad	6.44	Step-Pool

3.4 Hydrology

Please refer to the Kingsbury Branch of the Winooski River Watershed: River Corridor Plan (BCE, FWR and CVRPC, 2008) for an understanding of the flood history.

3.5 Ecological Setting

Please refer to the Kingsbury Branch of the Winooski River Watershed: River Corridor Plan (BCE, FWR and CVRPC, 2008) for a description of the ecological setting of the Pekin Brook watershed.

4.0 METHODS

4.1 Phase 1 Methodology

A Stream Geomorphic Assessment process is divided into three phases, based on VANR protocols. Phase 1, the remote sensing phase, involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies called "windshield surveys." The Phase 1 assessment provides an overview of the general physical nature of the watershed and identifies which reaches are in need of further assessment. A Phase 1 Assessment of the Pekin Brook watershed was completed in 2007.

4.2 Phase 2 Methodology

The Phase 2 assessment of the Pekin Brook followed procedures specified in the Vermont Stream Geomorphic Assessment Handbook Phase 2 (Vermont Agency of Natural

Resources, 2007b). All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the ANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated using the field data from the Phase 2 assessment in 2007 and 2009.

The parameters and protocols used for undertaking the Phase 2 assessment are outlined in the Phase 2 Handbook (Vermont Agency of Natural Resources, 2007b). The entire length of each Phase 2 reach was walked to determine segment breaks. Bank erosion, grade control structures, bank revetments, debris jams, depositional features, stormwater inputs, flood chutes, valley walls and other important features were mapped within all segments. BCE used the Stream Geomorphic Assessment Tool (SGAT) version 4.56 to index features that were mapped during the Phase 2 assessment. SGAT is an ArcView extension.

4.3 Bridge and Culvert

Bridge and culvert inventory and assessments were conducted by BCE during the Phase 2 Assessment to determine if stream crossings are contributing to localized streambank erosion, sedimentation, and reduced fish passage. Fourteen of these structures are located within the Pekin Brook Phase 2 study area. The Agency of Natural Resources Bridge and Culvert protocols were employed (Vermont Agency of Natural Resources, 2007b). The Vermont Culvert Geomorphic Screening Tool (Milone and MacBroom, Inc., 2008a) and the Vermont Culvert Aquatic Organism Passage Screening Tool (Milone and MacBroom, Inc, 2008b) were used to identify culverts within the Pekin Brook watershed that are highest priority for replacement/retrofit due to geomorphic incompatibility and/or for being potential barriers to movement and migration of aquatic organisms.

4.4 River Corridor Plan

The Vermont Agency of Natural Resources River Corridor Planning Guide (2007a) and Draft 9 of Chapter 5 of the plan dated October 2, 2007 were followed to generate a series of stressor maps, which are included in Section 6.0. The stressor maps were created using indexed data from the Phase 1 and Phase 2 Stream Geomorphic Assessments along with existing data available from VCGI, including e911 roads, e911 buildings and e911 driveways. The stressor maps were then used to identify potential project locations that have few constraints to channel adjustment.

4.5 Quality Control/Quality Assurance Procedures

To assure a high level of confidence in the Phase 1 and 2 SGA data, strict quality assurance/quality control (QA/QC) procedures were followed by BCE. These procedures involved a thorough in-house review of all data as well as automated and manual QC checks with the DEC River Management Program.

In late 2009, BCE completed its own in-house QA review after all the Phase 2 data were entered into the DMS and the Phase 1 data were updated. The Phase 1 DMS and ArcView shapefiles were updated by Pam DeAndrea based on the Phase 2 field assessment work during the Phase 2 QA/QC process. The DMS and the ArcView shapefiles for the Pekin Brook Phase 2 study were submitted to Sacha Pealer of the ANR for a Quality Assurance review in December 2009. Some minor revisions were made by BCE to the DMS following this review and the ANR QA review was completed in March 2010.

5.0 RESULTS

5.1 Phase 2 Results

Rapid Geomorphic Assessment

During the Phase 2 assessments, the seven reaches in the Pekin Brook watershed study area were broken into 12 segments based on detailed field observations. The reference and existing stream type for each assessed segment is included in Figures 3.3 and 5.1, respectively. Detailed segment summary data are provided in Appendix A.

There is only one segment where the existing stream type differs from the reference stream type or a stream type departure has taken place. A stream type departure occurs when the channel dimensions deviate so far from the reference condition that the existing stream type is no longer the reference stream type. A stream type departure from a reference "Cb" channel to a "B" channel has occurred in segment T3.08S1.04-B due to the placement of Dugar Brook Road. Stream type departures represent a significant change in floodplain access and stability. Watersheds which have lost attenuation or sediment storage areas due to human related constraints are generally more sensitive to erosion hazards, transport greater quantities of sediment and nutrients to receiving waters, and lack the sediment storage and distribution processes that create and maintain habitat (Vermont Agency of Natural Resources, 2007a).

The existing geomorphic condition is depicted in Figure 5.2. Except for two reaches/segments, the assessed segments and reaches in the Pekin Brook watershed were found to be in "fair" geomorphic condition. Segment T3.08S1.01-C and reach T3.08S1.02 on Dugar Brook, which are in close proximity to Dugar Brook Road, were found to be in "good" geomorphic condition. Both of these segments are not incised. Geomorphic condition is determined based on the degree of channel degradation, aggradation, widening, and planform adjustment. Segment T3.08S1.01-A at the mouth of Dugar Brook was not assessed because it is a wetland influenced by beaver dams. Another segment, T3.08S1.04-A, on Dugar Brook is located in a bedrock gorge and was, therefore, not assessed.

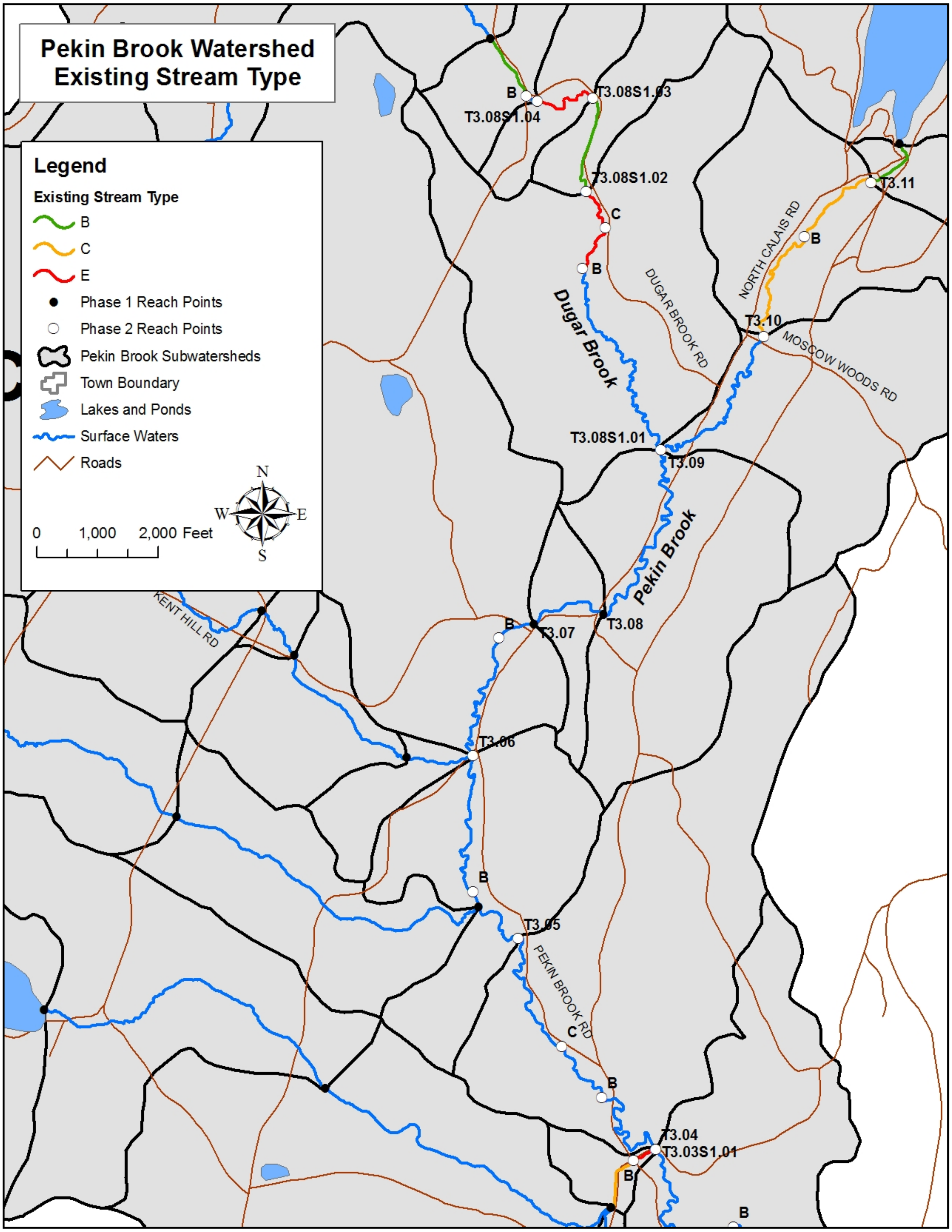

Figure 5.1 Existing Stream Type in Pekin Brook Watershed.

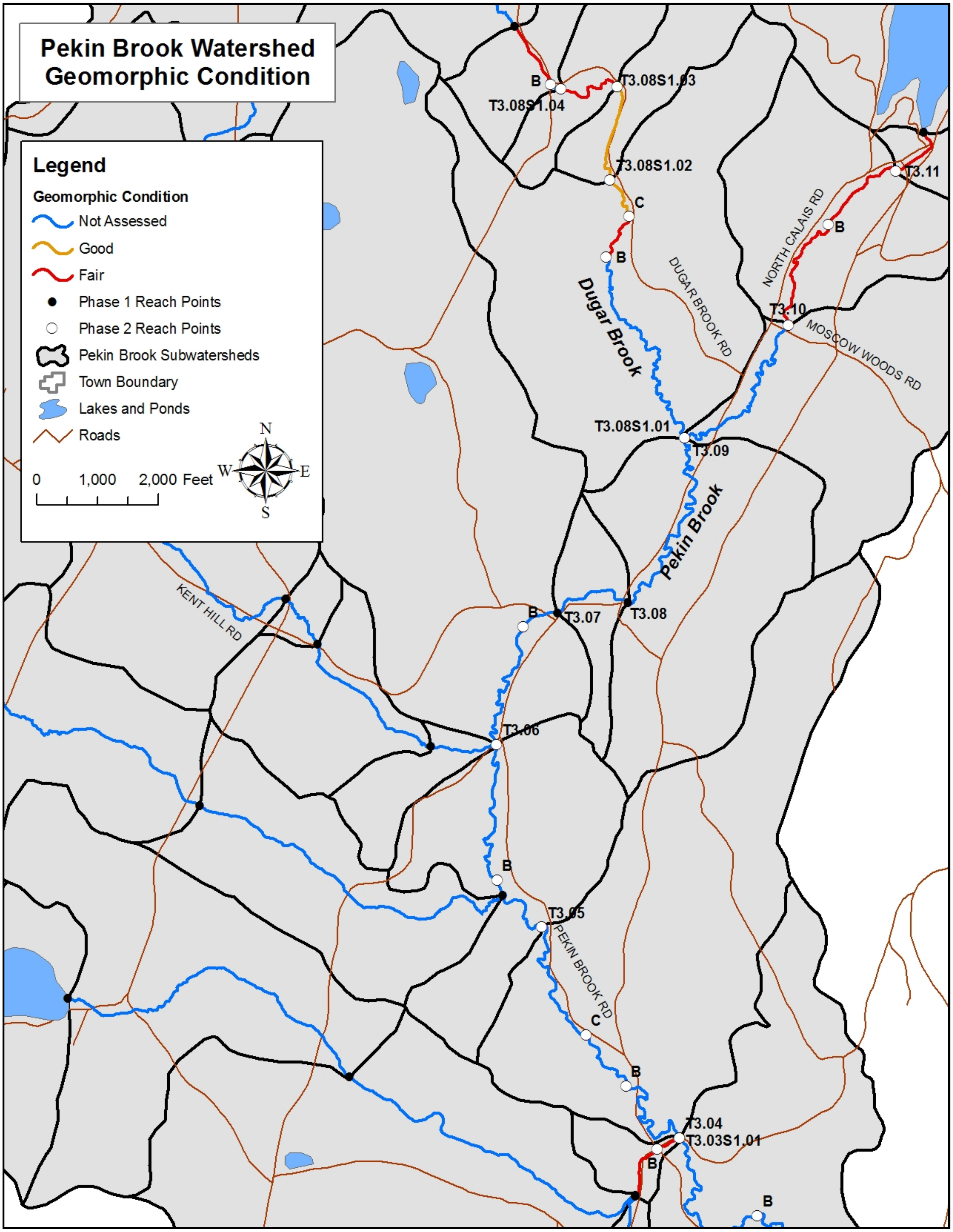

Figure 5.2. Phase 2 Geomorphic Condition of Pekin Brook Watershed

The reach condition ratings of the Pekin Brook watershed indicate that most of the reaches are actively, or have historically, undergone a process of minor or major geomorphic adjustment. Many of the reaches studied in the Pekin Brook watershed are undergoing a channel evolution process in response to large scale changes in its sediment, slope, and/or discharge associated with the human influences on the watershed. Table 3 below summarizes the channel evolution of each study reach and the primary adjustment processes that are occurring.

Both the "D" stage and "F" stage channel evolution model (Vermont Agency of Natural Resources, 2007b) are helpful for explaining the channel adjustment processes underway in the Pekin Brook watershed. The "F" stage channel evolution model is used to understand the process that occurs when a stream degrades (incises). The common stages of the "F" channel evolution stage, as depicted in Figure 5.3 include:

- A pre-disturbance period
- Incision – channel degradation
- Aggradation and channel widening
- The gradual formation of a stable channel with access to its floodplain at a lower elevation

The "D-stage" channel evolution model applies to reaches where there may have been some minor historic incision; however, the more dominant active adjustment process is aggradation, which then in turn leads to channel widening and planform adjustment. The D-stage adjustment process typically occurs in unconfined, low to moderate gradient valleys where the stream is not entrenched and has access to its floodplain or flood prone area at the 1-2 year flood stage.

When stream channels are altered through straightening, it can set this evolution process into motion and cause adjustment processes to occur. The bed erosion that occurs when a meandering river is straightened in its valley is a problem that translates to other sections of the stream. Localized incision will travel upstream and into tributaries eroding sediments from otherwise stable streambeds. These bed sediments will move into and clog reaches downstream leading to lateral scour and erosion of the streambanks. Channel evolution processes may take decades to play out. Even landowners that have maintained wooded areas along their stream and riverbanks may have experienced eroding banks as stream channel slopes adjust to match the valley slopes. It is difficult for streams to attain a new equilibrium where the placement of roads and other infrastructure has resulted in little or no valley space for the stream to access or to create a floodplain.

Channel equilibrium can be assessed by looking at the regimes of sediment transport within the watershed. The analysis of sediment regimes at the watershed scale is useful for summarizing the stressors affecting the equilibrium condition of river channels. Sediment regime mapping provides a context for understanding the sediment transport and channel evolution processes which govern changes in geometry and planform for river channels in a state of disequilibrium. Sediment Regime Maps have been prepared for each subwatershed to show departure from reference conditions due to human alterations.

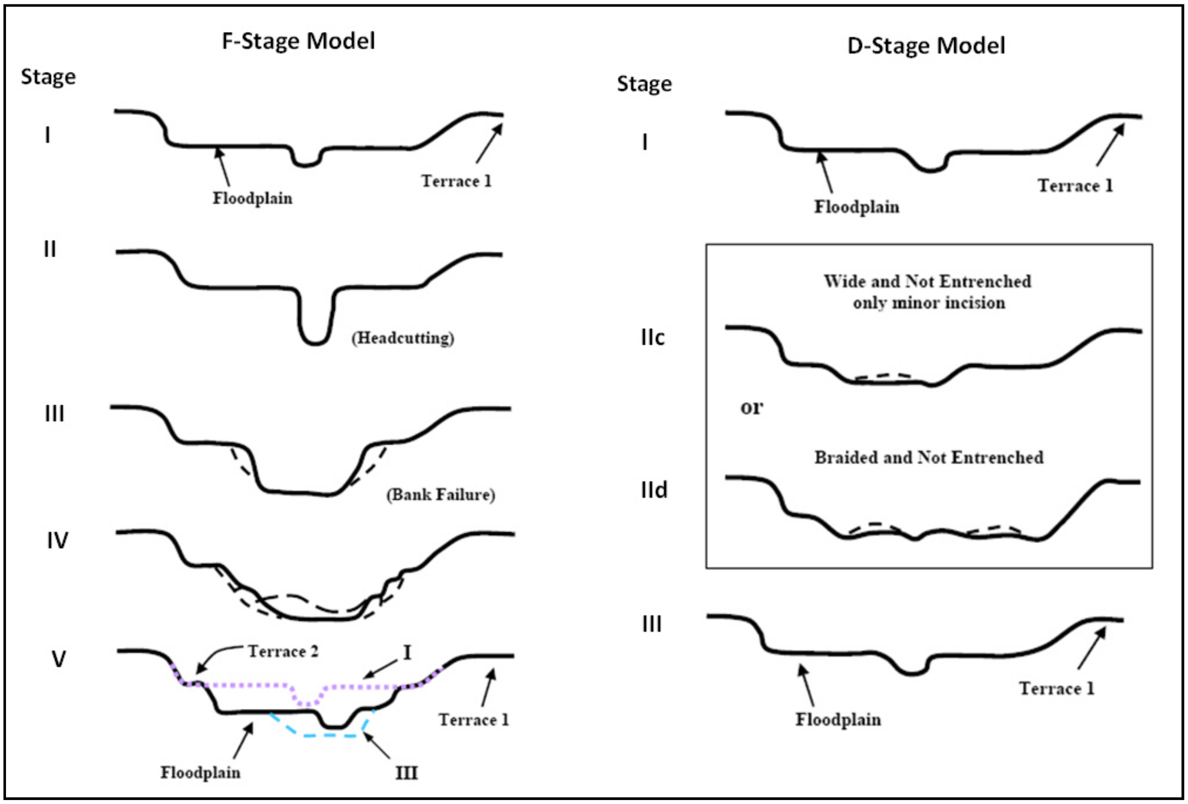

Figure 5.3 Typical channel evolution model for F-Stage and D-Stage (Vermont Agency of Natural Resources, 2007b)

In terms of the ANR channel evolution model, Pekin Brook is predominately at stage IV of the "F-stage" channel evolution model except for the reach just downstream of No. 10 Pond, T3.11, which is in stage II. In two segments of Pekin Brook (T3.10-A and T3.10-B), the channel has undergone historic degradation as evidenced by abandoned terraces. On Dugar Brook, the channel evolution stage is variable with segments ranging from the F-I to F-IV stages and one reach in stage D-IId. Segment T3.08S1.02 on Dugar Brook, which is adjacent to Dugar Brook Road, was found to be in stage I of the "F" channel evolution model, wherein the channel has not yet incised due to the presence of bedrock. Another segment on Dugar Brook, T3.08S1.01-C, fell into the "D-stage" evolution model, where the more dominant active adjustment process is aggradation. The tributary to Pekin Brook has undergone historic degradation and is in either stage II or III of the "F" model. The most upstream segment on this tributary is actively undergoing major aggradation, widening and planform change due to the lack of buffer. Many of the cross sections on study reaches were found to be incised, with six segments having moderate incision ratios. The incision ratios ranged from 1.0 to 1.51.

In some of the segments, the system is actively adjusting to this lower bed elevation by creating a new floodplain at a lower elevation. Channels are also adjusting their planform through lateral movement as shown by flood chutes, avulsions, and neck cutoffs. This planform adjustment is leading to another adjustment process, aggradation. Aggradation in the Pekin Brook study area seems to be a combination of endogenous sediment that is created as the stream widens and erodes its banks to reestablish a new floodplain as well as from exogenous sources such as gravel roads and land clearing. Unvegetated mid-channel bars, point bars, side bars, diagonal avulsions, flood chutes and impending neck cutoffs confirm that Dugar Brook, Pekin Brook, and the unnamed tributary are undergoing extensive lateral migration in some reaches.

Table 3. Stream Type and Channel Evolution Stage

Segment Number	Entrenchment Ratio	Width to Depth Ratio	Reference Stream Type	Incision Ratio[1]	Existing Stream Type	Channel Evolution Stage	Active Adjustment Process[2]
Trib. to Pekin Brook							
T3.03S1.01-A	45.6	7.93	E4	1.30	E4	F-II	Aggradation Widening **Planform**
T3.03S1.01-B	12.9	20.6	C4	1.18	C4	F-III	**Aggradation Widening Planform**
Dugar Brook							
T3.08S1.01-B	35.2	9.34	E4	1.51	E4	F-IV	**Aggradation** Widening Planform
T3.08S1.01-C	21.6	10.2	E4	1.00	E4	D-IId	**Aggradation** Widening Planform
T3.08S1.02	1.40	16.3	B4	1.00	B4	F-I	Aggradation Widening Planform
T3.08S1.03	12.5	10.9	E4	1.38	E4	F-III	**Aggradation Widening Planform**
T3.08S1.04-B	1.59	21.6	C3	1.43	B3	F-II	Aggradation Widening Planform
Pekin Brook							
T3.10-A	8.52	23.1	C4	1.43	C4	F-IV	Aggradation **Planform**
T3.10-B	3.71	14.8	C4b	1.51	C4	F-IV	Aggradation Widening Planform
T3.11	1.61	21.8	B3a	1.14	B3	F-II	Aggradation Widening **Planform**

[1] Blue denotes moderate incision ratio
[2] Bold Black lettering denotes major adjustment process; black lettering (no bold) denotes minor adjustment process.

HABITAT EVALUATION

Table 4 below shows a comparison of the habitat condition based on the Rapid Habitat Assessment (RHA) and the geomorphic condition based on the Rapid Geomorphic Assessment (RGA). For four of the ten assessed segments, both the RHA and the RGA resulted in a "fair" rating. Two segments (T3.08S1.01-C and T3.08S1.02) had a rating of "good" for both the RHA and the RGA. Four segments (T3.08S1.01-B, T3.08S1.03, T3.10-A and T3.10-B) had a rating of "good" for habitat but "fair" for geomorphic condition. Many of the reaches that had been straightened or had floodplain alterations lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Many reaches had major intrusion into their river corridor from roads and many had inadequate riparian buffers due to historic and/or recent land clearing. Overall, the RHA score was similar to the RGA score, implying that the ecological health of streams in the Pekin Brook Watershed is closely related to the geomorphic condition of the stream.

