Inter-Fluve, Inc.

Technical Memorandum

To:	Steve Landry, NH DES; Shane Csiki, NHGS
From:	Nick Nelson, Inter-Fluve
Date:	December 11, 2011
Regarding:	Basis of Design Memo for the Stabilization of the Suncook River - 30% complete designs

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Introduction

Inter-Fluve was contracted by the NH Department of Environmental Services (NH DES) to design and permit the restoration of the Suncook River in Epsom, NH. In 2006, a large flood event on the Suncook River resulted in a channel avulsion between the Huckins Mill Dam and the Rt 4 bridge. This avulsion caused the abandonment of the primary and secondary channels and created a new channel to the east of Bear Island. The Suncook River is continuing to adjust to its shorter channel length by migrating laterally and incising. The incision is highlighted by a series of knickpoints that are migrating upstream on the Suncook River and its tributaries, primarily the Little Suncook River and Leighton Brook. The primary goal of this project is to prevent the Rt 4 bridge over the Suncook River and the Black Hall Rd culvert at Leighton Brook from being undercut by these migrating knickpoints. The four study areas, as presented in the design plans, are the Second Riffle, Avulsion Site, Leighton Brook, and Little Suncook River (Figure 1).

Figure 1: Four study sites on the Suncook River and tributaries.

Existing Studies

Since the avulsion in 2006, multiple studies have been completed on the Suncook River. Water quality was described in 2006 immediately after the avulsion (Daley, 2006). The geology and geomorphology have been well described by Perignon (2007) in an undergraduate thesis and the technical report completed by VHB (2008). The USGS completed a flood study of the entire Suncook River mainstem to update the FEMA maps and flood lines (Flynn, 2009). Prior to the avulsion, the subsurface water resources were described in a geohydrology and water quality report completed by the USGS (Stekl and Flanagan, 1997).

In this report, we do not describe the geology, geomorphology, or water quality in detail as this has already been done, but we do refer to the reports mentioned above. Here, we describe the field work and modeling completed to guide the designs and the reasoning behind the designs.

Survey

In September 2011, Inter-Fluve completed topographic and bathymetric surveys in potential restoration areas as well as along cross sections from upstream of the Rt 4 bridge to downstream of Round Pond, including the Little Suncook River and Leighton Brook. Inter-Fluve completed this survey to collect the necessary information to complete a hydraulic model and design drawings sufficient for construction.

Inter-Fluve used a survey-grade RTK GPS (Top Con) as well as Sokkia total stations to complete the topographic surveys. We used the RTK in areas of minimal canopy cover and to establish control points throughout the study area. The base station for the RTK unit was set on the sand bar downstream of the avulsion site on river right as this provided a clear horizon and view of the sky as well as some protection from the public. Inter-Fluve downloaded and post-processed all RTK survey data to produce results with root mean square (RMS) errors of less than 0.05 feet. Where the RTK was not efficient or beneficial, we used the total station. All total station data was tied to the RTK data by surveying multiple control points common to both the RTK and the total station throughout the survey area. All combined survey data was brought into a common coordinate system: NAD83 New Hampshire State Plane Zone 2800, units in feet. We used NGVD29 as the vertical datum to maintain consistency with the USGS surveys and area control points established by Eastern Topographics in 2007 (Eastern Topographics, 2007). All survey data was aligned with control point HV0735 on Rt 4 established by Eastern Topographics.

Comparison with a second control point (HV0738) collected by Eastern Topographics and resurveyed by Inter-Fluve showed a difference of less than 0.06 feet horizontal and 0.01 feet vertical.

VHB and the USGS conducted previous cross sectional surveys in 2007 and 2009, respectively. Inter-Fluve's survey included the re-survey of 27 VHB cross sections (see Appendix A: Task 4 Technical Memo) as well as the resurvey of USGS cross sections from 2500 feet upstream of the Rt 4 bridge (USGS section 'DO') to downstream of Round Pond (USGS section 'CJ'). Inter-Fluve identified the VHB and USGS cross sections by loading the cross sections, air photos, control points and other information onto a Trimble GeoXT GPS. When found, Inter-Fluve resurveyed control points common to the VHB and USGS surveys so that all survey information could be combined into a common coordinate system and vertical datum and to allow for accurate comparisons between surveys.

Detailed survey data was collected from the Rte 4 bridge to the mouth of the Little Suncook River, at the failed railroad crossing over the Little Suncook River, along the banks and bed of the steep riffle upstream of the avulsion site, and between Black Hall Rd and the Suncook River along Leighton Brook. These are all locations where construction is expected, and detailed topographic information is necessary for accurate designs and construction details.

Inter-Fluve set permanent and temporary control points throughout the study area. Temporary control points were typically wooden stakes. Permanent control points were capped rebar, spikes in the ground, PK nails in the pavement of roads or sidewalks, and chiseled marks on rocks and concrete (Figure 2). These control points will be able to be used throughout the construction process and for any future surveys.

Figure 2: Types of control points set for the topographic survey: (top to bottom) capped rebar, spike, and PK nail.

Hydrology

The USGS Flood Study provides recurrence interval flows for the 1.8-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year flood events, as well as the April 2007 storm (Flynn, 2009). The USGS Flood Study used flow data from USGS gage 01089500: Suncook River at North Chichester, NH. For a complete description of the methods used by the USGS to develop the recurrence interval flows for the Suncook River, refer to the USGS scientific investigations report #2010-5127 (Flynn, 2009). Inter-Fluve used these flows in the steady state, 1-dimensional, HEC-RAS hydraulic model we developed for the main stem Suncook River (Table 1).

No flow data has been published, or could be found, for the tributaries in the study area, Little Suncook River and Leighton Brook. While the USGS model accounted for a flow change at the Little Suncook River, it did not account for Leighton Brook. Inter-Fluve used the USGS StreamStats program to estimate flow magnitudes for the recurrence intervals listed above for both the Little Suncook River and Leighton Brook (Appendix B). The StreamStats program uses regional regression equations, drainage area, regional precipitation, and land use statistics to approximate flows in watersheds with no gage information. Inter-Fluve compared the StreamStats output for the Little Suncook River with the difference in Suncook River flows in the USGS model based on the flow change locations. The StreamStats data ranged from 25% higher at the 2-yr flood to 7% higher at the 100-yr flood and 6% lower at the 500-yr flood (Table 1). These differences are likely due to the differences in timing of the peak flows between the Little Suncook River and the Suncook River. Suncook River peak flows are likely to occur afeeter the Little Suncook River has already peaked and is on the falling limb of the hydrograph. Inter-Fluve used the StreamStats hydrology data for the HEC-RAS model as it provides more conservative data and is more accurate for peak flows specific to the tributaries.

Table 1: Water discharge at various recurrence intervals for the Suncook River and tributaries using data from the USGS Flood Study (Flynn, 2009) and the USGS StreamStats program.

Stream and Location	Source of Data	Flows (cfs) at Given Recurrence Interval (yrs)								
		1.8	2	5	10	25	50	100	500	April 2007
Suncook River at Rt 4	USGS, 2009	2145	2,320	3,700	4,870	6,690	8,330	10,200	15,900	11,000
Little Suncook River at mouth	USGS, 2009	459	534	851	1,121	1,539	1,914	2,351	3,661	2,538
Little Suncook River at mouth	USGS StreamStats	650	713	1,100	1,420	1,820	2,150	2,530	3,440	2,700
Leighton Brook at mouth	USGS StreamStats	35	38.9	66.8	91.2	126	154	189	276	200

Hydraulics

The HEC-RAS hydraulic model developed recently by the USGS (Flynn, 2009) was modified for this project to build existing and proposed models. Channel geometry has continued to change on the Suncook River since the USGS survey was completed, so Inter-Fluve resurveyed all USGS cross sections and added additional cross sections where necessary. The USGS model extends sufficiently upstream and downstream of the project reach to make the effects of boundary condition assumptions insignificant within the project reach.

Inter-Fluve performed a site survey for design in September 2011 as described above. The USGS provided a shape file showing the geographical locations of the cross sections it used for the 2009 FEMA model report. The Inter-Fluve river channel data surveyed in 2011 was combined with the USGS overbank data used in its hydraulic model. During the process of combining the data sets, we discovered that not all USGS survey data were referenced to a horizontal datum. Instead, the USGS surveyed its sections to a relative vertical datum, and one survey point at the end of each section was surveyed to a horizontal and vertical datum using an RTK GPS or a level-loop survey. Thus, Inter-Fluve converted the elevations for each USGS section to the vertical datum, but spatial orientation in the horizontal plane was hand drawn relative to the endpoint of each section. The USGS method is a reasonable approximation for hydraulic modeling, but it was a challenging data set to combine with Inter-Fluve's 2011 data.

Inter-Fluve developed HEC-RAS cross sections from our survey data and fit them within the USGS HEC-RAS sections by adding a constant to cross section stationing and adjusting the constant until the riverbanks aligned. USGS HEC-RAS cross sections were then updated with Inter-Fluve survey data. In some cases, the Inter-Fluve survey provided overbank survey data and that was used instead of USGS data. A comparison of the sections used in the Inter-Fluve model and those used in the USGS model is provided in Appendix C.

Inter-Fluve also added cross sections to our HEC-RAS model that are not present in the USGS model to attain a better resolution of project site hydraulics. The added cross sections represent pool riffle sequences located within 1000 feet downstream of the Route 4 Bridge. Cross section locations are identified by their HEC-RAS River Station (RS) (Figure 3).

Inter-Fluve also surveyed cross sections at Leighton Brook and the Little Suncook River tributaries. Separate HEC-RAS hydraulic models were created for each tributary and the main stem Suncook River. We modeled the tributaries separately because the HEC-RAS model utilizes peak flows and differences in the timing of peak flows may exaggerate backwater conditions near the confluences with tributaries. By separating the tributaries and using a normal depth boundary condition (with bed slope), hydraulics in the tributaries are intensified to result in a more conservative design condition. Being conservative is considered a more desirable approach than underestimating hydraulic intensity, which could result from modeling a river network and overestimating backwater conditions near tributary confluences. Cross sections were surveyed and used in HEC-RAS between the Suncook River and Black Hall Rd on both the Little Suncook River and Leighton Brook (Figure 3).