Table 4. Comparison of RHA and RGA for Phase 2 Reaches

Segment Number	Score RHA	Score RGA	Rating RHA	Rating RGA
T3.03S1.01-A	0.41	0.54	Fair	Fair
T3.03S1.01-B	0.46	0.44	Fair	Fair
T3.08S1.01-A	Beaver Dam Influence – Not Assessed			
T3.08S1.01-B	0.73	0.61	Good	Fair
T3.08S1.01-C	0.75	0.65	Good	Good
T3.08S1.02	0.76	0.70	Good	Good
T3.08S1.03	0.66	0.48	Good	Fair
T3.08S1.04-A	Bedrock Gorge – Not Assessed			
T3.08S1.04-B	0.64	0.53	Fair	Fair
T3.07	No Landowner Permission – Not Assessed			
T3.08	No Landowner Permission – Not Assessed			
T3.09	No Landowner Permission – Not Assessed			
T3.10-A	0.67	0.59	Good	Fair
T3.10-B	0.72	0.59	Good	Fair
T3.11	0.51	0.55	Fair	Fair

5.2 Bridge and Culvert Assessment

A total of eight permanent structures (four bridges and four culverts) are located within the Phase 2 Pekin Brook study area (Figure 5.4). One additional culvert on a reach without landowner access (T3.09), which is at the Moscow Woods Road crossing, was assessed from the upstream end. Six of these stream crossings are on public roads. A bridge and culvert assessment using the VANR protocol was conducted on these structures during the Phase 2 Assessment. The geomorphic compatibility and AOP screening tools, photographs

and Phase 2 constriction notes were used to prioritize structures for replacement/retrofit. A list of resources for towns regarding funding, planning and design for replacement and retrofit of stream crossings is available on the Vermont River Management and the Vermont Department of Fish and Wildlife's web sites:
http://www.vtwaterquality.org/rivers/htm/rv_EducationalResources.htm
http://www.vtfishandwildlife.com/library.cfm?libbase_=Reports_and_Documents).

Table 5 summarizes the data collected for seven structures within the Phase 2 study reaches, and one within reach T3.09. The final column of Table 5 includes a prioritization of structures for replacement or retrofit based on three criteria: structure width in relation to bankfull channel width, aquatic organism passage (AOP) and geomorphic compatibility, and notes from the Phase 2 study. A summary of the structures is provided in Appendix B.

One of three priorities for replacement was assigned (low, moderate or high). The following criteria explain the priority level assigned to each structure:

High Priority: Structures with spans of approximately 50 percent of the bankfull width or less, which are significantly impeding natural sediment transport. Culverts that are impeding the passage of aquatic organisms are automatically placed in the high priority category (e.g. free fall outlet).

Moderate Priority: Structures with spans less than 50 percent that are not causing significant geomorphic instability and structures with spans greater than 50 percent that are causing instability. Culverts that are resulting in reduced aquatic organism passage (e.g. do not have material throughout the structure or have a cascade outfall) result in at least moderate priority.

Low Priority: Stream crossing structures that are not included in either of the two categories above.

Although the percent bankfull width is less than 50 percent, no significant sediment transport issues were noted at the box culvert at the North Calais Road crossing on Pekin Brook and the culvert screening tool resulted in a score of mostly compatible. In addition, the box culvert has bed material throughout the structure, thereby offering full aquatic organism passage. For these reasons, the North Calais Road culvert was assigned a replacement priority of low.

On Dugar Brook, the bridge at Apple Hill Road is undersized and has a small mass failure associated with some fallen rip-rap armoring on the downstream end. In 1973, a culvert at the Apple Hill Road crossing was washed downstream from a flood event. The culvert was replaced, but in 1984 another flood event caused the culvert to be blocked with debris and floodwaters were diverted onto Dugar Brook Road. The road was washed out for approximately 1,000 feet. According to local residents, the bridge was installed after the culvert at the crossing washed out the second time. The Apple Hill Road Bridge is low priority for replacement due to the abundant bedrock below the structure and the relatively good condition of the bridge.

Four structures (two culverts and two bridges) were identified as moderate priority for replacement/retrofit. The culverts in the moderate priority category fall within the partially compatible category using the geomorphic screening tool. Both of these structures, located on Pekin Brook Road and Moscow Woods Road, have reduced AOP passage due to lack of sediment throughout the structure. The Moscow Woods Road culvert is significantly undersized and has a percent bankfull width of less than 50 percent. One bridge that crosses Pekin Brook at TH16 is in poor alignment with the channel and is significantly undersized. Another bridge at a private crossing is significantly undersized. Both these bridges have a moderate priority for replacement.

The culvert at George Road on the tributary to Pekin Brook was assigned a high priority for replacement. This culvert was rated as mostly incompatible using the geomorphic screening tool. Scour is undermining the culvert on both the upstream and downstream ends. Bank armoring is failing and there is considerable erosion in the vicinity of the culvert. The culvert opening is blocked by woody debris and there is a mid-channel bar directly downstream of the culvert. The George Road culvert lacks sediment throughout the structure resulting in reduced aquatic organism passage.

A private driveway bridge on Dugar Brook is significantly undersized. The openings for the bridge are very small and obstructed by woody debris on the upstream end. The structure is unstable and has a low clearance. This bridge has been given a high priority for replacement.

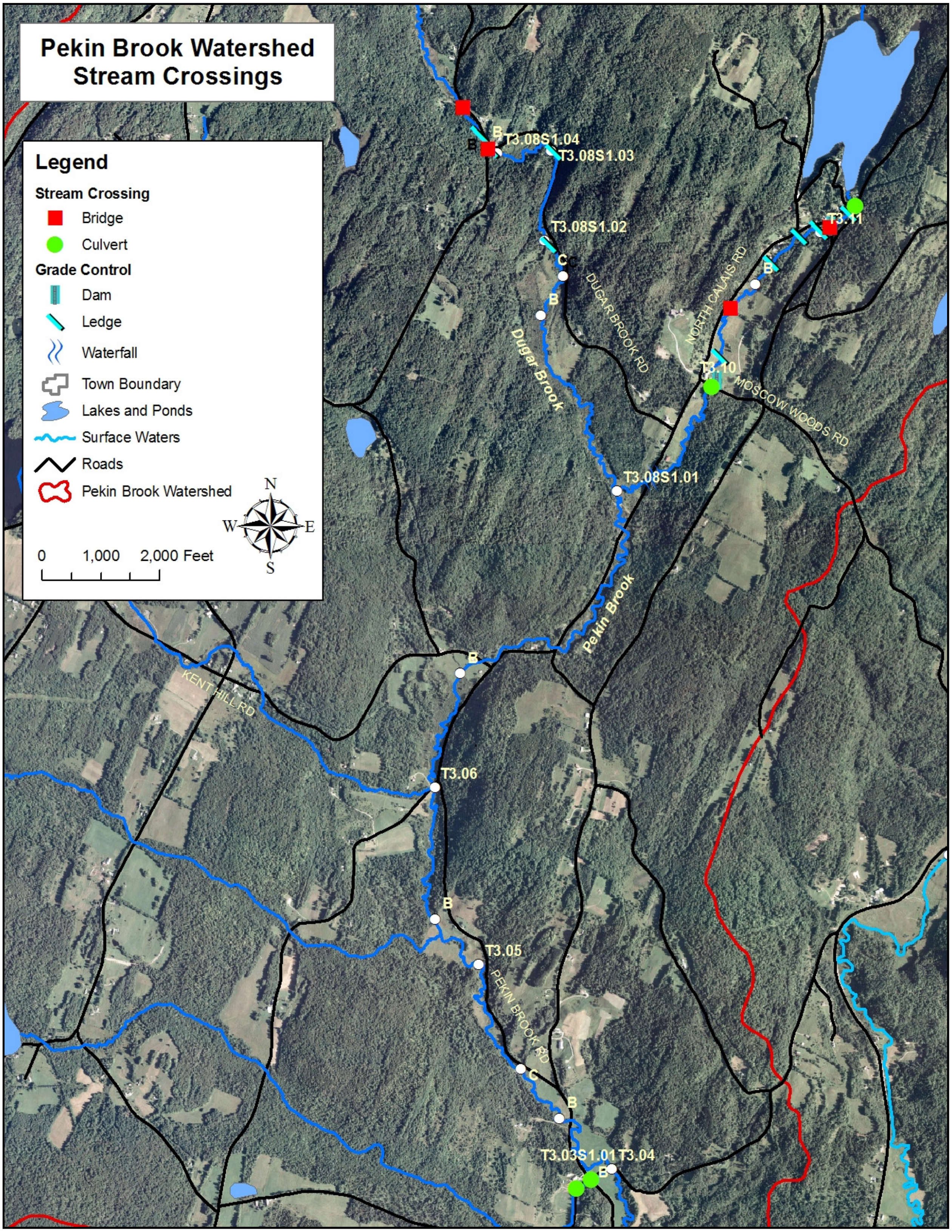

Figure 5.4. Stream Crossings within the Pekin Brook Watershed

Table 5
Pekin Brook Watershed
Evaluation using VANR Geomorphic Compatibility and AOP Screening Tools

Stream Name	Reach/ Segment Number	Road Name	Structure Type	Percent Bankfull Channel Width[1]	Aquatic Organism Passage (AOP)	Geomorphic Compatibility	Phase 2 Constriction Notes	Priority for Replacement or Retrofit
Tributary to Pekin Brook	T3.03S1.01-A	Pekin Brook Road	Box Culvert	101%[2]	Reduced	Partially Compatible	Scour below	Moderate
	T3.03S1.01-B	George Road	Culvert	23%[3]	Reduced	Mostly Incompatible	Deposition above, Deposition below, Scour below	High
Dugar Brook	T3.08S1.04-A	Apple Hill Road	Bridge	59%[3]	NA	NA	Scour above, Scour below; Contributing to mass failure	Low
	T3.08S1.04-B	Private Driveway	Bridge	14%[3]	NA	NA	Deposition below, Scour above, Scour below	High
Pekin Brook	T3.09	Moscow Woods Road	Culvert	22%[2]	Reduced	Partially Compatible	Scour above, Scour below	Moderate
	T3.10-A	Private Trail	Bridge	16%[3]	NA	NA	Deposition above, Scour below	Moderate
	T3.11	TH16	Bridge	23%[3]	NA	NA	Alignment	Moderate
	T3.11	North Calais Road	Box Culvert	33%[3]	Full	Mostly Compatible	Scour above, Scour Below, Alignment	Low

[1]Shaded for bankfull width percentage less than 50%, [2]Percent bankfull width measured during Phase 2 assessment, [3]Percent bankfull width based on Vermont Hydraulic Geometry Curves

6.0 Stressor, Departure and Sensitivity Analysis

Stressor, departure and sensitivity maps are presented here as a means of displaying the effects of significant physical processes occurring within the Pekin Brook watershed that were observed during the Phase 1 and Phase 2 Stream Geomorphic Assessments. These maps also provide an indication of the degree to which the channel adjustment processes within the watershed 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 alterations within the watershed. This is helpful in developing and prioritizing potential protection and restoration projects.

6.1 Stressor Identification

6.1.1 Hydrologic Regime Stressors

The hydrologic regime is the timing, volume, and duration of flow events throughout the year and over time and is characterized by the input and manipulation of water at the watershed scale. When the hydrologic regime has been significantly changed, stream channels will respond by undergoing a series of channel adjustments. The land use within the watershed plays an important role in the hydrology of the receiving waters. The percentage of urban and cropland development within the watershed are factors which change a watershed's response to precipitation. The most common effects of urban and cropland development is increasing peak discharges and runoff by reducing infiltration and travel time (United States Department of Agriculture 1986).

The dominant watershed land cover/land use within the Pekin Brook watershed is forest. All Phase 2 reaches resulted in a watershed land cover/land use impact rating of high (10% or more is crop and/or urban). Analysis of hydric soils located where current land uses are agricultural or urban indicates some loss of wetland attenuation (Figure 6.1). Historical deforestation in the Pekin Brook watershed may also have contributed to wetland loss.

The Pekin Brook watershed has a moderate network of roads throughout as shown in Figure 6.1. Extensive road networks can contribute significantly to increased flows within a river resulting both from increased runoff and stormwater ditching. According to Foreman and Alexander (1998), increased peak flows in streams may be evident at road densities of 3.2 miles/ square mile. Subwatersheds with road densities of greater than 3.2 miles/ square mile account for about 25 percent of the Pekin Brook watershed. The highest road densities within the watershed are along Pekin Brook just downstream of No. 10 Pond (Mirror Lake), along a tributary to Pekin Brook that follows Kent Hill Road, and at the mouth of Pekin Brook.

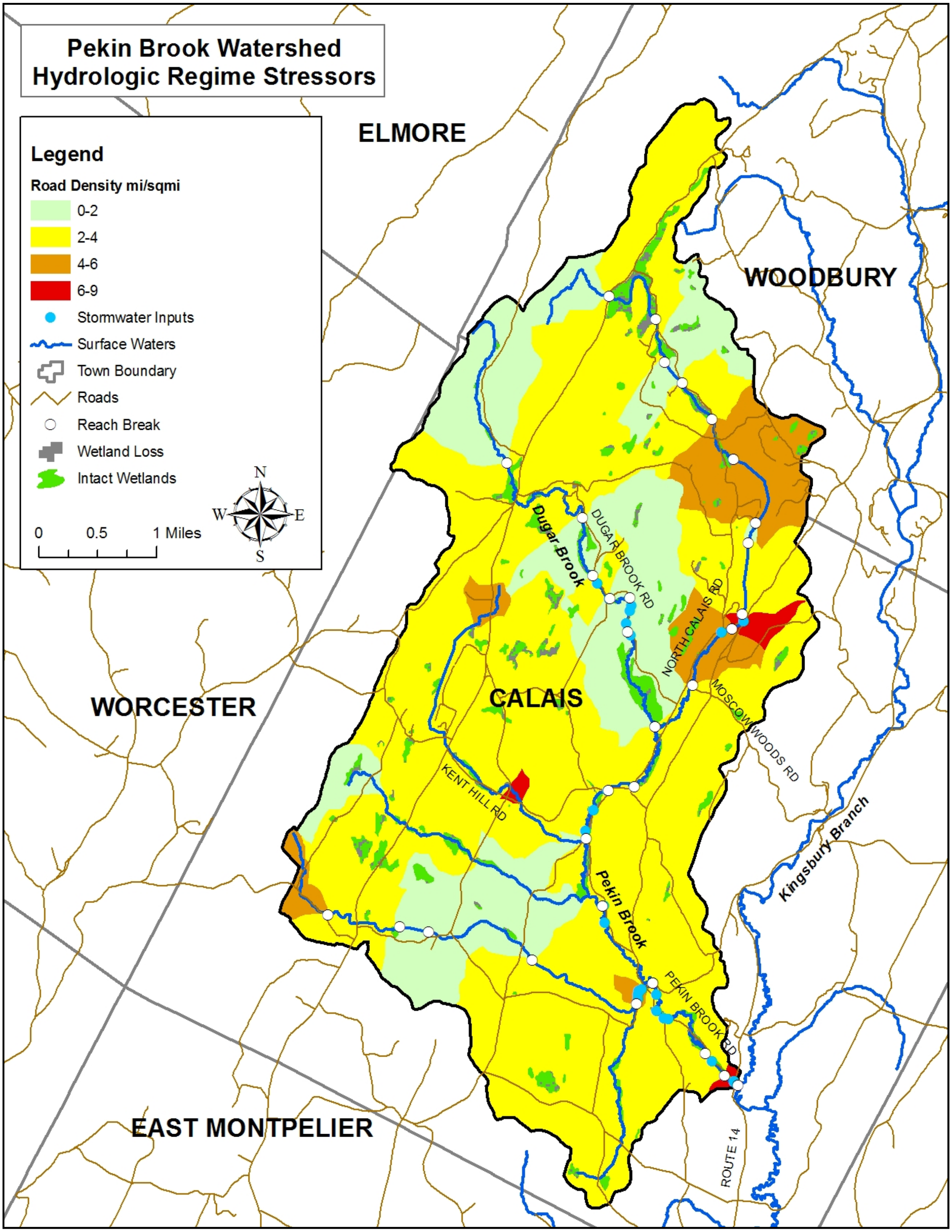

Figure 6.1 Hydrologic Regime Stressors in the Pekin Brook Watershed

6.1.2 Sediment Regime Stressors

The sediment regime is 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 the specific morphology of the valley, floodplain, and stream. The Sediment Load Indicators Map (Figure 6.2) shows the distribution of sediment load indicators in the study area. Figure 6.2 also shows the cumulative percentage of agricultural land (based on the percentage of cropland) for each subwatershed.

Bank erosion and mass failures contribute significant sediment inputs within the Pekin Brook watershed. Bank erosion is defined as "an area of raw and barren soils where the vegetation does not have the ability to hold the soil and/or the soil has slumped or fallen into the channel". Mass failures can occur when "a perennial stream erodes into or undercuts a high erodible landform, such as glacial lacustrine terrace" (Vermont Agency of Natural Resources, 2007b). Bank erosion mapped during the Phase 2 study totals approximately 18 percent on both the east and west banks of the seven reaches assessed indicating a moderate level of erosion. Four mass wasting sites were mapped during the Phase 2 assessment in 2009 and four were mapped during 2007. The total length of mass failures on the 2009 Phase 2 reaches of Pekin Brook is about 115 feet. One mass failure was found on the tributary to Pekin Brook, two on Pekin Brook and one on Dugar Brook near the Apple Hill Road crossing.

Depositional features per mile are mapped to show areas of deposition and planform adjustment. Steep riffles, mid-channel bars, delta bars, flood chutes, avulsions and braiding are parameters included in this depositional features parameter. This parameter does not necessarily explain the sources of sediment, but these depositional and channel bifurcation features are common in areas where the sediment transport capacity of the channel has been exceeded (Vermont Agency of Natural Resources, 2007a). Channel migration features (avulsions and flood chutes) are included on the map to show areas of significant planform adjustment. Ninety percent of the Phase 2 segments assessed in 2009 have a high number (>5) depositional features per mile. The most upstream segment assessed for Phase 2 on Dugar Brook (T3.08S1.04-B) is the only reach with a moderate (>2 <=5) number of depositional features per mile.

The moderate bank erosion and the prevalence of mass failures illustrate the streams within the Pekin Brook watershed have a high source of sediment input. This is resulting in the channels being overwhelmed by sediment and exceeding the sediment transport capability as observed by the numerous depositional features per mile. The high level of aggradation is especially evident in T3.08S1.01-B and T3.08S1.01-C on Dugar Brook where there are multiple depositional features and the segments are in stage F-IV and D-IId, respectively.

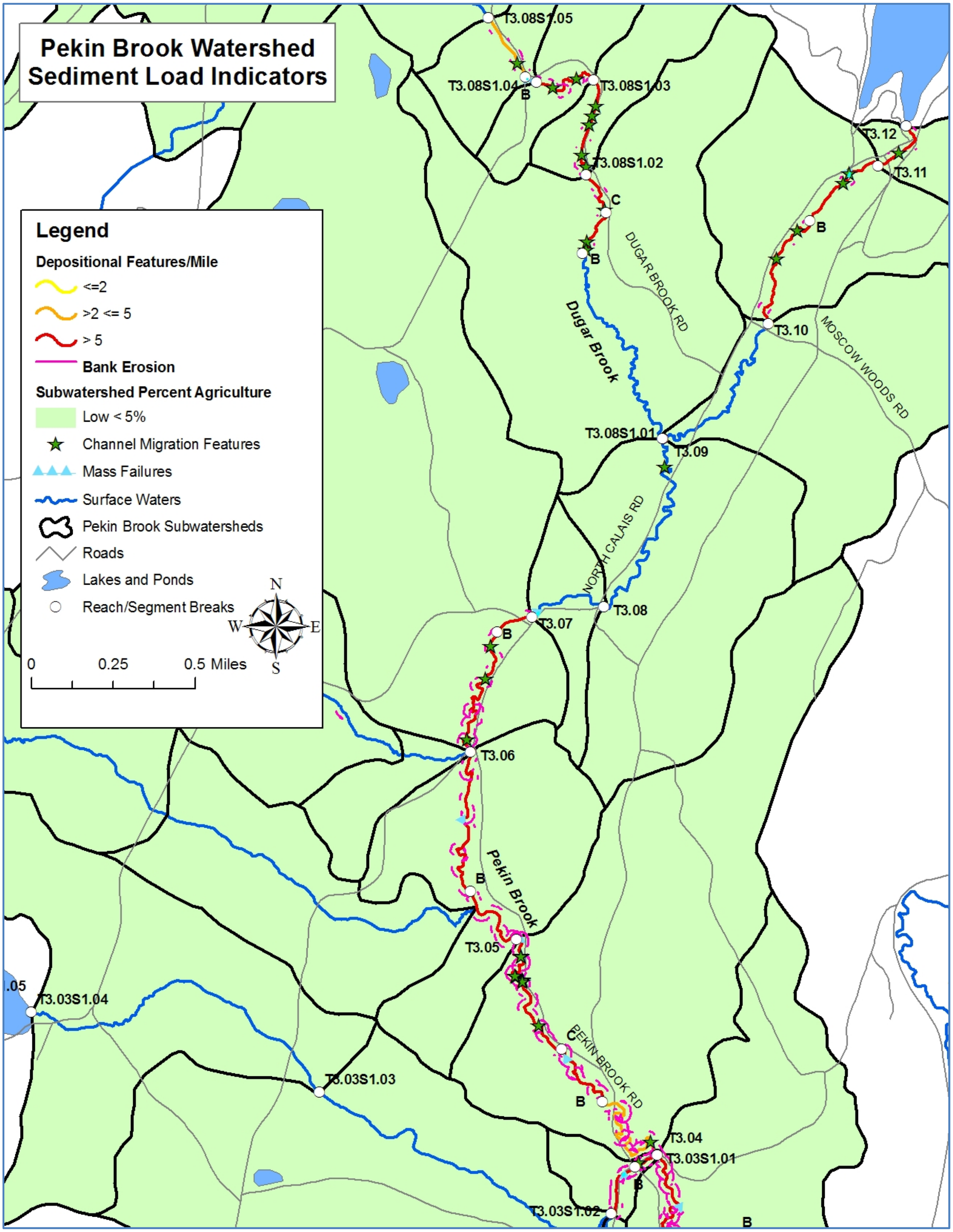

Figure 6.2. Sediment load indicators map for the Pekin Brook Watershed

6.1.3 Channel Modifiers

Channel straightening, floodplain encroachment, and berms and roads can increase the slope of a channel resulting in increased stream power. Increases in stream power (shown in red or orange in Figures 6.3 and 6.4) can initiate streambed erosion resulting in incision. The most extensive areas of channel straightening and floodplain encroachment (both development and adjacent berms and roads) are in the upstream reaches of Pekin Brook (T3.10 and T3.11) and the lowest reach on the tributary to Pekin Brook, T3.03S1.01 (Figures 6.3 and 6.4). The channel runs predominantly along North Calais Road and George Road. Dugar Brook has extensive encroachment along the channel from Dugar Brook Road, but only seems to be historically straightened in segment T3.08S1.04-B. Segment T3.08S1.02 appears to be naturally straight and the road was probably placed within the natural valley wall. The majority of the channel straightening within the Pekin Brook watershed is associated with roads that run parallel to the stream. The extensive areas with increases in stream power explain the high degree of channel adjustment that is occurring within the watershed.

Grade controls (waterfalls and ledge) and natural and manmade dams and constrictions (such bridges and culverts) constrict flows or raise the bed elevation. The backwater conditions and sediment deposition associated with these grade controls and constrictions typically reduces channel slope and stream power (Vermont Agency of Natural Resources, 2007a). Localized areas where slope decreases are expected in the Pekin Brook watershed are shown in blue and green in Figures 6.3 and 6.4.

6.1.4 Boundary Conditions and Riparian Modifiers

The resistance of the channel boundary materials is important for understanding the sensitivity of a channel and for predicting when a channel will undergo the adjustment process from stressors in the watershed. There are a number of factors that can result in decreased boundary condition. One of the most important factors is the quality of the riparian buffer. Riparian buffers provide many benefits. Some of these benefits are protecting and enhancing water quality, providing fish and wildlife habitat, providing streamside shading, and providing root structure to prevent bank erosion. Woody vegetation is essential for holding the bank soils to provide resistance to streambank erosion. There are many locations along Pekin Brook, the tributary to Pekin Brook, and Dugar Brook where there is little or no buffer as defined by buffers less than 25 feet in width (Figures 6.5 and 6.6). These stream reaches which lack a high quality riparian buffer are at a significantly higher risk of experiencing high rates of lateral erosion.

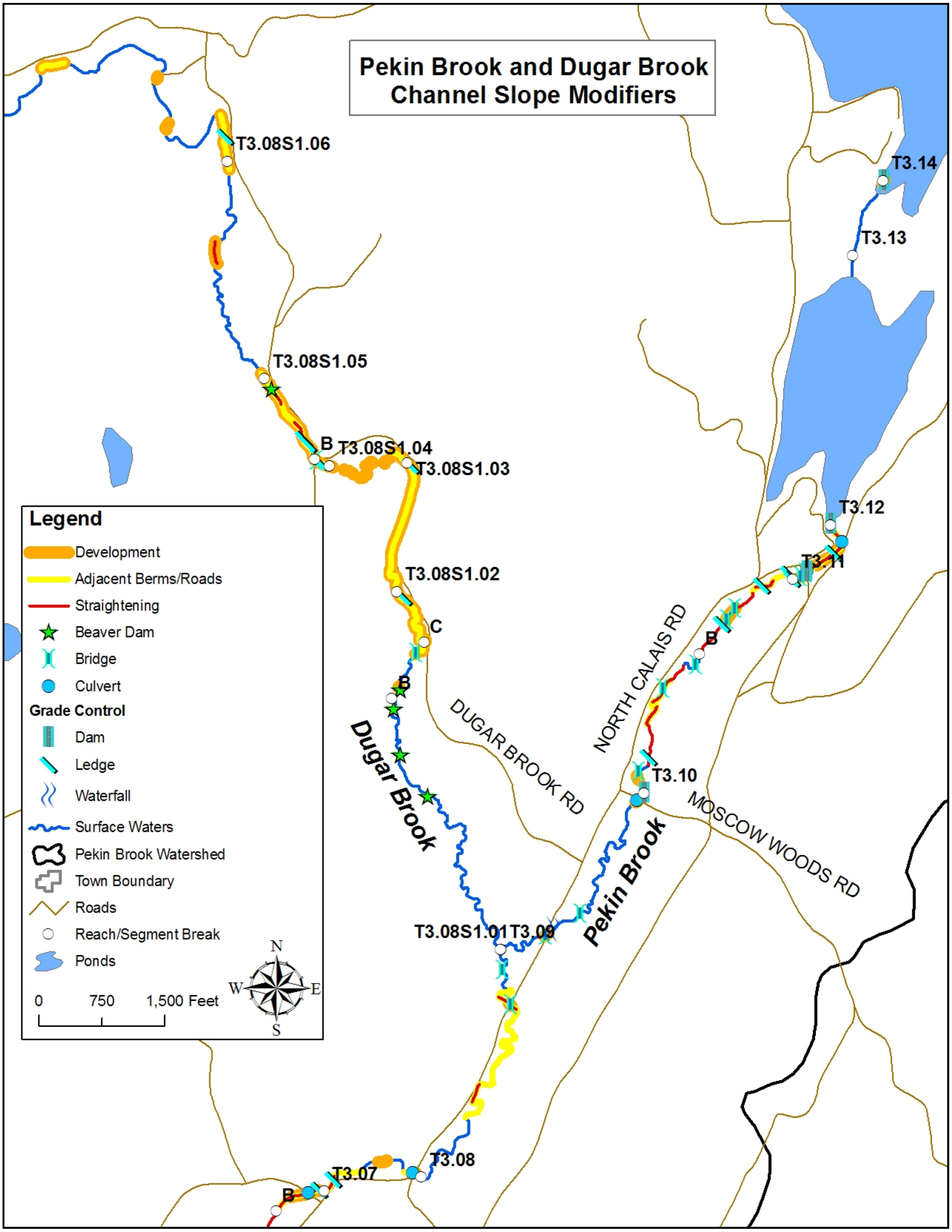

Figure 6.3. Channel slope modifiers map for the upper Pekin Brook watershed showing parameters contributing to increases (red, orange, and yellow) or decreases (blue and green) in slope.

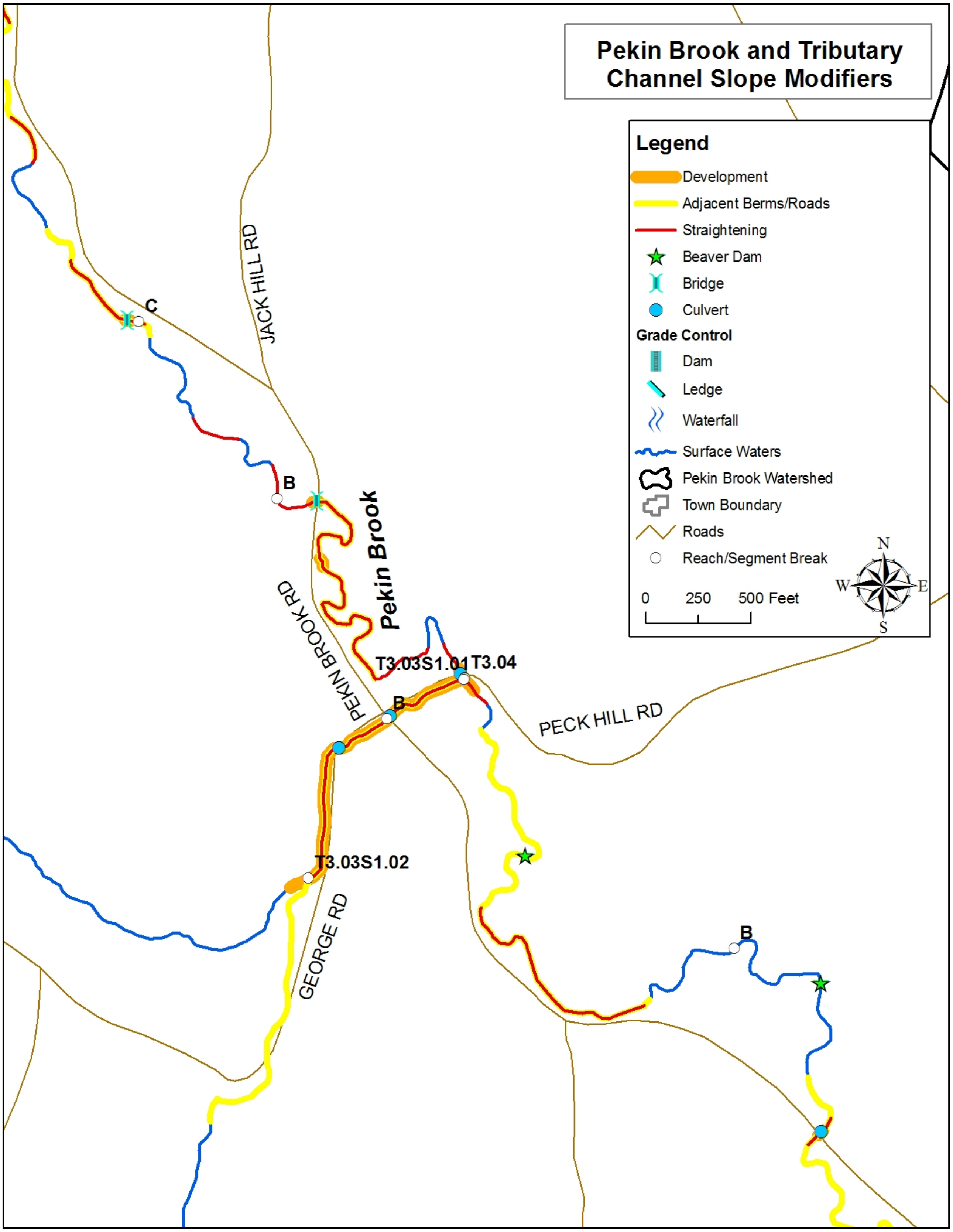

Figure 6.4. Channel slope modifiers map for the lower Pekin Brook watershed showing parameters contributing to increases (red, orange, and yellow) or decreases (blue and green) in slope.

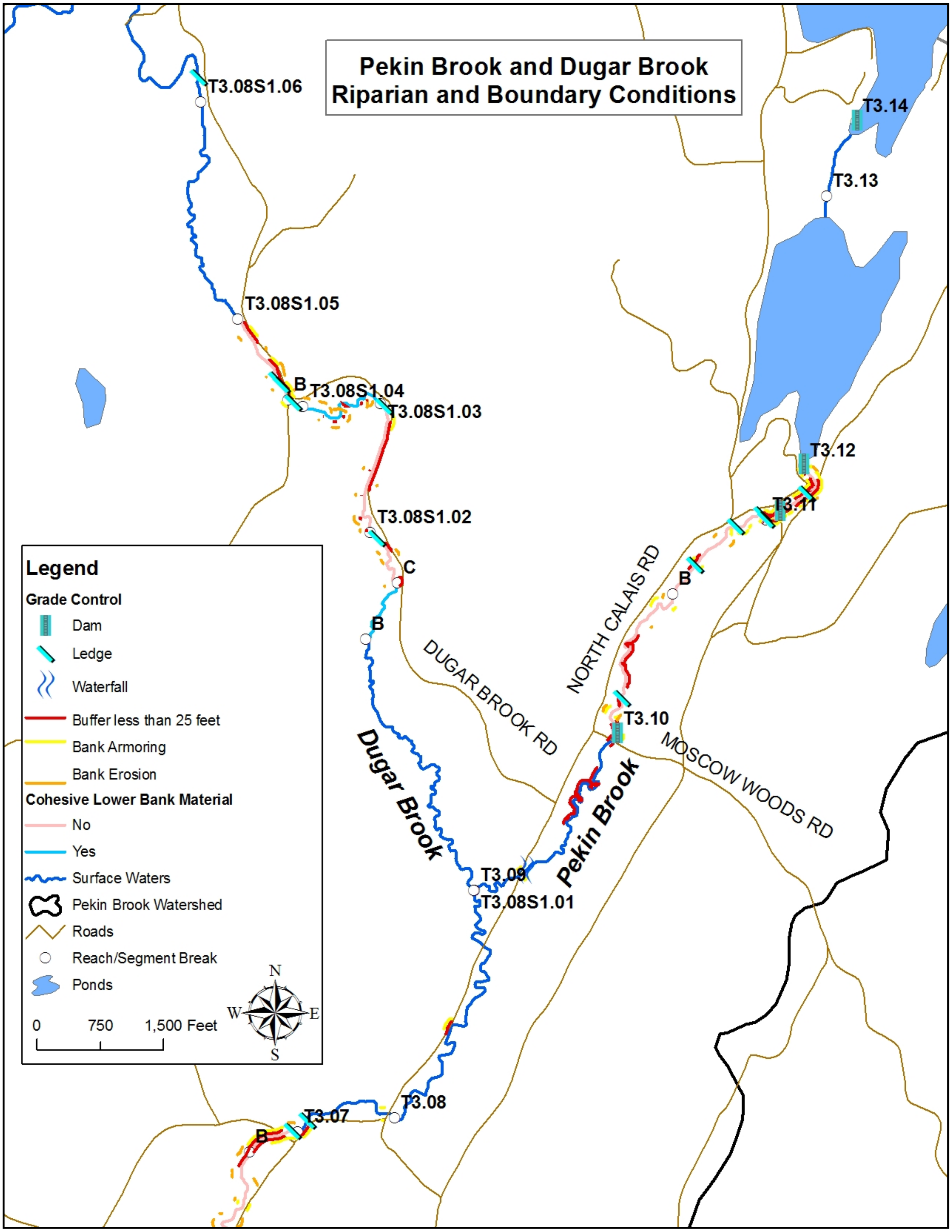

Figure 6.5. Boundary conditions and riparian modifications map for Pekin Brook and Dugar Brook showing areas of decreased boundary condition (red, orange, and yellow) and increased boundary condition (aqua).

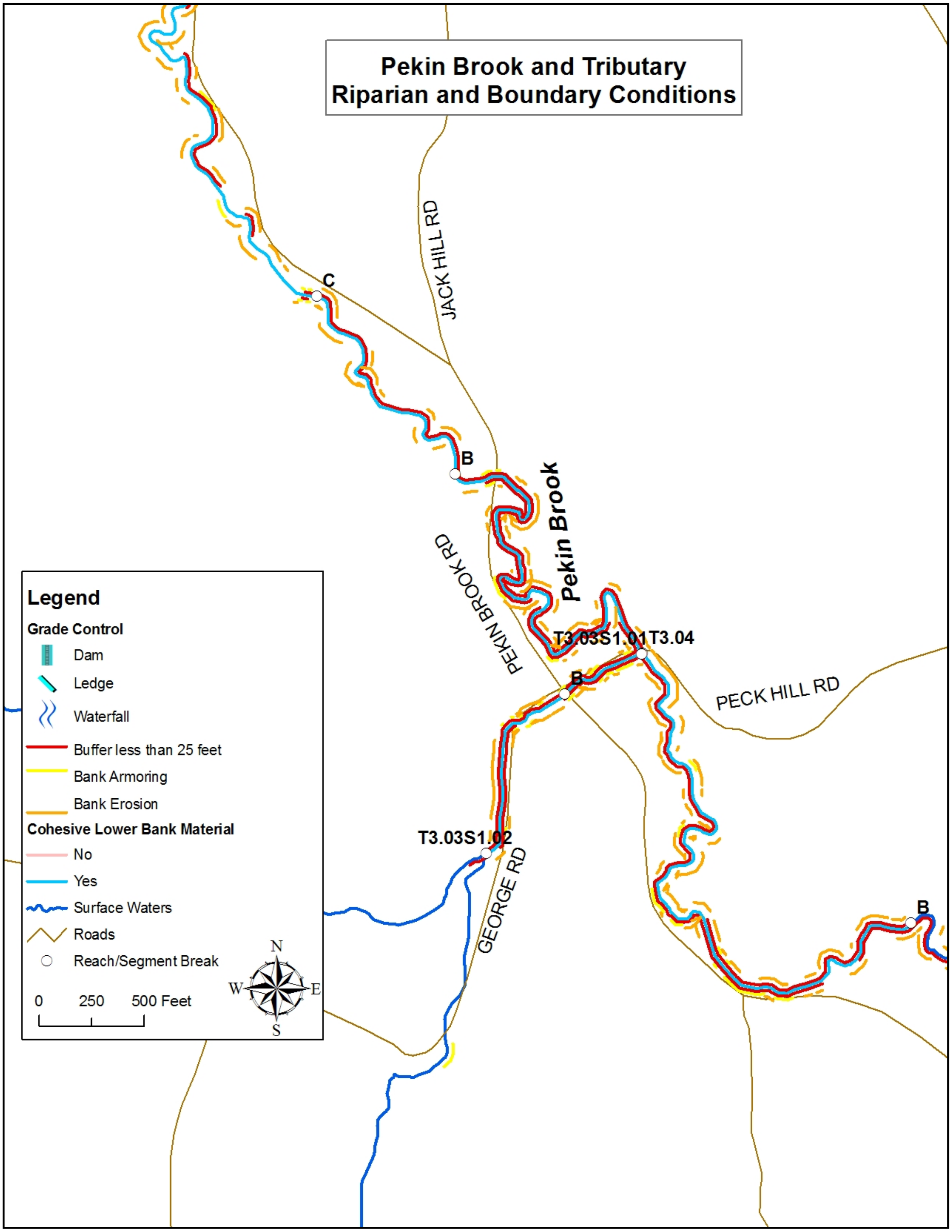

Figure 6.6. Boundary conditions and riparian modifications map for Pekin Brook and its tributary showing areas of decreased boundary condition (red, orange, and yellow) and increased boundary condition (aqua).

Parameters which are indicative of a decrease in boundary condition are shown in red, orange and yellow in Figures 6.5 and 6.6. While bank armoring may temporarily increase the boundary condition, it is indicative of where the stream power has resulted in bank erosion or widening of the channel. Extensive bank armoring may increase the stream power, resulting in erosion of banks located downstream. Areas where woody debris, bed substrate and plant material were removed from the channel also result in increased stream power.

Important factors that result in an increase in boundary condition are included in Figures 6.5 and 6.6 with aqua colored symbols. Natural and man-made grade controls increase the resistance of the bed to erosion. There were several locations where natural grade controls (ledge) were mapped based on the Phase 2 fieldwork including T3.10 and T3.11 on Pekin Brook and T3.08S1.01-C, T3.08S1.02, T3.08S1.04-A and T3.08S1.04-B on Dugar Brook. Man-made grade controls or dams were observed in T3.09 and T3.11. The cohesiveness of the lower bank materials is another factor that was considered in evaluating boundary resistance. Cohesive bank material can increase the boundary condition. The following were the only segments that had cohesive lower banks: T3.03S1.01-A, T3.03S1.01-B, T3.08S1.01-B, and T3.08S1.03.

6.2 Departure Analysis

Successful river corridor restoration and protection projects depend on a thorough understanding of the sources, volumes, and attenuation of flood flows and sediment loads within the stream network. If increased loads are transported through the network to a sensitive reach, where conflicts with human investments are creating a management expectation, little success can be expected unless the restoration design accommodates the increased load or finds a way to attenuate the loads upstream (Vermont Agency of Natural Resources, 2007a).

Within a reach, the principles of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time (Leopold, 1994). Changes or modifications to watershed inputs and hydraulic geometry create disequilibrium and lead to an uneven distribution of power and sediment. Large channel adjustments observed as dramatic erosional and depositional features may be the result of this uneven distribution of power and sediment, and these adjustments may continue until a state of equilibrium is reached.

The analysis of sediment regimes at the watershed scale is useful for summarizing the stressors affecting the equilibrium condition of river channels. Sediment regime mapping provides a context for understanding the sediment transport and channel evolution processes which govern changes in geometry and planform for river channels in a state of disequilibrium. Sediment Regime Maps have been prepared to show departure from reference conditions due to human alterations.

The reference sediment regime map (Figure 6.7) shows the Phase 1 reference stream sediment conditions for each reach within the stream network. In the reference condition, streams use available floodplain access as a means to store sediment within the watershed.

All segments of the Phase 2 study area have a reference sediment regime of Coarse Equilibrium & Fine Deposition (*Equilibrium*) or Transport. The majority of the stream network has a reference sediment regime of *Equilibrium*. *Equilibrium* channels are unconfined on at least one side, and they transport and deposit sediment in equilibrium, wherein the stream power is balanced by the sediment load, sediment size, and channel boundary resistance. *Transport* channels, on the other hand, are steep, dominated by bedrock and boulder/cobble substrates, and are typically in confined valleys. Transport channels do not supply appreciable quantities of sediments to downstream reaches (Vermont Agency of Natural Resources, 2007a).

Changes in hydrology (such as development and agriculture within the riparian corridor) and sediment storage within the watershed have altered the reference sediment regime types for some segments. All departures were derived from the DMS according to the sediment regime criteria established by the Vermont Agency of Natural Resources (2007a). Existing sediment regimes have not been established for reaches that were not assessed during the phase 2 stream geomorphic assessment. Many segments that were *Coarse Equilibrium (in=out) & Fine Deposition* type segments by reference have been converted to *Fine Source and Transport & Coarse Deposition* sediment regimes based on the Phase 2 Stream Geomorphic Assessment data (Figure 6.8). This means that most fine sediment entering the stream is transported through without being deposited as a result of channel incision and reduced floodplain access. Additionally, coarse sediment storage is increased due to increased load along with lower transport capacity. One segment, T3.03S1.01-A, near the mouth of the tributary to Pekin Brook, was converted to *Unconfined Source & Transport*. Due to the boundary resistance from bank armoring, T3.03S1.01-A is not a significant source of sediment. There is, however, some bank erosion; and sediment storage is negligible due to the incision and loss of floodplain access. Segment T3.06-A, which was assessed in 2007, has been converted to *Unconfined Source &Transport* sediment regime due to increased transport capacity derived from bank armoring and channel straightening in the vicinity of the former Calais Town Hall. These channel management practices have resulted in reduced attenuation of flood waters and sediment.

The existing sediment regime for the Pekin Brook watershed includes reduced floodplain access, increased stream power, reduced boundary resistance, and lateral constraints, such as roads, at various locations throughout the stream network. Watersheds which have lost attenuation or sediment storage areas, due to human related constraints, are generally more sensitive to erosion hazards, transport greater quantities of sediment and nutrients to receiving waters, and lack the sediment storage and distribution processes that create and maintain habitat (Vermont Agency of Natural Resources, 2007a).