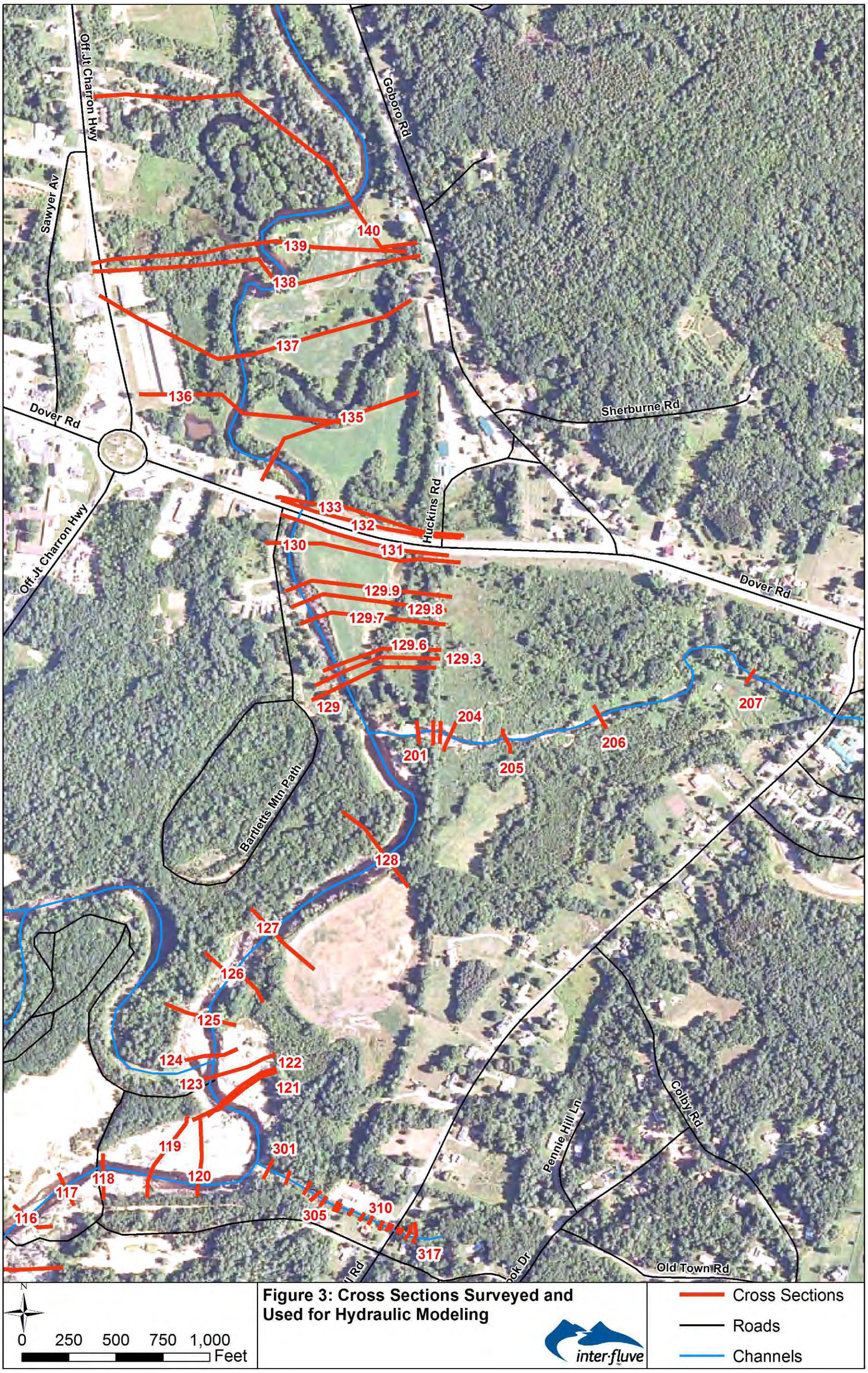

Figure 3: Cross Sections Surveyed and Used for Hydraulic Modeling

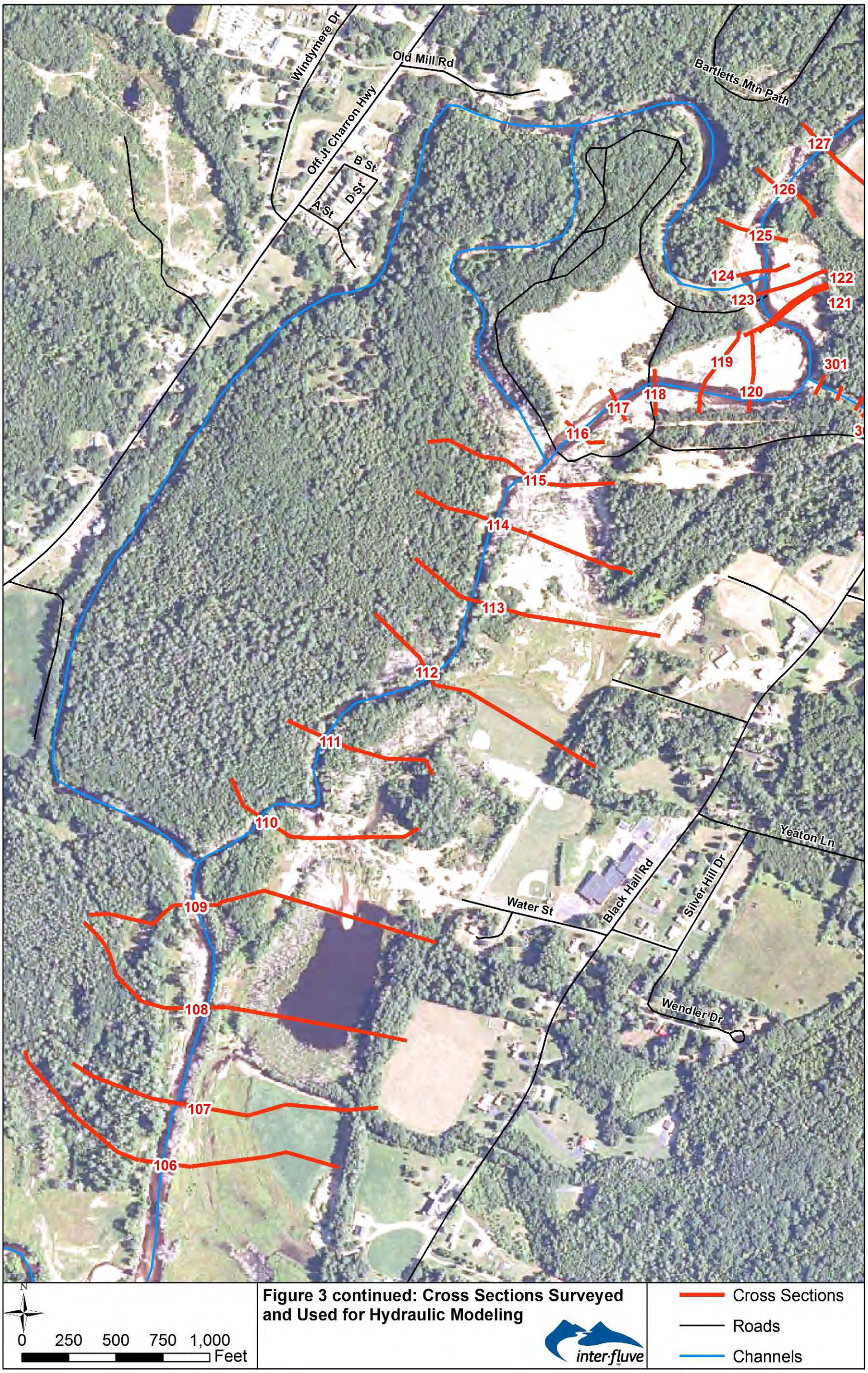

Figure 3 continued: Cross Sections Surveyed and Used for Hydraulic Modeling

Model Output

Main Stem Suncook River

We have provided both figures (Figures 4, 5) and tables (Appendix D) from the HEC-RAS model to display hydraulic parameters that impact design. Inter-Fluve's model used roughness values that are similar to those used in the USGS FEMA model because those values have already been calibrated and remain applicable. One of our methods of calibrating the model was to survey flood debris deposits and compare them to the April 2007 water surface elevations. We considered three debris lines: a flood debris line was 0.27 feet lower than the April 2007 water surface near HEC-RAS RS=113; a flood debris line near HESC-RAS RS=121 was 0.27 feet higher than the April 2007 flood; a flood debris line near HEC-RAS RS=123 was surveyed 0.14 feet lower than the April 2007 flood.

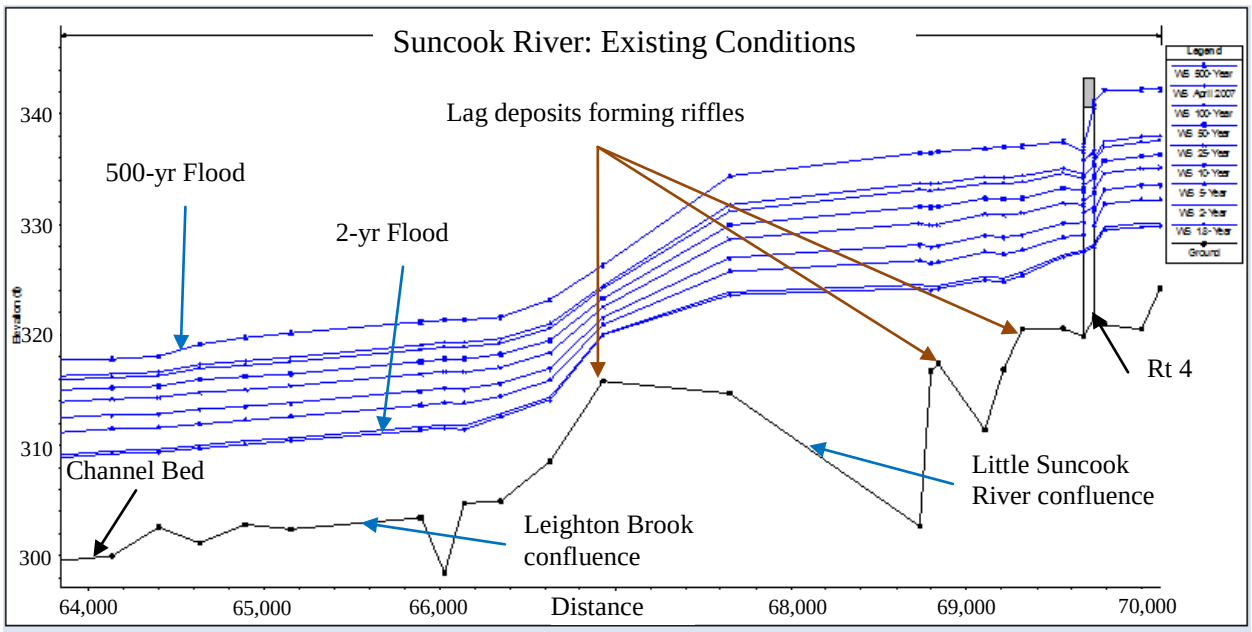

Figure 4: Existing conditions model output for the Suncook River from upstream of the Rt 4 bridge to the confluence with the abandoned secondary channel.

The longitudinal profile shows the Route 4 Bridge, riverbed and water surfaces at various flows (Figure 4). The drop in riverbed elevation between Stn 67,000 and 66,400 on the horizontal scale is an important feature that represents a glacial lag deposit upstream of the avulsion area. This feature provides stability to the lag deposits located near Stns 68,800 and 69,300 (riffles downstream of the Route 4 Bridge).

Channel shear stress is a hydraulic parameter that corresponds well to erosion potential. The channel bed along the lag deposit upstream of the avulsion site has very high shear stress values (Figure 5). Shear at this lag deposit approach values capable of moving a 3-feet diameter rock during large floods.