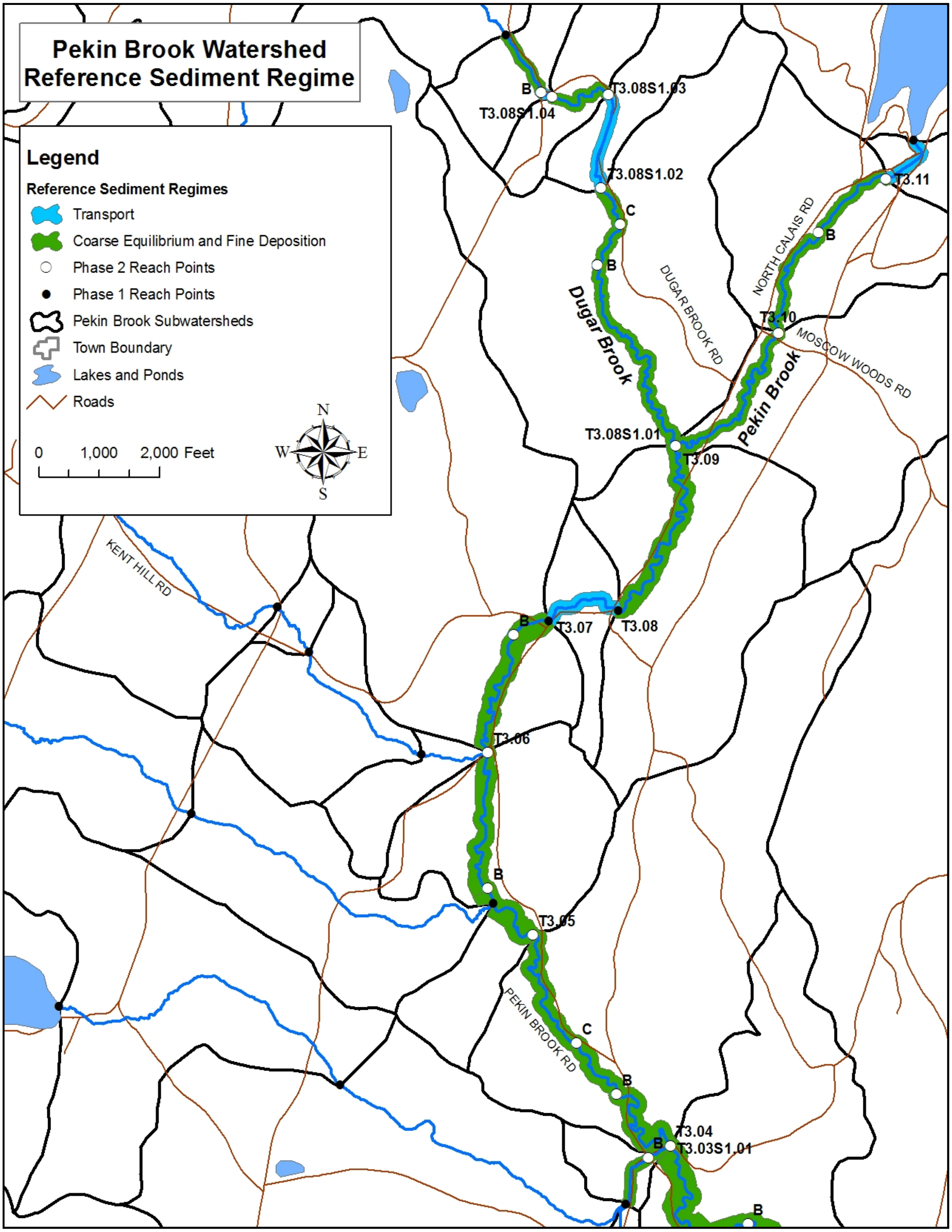

Figure 6.7. Reference Sediment Regime Departure Map showing areas of coarse equilibrium and fine deposition and transport reaches

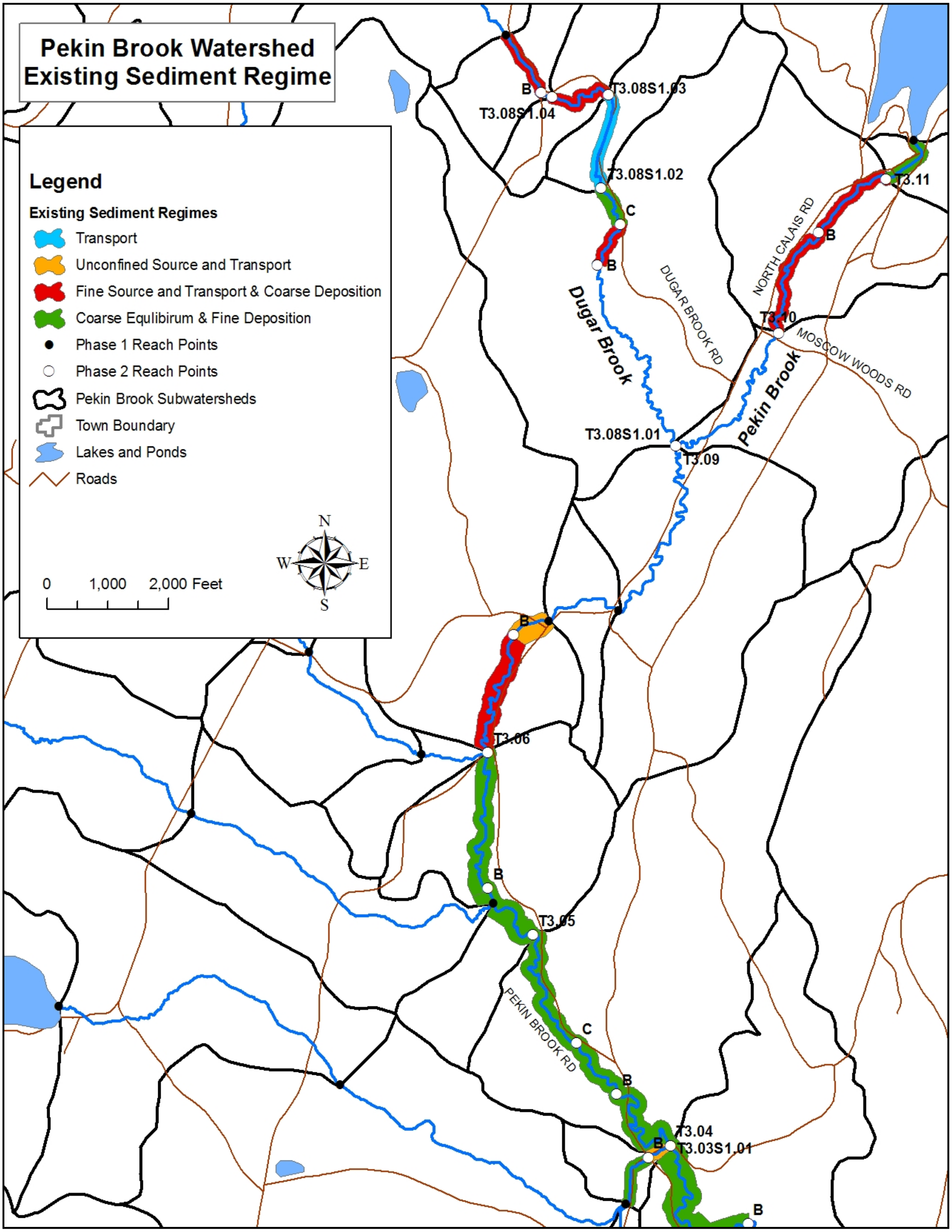

Figure 6.8. Existing Sediment Regime Departure Map

6.3 Sensitivity Analysis

Stream sensitivity refers to the likelihood that a stream will respond to a watershed or local disturbance or stressor, such as: floodplain encroachment, channel straightening or armoring, changes in sediment or flow inputs, and/or disturbance of riparian vegetation (Vermont Agency of Natural Resources, 2007b).

Assigning a sensitivity rating to a stream is done with the assumption that some streams, due to their setting and location within the watershed, are more likely to be in an episodic, rapid, and/or measurable state of change or adjustment. A stream's inherent sensitivity may be heightened when human activities alter the setting characteristics that influence a stream's natural adjustment rate including: boundary conditions; sediment and flow regimes; and the degree of confinement within the valley. Streams that are currently in adjustment, especially those undergoing degradation or aggradation, may become acutely sensitive (Vermont Agency of Natural Resources, 2007b). Stream sensitivity is assigned based on the existing stream type and condition. For a particular stream type, a segment in "reference" or "good" condition has a lower sensitivity than a reach in "fair" condition. The highest sensitivity is assigned for segments in poor condition and reaches which have undergone a stream type departure.

There are many variables that are contributing to the sensitivity of the reaches in the Pekin Brook watershed. In some reaches, the lack of bedrock and cohesive lower banks decrease the resistance to lateral and vertical adjustments; thereby, making the channel more sensitive. Additionally, bank vegetation and roots which hold the soil are lacking especially along Pekin Brook and its tributary along George Road. Reaches that are lacking high quality riparian vegetation are more sensitive to channel adjustment.

The location and slope of a stream affects its morphology and sensitivity. Streams that are transporting sediment through the channel are less sensitive than streams that are storing and responding to sediment. Low gradient streams, like lower Pekin Brook and Dugar Brook, with high sediment supplies are very sensitive and may undergo adjustment following minor changes in channel geometry or boundary condition. Additionally, flow regime and floodplain constrictions may be affecting the sensitivity of the Pekin Brook watershed. Changes in land use and land cover that increase impervious cover, peak discharges, and/or the frequency of high flows will heighten a stream's sensitivity to change and adjustment. Confinement becomes a significant sensitivity concern when structures such as roads, railroads, and berms significantly change the confinement ratio, reduce or restrict a stream's access to floodplain, and result in higher stream power during flood stage.

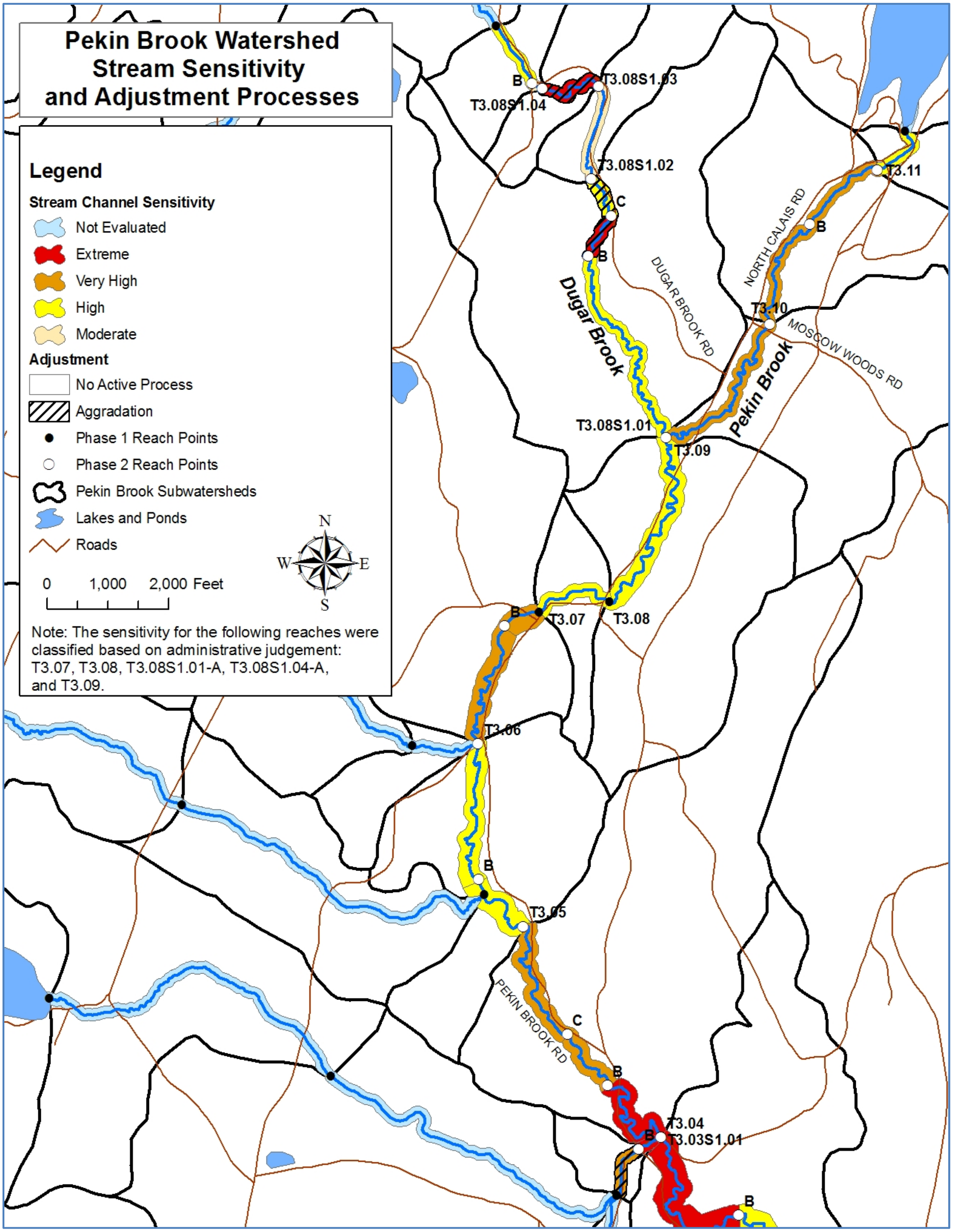

Figure 6.9. Stream sensitivity and current adjustment of the Pekin Brook Watershed

Figure 6.9 is a map presenting the stream sensitivity, generalized according to stream type and condition as per the VANR protocol, and current adjustments for each reach segment in the Pekin Brook watershed. Sensitivity ratings have not been assigned for bedrock dominated segments, impounded segments, and segments without landowner permission that were not assessed. Segments T3.08S1.01-B, T3.08S1.03, and T3.03S1.01-A are gravel dominated "E" channels that are in "fair" geomorphic condition. The "fair" condition has resulted in a change in sensitivity from high to extreme (Figure 6.9). Since the following segments were in "fair" geomorphic condition, there was a change in sensitivity to very high: T3.10-A, T3.10-B, and T3.03S1.01-B. In the most upstream Phase 2 reach on Pekin Brook, T3.11, a sensitivity change from moderate to high was assigned due to its "fair" condition. Segment T3.03S1.04-B, a cobble dominated segment, has undergone a sensitivity change (moderate to high) because of a stream type departure from a "C" channel to a "B" channel in places. This stream type departure is attributed to historic incision and the encroachment of Dugar Brook Road. Major aggradation adjustment processes are displayed on the corridor where they were found to be actively occurring and not evaluated as historic. Aggradation is a current major active process for three segments (T3.08S1.01-B, T3.08S1.01-C, and T3.08S1.03) on Dugar Brook and one segment (T3.03S1.01-B) on the tributary to Pekin Brook. This information is useful in prioritizing the implementation of the projects identified in Section 7 of this report, as certain management actions may be influenced by these active adjustment processes.

7.0 PRELIMINARY PROJECT IDENTIFICATION AND PRIORITIZATION

The departure and sensitivity analyses presented in Section 6.0 of this report provide beneficial background for selecting potential projects that will effectively help the channel return to equilibrium conditions by assessing limiting factors and by identifying underlying causes of channel instability. The stream reaches evaluated in this study present a variety of planning and management strategies which 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 or reduction of human constructed constraints or the construction of meanders, floodplains or stable banks. Active riparian buffer revegetation 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 the ideal results. Active riparian buffer revegetation and long-term protection of a river corridor is also essential to this alternative.

Conservation is an option to consider when stream conditions are generally good and nearing a state of dynamic equilibrium. Typically, conservation is applied to minimally disturbed stream reaches where river structure and function and vegetation associations are relatively intact.

There are a number of voluntary programs available for river protection. Two of the primary programs are the Conservation Reserve Enhancement Program (CREP) and the River Corridor Easement (RCE). CREP is a program that helps protect environmentally sensitive land, decrease erosion, and restore wildlife habitat by taking land out of agricultural production. An overview of the Conservation Reserve Enhancement Program is found at http://www.fsa.usda.gov/FSA/webapp?area=home&subject=lown&topic=cep. The River Corridor Easement is designed to promote the long term physical stability of the river by allowing the river to achieve a state of equilibrium (where sediment and water loads are in balance). River corridor easements are vital for a passive geomorphic restoration approach and can also be used for conserving rivers that are in good condition (equilibrium). Rivers that are in equilibrium have access to their floodplains and therefore experience less erosion and negative impacts from flooding events. A description of each of the programs prepared by the Vermont River Management Program is provided below.

Conservation Reserve Enhancement Program

- CREP can be either a 15 or 30 year contract to plant trees.
- 90% of the practice costs are covered with the remaining 10% either resting with the participants or could be paid by the US Partners for Fish and Wildlife. Examples of the practice costs include fencing, watering facilities, and trees. There are some costs that are capped, but generally all the practice costs can be paid through the program.
- To provide additional incentives to enroll in CREP, the program offers upfront and annual rental payments for the land where agricultural production is lost during the contract period.

River Corridor Easement (RCE)

- Easements are in perpetuity, meaning the agreement stays with the land forever.
- A onetime payment is received by the landowner for transferal of channel management rights to a second party (a land trust).
- Transferal of channel management rights means that the landowner would no longer be able to rock line river banks or remove gravel for personal use.
- A management plan accompanies the easement outlining the management and land use practices expected to occur within the corridor and describe any accommodations that must be made for existing structures (e.g. outbuildings, stream crossing, etc.).
- A RCE requires a minimum 50 foot buffer that floats with the river. No active land use is allowed within the buffer. The buffer can be actively planted or allowed to revegetate passively.
- The easement does not take away the agricultural land use rights, so the landowner could continue to crop or pasture the farm land mapped outside of the buffer, yet within the corridor, for as long as the river allows.

7.1Watershed-Level Opportunities

Fluvial Erosion Hazard Zones

Of all types of natural hazards experienced in Vermont, flash flooding represents the most frequent disaster mode and has resulted in by far the greatest magnitude of damage suffered by private property and public infrastructure. While inundation-related flood loss is a significant component of flood disasters, the predominant mode of damage is associated with the dynamic, and oftentimes catastrophic, physical adjustment of stream channel dimensions and location during storm events due to bed and bank erosion, debris and ice jams, structural failures, flow diversion, or flow modification by man-made structures. These channel adjustments and their devastating consequences have frequently been documented wherein such adjustments are related to historic channel management activities, floodplain encroachments, adjacent land use practices and/or changes to watershed hydrology associated with land use and drainage.

The purpose of defining Fluvial Erosion Hazard Zones is to prevent increases in fluvial erosion resulting from uncontrolled development in identified fluvial erosion hazard areas; minimize property loss and damage due to fluvial erosion; prohibit land uses and development in fluvial erosion hazard areas that pose a danger to health and safety; and discourage the acquisition of property that is unsuited for the intended purposes due to fluvial erosion hazards. The basis of a Fluvial Erosion Hazard Zone is a defined river corridor which includes the course of a river and its adjacent lands. The width of the corridor is defined by the lateral extent of the river meanders, called the meander belt width, which is governed by valley landforms, surficial geology, and the length and slope requirements of the river channel. The width of the corridor is also governed by the stream type and sensitivity of the stream. River corridors, defined through VTANR Stream Geomorphic Assessment (2007b), are intended to provide landowners, land use planners, and river managers with a meander belt width which would accommodate the meanders and slope of a balanced or equilibrium channel, which when achieved, would serve to maximize channel stability and minimize fluvial erosion hazards. Information collected during the Phase 2 Assessment including reach sensitivity, reach condition, and stream type is used to develop these zones. Towns have the opportunity to work with the Vermont River Management Program to develop fluvial erosion hazard zones to reduce conflicts within the river corridor.

Figure 7.1displays the Draft Fluvial Erosion Hazard Zones for the Pekin Brook watershed. The map includes a legend that provides the erosion potential from moderate erosion hazard to extreme erosion hazard. As previously discussed in Section 6.3, the sensitivity ratings are based on stream type and condition. The corridor widths used to generate the draft fluvial erosion hazard zones for the Pekin Brook watershed are based on the recommendations presented in the document, "River Corridor Protection: A Vermont Technical Guide", prepared by the Vermont River Management Program (Vermont Agency of Natural Resources, 2008). Dan Currier of the Central Vermont Regional Planning Commission and Gretchen Alexander of the Vermont Agency of Natural Resources, River Management Program worked together to develop the draft Fluvial Erosion Hazard Zones.

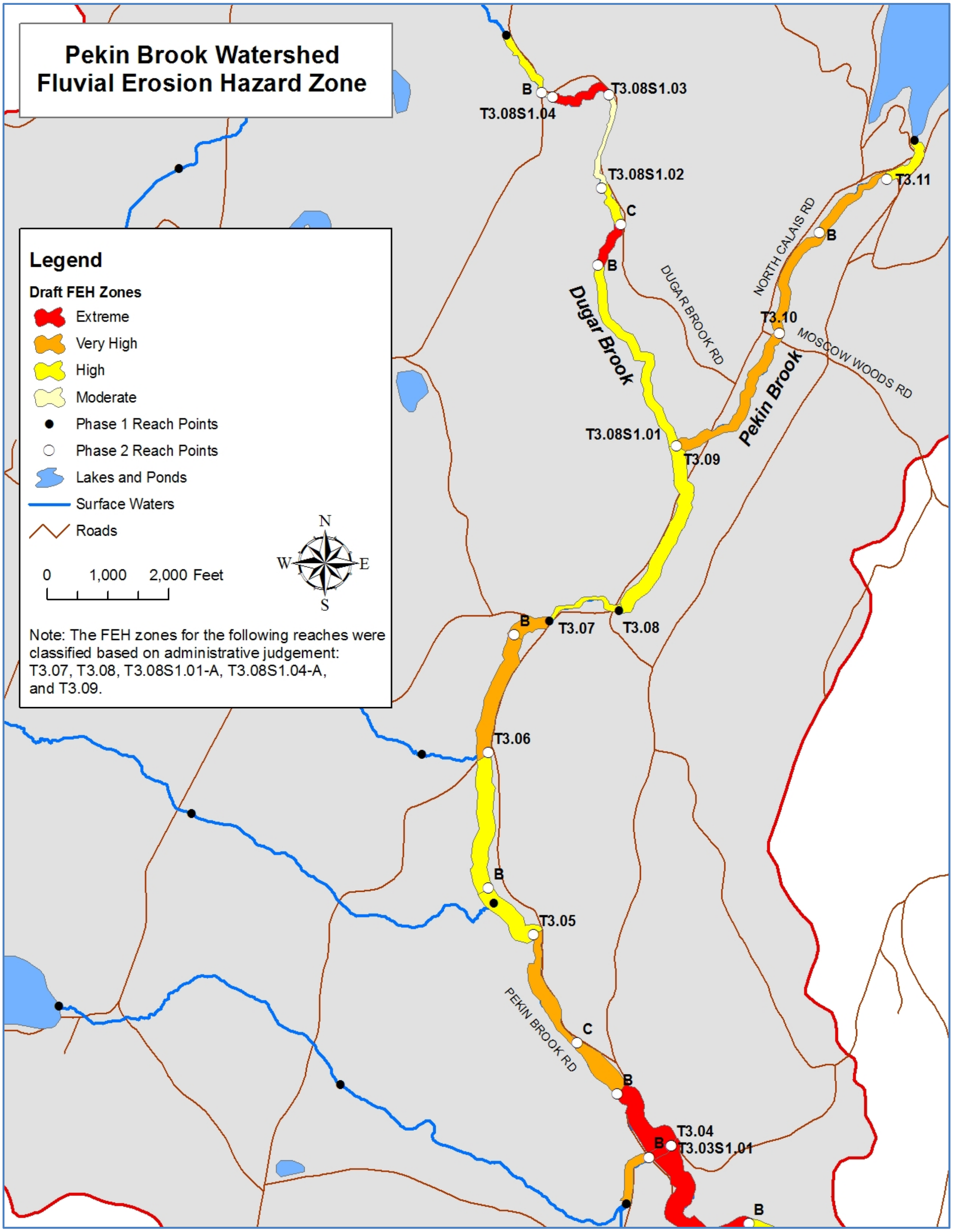

Figure 7.1: Draft Fluvial Erosion Hazard Zone Map for Pekin Brook Watershed (FEH zones created by Dan Currier of CVRPC and Gretchen Alexander of VANR)

STORMWATER

Stormwater runoff rates are of particular concern in urbanized and agricultural watersheds because stormwater runs off from impervious surfaces rather than naturally infiltrating the soil. The cumulative effect of the increased frequency, volume, and rate of stormwater runoff results in increases in wash-off pollutant loading to streams and destabilization of stream channels. All potential restoration projects within the Pekin Brook watershed should be evaluated in terms of their effects on stormwater.

7.2 Reach-Level Opportunities

A description of each reach/segment is provided in this section along with general recommendations for restoration and protection strategies. The reaches are listed from downstream to upstream. Further details about project types for each reach will be discussed in Section 7.3. The reaches are broken into sections based on the stream in which they are located: Tributary to Pekin Brook, Pekin Brook, and Dugar Brook.

Tributary to Pekin Brook:

Segment T3.03S1.01-A
Streamside Plantings
Buffer Restoration
River Corridor Protection
CREP

T3.03S1.01-A is a 430 foot long segment, which begins at the confluence of Pekin Brook and continues until the George Road crossing. Segment T3.03S1.01-A is an "E" channel with a poor riparian zone that has experienced major historic degradation and whose planform has been completely altered due to the straightening. Adequate buffers are lacking due to the encroachment of Peck Hill Road and George Road; hay fields line the eastern bank. The riffle-pool bedform is weak and is plane bed in places. The upper part of the segment, just downstream from George Road crossing contains a mass failure.

Figure 7.2. Straightened section and plane bed features in T3.03S1.01-A

Figure 7.3. Agricultural land use within the corridor of T3.03S1.01-B

Segment T3.03S1.01-B
Streamside Plantings
Buffer Restoration
River Corridor Protection
CREP

T3.03S1.01-B begins at the George Road crossing and continues approximately 1000 feet until the confluence with an unnamed tributary. The stream type for T3.03S1.01-B is "C". Segment T3.03S1.01-B has been extensively straightened and adequate buffers are lacking due to grazing of cattle among the stream banks. There is considerable erosion along the banks resulting in channel widening. Although historic degradation is minor, erosion along the banks has led to major widening, aggradation and planform change. Segments T3.03S1.01-B and T3.03S1.01-A would be good locations for a CREP project due to the agricultural land use within the river corridor.

Pekin Brook:

Reach T3.07
River Corridor Protection

T3.07 begins just upstream of the Kent Hill Road crossing. Due to lack of landowner permission, Reach T3.07 did not receive a full Phase 2 assessment. Based on administrative judgment, this is a "B" channel. There is a mass failure approximately 20 feet high by 20 feet wide on the downstream end of the reach just below a waterfall (Figure 7.4). The downstream end of the reach has been straightened and armored with rip-rap where it is close to North Calais Road (Figure 7.5).

Figure 7.4. Mass failure in reach T3.07

Figure 7.5. Straightened section of reach T3.07

Reach T3.08
River Corridor Protection

Reach T3.08 begins just upstream from the next crossing (North Calais Road) on Pekin Brook and continues until the confluence with Dugar Brook. Similar to T3.07, Reach T3.08 did not receive a full Phase 2 assessment due to lack of landowner permission. Observations were made from two crossings along North Calais Road and from one point along the road. From all three locations, the reach appears to be a sand dominated, "E" type stream (Figure 7.6) with high sinuosity. The buffers are well vegetated with shrub/saplings except for road crossings and areas where North Calais Road encroaches the river corridor.

Figure 7.6. Sand dominated "E" channel in reach T3.08

Reach T3.09
River Corridor Protection
Streamside Plantings
Buffer Restoration

Reach T3.09 starts at the confluence of Dugar Brook and continues until a rock dam just upstream of Moscow Woods Road. Only the most upstream part of the reach was accessible due to lack of landowner permission; therefore, a full Phase 2 assessment was not conducted. The beginning of the reach is well buffered with predominantly shrub/sapling vegetation and is probably a continuation of the "E" type channel in reach T3.08, but the substrate appears to be gravel dominated (Figure 7.7). The channel crosses North Calais Road and enters a short "B" stream type section (Figure 7.8) where there is a waterfall grade control. Upstream of the grade control, the channel lies within a poorly buffered valley with a hay field on the west side that is mowed right up to the stream bank (Figure 7.9). This section of the reach was classified as a "C" channel based on administrative judgment. In the upstream part of the reach, there is an old rock dam acting as a grade control, which is constricting the channel flow and holding back sediment. (Figure 7.10).

Figure 7.7. Gravel dominated "E" channel in reach T3.09

Figure 7.8. Short "B" channel section in reach T3.09

Figure 7.9. Lack of buffer in reach T3.09

Figure 7.10. Old rock dam in T3.09 causing grade control and channel constriction

Segment T3.10-A
Streambank Plantings
Buffer Restoration
River Corridor Protection
Dam Removal

Segment T3.10-A begins just upstream of the Moscow Woods Road crossing at the old rock dam and continues 2,320 feet until the channel becomes more entrenched and begins to contain step-pool bedform features. There is a small wetland section (Figure 7.11) in the downstream end of Segment T3.10-A. The wetland may have been created as a result of backwater from the downstream dam in reach T3.09. Heading upstream, the riparian area is then dominated by hay and residential lawn, which is mowed close to the streambank (Figure 7.12). Upstream from the mowed lawn, the buffer and riparian corridor contain more shrub/saplings. Buffers less than 25 feet make up 40 percent of the east bank.

Figure 7.11. Wetland in downstream end of T3.10-A

Figure 7.12. Lack of buffer in Segment T3.10-A

Segment T3.10-A is a gravel dominated "C" channel that has experienced major historic incision as evident from its abandoned terrace at a higher elevation. There is some aggradation, but major planform adjustment is occurring as shown by the presence of a channel avulsion and neck cut-off. The channel has been altered by straightening of 60 percent its length for agriculture.

<u>Segment T3.10-B</u>
Buffer Restoration

Segment T3.10-B begins where the reach becomes more entrenched and forested along the east side (Figure 7.13). It has a greater slope than downstream and is therefore a "Cb" channel with step-pool features as its dominant bedform. The west side of the corridor is residential with a valley wall continuous with the stream bank in some places. There are four bedrock grade controls (Figure 7.14) with a cascade section at the top of the segment with no buffer along the west bank (Figure 7.15). Similar to its downstream segment (T3.10-A), T3.10-B has experienced major historic incision (1.51 incision ratio), but aggradation, widening and planform adjustment is minor.

Figure 7.13. Forested east bank and residential west bank in Segment T3.10-B

Figure 7.14 Grade control in Segment T3.10-B

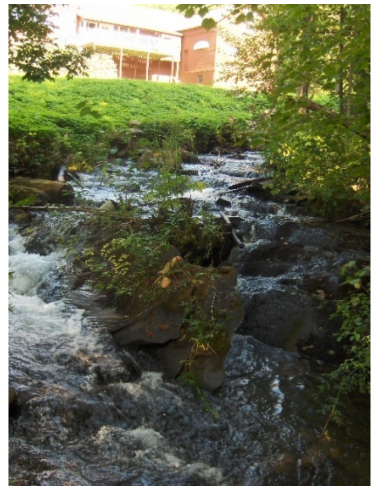

Figure 7.15. Lack of buffer in upstream section of T3.10-B

<u>Reach T3.11</u>
Buffer Restoration
Streamside Plantings
Dam Removal

Reach T3.11 begins at the top of a large grade control near a house along the west side of the channel and continues until the dam at No. 10 Pond (Mirror Lake). A house is located right on the bank and is acting as the valley wall (Figure 7.16). The reach continues under a bridge at TH16 and then meets another on-stream dam (Figure 7.17). There is a large pool behind the dam and considerable amounts of sediment are being held back by the dam, thereby starving the downstream segment of sediment (Figure 7.18). Large trout were observed in this pool during the Phase 2 assessment. There is another dam at the upstream end of the section at the outlet of No. 10 Pond (Figure 7.19).

Figure 7.16. House right along west bank on Reach T3.11 of Pekin Brook

Figure 7.17. Rock dam in Reach T3.11

Figure 7.18. Sediment deposition upstream of dam on T3.11

Figure 7.19. Dam at No. 10 Pond at upstream end of T3.11

On both sides of the stream in T3.11, the river corridor is predominantly residential. Bank armoring covers 75 and 55 percent of the east and west banks, respectively. Some of the armoring is actually high rock walls. The channel has been straightened 100 percent for development, but the channel has not incised as much as the downstream reach most likely due to the presence of bedrock in the bed. Planform adjustment is major in response to the extensive straightening. This is the only reach/segment on Pekin Brook that had a "fair" RHA rating (the other two segments were scored "good" for habitat). The poor channel alteration, bank vegetative protection, and riparian vegetative buffer along the west bank mostly contributed to the "fair" condition. All segments/reaches assessed on Pekin Brook had a "fair" rating for geomorphic condition.

Dugar Brook:

<u>T3.08S1.01</u>
River Corridor Protection

The lowest reach on Dugar Brook was broken into three segments. Segment T3.08S1.01-A is a wetland with numerous beaver dams and was therefore excluded from the Phase 2 Assessment due to beaver dam influence (Figure 7.20). T3.08S1.01-A begins at the confluence with Pekin Brook and continues 4,663 feet until the influence from the beaver dams ends. Segments B and C were created due to differences in banks and buffers and valley widths.

Figure 7.20. Wetland at downstream end of Dugar Brook

The middle segment in reach T3.08S1.01, T3.08S1.01-B, begins where the beaver dam influence ends and continues 900 feet to upstream of where Dugar Brook Road encroaches on the eastern corridor and vegetation changes to include more trees. T3.08S1.01-B is sinuous with a beaver dam at the downstream end causing significant deposition behind it (Figures 7.21 and 7.22). The fields along the channel were most likely historically used for agriculture and are now regenerating into shrub/saplings. There is a small wooden bridge that is used as a crossing for ATVs.

Figure 7.21. Beaver dam in T3.08S1.01-B

Figure 7.22. Upstream deposition from beaver dam in T3.08S1.01-B

Historic incision is major in segment T3.08S1.01-B as shown by an abandoned floodplain on the west side. The channel is now building a new floodplain and is currently experiencing major aggradation as demonstrated by its numerous depositional features. A flood chute and an avulsion are evidence that planform adjustment is a major process.

The most upstream segment of T3.08S1.01, segment C, begins where the corridor is more forested and the valley wall becomes narrower. Dugar Brook Road encroaches upon the corridor on the east side for approximately 20 percent of the segment. There is a bedrock grade control at the upstream end of the segment (Figure 7.23).

T8.08S1.01-C has not incised like the downstream segments most likely due to the presence of the grade control. However, there are many large depositional features, some of which are higher than half the bankfull elevation (Figure 7.24), indicating aggradation as a major process. The sediment transport capacity has therefore been exceeded. Since Segment T8.08S1.01-C is mostly aggradational, the channel evolution model is D-IId. All other geomorphic processes are minor. Aside from the road encroachment, Segment T8.08S1.01-C has a riparian buffer in good condition.

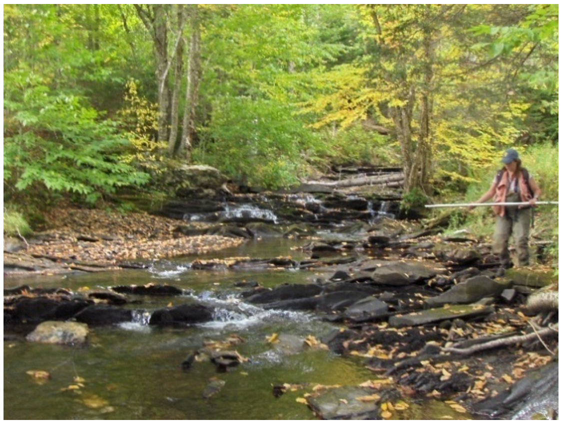

Figure 7.23. Bedrock grade control in upper part of T3.08S1.01-C

Figure 7.24. Large side bar indicating major aggradation in Segment T3.08S1.01-C

Reach T3.08S1.02
River Corridor Protection
Stormwater Management

Reach T3.08S1.02 begins just upstream of the bedrock grade control and continues until the valley becomes wider above the next series of bedrock grade controls. Dugar Brook Road encroaches upon the entire length of the eastern corridor. Buffers less than 25 feet comprise 50 percent of the reach on the east side. Aside from the placement of the road, the river corridor is well forested. The channel appears to be naturally straight and is a moderately entrenched "B" type channel (Figure 7.25).

Bedrock grade controls have prevented the reach from incising (Figure 7.26). The top of the reach contains a cascade with series of bedrock grade controls that is holding back sediment. At the upstream end of the cascade there used to be an old mill dam, which is no longer present. The reach is in "good" condition and all adjustment processes are minor. Since the river corridor is well forested except for the road, protecting the river corridor is important to maintain the high quality riparian corridor.

Figure 7.25. Typical "B" channel in T3.08S1.02 most likely naturally straight

Figure 7.26. Series of bedrock grade controls in T3.08S1.02

Reach T3.08S1.03

River Corridor Protection

Reach T3.08S1.03 begins at the top of the bedrock grade controls where the valley becomes much wider and continues until a small bedrock gorge. The bedrock grade control in the downstream reach is holding back sediment. According to local residents, the channel was impounded by a dam at bottom of the reach. The dam is now removed, but is likely the cause of the considerable sediment retention (Figure 7.27). The channel is most likely re-adjusting from being impounded and is now seeking equilibrium.

Figure 7.27. Deposition in T3.08S1.03 upstream from bedrock grade controls and former dam

Figure 7.28. Flood chute in reach T3.08S1.03

The buffers in T3.08S1.03 are well vegeated with shrub/sapling dominant on the east side and forest dominant on the west side. The channel exhibits an "E" type morphology that has historically incised. The active channel adjustment processes include major aggradation, widening, and planform adjustment. There are many large side bars and two flood chutes (Figure 7.28).

<u>Reach T3.08S1.04</u>
River Corridor Protection
Bridge Replacement

The fourth reach on Dugar Brook was divided into two segments due to a bedrock gorge in the first 200 feet (Figure 7.29). Segment T3.08S1.04-A is a bedrock gorge and, therefore, was not assessed. The segment begins at the start of the bedrock and continues until the Apple Hill Road Bridge. There is one small mass failure associated with rip-rap falling in at the bridge crossing at Apple Hill Road (Figure 7.30).

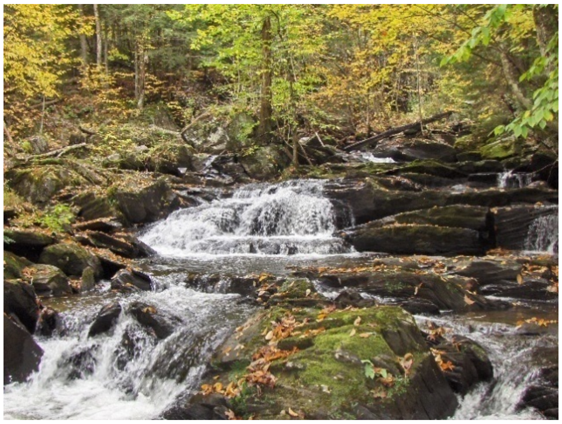

Figure 7.29. Bedrock grade controls in T3.08S1.04-A

Figure 7.30. Mass failure at Apple Hill Road crossing in T3.08S1.04-A

The next segment, T3.08S1.04-B, begins at Apple Hill Road and continues until the stream reaches a beaver dam at a wetland. The channel alternates between a "B" and a "Cb" morphology in stage II-III of the F channel evolution model. In some places along the segment the channel is naturally a "B", but at other times the entrenchment has changed due to the placement of Dugar Brook Road and there is a stream type departure from a "C" to a "B" channel. This departure mostly occurs at the downstream and upstream ends of the segment.

Figure 7.31. Straightened section of Dugar Brook just upstream of Apple Hill Road crossing with armoring on left bank

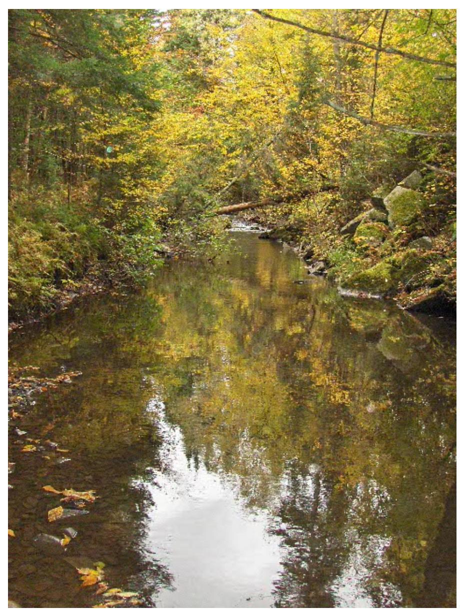

Figure 7.32. Plane bed section of Dugar Brook in segment T3.08S1.04-B

The channel in segment T3.08S1.04-B has been straightened and is heavily armored with rip-rap on the east side of the channel (Figure 7.31). The riparian buffer on the west side is high quality with mostly forested land, but the east side has a buffer less than 25 feet for 70 percent of its length due to Dugar Brook Road. Channel straightening has led to major historic incision, but the other adjustment processes have remained minor. This was the only segment on Dugar Brook that came out "fair" for the RHA. The "fair" habitat condition is mostly due to the extensive channel alteration, the narrow riparian buffer and lack of bank vegetative protection on the east side, and reduced cover for fish and aquatic organisms. The RGA scored "fair" mostly due to major historic incision. Segment T3.08S1.04-B has a weak riffle-pool sequence in spots with more of a plane bed bedform (Figure 7.32).

7.3 Site Level Opportunities

Site specific projects were identified using the criteria outlined by the ANR in Chapter 6 – Preliminary Identification and Prioritization (Vermont Agency of Natural Resources 2007a). This planning guide is intended to aid in the development of projects that protect and restore river equilibrium. The site level projects that were developed for the Pekin Brook watershed are provided below in Table 7. High priority projects include river corridor protection to provide attenuation of sediment and floodwaters through conservation and corridor easements, riparian buffer improvement areas, and the replacement or retrofitting of undersized stream crossing structures. Information from the Phase 2 stream geomorphic assessment and ANR bridge and culvert assessment could be used to inform the Town of Calais of which stream crossings are contributing to localized instability.

The project strategy, technical feasibility, and priority for each project are listed by project number and reach. A total of 18 projects were identified to promote the restoration or projection of channel stability and aquatic habitat in the Pekin Brook watershed. Table 7 provides information for each project, including the project strategy, technical feasibility, and general cost. The projects are broken down by category as follows: 10 passive restoration (river corridor protection, streamside plantings or buffer improvement projects); 8 active restoration (5 bridge or culvert replacement or retrofit projects, 2 dam removal projects, and one mass failure stabilization project). The project locations and categories identified for Pekin Brook, Dugar Brook, and the unnamed tributary to Pekin Brook are depicted below in Figure 7.33. The projects include:

<u>Unnamed Tributary to Pekin Brook</u>

- **Passive Restoration** with river corridor protection, streamside plantings, and fencing out livestock through CREP program from confluence of Pekin Brook to the confluence with a small tributary near the dairy farm (project #1);
- **Active Restoration** by replacing undersized culvert at Pekin Brook Road that is causing localized geomorphic instability (project #2);
- **Active Restoration** by replacing undersized culvert at George Road that is causing localized geomorphic instability (project #3).

Pekin Brook

- **Passive Restoration** with river corridor protection from just upstream of Kent Hill Road to where forested buffer ends (project #4);
- **Passive Restoration** with river corridor protection and natural buffer regeneration and/or plantings from just upstream of waterfall where forested buffer ends to Moscow Woods Road (project #5);
- **Active Restoration** by replacing undersized culvert at Moscow Wood Road that is causing localized geomorphic instability (project #6);
- **Active Restoration** by removing dam near Moscow Woods Road (project #7);
- **Passive Restoration** with river corridor protection and natural buffer regeneration from the crossing at Moscow Woods Road to rock bridge; streamside plantings just downstream from bridge (project #8);
- **Passive Restoration** with river corridor protection from rock bridge to just downstream of TH16 crossing (project #9);
- **Passive Restoration** with streamside plantings and rip rap removal just downstream of TH16 crossing (project #10);
- **Active Restoration** by replacing undersized bridge at TH16 crossing that is causing localized geomorphic instability (project #11);
- **Active Restoration** by removing dam near TH16 (project #12);
- **Passive Restoration** by establishing fluvial erosion overlay district from just downstream of TH16 to No. 10 Pond (project #13).

Dugar Brook

- **Passive Restoration** with river corridor protection from confluence with Pekin Brook to end of beaver dam influence (project #14);
- **Passive Restoration** with river corridor protection and riparian buffer though natural regeneration from end of beaver dam influence to beginning of forested corridor (project #15);
- **Passive Restoration** of river corridor from top of forested area to wetland area upstream of Apple Hill Road crossing (project #16);
- **Active Restoration** by installing netting and planting on west bank where there is a mass failure from the bridge (project #17);
- **Active Restoration** by replacing undersized bridge at private driveway that is causing localized geomorphic instability (project #18).

Table 7. Pekin Brook Site Level Opportunities for Restoration and Protection Calais, Vermont								
Project # Segment	**Type of Project**	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Technical Feasibility and Priority**	**Other Social Benefits**	**Costs**	**Land Use Conversion**	**Potential Partners**
#1 From confluence with Pekin Brook to tributary confluence T3.03S1.01-A and T3.03S1.01-B	Passive Restoration	Reach impacted by farming operations. No buffer due to haying and cow pasturing.	Protect River Corridor through corridor easement and/or CREP; improve riparian buffer with streamside plantings.	High priority for corridor easement (natural attenuation area). High priority for plantings; establish no mow zone	Flood and sediment attenuation; prevent erosion, improve habitat and reduce water temperature	Cost of conservation easement. Low cost of plantings or no cost to stop mowing. Cost of fencing.	Hay fields and cow pasture to forested buffer	ANR, CVRPC, landowners, CREP, land trust, FWR, Calais Conservation Commission (CCC)
#2 Pekin Brook Road crossing T3.03S1.01-A	Active Restoration	The Pekin Brook Road culvert was found to be partially compatible using the geomorphic screening tool. Downstream scour is an issue with the culvert.	Culvert Replacement	Moderate priority	Improved geomorphic stability	High cost for replacement	Unknown	Town of Calais, ANR, CVRPC
#3 George Road crossing T3.03S1.01-B	Active Restoration	The George Road culvert was found to be mostly incompatible using the geomorphic screening tool. Upstream and downstream deposition and downstream scour are issues with the culvert.	Culvert Replacement	High priority	Improved geomorphic stability	High cost for replacement	Unknown	Town of Calais, ANR, CVRPC
#4 From North Calais Road crossing to end of forested buffer T3.07 through downstream end of T3.09	Passive Restoration	Except for road crossings and encroachment, high quality shrub/sapling buffer and forested buffer on upstream end.	Protect River Corridor through corridor easement	High priority	Flood and sediment attenuation	Cost of corridor easements	Maintain current dominant shrub/sapling or forested vegetation	ANR, CVRPC, landowners, land trust, FWR, CCC

**Table 7. Pekin Brook Site Level Opportunities for Restoration and Protection
Calais, Vermont**

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
#5 From just upstream of North Calais Road crossing where forested buffer ends to Moscow Woods Road crossing T3.09	Passive Restoration	Hay fields on west side then some residential lawn area lacking riparian vegetation.	Protect River Corridor through corridor easement; Buffer restoration – Natural Regeneration: Increase buffer width where feasible with low cost plantings or let vegetation grow back on its own.	High priority for corridor easement and buffer regeneration; establish no mow zone.	Flood and sediment attenuation; Improve water quality.	Cost of corridor easements; low cost for buffer improvement. No cost for no mow zone.	Hay fields and residential lawn to forested	ANR, CVRPC, landowners, land trust, FWR, CCC
#6 Moscow Woods Road crossing T3.09	Active Restoration	The Moscow Woods Road culvert was found to be partially compatible using the geomorphic screening tool. Upstream and downstream scour are issues with the culvert.	Culvert Replacement	Moderate priority	Improved geomorphic stability	High cost for replacement	Unknown	Town of Calais, ANR, CVRPC
#7 Just upstream of Moscow Woods Road crossing T3.10-A	Active Restoration	Dam is about 8 feet high and a fish passage issue. Abutments are causing channel constriction. Wetland just upstream from dam and sediment retention above dam.	Alternative analysis for dam removal	High priority due to fish passage issue and sediment retention.	Improve habitat and geomorphic stability	Cost of alternative analysis and dam destruction	Dam to natural stream channel	ANR, CVRPC, landowners, Town of Calais, FWR

Table 7. Pekin Brook Site Level Opportunities for Restoration and Protection
Calais, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
#8 From Moscow Woods Road to rock bridge across Pekin Brook. T3.10-A	Passive Restoration	Hay fields on downstream end then some residential lawn area lacking riparian vegetation.	Protect River Corridor through corridor easement; Buffer restoration – Natural Regeneration: Increase buffer width where feasible with low cost plantings or let vegetation grow back on its own. Streamside plantings in T3.10-A just downstream of rock bridge on east side.	High priority for corridor easement; High priority for plantings in T3.10-A and no mow zone.	Flood and sediment attenuation; Improve water quality.	Cost of corridor easements; Low cost for buffer improvement. No cost for no mow zone.	Hay fields and residential lawn to forested	ANR, CVRPC, landowners, land trust, FWR, CCC
#9 From rock bridge to where valley gets narrower just downstream of TH16. T3.10-B	Passive Restoration	Shrub/sapling river corridor on west side and forested on right side.	Protect River Corridor through corridor easement.	High priority for corridor easement.	Flood and sediment attenuation	Cost of conservation easement	No new structures in corridor	ANR, CVRPC, landowners, land trust, FWR, CCC
#10 Just downstream of TH16 T3.11	Passive Restoration	Lack of buffer due to residential lawn. Armored with rip-rap that is holding back water before bedrock grade control	Streamside plantings and riprap removal	High priority plantings.	Flood and sediment attenuation.	Low cost of plantings	Residential lawn to forested buffer	ANR, CVRPC, landowners, FWR, CCC
#11 TH16 crossing T3.11	Active Restoration	The width of the TH16 bridge is 23 percent of the bankfull width. There is an alignment issue with the structure.	Bridge Replacement	Moderate priority	Improved geomorphic stability	High cost for replacement	Unknown	Town of Calais, ANR, CVRPC