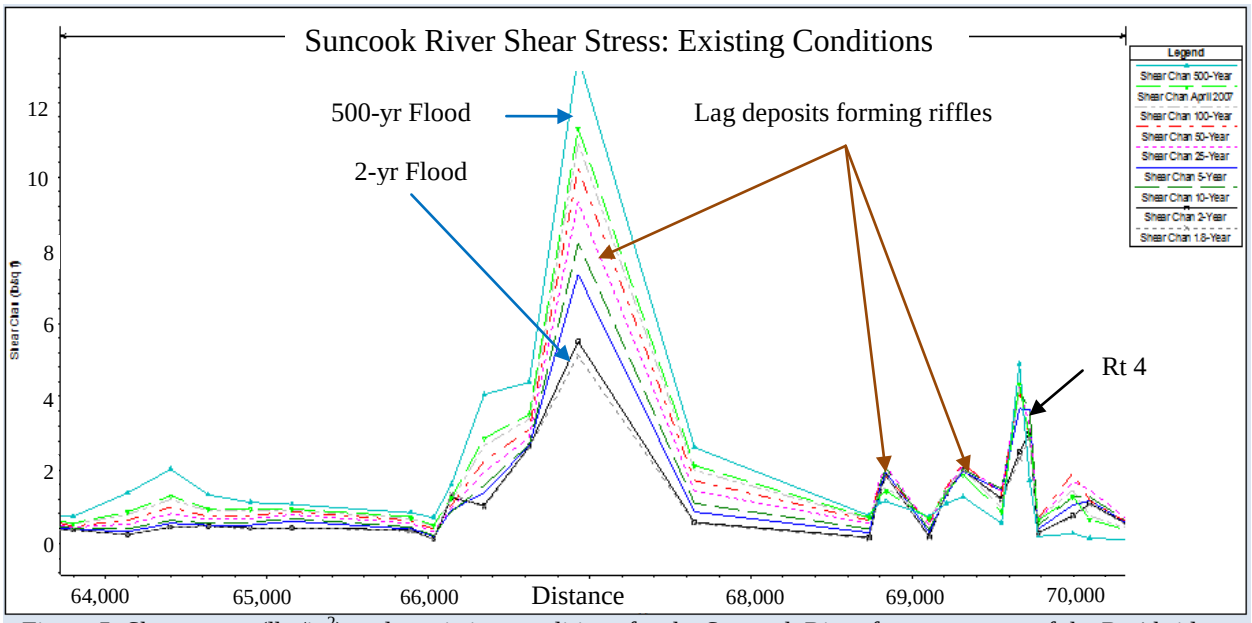

Figure 5: Shear stress (lbs/in^2) under existing conditions for the Suncook River from upstream of the Rt 4 bridge to the confluence with the abandoned secondary channel.

The main stem Suncook River appears to be moving laterally at the lag deposit upstream of the avulsion. The left bank (looking downstream) is retreating and there is the possibility that the exposed lag deposit may lower in elevation as it moves laterally. This lag deposit has several downed trees in the channel along the left bank, and the bank soils at the left bank are fine grained and appear to offer little erosional resistance (Figure 6). Analysis of air photos from different years following the avulsion show progressive bank erosion. If the Suncook River continues to move laterally at this location and the lag deposit lowers in elevation as it does, a head cut will migrate upstream and the two lag deposits (riffles) within 1000 feet downstream of the Route 4 Bridge may destabilize. Destabilization of the lag deposits downstream of the Route 4 Bridge will likely result in structural failure of the bridge.

Proposed conditions for the main stem Suncook River include stabilization of the lag deposit located upstream of the avulsion area and the lag deposit located approximately 1000 feet downstream of the Route 4 Bridge (Second Riffle). Stabilization of the lag deposit upstream of

the avulsion area includes placing rock along the left bank to arrest lateral erosion. Stabilization at the lag deposit located 1000 feet downstream of the Route 4 Bridge includes armoring both banks and the channel bottom at the downstream end of the lag deposit. Both of these stabilizations include filling within the active channel of the Suncook River. Filling of the channel does affect the FEMA Base Flood Elevation (BSE) in the Suncook River, and a Conditional Letter of Map Revision (CLOMR) may be required to move forward with the design. The proposed 30 percent designs raise the BSE 1.27 feet. This rise in the BSE will likely be reduced as designs are developed further, however, at this time it should be assumed that a letter of map revision will be required. Design development will include reducing encroachments in an effort to reduce any increases in the BSE.

Figure 6: Instability at lag deposit upstream of avulsion site. (Top to bottom) Looking upstream at lag deposit; looking downstream at fallen trees along left bank; looking at sand bank.

Little Suncook River

Appendix E provides tabular output for the Little Suncook River. Only existing conditions were considered for the Little Suncook River, since proposed conditions do not alter the cross sectional geometry. As such, hydraulics will not change for the Little Suncook River resulting from proposed conditions.

Leighton Brook

Leighton Brook has been subject to severe erosion, and we identified no calibration points in Leighton Brook during the survey. We included several interpolated sections along Leighton Brook in the hydraulic model. Roughness values used were estimated for existing and proposed conditions. Proposed conditions for Leighton Brook include a step-pool channel configuration (Figure 7). This configuration results in the significant reduction of channel shear stress values (Figure 8, Appendix F).

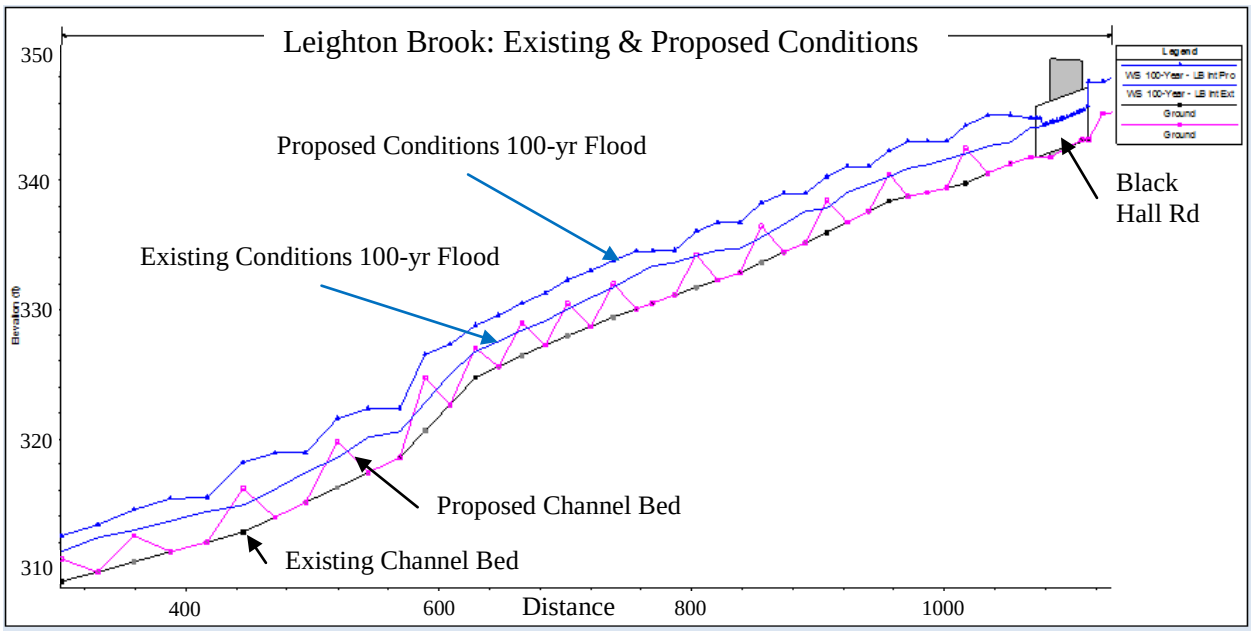

Figure 7: Existing and proposed ground surface and water surface elevation during the 100-yr recurrence flood on Leighton Brook.