Table 7. Pekin Brook Site Level Opportunities for Restoration and Protection Calais, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
#12 Old dam just upstream of TH16 crossing T3.11	Active Restoration	Old dam with 9 foot drop and two in-dam culverts is a fish passage issue. Significant deposition upstream of dam.	Alternative analysis for dam removal	High priority	Improve habitat and geomorphic stability	Cost of alternative analysis and dam destruction	Dammed stream to natural stream channel	ANR, CVRPC, landowners, Town of Calais. FWR
#13 From just downstream of TH16 crossing to No. 10 Pond T3.11	Passive Restoration	Residential land use here has multiple landowners along Pekin Brook in the Village of North Calais and is well suited for a fluvial erosion overlay district.	Fluvial Erosion (FEH) overlay district	High priority for corridor protection as FEH overlay district due to multiple landowners	Reduced fluvial erosion hazard and property damage	Unknown	No new structures in corridor	ANR, CVRPC, Town of Calais, CCC
#14 From confluence with Pekin Brook to where beaver dam influence ends. T3.08S1.01-A	Conservation	Wetland area due to series of beaver dams	Protect River Corridor through corridor easement	Low priority for conservation easement; wetland provides natural protection	Flood and sediment attenuation	Cost of corridor easements	No new structures in corridor	ANR, CVRPC, landowners, land trust, FWR, CCC
#15 From where beaver dam influence ends to where corridor becomes more forested T3.08S1.01-B	Passive Restoration	Old hay fields lacking some riparian vegetation in river corridor.	Protect River Corridor through corridor easement; Buffer restoration – Natural Regeneration: Increase buffer width where feasible with low cost plantings or let vegetation grow back on its own.	High priority for corridor easement; moderate priority for plantings.	Flood and sediment attenuation; improve water quality.	Cost of corridor easements; low cost for buffer improvement.	Herbaceous to forested	ANR, CVRPC, landowners, land trust, FWR, CCC

Table 7. Pekin Brook Site Level Opportunities for Restoration and Protection
Calais, Vermont

Project # Segment	Type of Project	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners
# 16 From where corridor becomes forested to wetland area upstream of Apple Hill Road crossing T3.08S1.01-C through T3.08S1.04-B	Passive Restoration	High quality riparian buffers except where Dugar Brook Road encroaches upon the river corridor. Well forested or shrub/sapling vegetation and numerous bedrock grade controls.	Protect River Corridor	High priority for conservation easement.	Flood and sediment attenuation and improve sediment transport	Cost of conservation easement	No new structures in corridor	ANR, CVRPC, landowners, land trust, FWR, CCC
#17 Just downstream of Apple Hill Road crossing T3.08S1.04-A	Active Restoration	Mass failure just downstream of Apple Hill Road bridge due to rip-rap failure	Install netting and plants to arrest erosion	Low priority	Prevent erosion	Low cost for plantings and netting	Unknown	ANR, CVRPC, landowners, FWR
#18 Private driveway crossing just downstream of wetland area T3.08S1.04-B	Active Restoration	The width of the private driveway bridge is 10 percent of the bankfull width. There is debris blocking the two openings on the upstream end of the structure	Bridge Replacement	High priority	Improved geomorphic stability	High cost for replacement	Unknown	ANR, CVRPC, landowner

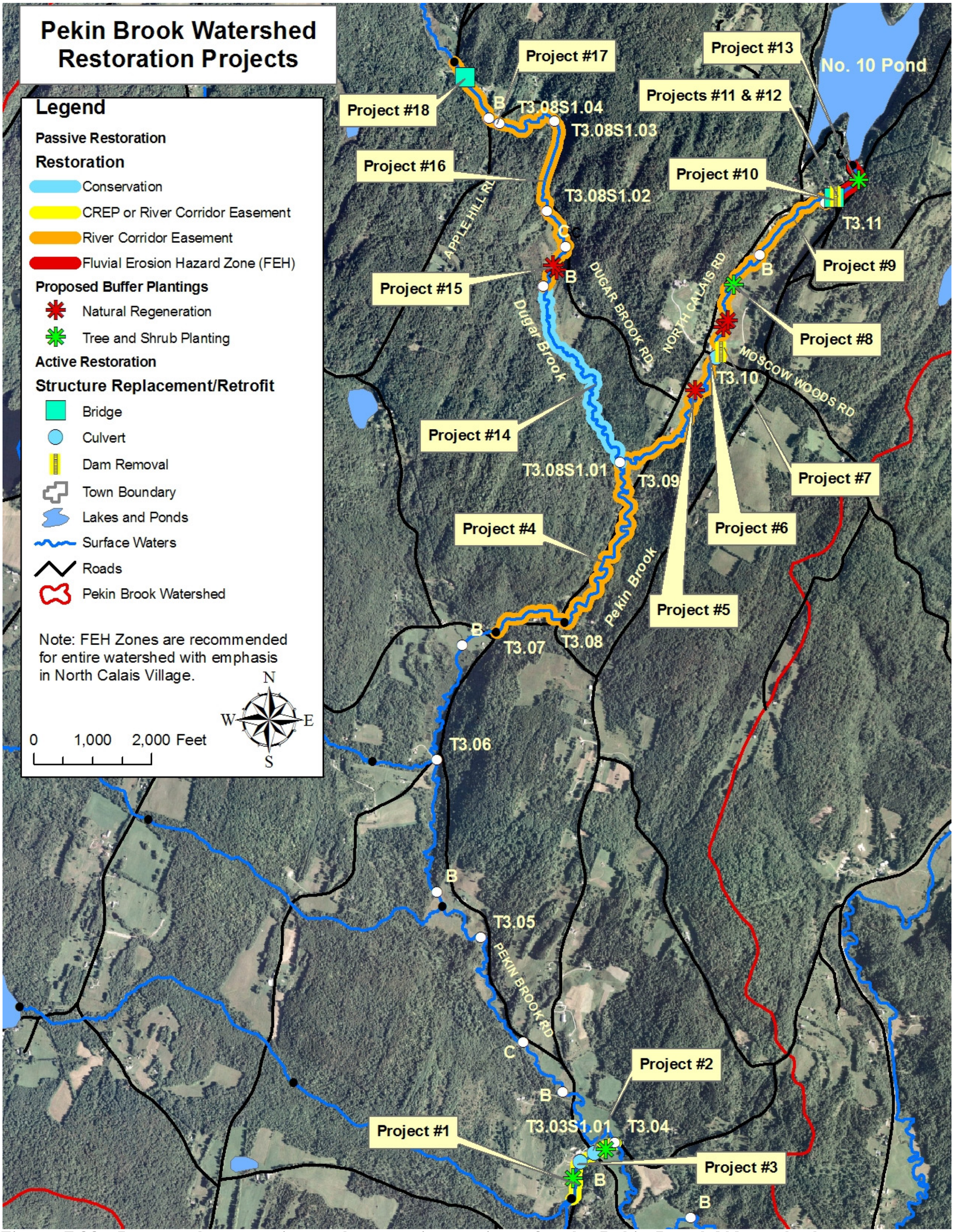

Figure 7.33. Proposed restoration and protection projects for the Pekin Brook Watershed

7.4 Next Steps

There are many opportunities to restore Pekin Brook and its tributaries to a stable condition. Types of reach level and site level projects that have been identified in this plan include river corridor protection, streamside plants, retrofit and/or replacement of stream crossings, and dam removal. On the watershed level, the development and implementation of fluvial erosion hazard zones is recommended to avoid conflicts regarding land use and to save money spent on flood damage and river maintenance. The Town of Calais could pursue the opportunity to work with the CVRPC and the Vermont River Management Program to develop fluvial erosion hazard zones for the land surrounding Pekin Brook and its tributaries. Fluvial erosion hazard zones are recommended for the entire watershed, and would be most beneficial in the Village of North Calais where there are multiple property owners within the corridor. The following are recommendations for next steps:

1. Outreach to private landowners and the public about the plan and potential restoration and protection opportunities to be completed by the State and/or CVRPC.
2. Town, State, CVRPC, and FWR representatives meet to discuss the various restoration and protection opportunities and set priorities for action.
3. Meetings to be held with additional partners (Winooski Natural Resources Conservation District, Department of Agriculture, Natural Resources Conservation Service, Vermont Agency of Transportation, etc.) to discuss implementation of priority projects.
4. Summary and prioritization of potential projects.
5. Implementation of priority projects with project partners and landowners.

For additional information about fluvial erosion hazard (FEH) zones or project development, please contact the CVRPC:

Central Vermont Regional Planning Commission
29 Main Street
Montpelier, VT 05602

(802)229-0389

www.centralvtplanning.org

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, Appendix Q, 2004, VT Agency of Natural Resources, Waterbury, VT. http://www.vtwaterquality.org/rivers/docs/assessmenthandbooks/rv_apxqglossary.pdf

Adjustment process – 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 the stream discharge and/or bed load characteristics are changing. Opposite of degradation.

Alluvial fan – A fan-shaped accumulation of alluvium (alluvial soils) deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stem where there is an abrupt change in slope.

Alluvial soils – Soil deposits from rivers.

Alluvium – A general term for detrital deposits made by streams on riverbeds, floodplains, and alluvial fans.

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

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 bankfull discharge.

Bankfull channel width - The top surface width of a stream channel when flowing at a bankfull 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.

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.

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.

Cascade – River bed form where the channel is very steep with narrow confinement. There are often large boulders and bedrock with waterfalls.

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

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

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.

Delta bar – A deposit of sediment where a tributary enters the mainstem of a river.

Depositional features – Types of sediment deposition and storage areas in a channel (e.g. mid-channel bars, point bars, side bars, diagonal bars, delta bars, and islands).

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.

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.

Floodplain – Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.

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

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.

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

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

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.

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

Lacustrine soils- Soil deposits from lakes.

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 migration – The change of course or movement of a channel. The movement of a channel over time is natural in most alluvial systems. The rate of movement may be increased if the stream is out of balance with its watershed inputs.

Meander belt width – The horizontal distance between the opposite outside banks of fully developed meanders determined by extending two lines (one on each side of the channel) parallel to the valley from the lateral extent of each meander bend along both sides of the channel.

Meander wavelength - The lineal distance downvalley between two corresponding points of successive meanders of the same phase.

Meander wavelength ratio – The meander wavelength divided by the bankfull channel width.

Meander width ratio – The meander belt width divided by the bankfull channel width.

Mid-channel bar – Sediment deposits (bar) 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.

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.

Plane bed – Channel lacks discrete bed features (such as pools, riffles, and point bars) and may have long stretches of featureless bed.

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

Pool -- A habitat feature (section of stream) that is characterized by deep, low-velocity water and a smooth surface.

Reach - Section of river with similar characteristics such as slope, confinement (valley width), and tributary influence.

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

Riffle - A habitat feature (section of stream) that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle-pool - Channel has undulating bed that defines a sequence of riffles, runs, pools, and point bars. Occurs in moderate to low gradient and moderately sinuous channels, generally in unconfined valleys with well-established floodplains.

Riparian Buffer – The width of naturally vegetated land adjacent to the stream between the top of the bank 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.

Riparian Corridor – Lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile and sediment regime.

Segment – A relatively homogeneous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach.

Sensitivity – The valley, floodplain and/or channel condition's likelihood to change due to natural causes and/or anticipated human activity.

Side bar – Unvegetated sediment deposits located along the margins or the channel in locations other than the inside of channel meander bends.

Step-pool – Characterized by longitudinal steps formed by large particles (boulder/cobbles) organized into discrete channel-spanning accumulations that separate pools, which contain smaller sized materials. Often associated with steep channels in confined valleys.

Surficial sediment/geology – Sediment that lies on top of bedrock.

Tributary – A stream that flows into another stream, river, or lake.

Urban runoff – Storm water from city streets and gutters that usually carries a great deal of litter and organic and bacterial wastes into the receiving waters.

9.0 REFERENCES

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APPENDIX A

STANDARD PHASE 2 DMS REPORTS

April 26, 2010 SGAT Version: 4.56

Phase 2 Segment Summary

Project: **Kingsbury Branch**
Stream: **Pekin Brook** Reach # **T3.07** Segment: **0** Completion Date: **September 29, 2009**
Organization: **Bear Creek Environmental** Observers: **PD** Why Not assessed: **no property access** Rain: **No**
Segment Length (ft): **1,489** Segment Location: **Reach begins just upstream from the crossing of Kent Hill Road and conitnues until just**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	729	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	114	0

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features
Valley Width (ft) **0**
Width Determination
Confinement Type
Rock Gorge?
Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**
2.2 Max Depth (ft) **0.00**
2.3 Mean Depth (ft) **0.00**
2.4 Floodprone Width (ft) **0**

Notes:

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **0.00**
2.7 Entrenchment Ratio **0.00**
2.8 Incision Ratio **0.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) **0**
2.12 Substrate Composition

Silt/Clay Present?
Detritus **0** %
Large Woody **0**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**

2.14 Stream Type
Stream Type: **B**
Bed Material: **Cobble**
Subclass Slope: **a**
Bed Form: **Step-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	20.00
Gullies	None	0.00

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
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	182	38

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	138	0

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	23
Height	0	20

Gullies **0**
Length **0**
Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps
4.2 Adjacent Wetlands
4.3 Flow Status
4.4 # of Debris Jams **0**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **346**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pekin Brook** Reach # **T3.07** Segment: **0** Completion Date: **September 29,**

Organization: **Bear Creek Environmental** Observers: **PD** Rain: **No**

Segment Length (ft): **1,489** Segment Location: **Reach begins just upstream from the crossing of Kent Hill Road and conitnues until**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Project: Kingsbury Branch | **Phase 2 Segment Summary** | | April 26, 2010 SGAT Version: 4.56

Stream: **Pekin Brook** | Reach # **T3.08** | Segment: **0** | Completion Date: **September 29, 2009**

Organization: **Bear Creek Environmental** | Observers: **PD** | Why Not assessed: **no property access** | Rain: **No**

Segment Length (ft): **4,599** | Segment Location: **Reach begins just upstream of North Calais Road crossing and conitnues until confluence**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	2,693	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	81

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	0	148

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	0
Height	0	0

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **495**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pekin Brook** Reach # **T3.08** Segment: **0** Completion Date: **September 29,**

Organization: **Bear Creek Environmental** Observers: **PD** Rain: **No**

Segment Length (ft): **4,599** Segment Location: **Reach begins just upstream of North Calais Road crossing and conitnues until**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: Kingsbury Branch
Stream: Pekin Brook
Organization: Bear Creek Environmental
Segment Length (ft): 3,725

Phase 2 Segment Summary

April 26, 2010 SGAT Version: 4.56

Reach # T3.09 Segment: 0 Completion Date: **September 29, 2009**
Observers: PD Why Not assessed: **no property access** Rain: **Yes**
Segment Location: **Reach begins at confluence with Dugar Brook and continues to just above the culvert**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation
1.2 Alluvial Fan **None**
1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	86

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features
Valley Width (ft) 0
Width Determination
Confinement Type
Rock Gorge?
Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width 0
2.2 Max Depth (ft) 0.00
2.3 Mean Depth (ft) 0.00
2.4 Floodprone Width (ft) 0

Notes:

Step 2. (Contued)

2.5 Aband. Floodpln 0.00 ft.
Human Elev Floodpln 0.00 ft.
2.6 Width/Depth Ratio 0.00
2.7 Entrenchment Ratio 0.00
2.8 Incision Ratio 0.00
Human Elevated Inc Rat 0.00
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) 0
2.12 Substrate Composition

Silt/Clay Present?
Detritus 0 %
Large Woody 0
2.13 Average Largest Particle on
Bed 0.0
Bar 0.0

2.14 Stream Type
Stream Type: **C**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Riffle-Pool**
Field Measured Slope:
2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	67	76

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	154	1,430

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	0
Height	0	0

Gullies 0
Length 0
Height 0.00

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps
4.2 Adjacent Wetlands
4.3 Flow Status
4.4 # of Debris Jams 0
4.5 Flow Regulation Type **Small Run of**
Flow Regulation Use **Hydro-electric**
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.9 # of Beaver Dams 0
Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **281**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Kingsbury Branch** **Phase 2 Reach Summary** April 26, 2010

Stream: **Pekin Brook** Reach # **T3.09** Segment: **0** Completion Date: **September 29,**

Organization: **Bear Creek Environmental** Observers: **PD** Rain: **Yes**

Segment Length (ft): **3,725** Segment Location: **Reach begins at confluence with Dugar Brook and continues to just above the culvert**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	0.00	0.00	No	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Project: Kingsbury Branch | **Phase 2 Segment Summary** | page 1 of 2 | April 26, 2010 SGAT Version: 4.56

Stream: **Pekin Brook** | Reach # **T3.10** | Segment: **A** | Completion Date: **September 2, 2009**

Organization: **Bear Creek Environmental** | Observers: **PD, DC, AA** | Why Not assessed: | Rain: **No**

Segment Length (ft): **2,323** | Segment Location: **Upstream from the intersection of Moscow Woods Road and North Calais Road**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Banks and Buffers**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	752	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	57	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **480**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **26**

2.2 Max Depth (ft) **1.85**

2.3 Mean Depth (ft) **1.11**

2.4 Floodprone Width (ft) **218**

Notes:

There is a significant lack of buffer in this reach due to mowing and haying right up to the edge of the banks. Sand dominates the lower end of the reach and there is major sediment buildup at the upstream end of the rock dam at the downstream reach break.

Step 2. (Contued)

2.5 Aband. Floodpln **2.65** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **23.06**

2.7 Entrenchment Ratio **8.52**

2.8 Incision Ratio **1.43**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **61**

2.12 Substrate Composition

Bedrock	0 %
Boulder	1 %
Cobble	7 %
Coarse Gravel	52 %
Fine Gravel	24 %
Sand	16 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **6.9** inches

Bar **2.3** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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)	32	27
Erosion Height (ft)	1.64	2.49
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	80	70

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	51-100
Sub-dominant	>100	0-25
W less than 25	980	252

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Hay
Sub-dominant	Shrubs/Saplin	Residential
Mass Failures	0	0
Height	0	0

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	4
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	1	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,387**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pekin Brook** Reach # **T3.10** Segment: **A** Completion Date: **September 2,**

Organization: **Bear Creek Environmental** Observers: **PD, DC, AA** Rain: **No**

Segment Length (ft): **2,323** Segment Location: **Upstream from the intersection of Moscow Woods Road and North Calais Road**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	Mid-segment	8.00	8.00	Yes	
Ledge	Mid-segment	1.00	1.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	13.5	Yes	Yes	No	No
Problem	None				
Bridge	4.40	Yes	Yes	Yes	No
Problem	Deposition Above,Scour Below				
Other	8.00	Yes	No	Yes	Yes
Problem	Deposition Above,Scour Below				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**17**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**47**		
Geomorphic Rating	**0.5875**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	18
6.5 Channel Flow Status	17
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	18
6.8 Bank Stability	Left: 9 Right: 9
6.9 Bank Vegetation Protection	Left: 6 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 2 Right: 7
Total Score	133
Habitat Rating	0.665

Habitat Stream Condition **Good**

Narrative:

Major historic channel incision as shown by the abandoned floodplain on left. Channel undergoing some aggradation and planform adjustment. Aggradation is most pronounced just upstream of dam at downstream end of reach. Dam is a fish passage issue.

Stream: **Pekin Brook** Reach # **T3.10** Segment: **B** Completion Date: **September 2, 2009**

Organization: **Bear Creek Environmental** Observers: **PD, DC, AA** Why Not assessed: Rain: **No**

Segment Length (ft): **1,652** Segment Location: **Segment begins approximately 2,300 feet upstream of the dam just upstream of Moscow**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Banks and Buffers**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	619	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	210	0

1.4 Adjacent Side

	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Sand

1.5 Valley Features

Valley Width (ft) **330**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **21**

2.2 Max Depth (ft) **2.15**

2.3 Mean Depth (ft) **1.39**

2.4 Floodprone Width (ft) **76**

Notes:

Segment is much more entrenced thatn downstream with many bedrock grade controls. Encroachment of development has impacted this segment. Significant garbage observed along banks.

Step 2. (Contued)

2.5 Aband. Floodpln **3.25** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **14.75**

2.7 Entrenchment Ratio **3.71**

2.8 Incision Ratio **1.51**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **62**

2.12 Substrate Composition

Bedrock	0%
Boulder	4%
Cobble	32%
Coarse Gravel	42%
Fine Gravel	16%
Sand	6%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **0** %

Large Woody **39**

2.13 Average Largest Particle on

Bed **12.4** inches

Bar **3.3** inches

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

C 4 b Step-Pool

3.3 old	Amount	Mean Height
Failures	One	10.00
Gullies	None	0.00

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)	51	40
Erosion Height (ft)	2.00	4.00
Revetmt. Type	Multiple	Rip-Rap
Revetmt. Length (ft)	196	129

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	51-75

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	26-50
Sub-dominant	None	0-25
W less than 25	0	304

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Shrubs/Saplin
Sub-dominant	None	Residential
Mass Failures	0	43
Height	0	10

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

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**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
8	0	1
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,209**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pekin Brook** Reach # **T3.10** Segment: **B** Completion Date: **September 2,**

Organization: **Bear Creek Environmental** Observers: **PD, DC, AA** Rain: **No**

Segment Length (ft): **1,652** Segment Location: **Segment begins approximately 2,300 feet upstream of the dam just upstream of**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	Mid-segment	3.00	2.00	Yes	
Ledge	Mid-segment	4.00	3.00	Yes	
Ledge	Mid-segment	6.00	5.00	Yes	
Ledge	Mid-segment	5.00	4.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	23.5	Yes	Yes	No	No
Problem	Deposition Below				
Bridge	0.00	Yes	No	No	No
Problem	Scour Below				
Bedrock	10.0	Yes	Yes	Yes	Yes
Problem	Scour Below				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**47**		
Geomorphic Rating	**0.5875**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	14
6.2 Embeddedness	12
6.3 Velocity/Depth Patterns	18
6.4 Sediment Deposition	12
6.5 Channel Flow Status	17
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 9 Right: 9
6.9 Bank Vegetation Protection	Left: 8 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 4
Total Score	144
Habitat Rating	0.72

Habitat Stream Condition **Good**

Narrative:

Major historic degradation with RAF seen on left side. Some aggradation as evident by mid-channel bars. Planform change is occuring in reach as well - flood chutes.

Project: Kingsbury Branch | **Phase 2 Segment Summary** | April 26, 2010 SGAT Version: 4.56

Stream: **Pekin Brook** Reach # **T3.11** Segment: **0** Completion Date: **September 9, 2009**

Organization: **Bear Creek Environmental** Observers: **PD, AA** Why Not assessed: Rain: **No**

Segment Length (ft): **1,024** Segment Location: **Reach begins about 200 feet downstream of bridge on the road that connects Upper Road**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	480	303
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	66	265

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **210**

Width Determination **Measured**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **28**

2.2 Max Depth (ft) **2.10**

2.3 Mean Depth (ft) **1.26**

2.4 Floodprone Width (ft) **44**

Notes:

Reach has been armored siginifcantly and probably straightened 100%. There is considerable hard bank along reach on both banks due to rock walls as well as rip-rap armoring.

Step 2. (Contued)

2.5 Aband. Floodpln **2.40** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **21.83**

2.7 Entrenchment Ratio **1.61**

2.8 Incision Ratio **1.14**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **88**

2.12 Substrate Composition

Bedrock	4%
Boulder	12%
Cobble	38%
Coarse Gravel	33%
Fine Gravel	9%
Sand	4%
Silt and smaller	0%

Silt/Clay Present? **Yes**

Detritus **0** %

Large Woody **15**

2.13 Average Largest Particle on

Bed	9.0	inches
Bar	4.9	inches

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **a**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	23	11
Erosion Height (ft)	8.82	4.00
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	574	764

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	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	612	329

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Herbaceous
Sub-dominant	Herbaceous	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Residential
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **Small Run of**

Flow Regulation Use **Recreation**

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

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**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
4	0	6
Diagonal	Delta	Island
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,024**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pekin Brook** Reach # **T3.11** Segment: **0** Completion Date: **September 9,**

Organization: **Bear Creek Environmental** Observers: **PD, AA** Rain: **No**

Segment Length (ft): **1,024** Segment Location: **Reach begins about 200 feet downstream of bridge on the road that connects Upper**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	Mid-segment	9.00	9.00	Yes	
Ledge	Mid-segment	7.00	6.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	5.50	Yes	Yes	Yes	Yes
Problem	Deposition Below,Scour Below				
Bridge	6.00	Yes	Yes	Yes	Yes
Problem	Alignment				
Culvert	1.70	Yes	No	Yes	Yes
Problem	Deposition Above,Scour Above,Scour				
Other	2.10	Yes	No	Yes	Yes
Problem	Deposition Above,Scour Above,Scour				
Bedrock	11.5	Yes	No	Yes	Yes
Problem	Scour Below				
Culvert	8.80	Yes	Yes	Yes	Yes
Problem	Scour Above,Scour Below,Alignment				
Other	7.50	Yes	No	Yes	Yes
Problem	Deposition Above,Scour Below				

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	**12**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**44**		
Geomorphic Rating	**0.55**		

Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	12
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	10
6.5 Channel Flow Status	14
6.6 Channel Alteration	1
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 9 Right: 9
6.9 Bank Vegetation Protection	Left: 3 Right: 2
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 1
Total Score	101
Habitat Rating	0.505

Habitat Stream Condition **Fair**

Narrative:

Minor historic incision. Some aggradation and planform change. May have widened. Reach has been straightened 100%. Probably has not incised much due to bedrock in bed. Little erosion due to rock wall armoring on both banks.

Project: **Kingsbury Branch** | **Phase 2 Segment Summary** | April 26, 2010 SGAT Version: 4.56

Stream: **Dugar Brook** | Reach # **T3.08S1.01** | Segment: **A** | Completion Date: **September 23, 2009**

Organization: **Bear Creek Environmental** | Observers: **PD, AA** | Why Not assessed: **wetland** | Rain: **No**

Segment Length (ft): **4,663** | Segment Location: **Segment begins at confluence with Pekin Brook and continues until wetland channel is no**

QC Status - Staff: **Provisional Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**0**	**0**
height	**0**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**0**	**0**

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	**None**	**0.00**
Gullies	**None**	**0.00**

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**
Erosion Height (ft)	**0.00**	**0.00**
Revetmt. Type	**None**	**None**
Revetmt. Length (ft)	**0**	**0**

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	**0**	**0**

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	**0**	**0**
Height	**0**	**0**

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **3**

Affected Length (ft) **750**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	**0**	**0**

Diagonal	Delta	Island
0	**0**	**0**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Dugar Brook** Reach # **T3.08S1.01** Segment: **A** Completion Date: **September 23,**
Organization: **Bear Creek Environmental** Observers: **PD, AA** Rain: **No**
Segment Length (ft): **4,663** Segment Location: **Segment begins at confluence with Pekin Brook and continues until wetland channel is**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition **Good**
Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Kingsbury Branch** | **Phase 2 Segment Summary** | April 26, 2010 SGAT Version: 4.56

Stream: **Dugar Brook** | Reach # **T3.08S1.01** | Segment: **B** | Completion Date: **September 23, 2009**

Organization: **Bear Creek Environmental** | Observers: **PD, AA** | Why Not assessed: | Rain: **No**

Segment Length (ft): **900** | Segment Location: **Segment begins where wetland channel is not influenced by beaver dams and continues**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Banks and Buffers**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	102	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Very Steep
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **780**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **21**

2.2 Max Depth (ft) **2.85**

2.3 Mean Depth (ft) **2.29**

2.4 Floodprone Width (ft) **753**

Notes:

Reach is channel that goes from forested area to wetland that is impacted by beaver dams. Planform has been affected due to beaver activity within reach.

Step 2. (Contued)

2.5 Aband. Floodpln **4.30** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **9.34**

2.7 Entrenchment Ratio **35.19**

2.8 Incision Ratio **1.51**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **67**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	3%
Coarse Gravel	24%
Fine Gravel	44%
Sand	29%
Silt and smaller	0%

Silt/Clay Present? **Yes**

Detritus **0** %

Large Woody **22**

2.13 Average Largest Particle on

Bed **8.2** inches

Bar **3.2** inches

2.14 Stream Type

Stream Type: **E**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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	Silt	Silt
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	20	8
Erosion Height (ft)	2.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Herbaceous
Sub-dominant	Herbaceous	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	None
W less than 25	3	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Residential	None
Mass Failures	0	0
Height	0	0

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.9 # of Beaver Dams **1**

Affected Length (ft) **50**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	5	6
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Dugar Brook** Reach # **T3.08S1.01** Segment: **B** Completion Date: **September 23,**

Organization: **Bear Creek Environmental** Observers: **PD, AA** Rain: **No**

Segment Length (ft): **900** Segment Location: **Segment begins where wetland channel is not influenced by beaver dams and**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	30.0	Yes	Yes	No	No

Problem Deposition Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**Yes**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**49**		
Geomorphic Rating	**0.6125**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Pool Substrate	15
6.3 Pool Variability	12
6.4 Sediment Deposition	9
6.5 Channel Flow Status	17
6.6 Channel Alteration	18
6.7 Channel Sinuosity	8
6.8 Bank Stability	Left: 10 Right: 10
6.9 Bank Vegetation Protection	Left: 8 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 10
Total Score	145
Habitat Rating	0.725

Habitat Stream Condition **Good**

Narrative:

Major historic incision. Some aggradation as seen through softened bed. Minor planform changes in spots due to beaver activity. Stream does not seem to be widening.

Project: Kingsbury Branch | **Phase 2 Segment Summary** | page 1 of 2 | April 26, 2010 SGAT Version: 4.56

Stream: **Dugar Brook** | Reach # **T3.08S1.01** | Segment: **C** | Completion Date: **September 23, 2009**

Organization: **Bear Creek Environmental** | Observers: **PD, AA** | Why Not assessed: | Rain: **No**

Segment Length (ft): **900** | Segment Location: **Segment begins where buffer turns more forested and continues until just upstream of a**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Banks and Buffers**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	900	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side

	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Sand	Not Evalua

1.5 Valley Features

Valley Width (ft) **470**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **21**

2.2 Max Depth (ft) **2.95**

2.3 Mean Depth (ft) **2.05**

2.4 Floodprone Width (ft) **450**

Notes:

Lots of sediment working its way through reach. High elevation bars.

Step 2. (Contued)

2.5 Aband. Floodpln **2.95** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **10.15**

2.7 Entrenchment Ratio **21.63**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **58**

2.12 Substrate Composition

Bedrock	0 %
Boulder	2 %
Cobble	5 %
Coarse Gravel	40 %
Fine Gravel	28 %
Sand	25 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **0** %

Large Woody **65**

2.13 Average Largest Particle on

Bed	7.5	inches
Bar	4.1	inches

2.14 Stream Type

Stream Type: **E**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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	Mix	Mix
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	21	36
Erosion Height (ft)	3.00	2.55
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	26-50	>100
Sub-dominant	51-100	None
W less than 25	153	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	Forest
Mass Failures	0	0
Height	0	0

Gullies **0**

Length **0**

Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

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**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	5	9
Diagonal	Delta	Island
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Dugar Brook** Reach # **T3.08S1.01** Segment: **C** Completion Date: **September 23,**

Organization: **Bear Creek Environmental** Observers: **PD, AA** Rain: **No**

Segment Length (ft): **900** Segment Location: **Segment begins where buffer turns more forested and continues until just upstream of**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	12.00	9.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	13.0	Yes	No	Yes	Yes
Problem	Deposition Above,Deposition Below,Scour				
Bedrock	35.0	Yes	No	No	Yes
Problem	Deposition Above,Deposition Below,Scour				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**No**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**15**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**52**		
Geomorphic Rating	**0.65**		

Channel Evolution Model **D**

Channel Evolution Stage **IId**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	17
6.2 Pool Substrate	16
6.3 Pool Variability	14
6.4 Sediment Deposition	10
6.5 Channel Flow Status	8
6.6 Channel Alteration	18
6.7 Channel Sinuosity	13
6.8 Bank Stability	Left: 9 Right: 9
6.9 Bank Vegetation Protection	Left: 9 Right: 10
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 10
Total Score	149
Habitat Rating	0.745

Habitat Stream Condition **Good**

Narrative:

Major aggradation, sediment working through reach, large bars (high elevation on some). Potential for change in planform; some neck cut offs.

Project: Kingsbury Branch
Stream: Dugar Brook
Reach # T3.08S1.02
Segment: 0
Completion Date: September 23, 2009
Organization: Bear Creek Environmental
Observers: PD, AA
Why Not assessed:
Rain: No
Segment Length (ft): 1,694
Segment Location: Reach begins at top of bedrock grade control where stream becomes close to road and is

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation None
1.2 Alluvial Fan None

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,694	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Sand

1.5 Valley Features

Valley Width (ft) 89
Width Determination Measured
Confinement Type Semi-confined
Rock Gorge? No
Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 26
2.2 Max Depth (ft) 2.40
2.3 Mean Depth (ft) 1.59
2.4 Floodprone Width (ft) 37

Notes:

Dugar Brook Road encroaches upon this reach considerably, but the reach has not incised since there is considerable bedrock in the bed. There are some stormwater inputs from the road that are bringing in more sediment to the reach. Reach is probably

Step 2. (Contued)

2.5 Aband. Floodpln 2.40 ft.
Human Elev Floodpln 0.00 ft.
2.6 Width/Depth Ratio 16.35
2.7 Entrenchment Ratio 1.40
2.8 Incision Ratio 1.00
Human Elevated Inc Rat 0.00
2.9 Sinuosity Low
2.10 Riffles Type Complete
2.11 Riffle/Step Spacing (ft) 61

2.12 Substrate Composition

Bedrock	0 %
Boulder	14 %
Cobble	24 %
Coarse Gravel	27 %
Fine Gravel	26 %
Sand	9 %
Silt and smaller	0 %

Silt/Clay Present? No
Detritus 0 %
Large Woody 82

2.13 Average Largest Particle on

Bed 14.4 inches
Bar 4.4 inches

2.14 Stream Type

Stream Type: B
Bed Material: Gravel
Subclass Slope: None
Bed Form: Riffle-Pool
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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)	9	68
Erosion Height (ft)	2.00	4.02
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	168	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	76-100

Mid-Channel Canopy Closed

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	>100
Sub-dominant	26-50	None
W less than 25	851	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Forest
Sub-dominant	Forest	Shrubs/Saplin
Mass Failures	0	0
Height	0	0

Gullies 0
Length 0
Height 0.00

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 Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg None
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	2
Other	0	Tile Drain	0
Overland Flow	1	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams 0
Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
4	1	12
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
5	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal No
5.5 Straightening None
Straightening Length: 0
5.5 Dredging None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Kingsbury Branch** **Phase 2 Reach Summary**

Stream: **Dugar Brook** Reach # **T3.08S1.02** Segment: **0** Completion Date: **September 23,**

Organization: **Bear Creek Environmental** Observers: **PD, AA** Rain: **No**

Segment Length (ft): **1,694** Segment Location: **Reach begins at top of bedrock grade control where stream becomes close to road and**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	6.00	5.00	Yes	

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**56**		
Geomorphic Rating	**0.7**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	15
6.2 Embeddedness	15
6.3 Velocity/Depth Patterns	14
6.4 Sediment Deposition	13
6.5 Channel Flow Status	16
6.6 Channel Alteration	17
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 10 Right: 9
6.9 Bank Vegetation Protection	Left: 6 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 1 Right: 10
Total Score	151
Habitat Rating	0.755

Habitat Stream Condition **Good**

Narrative:

Channel has not incised because of bedrock control. The reach is probably naturally straight, but it is difficult to know for sure.

Phase 2 Segment Summary

April 26, 2010 SGAT Version: 4.56

Project: **Kingsbury Branch**
Stream: **Dugar Brook** Reach # **T3.08S1.03** Segment: **0** Completion Date: **September 30, 2009**
Organization: **Bear Creek Environmental** Observers: **PD, DC** Why Not assessed: Rain: **Yes**
Segment Length (ft): **1,302** Segment Location: **Segment begins near the top of the waterfalls and continues until just below bedrock grade**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	209	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Sand

1.5 Valley Features
Valley Width (ft) **300**
Width Determination **Measured**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **21**
2.2 Max Depth (ft) **2.65**
2.3 Mean Depth (ft) **1.94**
2.4 Floodprone Width (ft) **264**

Notes:
Reach has experienced planform change.
Large flood chutes and depositional bars.

Step 2. (Contued)

2.5 Aband. Floodpln **3.65** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **10.88**
2.7 Entrenchment Ratio **12.50**
2.8 Incision Ratio **1.38**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Moderate**
2.10 Riffles Type **Complete**
2.11 Riffle/Step Spacing (ft) **125**

2.12 Substrate Composition

Bedrock	0%
Boulder	13%
Cobble	35%
Coarse Gravel	30%
Fine Gravel	14%
Sand	8%
Silt and smaller	0%

Silt/Clay Present? **Yes**
Detritus **0** %
Large Woody **20**

2.13 Average Largest Particle on
Bed **15.8** inches
Bar **7.3** inches

2.14 Stream Type
Stream Type: **E**
Bed Material: **Gravel**
Subclass Slope: **b**
Bed Form: **Riffle-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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	Silt	Silt
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	166	133
Erosion Height (ft)	3.07	4.15
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Forest
Sub-dominant	Residential	Shrubs/Saplin
Mass Failures	0	0
Height	0	0

Gullies **0**
Length **0**
Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**
4.2 Adjacent Wetlands **Abundant**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **0**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	1	5
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **None**
Straightening Length: **0**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Dugar Brook** Reach # **T3.08S1.03** Segment: **0** Completion Date: **September 30,**

Organization: **Bear Creek Environmental** Observers: **PD, DC** Rain: **Yes**

Segment Length (ft): **1,302** Segment Location: **Segment begins near the top of the waterfalls and continues until just below bedrock**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**Yes**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**7**		**No**
Total Score	**38**		
Geomorphic Rating	**0.475**		

Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	10
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	5
6.5 Channel Flow Status	8
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	17
6.8 Bank Stability	Left: 7 Right: 7
6.9 Bank Vegetation Protection	Left: 9 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 10
Total Score	132
Habitat Rating	0.66

Habitat Stream Condition **Good**

Narrative:
Channel incised slightly and then widened. Large flood chutes and depositional bars. Major aggradation and change in planform.

Phase 2 Segment Summary

April 26, 2010 SGAT Version: 4.56

Project: **Kingsbury Branch**
Stream: **Dugar Brook** Reach # **T3.08S1.04** Segment: **A** Completion Date: **September 30, 2009**
Organization: **Bear Creek Environmental** Observers: **PD, DC** Why Not assessed: **bedrock gorge** Rain: **Yes**
Segment Length (ft): **197** Segment Location: **Segment begins at the bottom of the ledge grade controls just downstream of Apple Hill**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	184	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	24

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Bedrock

1.5 Valley Features
Valley Width (ft) **77**
Width Determination **Measured**
Confinement Type **Semi-confined**
Rock Gorge? **Yes**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **0**
2.2 Max Depth (ft) **0.00**
2.3 Mean Depth (ft) **0.00**
2.4 Floodprone Width (ft) **0**

Notes:
Reach contains several bedrock grade controls that were all added up as one. Reach is very stable apart from a small mass failure just downstream of the bridge, which is a result of rip-rap failure at the bridge. The valley is well forested. Dugar Brook Road is

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **0.00**
2.7 Entrenchment Ratio **0.00**
2.8 Incision Ratio **0.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) **0**
2.12 Substrate Composition

Silt/Clay Present?
Detritus **0** %
Large Woody **0**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**

2.14 Stream Type
Stream Type: **B**
Bed Material: **Cobble**
Subclass Slope: **a**
Bed Form: **Step-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
B 3 a Step-Pool

3.3 old	Amount	Mean Height
Failures	One	13.00
Gullies	None	0.00

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	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	14	0
Erosion Height (ft)	2.00	0.00
Revetmt. Type	Hard Bank	Hard Bank
Revetmt. Length (ft)	30	29

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	26-50	51-100
W less than 25	30	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Forest
Sub-dominant	Forest	Residential
Mass Failures	0	10
Height	0	13

Gullies **0**
Length **0**
Height **0.00**

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 Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.7 StormwaterInputs

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**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **37**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project:	**Kingsbury Branch**		**Phase 2 Reach Summary**	page 2 of 2	April 26, 2010
Stream:	**Dugar Brook**	Reach #	**T3.08S1.04**	Segment: **A**	Completion Date: **September 30,**
Organization:	**Bear Creek Environmental**	Observers:	**PD, DC**		Rain: **Yes**
Segment Length (ft):	**197**	Segment Location:	**Segment begins at the bottom of the ledge grade controls just downstream of Apple**		

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	27.00	23.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	12.0	Yes	Yes	Yes	Yes

Problem Scour Above,Scour Below

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Dugar Brook** Reach # **T3.08S1.04** Segment: **B** Completion Date: **September 30, 2009**

Organization: **Bear Creek Environmental** Observers: **PD, DC** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,157** Segment Location: **Segment begins just upstream of Apple Hill Road crossing and continues about 1150 feet**

QC Status - Staff: **Provisional** **Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Grade Controls**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,157	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	52	2

1.4 Adjacent Side

	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Sand

1.5 Valley Features

- Valley Width (ft) **107**
- Width Determination **Measured**
- Confinement Type **Narrow**
- Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	29
2.2 Max Depth (ft)	2.10
2.3 Mean Depth (ft)	1.34
2.4 Floodprone Width (ft)	46

Notes:

Segment has been impacted by road placement. It has been straightened and armored with rip-rap and the flood plain has been modified such that there has been a stream type departure in parts of the segment. There is a small section of plane

Step 2. (Contued)

2.5 Aband. Floodpln	3.00 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	21.64
2.7 Entrenchment Ratio	1.59
2.8 Incision Ratio	1.43
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	110

2.12 Substrate Composition

Bedrock	0 %
Boulder	17 %
Cobble	35 %
Coarse Gravel	27 %
Fine Gravel	9 %
Sand	12 %
Silt and smaller	0 %

- Silt/Clay Present? **Yes**
- Detritus **0** %
- # Large Woody **15**

2.13 Average Largest Particle on

Bed	12.1	inches
Bar	7.4	inches

2.14 Stream Type

- Stream Type: **B**
- Bed Material: **Cobble**
- Subclass Slope: **None**
- Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	136	66
Erosion Height (ft)	5.19	2.68
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	444	29

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Coniferous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	26-50	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	>100
Sub-dominant	26-50	51-100
W less than 25	822	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Coniferous
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Forest
Sub-dominant	Shrubs/Saplin	Residential
Mass Failures	0	0
Height	0	0

- Gullies **0**
- Length **0**
- Height **0.00**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
4.2 Adjacent Wetlands	Abundant
4.3 Flow Status	Moderate
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	1
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **1**
- Affected Length (ft) **500**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	4

Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **Straightening**
- Straightening Length: **740**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Dugar Brook** Reach # **T3.08S1.04** Segment: **B** Completion Date: **September 30,**

Organization: **Bear Creek Environmental** Observers: **PD, DC** Rain: **Yes**

Segment Length (ft): **1,157** Segment Location: **Segment begins just upstream of Apple Hill Road crossing and continues about 1150**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	4.00	2.00	Yes	
Ledge	Mid-segment	5.00	3.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	13.0	Yes	Yes	Yes	Yes
Problem	Scour Above,Scour Below				
Bridge	2.80	Yes	Yes	Yes	Yes
Problem	Deposition Below,Scour Above,Scour				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**7**	**C to B**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**42**		
Geomorphic Rating	**0.525**		

Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	10
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	17
6.4 Sediment Deposition	14
6.5 Channel Flow Status	13
6.6 Channel Alteration	4
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 7 Right: 9
6.9 Bank Vegetation Protection	Left: 5 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 2 Right: 9
Total Score	128
Habitat Rating	0.64

Habitat Stream Condition **Fair**

Narrative:

Channel evolution is FII-III. Major historic incision due to road and straightening. Minor aggradation. Channel width is wider than reference. Stream type departure and valley type change.

Project: Kingsbury Branch — **Phase 2 Segment Summary** — April 26, 2010 SGAT Version: 4.56

Stream: **Trib 1 to Pekin Brook** Reach # **T3.03S1.01** Segment: **A** Completion Date: **October 8, 2009**

Organization: **Bear Creek Environmental** Observers: **PD, SP, AA** Why Not assessed: Rain: **Yes**

Segment Length (ft): **431** Segment Location: **Segment begins at confluence with Pekin Brook and continues until just upstream of**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	431	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	32

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Very Steep
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **630**
Width Determination **Estimated**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **14**
2.2 Max Depth (ft) **2.65**
2.3 Mean Depth (ft) **1.74**
2.4 Floodprone Width (ft) **630**

Notes:

There was no valley wall observable. Valley hits Pekin Brook and both sides. Valley width was estimated. Segment has been armored and straightened considerably and there is no buffer on either side.

Step 2. (Contued)

2.5 Aband. Floodpln **3.45** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **7.93**
2.7 Entrenchment Ratio **45.65**
2.8 Incision Ratio **1.30**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **95**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	26 %
Fine Gravel	47 %
Sand	27 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**
Detritus **0** %
Large Woody **0**

2.13 Average Largest Particle on

Bed **1.9** inches
Bar **1.5** inches

2.14 Stream Type

Stream Type: **E**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Riffle-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
E 4 Non Riffle-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

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	Silt	Silt
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	91	213
Erosion Height (ft)	2.92	2.81
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	102	162

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	None	None
W less than 25	418	403

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Hay
Sub-dominant	Pasture	None
Mass Failures	0	0
Height	0	0

Gullies **0**
Length **0**
Height **0.00**

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 Regulation Use
Impoundments
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	3
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **422**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Trib 1 to Pekin Brook** Reach # **T3.03S1.01** Segment: **A** Completion Date: **October 8, 2009**

Organization: **Bear Creek Environmental** Observers: **PD, SP, AA** Rain: **Yes**

Segment Length (ft): **431** Segment Location: **Segment begins at confluence with Pekin Brook and continues until just upstream of**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	14.0	Yes	Yes	Yes	Yes

Problem Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**43**		
Geomorphic Rating	**0.5375**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	10
6.2 Pool Substrate	16
6.3 Pool Variability	3
6.4 Sediment Deposition	5
6.5 Channel Flow Status	18
6.6 Channel Alteration	5
6.7 Channel Sinuosity	3
6.8 Bank Stability	Left: 6 Right: 3
6.9 Bank Vegetation Protection	Left: 6 Right: 5
6.10 Riparian Vegetation Zone Width	Left: 1 Right: 1
Total Score	82
Habitat Rating	0.41

Habitat Stream Condition **Fair**

Narrative:

Evolution stage FII - III. Historic incision; lots of erosion (banks are falling in), but has not widened much. Riffles are not formed well from minor aggradation. Planform completely altered due to straightening for road and ag. fields.