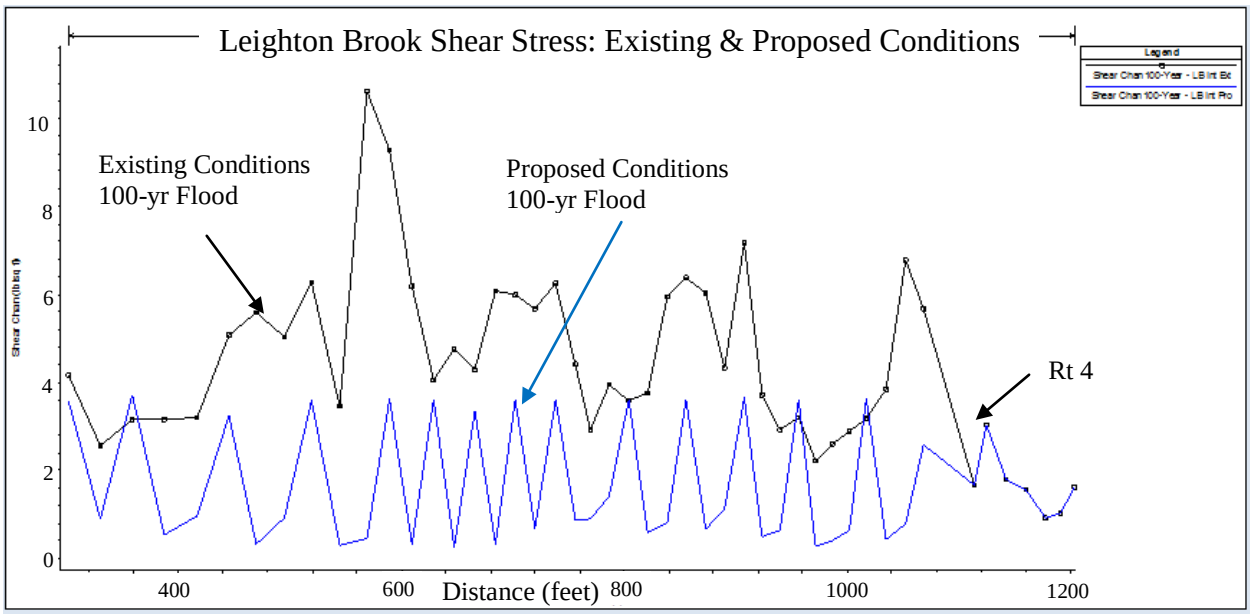

Figure 8: Channel shear stress (lbs/in^2) under existing and proposed conditions for Leighton Brook during the 100-yr flood.

Design

This project is focused on the protection of the Rt. 4 bridge over the Suncook River and the Black Hall Rd bridge over Leighton Brook. The Rt. 4 bridge has footings that are generally at or above the existing water surface and, therefore, are at risk of being undermined if any incision occurs at the bridge (2011 Structural Assessment Technical Memo, Appendix G). Two riffles, consisting of cobbles, boulders, and consolidated till, exist about 500 and 1000 feet downstream of the Rt 4 bridge. Downstream of each of these are deep scour pools. The immediate concern for the bridge is the near-term migration of the knickpoint that is currently stalled at these riffles. The large riffle lag deposit upstream of the avulsion site that is described above is also an area of great concern. The river is beginning to fall off this lag deposit grade control upstream of the avulsion site by eroding the left bank and scouring the channel bed. If the channel migrates around this grade control and no material is available to slow the knickpoint, an approximately 10-foot knickpoint could migrate upstream to the Rt 4 bridge as well as up the Little Suncook River to the Black Hall Rd crossing. Inter-Fluve's designs, as discussed below, address these concerns.

Hard vs Soft Engineering Practices

As a river and wetland restoration firm, Inter-Fluve has built its reputation on sound scientific research and engineering standards. We developed and perfected many of the bioengineering practices that have become standard today in many regions of the country. Our goal on many projects is that within 5-10 yrs visitors to the restoration site will not be able to tell that any work was done; the site will look like a natural stream or wetland with little to no evidence of designs or construction. We use logs, root wads, natural river rock, fabric soil lifeets and other techniques to achieve this natural look and to provide stability while also allowing for long-term channel mobility where possible. We restore the natural riverine processes and allow these processes to restore natural habitat.

Some of Inter-Fluve's projects have challenges and restrictions that prevent the full restoration of some natural processes. These include projects in urban areas where channel migration is unacceptable or where infrastructure is involved. The Suncook River restoration project is one of these types of projects, as a goal of this project is to protect bridge infrastructure. Because of the catastrophic changes that occurred to the river in 2006 and the location of the bridge

infrastructure and adjacent houses and farms, channel restoration techniques that would allow natural channel processes to recover are more costly. Allowing large-scale channel migration could also put homes and farm fields at risk. In this design submittal, we have presented designs, and an explanation of designs, that we believe achieve the goals of the project while also staying within, or close to, the known existing budget for construction. Following the explanation of designs for this submittal, we present ideas for restoration that are more aesthetically pleasing and ecologically sound but which would require more resources than are currently available.

Second Riffle Downstream of Rt 4

Within 1000 feet downstream of Rt 4, two riffles comprised of lag deposits of consolidated soils and boulders have slowed the upstream migration of the knickpoint (Figure 9). Shear stresses at these riffles and downstream site conditions require the stabilization of this area to protect the Rt 4 bridge. We recommend the installation of a rock riffle that is extended laterally into the banks at the second riffle downstream of the bridge (see design plans, Sheets 4-7). Because of shear stresses at this location, the rock size required to maintain long-term stability is 3-4 feet in diameter. Smaller stone will be used to fill the interstitial spaces, improving stability and creating the natural functionality and aesthetic of a typical riffle. Large stone placed at the top of the riffle will result in raising of the water elevation that would backwater much of the first riffle below the Rt 4 bridge. This would reduce the shear at this location and minimize the risk of the first riffle failing and resulting in instability at the bridge.

Figure 9: Looking downstream at lag deposits (top) about 500 feet and (bottom) about 1000 feet downstream from the Rt 4 bridge.

Within the channel, the rock will be installed from the top of the riffle and will extend downstream to the toe of the riffle in the deep pool. The stone within this pool will help slow incision if further knickpoints migrate from downstream reaches. Stone will be extended into the banks of the channel to prevent lateral migration of the channel and knickpoint. The lateral extent of this stone will be approximately 50 feet and will be in the location of the access points

on each side of the river. To place stone in the channel bed, vehicles will need to drive down the channel banks. To do this, access roads will be cut through the banks at a gradual angle. Once the riffle has been created and the trucks are no longer needed in the channel, stone will be placed in the access roads as the trucks retreat up the banks. This will provide resistance to attempts at lateral channel migration.

The channel banks at, and immediately downstream of, this riffle will be stabilized with similarly-sized stone on either side of the channel to prevent further erosion that could encourage lateral migration. Shear stresses in this area are great enough that further incision from downstream could destabilize soil or plantings, so stone will be placed to within 2 feet of the top of the channel banks. We will fill the top 2 feet with native material and native vegetation.

As a further precaution against the channel migrating around the stone treatment, we recommend extending the treatment to the railroad berm to the east and for about 150 feet to the west. While we would prefer the installation of a valley-wide stone grade control, the excavation and stone fill required is very costly. Instead, if this extension is desired by the project partners, sheet pile driven to the refusal depth could be a less costly alternative. This grade control can either be done immediately, or the sheet pile could be installed after restoration if monitoring indicates that it will become necessary due to downstream destabilization.

Access to this site is relatively easy. A dirt driveway exists on the west side of the channel and extends to an abandoned horse racing track (Figure 10). While dirt driveway is on private land, the access and staging areas are available with landowner permission. Additional clearing is likely unnecessary. A curb cut and farm access on the east side of the channel is also available to access the eastern channel bank. An access road could be built through the farm field, which could be used for staging as well. Access and staging on both sides of the river will be necessary and both will require the approval of the landowners.

Figure 10: Driveway and potential access on west side of channel looking north towards Rt 4.

Lag Deposit ~1000 feet Upstream of Avulsion

To prevent the lateral migration of the channel to the southeast off of the lag deposit and the subsequent upstream migration of an approximately 10-feet knickpoint, Inter-Fluve recommends

stabilizing the left (looking downstream) bank with appropriately-sized stone up to the extent of the flood water surfaces (see design plans, Sheets 8-10). This stone will be placed at a 2:1 angle (horizontal:vertical) and will be approximately 3-4 feet in diameter. Smaller stone will be placed in the interstitial spaces to provide additional stability and minimize piping. Prior to stone placement, we will place geotextile fabric on the channel banks. The stone will hold the fabric in place, and the fabric will be keyed into the top bank surface. This fabric will help prevent piping that could potentially destabilize the bank treatment.

In a similar manner as described above, access roads necessary to reach the channel bed will be built on the upstream and downstream ends of the construction area. These access roads will be filled with stone as the trucks retreat from the site. This lateral bank treatment will help prevent lateral migration of the channel around the bank treatment at both ends of the site.

We will fill the bank above the flood water elevations with native material and will seed and plant native vegetation.

The recommended access for this site is through private land. A direct route from Black Hall Rd includes a previously existing path, which requires some clearing (Figure 11). An alternative access route is further south along Black Hall Rd, where a dirt driveway is actively used to access the field adjacent to this project site for farming. Access through the field and staging in the field would need to be approved and done in cooperation with the landowner.

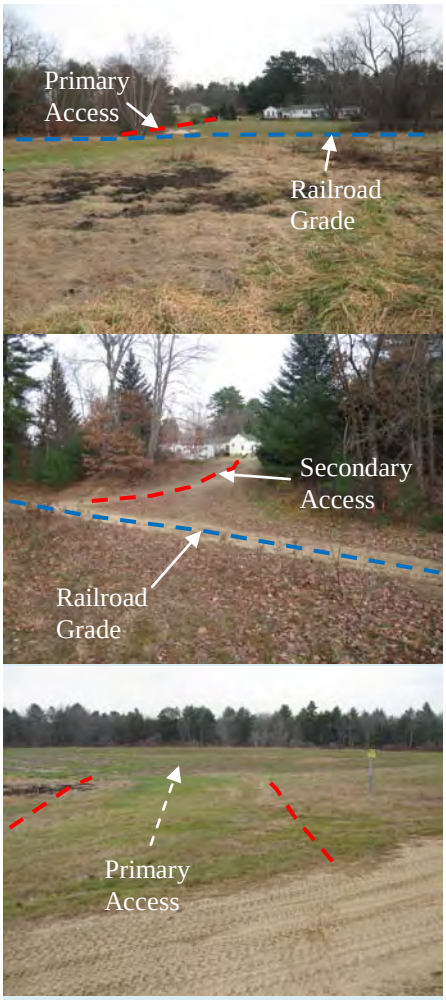

Figure 11: Access to avulsion site. (Top) Looking towards Black Hall Rd along primary access through overgrown path and (middle) along active secondary access road; (bottom) looking towards river at access through field from railroad grade.

Leighton Brook

Multiple concerns exist at Leighton Brook. The final designs and constructed product need to protect the Black Hall Rd bridge against the upstream migration of existing headcuts (Figure 12). We also needed to consider the likelihood that the Suncook River will continue to migrate

eastward thus continuing to shorten the length of Leighton Brook. As the mouth of Leighton Brook continues to fall into the Suncook River, the base level of Leighton Brook will decrease, which could cause additional headcuts to migrate upstream. Because of the steepness of the channel, shear stresses are relatively high compared to what is expected for most channels of this size, adding to the potential for instability.

To provide vertical stability in the near and long term, we have designed a step-pool channel system with multiple constructed rock steps between Black Hall Rd and the Suncook River (see design plans, Sheets 11-17). The steps will diffuse energy during high flows and reduce the potential for continued incision. While this system does raise the water surface elevation in some locations, water surfaces remain below the tops of banks.

Near the mouth of Leighton Brook, we have designed a stone buttress to be buried below the existing grade (Sheet 12 of the design sheets). If the base level continues to drop due to Suncook River migration, this stone will drop into the lower channel as a 'launchable riffle' and provide flexible grade control, thus slowing or preventing a large knickpoint from migrating upstream.

Access at Leighton Brook will be along Rhodora Drive, a public road off of Black Hall Rd (Figure 13). Access into the channel will require constructing an access road through the steep left bank downstream of the snowmobile path to reach the lower portions of Leighton Brook.

Figure 12: Looking downstream at incision along Leighton Brook (top) from Black Hall Rd and (bottom) near the confluence with the Suncook River.

Figure 13: Leighton Brook access along Rhodora Drive from Black Hall Rd.

Little Suncook River

Inter-Fluve evaluated the potential for improving floodplain access along the Little Suncook River upstream of the abandoned railroad grade. Our goal was to determine if any changes to the

railroad grade or the Little Suncook River channel and floodplain could be made to reactivate wide floodplain areas that could have flood storage and retention benefits.

Prior to the avulsion on the Suncook River, the lower portions of the Little Suncook River were backwatered due to the dams on the Suncook River and the constricted opening at the railroad crossing over the Little Suncook River. For more than 100 years, sediment accumulated upstream of the railroad crossing on the floodplains and within the channel of the Little Suncook River. When the avulsion occurred, the dams no longer provided the backwater. The base level lowering of the Suncook River caused the base level of the Little Suncook River to lower as well, which undermined the railroad crossing and resulted in the failure of the railroad bridge (Figure 14). The lowering of the mouth of the Little Suncook resulted in subsequent incision and upstream knickpoint migration along the Little Suncook. The knickpoint has moved approximately 1900 feet upstream from the mouth and is still about 1000 feet downstream from the Black Hall Rd bridge (Figure 14). The knickpoint has been dissipating and is becoming less severe as it migrates upstream, but it should be monitored to evaluate the potential risks to the bridge.

Figure 14: Little Suncook River (top) looking north at failed bridge along railroad grade; (middle) looking upstream at incised channel; (bottom) looking upstream at channel between the knickpoint and the Black Hall Rd bridge.

The field geomorphic investigation and hydraulic modeling suggest that the existing conditions likely provide the best flood storage option for several reasons. Under existing conditions, flood waters from the Suncook River move up the Little Suncook River through the opening in the railroad grade. As flood waters rise, the relatively flat, floodplain areas adjacent to the Little Suncook become inundated. As the flood waters lower, the constriction at the railroad crossing slows the discharge of floodwaters to the Suncook River, thus providing some flood mitigation. If the opening were widened, or if additional openings in the railroad grade were built, flood waters would be able to reach the large floodplains more

quickly, but the floodwaters would also leave more quickly and result in larger volumes of water downstream during the falling limb of the flood hydrograph.

We recommend monitoring the Little Suncook River closely to determine the need for future grade control and river restoration. If the existing knickpoint downstream of the Black Hall Rd bridge continues to migrate upstream and threatens the bridge, a stabilized riffle should be built below the bridge. There is also a knickpoint that is currently at the railroad opening and is being partially stabilized by the granite blocks and debris from the former bridge. If the knickpoint moves through this debris, it could further destabilize the Little Suncook River and threaten the bridge. In this case, we recommend channel restoration of the Little Suncook River. This would involve constructing a new, more sinuous channel that could utilize former stream beds on the adjacent floodplains (Figure 15). Increasing the sinuosity of this channel would dissipate grade drops over a longer channel length, thus decreasing the overall slope of the channel. A riffle-pool stream structure could be built through this area that would provide grade control and good aquatic habitat.