Project:	Kingsbury Branch		**Phase 2 Segment Summary**	page 1 of 2	April 26, 2010 SGAT Version: 4.56
Stream:	**Trib 1 to Pekin Brook**	Reach #	**T3.03S1.01**	Segment: **B**	Completion Date: **October 8, 2009**
Organization:	**Bear Creek Environmental**	Observers:	**PD, SP, AA**	Why Not assessed:	Rain: **Yes**
Segment Length (ft):	**965**	Segment Location:	**Segment begins at crossing of Pekin Brook Road and continues until confluence with**		

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	965	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	160	17

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Sand

1.5 Valley Features

- Valley Width (ft) **283**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	26
2.2 Max Depth (ft)	2.20
2.3 Mean Depth (ft)	1.26
2.4 Floodprone Width (ft)	336

Notes:

Segment is considerably impacted by agricultural activities at the dairy farm. No buffer and animal fords have contributed to bank erosion. Tile drains are creating stormwater inputs as well. Good CREP project location.

Step 2. (Contued)

2.5 Aband. Floodpln	2.60 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	20.63
2.7 Entrenchment Ratio	12.90
2.8 Incision Ratio	1.18
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Sedimented
2.11 Riffle/Step Spacing (ft)	175

2.12 Substrate Composition

Bedrock	0 %
Boulder	1 %
Cobble	18 %
Coarse Gravel	43 %
Fine Gravel	15 %
Sand	23 %
Silt and smaller	0 %

- Silt/Clay Present? **Yes**
- Detritus **0** %
- # Large Woody **4**

2.13 Average Largest Particle on

Bed	9.0	inches
Bar	3.8	inches

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Gravel**
- Subclass Slope: **None**
- Bed Form: **Riffle-Pool**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	100.00
Gullies	None	0.00

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	Silt	Silt
Consistency	Cohesive	Cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	631	398
Erosion Height (ft)	2.32	2.62
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	65	58
Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Coniferous
Sub-dominant	Shrubs/Saplin	Herbaceous
Bank Canopy	Left	Right
Canopy %	1-25	51-75
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	26-50
Sub-dominant	None	>100
W less than 25	964	628
Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Coniferous
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Pasture	Residential
Sub-dominant	Residential	Forest
Mass Failures	0	40
Height	0	100
Gullies	0	
Length	0	
Height	0.00	

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	1
4.5 Flow Regulation Type	Small
Flow Regulation Use	Other
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	1
Other	0	Tile Drain	3
Overland Flow	1	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	2	3
Diagonal	**Delta**	**Island**
3	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

- 5.4 Stream Ford or Animal **Yes**
- 5.5 Straightening **Straightening**
- Straightening Length: **944**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream:	**Trib 1 to Pekin Brook**	Reach #	**T3.03S1.01**
Segment:	**B**	Completion Date:	**October 8, 2009**
Organization:	**Bear Creek Environmental**	Observers:	**PD, SP, AA**
Rain:	**Yes**	Segment Length (ft):	**965**
Segment Location:	**Segment begins at crossing of Pekin Brook Road and continues until confluence with**		

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	5.50	Yes	Yes	Yes	Yes

Problem Deposition Above,Deposition Below,Scour

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**12**	**None**	**Yes**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**7**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**35**		
Geomorphic Rating	**0.4375**		

Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	5
6.2 Embeddedness	14
6.3 Velocity/Depth Patterns	10
6.4 Sediment Deposition	9
6.5 Channel Flow Status	15
6.6 Channel Alteration	6
6.7 Frequency of Riffles/Steps	15
6.8 Bank Stability	Left: 1 Right: 3
6.9 Bank Vegetation Protection	Left: 2 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 2 Right: 3
Total Score	92
Habitat Rating	0.46

Habitat Stream Condition **Fair**

Narrative:

Very minor incision although small downstream section is more incised due to road probably. Channel has widened due to bank erosion. A large portion of segment (75%) is accessible by pasture cows. Change in planform due to straightening of reach.

Stream Geometry Data

Kingsbury Branch

Reach	Seg-ment	Stream Type	Bed Material	Bedform	Subcl. Slope	Sub Rch?	Channel Slope	Channel width	Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn FldPln	W/D Ratio	Entrench-ment	Incision Ratio	Stage Evol.	Evol. Model	RGA Cond.	RHA Cond.	QC Stf	QC Aut
		Phase 2 Stream Type					Phase 1 Data		Phase 2 Channel Data													
M01	0	C	Sand	Plane Bed	None	No	0.15	46.00	46.0	4.7	3.74	227.0	7.8	12.30	4.93	1.66	III	F	Fair	Fair	P	P
M02	0	C	Sand	Dune-Ripple	None	No	0.16	58.80	58.8	6.3	3.6	360.0	9.1	16.33	6.12	1.44	III	F	Fair	Good	P	P
M03	0	E	Sand	Dune-Ripple	None	No	0.23	74.71											Fair		P	F
M05	0	E	Sand	Dune-Ripple	None	No	0.02	71.89											Good		P	F
M06	0	E	Sand	Dune-Ripple	None	No	0.07	35.50	35.5	6.7	4.43	360.0	6.7	8.01	10.14	1.00	IIc	D	Fair	Fair	P	P
M07	0	E	Sand	Dune-Ripple	None	No	0.07	34.20	34.25	5.6	4.33	465.0	6.6	7.91	13.58	1.18	IIc	D	Fair	Fair	P	P
M08	A	E	Sand	Dune-Ripple	None	No	0.13	51.03											Fair		P	F
M08	B	E	Gravel	Riffle-Pool	None	No	0.13	51.03											Fair		P	F
M09	0	E	Gravel	Riffle-Pool	None	No	0.15	31.50	31.5	4.0	2.72	327.0	6.7	11.58	10.38	1.67	III	F	Fair	Fair	P	P
M10	0	E	Gravel	Riffle-Pool	None	No	0.29	31.80	31.8	3.7	2.79	308.0	5.6	11.40	9.69	1.51	III	F	Fair	Fair	P	P
M11	A	C	Gravel	Riffle-Pool	None	No	0.63	49.45	45.5	3.65	2.32	709.0	3.65	19.61	15.58	1.00	IId	D	Fair	Fair	P	P
M11	B	B	Gravel	Riffle-Pool	c	No	0.63	49.45	48.5	3.0	2.07	78.0	10.0	23.43	1.61	3.33	III	F	Fair	Good	P	P
M12	A	B	Gravel	Plane Bed	None	No	4.72	47.37	36.4	3.5	2.89	58.9	4.6	12.60	1.62	1.31	III	F	Good	Good	P	P
M12	B	A	Cobble	Cascade	None	Yes	4.72	47.37											Good		P	F
M14	A	C	Gravel	Riffle-Pool	None	No	0.31	47.10											Good		P	F
M14	B	E	Sand	Dune-Ripple	None	Yes	0.31	47.10	21.0	3.3	2.49	485.0	3.3	8.43	23.10	1.00	IIc	D	Good	Good	P	P
M14	C	C	Gravel	Riffle-Pool	None	No	0.31	47.10	41.5	3.3	1.9	548.0	3.3	21.84	13.20	1.00	IIc	D	Good	Good	P	P
M15	A	C	Gravel	Riffle-Pool	None	No	0.43	44.37	40.3	3.1	1.77	650.0	3.1	22.77	16.13	1.00	IIc	D	Good	Fair	P	P
M15	B	C	Gravel	Riffle-Pool	None	No	0.43	44.37	41.0	3.2	2.0	208.0	3.2	20.50	5.07	1.00	IId	D	Fair	Good	P	P
M16	0	C	Gravel	Riffle-Pool	None	No	0.42	43.10	47.0	2.8	1.98	119.0	3.3	23.74	2.53	1.18	IIc	D	Fair	Good	P	P
T3.01	0	E	Sand	Dune-Ripple	None	No	0.37	51.73											Fair		P	F
T3.02	0	E	Sand	Plane Bed	None	No	0.22	31.30	31.3	4.8	3.88	116.0	5.5	8.07	3.71	1.15	IIc	D	Fair	Fair	P	P
T3.03	A	E	Sand	Dune-Ripple	None	No	0.06	38.00											Good		P	F
T3.03	B	E	Sand	Dune-Ripple	None	No	0.06	38.00	38.0	4.5	3.5	292.0	4.5	10.86	7.68	1.00	IIc	D	Fair	Fair	P	P
T3.03S1.01	A	E	Gravel	Riffle-Pool	None	Yes	0.64	24.11	13.8	2.65	1.74	630.0	3.45	7.93	45.65	1.30	II	F	Fair	Fair	P	P
T3.03S1.01	B	C	Gravel	Riffle-Pool	None	No	0.64	24.11	26.0	2.2	1.26	335.5	2.6	20.63	12.90	1.18	III	F	Fair	Fair	P	P
T3.04	A	E	Sand	Dune-Ripple	None	Yes	0.17	46.45	29.0	4.0	3.2	418.0	4.0	9.06	14.41	1.00	IIc	D	Fair	Fair	P	P
T3.04	B	C	Sand	Riffle-Pool	None	No	0.17	46.45	44.0	3.6	2.3	348.0	3.6	19.13	7.91	1.00	IIc	D	Fair	Fair	P	P
T3.04	C	C	Gravel	Riffle-Pool	None	No	0.17	46.45	33.0	4.25	2.27	312.0	4.95	14.54	9.45	1.16	IIc	D	Fair	Fair	P	P
T3.05	A	C	Gravel	Riffle-Pool	None	No	0.50	45.40	47.2	3.3	1.83	547.0	3.3	25.79	11.59	1.00	IIc	D	Good	Fair	P	P
T3.05	B	C	Gravel	Riffle-Pool	None	No	0.50	45.40	49.0	3.2	1.78	165.0	3.2	27.53	3.37	1.00	IIc	D	Good	Good	P	P
T3.06	A	C	Gravel	Riffle-Pool	None	No	0.49	40.32	44.0	3.2	2.16	162.0	5.9	20.37	3.68	1.84	III	F	Fair	Good	P	P

		Phase 2 Stream Type					Phase 1 Data		Phase 2 Channel Data													
Reach	Seg-ment	Stream Type	Bed Material	Bedform	Subcl. Slope	Sub Rch?	Channel Slope	Channel width	Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn FldPln	W/D Ratio	Entrench-ment	Incision Ratio	Stage Evol.	Evol. Model	RGA Cond.	RHA Cond.	QC Stf	QC Aut
T3.06	B	C	Gravel	Plane Bed	None	No	0.49	40.32	32.0	3.8	2.15	298.7	7.4	14.88	9.33	1.95	II	F	Fair	Fair	P	P
T3.07	0	B	Cobble	Step-Pool	a	No	5.31	38.01											Fair		P	F
T3.08	0	E	Sand	Dune-Ripple	None	No	0.13	37.87											Good		P	F
T3.08S1.01	A	E	Sand	Dune-Ripple	None	No	0.57	21.00											Good		P	F
T3.08S1.01	B	E	Gravel	Riffle-Pool	None	No	0.57	21.00	21.4	2.85	2.29	753.0	4.3	9.34	35.19	1.51	IV	F	Fair	Good	P	P
T3.08S1.01	C	E	Gravel	Riffle-Pool	None	No	0.57	21.00	20.8	2.95	2.05	450.0	2.95	10.15	21.63	1.00	IId	D	Good	Good	P	P
T3.08S1.02	0	B	Gravel	Riffle-Pool	None	No	2.18	23.70	26.0	2.4	1.59	36.5	2.4	16.35	1.40	1.00	I	F	Good	Good	P	P
T3.08S1.03	0	E	Gravel	Riffle-Pool	b	No	2.69	23.18	21.1	2.65	1.94	263.7	3.65	10.88	12.50	1.38	III	F	Fair	Good	P	P
T3.08S1.04	A	B	Cobble	Step-Pool	a	Yes	3.40	21.90											Good		P	F
T3.08S1.04	B	B	Cobble	Riffle-Pool	None	No	3.40	21.90	29.0	2.1	1.34	46.0	3.0	21.64	1.59	1.43	II	F	Fair	Fair	P	P
T3.09	0	C	Gravel	Riffle-Pool	None	No	1.72	28.77											Fair		P	F
T3.10	A	C	Gravel	Riffle-Pool	None	No	1.66	27.33	25.6	1.85	1.11	218.0	2.65	23.06	8.52	1.43	IV	F	Fair	Good	P	P
T3.10	B	C	Gravel	Step-Pool	b	Yes	1.66	27.33	20.5	2.15	1.39	76.0	3.25	14.75	3.71	1.51	IV	F	Fair	Good	P	P
T3.11	0	B	Cobble	Step-Pool	a	No	5.86	26.47	27.5	2.1	1.26	44.2	2.4	21.83	1.61	1.14	II	F	Fair	Fair	P	P

Rapid Geomorphic Assessment

Kingsbury Branch

Reach	Seg-ment	Sub-Rch?	Degradation Score	Degradation STD	Degradation Historic	Aggradation Score	Aggradation STD	Aggradation Historic	Widening Score	Widening Historic	Planform Score	Planform Historic	Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC Stf	QC Aut
M01	0	No	7	None	Yes	5	Other	No	12	No	13	No	0.46	Fair	III	BD	Extreme	P	P
M02	0	No	8	None	Yes	9	None	No	10	No	9	No	0.45	Fair	III	BD	Extreme	P	P
M03	0	No											0.00	Fair		BD	Extreme	P	F
M05	0	No											0.00	Good		BD	High	P	F
M06	0	No	16	None	No	12	None	No	13	No	6	No	0.59	Fair	IIc	VB	Extreme	P	P
M07	0	No	16	None	No	13	None	No	12	No	8	No	0.61	Fair	IIc	VB	Extreme	P	P
M08	A	No											0.00	Fair		BD	Extreme	P	F
M08	B	No											0.00	Fair		VB	Extreme	P	F
M09	0	No	8	None	Yes	12	None	No	13	No	9	No	0.53	Fair	III	BD	Extreme	P	P
M10	0	No	8	None	Yes	10	None	No	10	No	8	No	0.45	Fair	III	BD	Extreme	P	P
M11	A	No	18	None	No	7	None	No	13	No	5	No	0.54	Fair	IId	VB	Very	P	P
M11	B	No	3	C to B	Yes	13	None	No	13	No	13	No	0.53	Fair	III	BD	Very	P	P
M12	A	No	13	None	Yes	14	None	No	18	No	9	No	0.68	Good	III	SC	Moderat	P	P
M12	B	Yes											0.00	Good		NC	High	P	F
M14	A	No											0.00	Good			High	P	F
M14	B	Yes	16	None	No	13	None	No	18	No	12	No	0.74	Good	IIc	VB	High	P	P
M14	C	No	17	None	No	13	None	No	13	No	9	No	0.65	Good	IIc	VB	High	P	P
M15	A	No	16	None	Yes	13	None	No	15	No	12	No	0.70	Good	IIc	VB	High	P	P
M15	B	No	16	None	No	8	None	No	14	No	5	No	0.54	Fair	IId	VB	Very	P	P
M16	0	No	16	None	Yes	10	None	No	12	No	9	No	0.59	Fair	IIc	NW	Very	P	P
T3.01	0	No											0.00	Fair		BD	Extreme	P	F
T3.02	0	No	17	None	No	14	None	No	8	No	8	No	0.59	Fair	IIc	NW	Extreme	P	P
T3.03	A	No											0.00	Good		NW	High	P	F
T3.03	B	No	18	None	No	12	None	No	12	No	8	No	0.63	Fair	IIc	VB	Extreme	P	P
T3.03S1.01	A	Yes	10	None	Yes	12	None	No	13	No	8	No	0.54	Fair	II	VB	Extreme	P	P
T3.03S1.01	B	No	12	None	Yes	8	None	No	7	No	8	No	0.44	Fair	III	VB	Very	P	P
T3.04	A	Yes	18	None	No	12	None	No	12	No	3	No	0.56	Fair	IIc	VB	Extreme	P	P
T3.04	B	No	17	None	No	12	None	No	12	No	9	No	0.63	Fair	IIc	NW	Very	P	P
T3.04	C	No	16	None	No	11	None	No	12	No	7	No	0.58	Fair	IIc	BD	Very	P	P
T3.05	A	No	16	None	No	12	None	No	13	No	13	No	0.68	Good	IIc	VB	High	P	P
T3.05	B	No	18	None	No	12	None	No	14	No	10	No	0.68	Good	IIc	BD	High	P	P
T3.06	A	No	7	None	Yes	12	None	No	14	No	8	No	0.51	Fair	III	BD	Very	P	P
T3.06	B	No	6	None	Yes	12	None	No	14	No	8	No	0.50	Fair	II	VB	Very	P	P

Reach	Seg-ment	Sub-Rch?	Degradation Score	Degradation STD	Degradation Historic	Aggradation Score	Aggradation STD	Aggradation Historic	Widening Score	Widening Historic	Planform Score	Planform Historic	Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC Stf	QC Aut
T3.07	0	No											0.00	Fair				P	F
T3.08	0	No											0.00	Good				P	F
T3.08S1.01	A	No											0.00	Good				P	F
T3.08S1.01	B	No	10	None	Yes	8	None	No	16	No	15	No	0.61	Fair	IV	VB	Extreme	P	P
T3.08S1.01	C	No	14	None	No	9	None	No	15	No	14	No	0.65	Good	IId	VB	High	P	P
T3.08S1.02	0	No	14	None	No	15	None	No	14	No	13	No	0.70	Good	I	SC	Moderat	P	P
T3.08S1.03	0	No	14	None	Yes	9	None	No	8	No	7	No	0.48	Fair	III	VB	Extreme	P	P
T3.08S1.04	A	Yes											0.00	Good		SC		P	F
T3.08S1.04	B	No	7	C to B	Yes	13	None	No	11	No	11	No	0.53	Fair	II	NW	High	P	P
T3.09	0	No											0.00	Fair				P	F
T3.10	A	No	9	None	Yes	11	None	No	17	No	10	No	0.59	Fair	IV	VB	Very	P	P
T3.10	B	Yes	8	None	Yes	14	None	No	13	No	12	No	0.59	Fair	IV	VB	Very	P	P
T3.11	0	No	11	None	Yes	13	None	No	12	No	8	No	0.55	Fair	II	BD	High	P	P

APPENDIX B

STREAM CROSSING ASSESSMENTS

Unnamed Tributary to Pekin Brook
Pekin Brook Road
Segment T3.03S1.01-A

Culvert Length: 29.5 feet
Culvert Height: 5.1 feet
Culvert Width: 14 feet


Outlet


Inlet

Geomorphic Compatibility – Partially Compatible

Percent Bankfull Width – Sufficient (101%)
Slope – Culvert slope is lower than channel
Approach Angle – Channelized straight
Erosion and Armoring – High erosion downstream, low upstream; armoring intact
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Additional problems noted: scour below; mid-channel bar in structure; low clearance

Aquatic Organism Passage – Reduced

Priority for Replacement - Moderate

Unnamed Tributary to Pekin Brook
George Road
Segment T3.03S1.01-B

Culvert Length: 40 feet
Culvert Height: 5.5 feet
Culvert Width: 5.5 feet

Outlet

Geomorphic Compatibility – Mostly Incompatible

Percent Bankfull Width – Significantly Undersized (23%)
Slope – Culvert slope as compared to channel slope is the same
Approach Angle – Sharp bend
Erosion and Armoring – Erosion is high and armoring is failing both upstream and downstream
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Scour below structure, deposition above and below; structured skewed to roadway

Aquatic Organism Passage – Reduced

Priority for Replacement - High

Dugar Brook
Apple Hill Road
Segment T3.08S1.04-A

Road Width: 29 feet
Bridge Clearance: 9.1 feet
Bridge Span: 13 feet


Inlet


Outlet

Geomorphic Compatibility – Not applicable

Percent Bankfull Width – Undersized (59%)
Slope – Not applicable to bridges
Approach Angle – Channelized straight
Erosion and Armoring – Upstream hard bank armoring intact, downstream failing and creating mass failure
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Scour above and below structure; bedrock present; good location for bridge due to bedrock; structure located at a significant change in valley slope

Aquatic Organism Passage – Not applicable

Priority for Replacement - Low

Dugar Brook
Private Driveway
Segment T3.08S1.04-B

Road Width: 12 feet
Bridge Clearance: 2.5 feet
Bridge Span: 2.8

Outlet

Inlet

Geomorphic Compatibility – Not applicable

Percent Bankfull Width – Significantly Undersized (14%)
Slope – Not applicable to bridges
Approach Angle – Channelized straight
Erosion and Armoring – No erosion or hard bank armoring upstream or downstream
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Deposition below, scour above and below; woody debris at upstream opening; unstable – made of timber and shale slabs that are falling in; low clearance

Aquatic Organism Passage – Not applicable

Priority for Replacement - High

Pekin Brook
Moscow Woods Road
Reach T3.09

Culvert Length: 47 feet
Culvert Height: 6.1 feet
Culvert Width: 5.7 feet

Inlet

Geomorphic Compatibility – Partially Compatible

Percent Bankfull Width –Significantly Undersized (22%)
Slope – Culvert slope higher than channel slope
Approach Angle – Channelized straight
Erosion and Armoring – Low erosion downstream; upstream armoring intact
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Scour above and below; no material in structure; bow in center of structure; cascade at downstream end with 0.3 foot drop; pool >4 feet deep downstream of structure

Aquatic Organism Passage – Reduced

Priority for Replacement - Moderate

Pekin Brook
Private Crossing
Segment T3.10-A

Road Width: 12.5 feet
Bridge Clearance: 3.6 feet
Bridge Span: 4.4 feet


Outlet


Inlet

Geomorphic Compatibility – Not applicable

Percent Bankfull Width – Significantly Undersized (16%)
Slope – Not applicable to bridges
Approach Angle – Mild bend
Erosion and Armoring – No erosion upstream and downstream; downstream armoring failing
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Downstream scour, upstream deposition; steep riffle upstream of structure

Aquatic Organism Passage – Not applicable

Priority for Replacement - Moderate

Pekin Brook
TH 16
Reach T3.11

Road Width: 17 feet
Bridge Clearance: 6.5 feet
Bridge Span: 6 feet


Inlet


Outlet

Geomorphic Compatibility – Not applicable

Percent Bankfull Width – Significantly Undersized (23%)
Slope – Not applicable to bridges
Approach Angle – Channelized straight
Erosion and Armoring – Upstream and downstream armoring is failing
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Dam just upstream of structure; bedrock present upstream and downstream; structure close to house; structure not aligned with channel; steep riffle upstream of structure

Aquatic Organism Passage – Not applicable

Priority for Replacement - Moderate

Pekin Brook
North Calais Road
Reach T3.11

Culvert Length: 50 feet
Culvert Height: 13 feet
Culvert Width: 9 feet

Outlet

Inlet

Geomorphic Compatibility – Mostly Compatible

Percent Bankfull Width – Significantly Undersized (33%)
Slope – Culvert slope as compared to channel slope is the same
Approach Angle – Channelized straight
Erosion and Armoring – No erosion; armoring intact
Sediment Continuity – No sediment deposits greater than ½ bankfull channel width
Notes: Channelized through box culvert with hard bank walls; deep pool at outlet; scour upstream and downstream; structure not aligned with channel.

Aquatic Organism Passage – Full

Priority for Replacement – Low