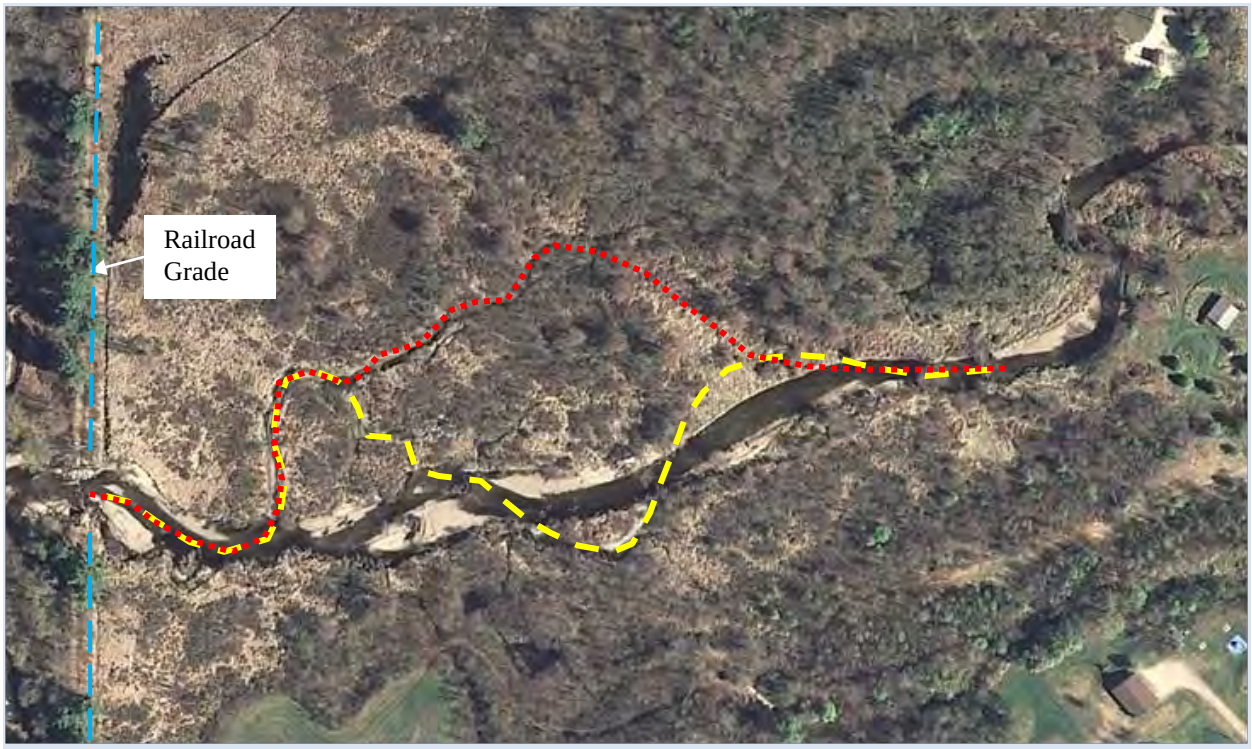

Figure 15: Possible realignments of the Little Suncook River that would help diffuse the knickpoint at the railroad crossing over a longer channel length. These realignments would follow portions of existing abandoned or side channels.

The final scenario for the Little Suncook River is the potential for a large knickpoint to develop if the Suncook River drops off of the lag deposit that is just upstream of the avulsion site. This could potentially result in a knickpoint of up to 10 feet migrating upstream. If the Suncook River at the mouth of the Little Suncook drops 10 feet in elevation, the base level change will dramatically impact the Little Suncook. There is no amount of appropriate channel sinuosity that could be constructed between the mouth and Black Hall Rd that could make up for this amount of grade drop. To protect against this scenario, we recommend placing sheet pile below the stream bed and floodplain immediately downstream of the railroad opening on the Little Suncook River. The sheet pile would tie into the railroad grade on either side. This would be a stop-gap measure to prevent the potentially extreme incision and bank erosion that could occur if the knickpoint migrates upstream. If the knickpoint were to migrate and expose the sheetpile, maintenance would be required to backfill with stone to cover the sheet pile and create a more gradual cascade, rather than a waterfall. This process eliminates the very costly and challenging task of excavating large amounts of sand and gravel from the bed now to build a rock riffle that could protect against base level changes in the future. In our design submittal, we have included sheets displaying this last scenario (see design plans, Sheet 18).

Access and staging for work on the Little Suncook River would be along the abandoned railroad grade and existing snowmobile trail.

Use of Large Woody Material

Although we have not included large wood installation on the design sheets, we do plan on utilizing salvaged logs and root wads to provide added bank toe stability and in-stream habitat. Many trees have fallen into the Suncook River below the Rt 4 bridge, along the left bank upstream of the avulsion site, and along Leighton Brook. Many of these trees are large enough and have intact root wads that would be suitable for installation at the toe of the banks. We propose to utilize these logs and root wads by placing them at the toe of the banks with the root wads projecting into the channel. The wood would be held in place by stone that will be placed along the banks as shown on the plans. We will include this large woody material in the next set of engineering plans (75%).

Area of Impact

River restoration projects necessarily alter the landscape. The project goals are to protect infrastructure. To do this, rock and other material will need to be installed in the channel, on the banks, and through the floodplains. This project will necessarily impact the channel and adjacent wetlands. Because we are not excavating the channel bed, but simply filling portions with stone, we propose to work in wet, low-flow conditions rather than building coffer dams and pumping water around the work site. Building coffer dams and pumping water around work areas on the Suncook River would be extremely expensive and would also increase the amount of time that the river bed will be disturbed. Working in wet conditions will allow for efficient construction, thus minimizing the impacts to the in-stream ecology.

The bordering vegetated wetlands have been delineated by a NH-registered wetland scientist. The wetland boundaries will be incorporated into the 75% design submittal as necessary for permit review. Inter-Fluve surveyed river banks during the topographic survey, and these data will also be included in the 75% design submittal for permitting.

Alternative Restoration Ideas

Our proposed designs, as described above and on the 30% design submittal, involve the installation of artificial geology to maintain vertical and lateral stability in the vicinity of infrastructure. Because of the infrastructure constraints, as well as cost limitations, we are proposing to contain the channel within its existing banks and minimize lateral migration and vertical changes in a few locations. This is inherently unnatural and forces a geomorphic configuration with a shorter channel length and steeper channel profile through the installation of large rock (artificial geology) in a sand-dominated landscape. Under natural conditions and without bridges and other infrastructure, the Suncook River would migrate across the alluvial valley and likely undergo multiple large-scale channel changes before stabilizing in a new plan form and longitudinal profile. Analysis of air photos and a field reconnaissance reveals multiple abandoned oxbow ponds or scars identifying past channel locations and suggesting a long history of channel migration. This type of channel mobility is not desired at a few locations because of roads, bridges, and houses that could be impacted.

A restoration alternative that would be preferred from an ecological, aesthetic, and geomorphic perspective, involves the construction of multiple valley-wide grade control riffles. Rather than

stabilizing the left bank above the avulsion and building one large grade control downstream of the bridge that includes possible sheet pile in the floodplain areas, valley-wide grade control would diffuse the gradient over a few thousand feet of channel length and would allow the channel to continue adjusting its planform. In this scenario, four valley-wide riffles would be built between the large lag deposit upstream of the avulsion and the second riffle downstream of the Rt 4 bridge. Each of these riffles would account for 2.5 feet of elevation loss if the channel falls off the lag deposit for a total of 10 feet of vertical grade control. These riffles would extend eastward to the railroad grade and westward to higher elevation areas (Figure 16). This would provide vertical stability even as the Suncook River channel migrates laterally. This alternative would allow for natural riverine processes to take place but would also provide stability for the channel near the bridge. It would not provide protection for adjacent farms and residential structures, however, as the channel would be allowed to migrate. The excavation costs for digging valley-wide riffles and the costs of placing rock in these areas would be beyond the existing construction budget.

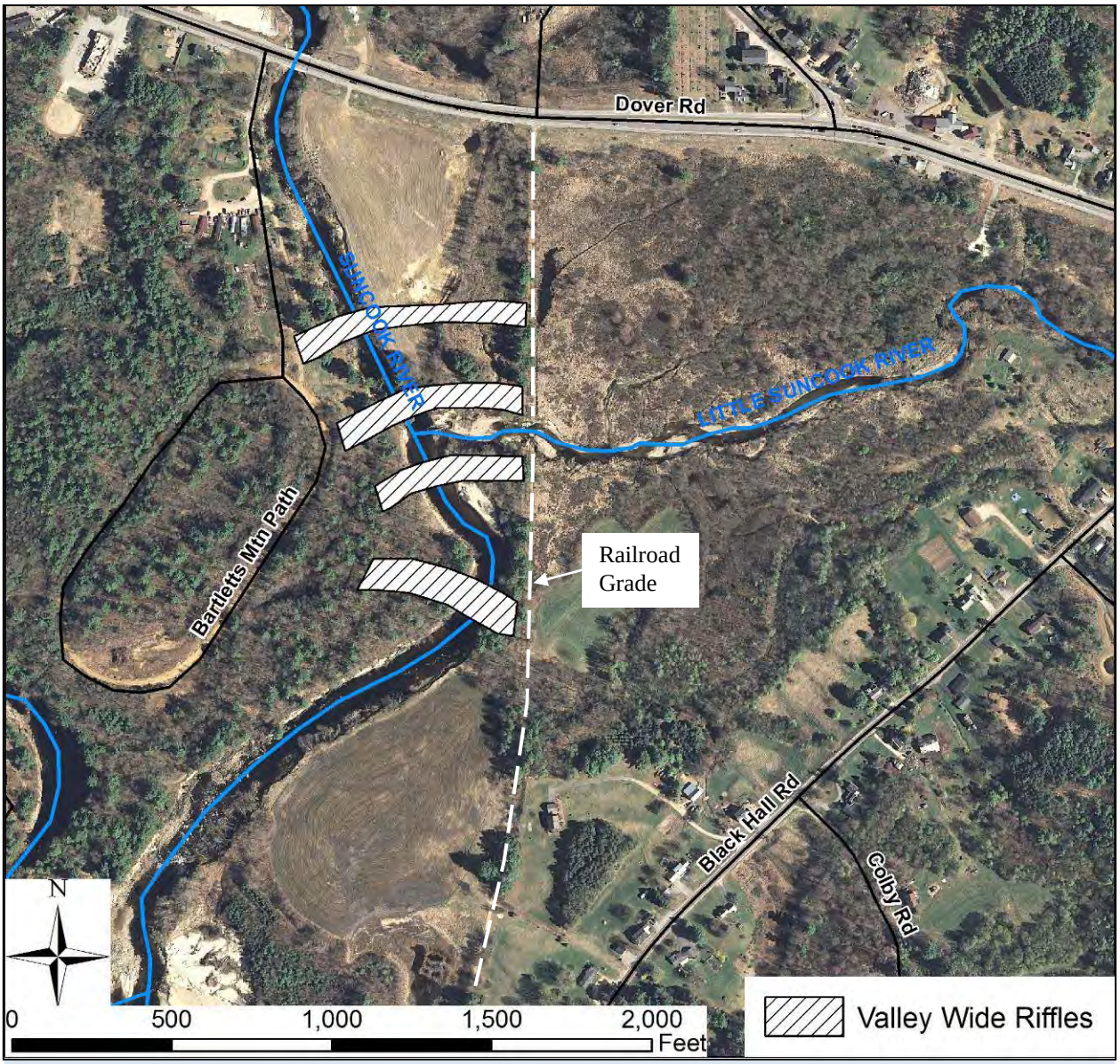

Figure 16: Possible placement of valley-wide grade controlling riffles on the Suncook River. This is a more aesthetically pleasing and ecologically sound, though more costly, alternative for the protection of the Rt 4 bridge against the migration of knickpoints between the bridge and the avulsion site.

A second alternative for restoration of the Suncook River would be to alter the Rt 4 bridge instead of placing grade control in the channel. The bridge could be replaced with a wider span and could be placed on piles driven to refusal. This would provide bridge stability in the event of continued upstream migration of knickpoints. If project partners prefer to retain the existing bridge prism, deep piles could potentially be placed to the refusal depth with the existing bridge resting on top. While costly, this alternative would eliminate the need for artificially placing geologic structures in the riverbed and floodplains. It would, however, not protect adjacent farms

and residences and the continued upstream migration of the knickpoints would need to be monitored to determine upstream threats.

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VHB, 2008. Suncook River Avulsion, Geomorphology-based Alternatives Analysis: Final Technical Report. Bedford, NH.

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Stekl, P.J. and Flanagan, S.M., 1997. Geohydrology and Water Quality of Stratified-Drift Aquifers in the Upper Merrimack River Basin, South-Central New Hampshire. USGS Water-Resources Investigations Report 95-4123. Pembroke, NH.

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Inter-Fluve, Inc., 2011. Task 4 Technical Memorandum: Suncook River Design Survey

Cost Estimate

The following cost estimate provides costs to the 30% design level for the phases of construction, 20% contingency, and construction oversight. The optional alternative items of sheet pile installation and Little Suncook River restoration are separated out. The total cost, including the optional items, is approximately **$1,360,000**. Removing the Suncook River floodplain sheetpile and Little Suncook River work, the total cost for restoring the Suncook River and Leighton Brook is approximately **$810,000**.

Suncook River and Leighton Brook Restoration Cost Estimate

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
1	Mobilization & Demobilization	LS	$90,000	1	$90,000
2	Access & Traffic Control	LS	$20,000	1	$20,000
3	Erosion & Pollution Control	LS	$25,000	1	$25,000
4	Flow Management	LS	$15,000	1	$15,000
5	Excavation (cut)	CY	$6	3,200	$19,200
6	Excavation (fill)	CY	$6	3,200	$19,200
7	Rock	TON	$65	5,512	$358,289
8	Surface Fabric Treatment	SY	$6	889	$5,333
9	Existing Wood Salvage	EA	$200	20	$4,000
10	Seed	LB	$100	35	$3,500
11	7-Gallon Container Plants	EA	$160	220	$35,200
12	5-Gallon Container Plants	EA	$100	120	$12,000
			Construction Subtotal		$606,723
Alternate Items					
13	Suncook Floodplain Sheetpile	SF	$35	9,100	$318,500
14	Little Suncook Flow Management	LS	$15,000	1	$15,000
15	Little Suncook Sheetpile	SF	$35	3,600	$126,000
				Subtotal	$459,500
Contingency & Construction Oversight					
16	20% Contingency	20% Subtotal	20%	--	$213,245
17	Construction Oversight	LS	$80,000	1	$80,000
			Construction Total		$1,359,467
				GRAND TOTAL	**$1,360,000**

Suncook River Restoration Cost Estimate

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
S1	Mobilization & Demobilization	LS	$55,000	1	$55,000
S2	Access & Traffic Control	LS	$15,000	1	$15,000
S3	Erosion & Pollution Control	LS	$15,000	1	$15,000
S4	Excavation (cut)	CY	$6	2,000	$12,000
S5	Excavation (fill)	CY	$6	2,000	$12,000
S6	Rock	TON	$65	3,369	$219,004
S7	Surface Fabric Treatment	SY	$6	889	$5,333
S8	Existing Wood Salvage	EA	$200	20	$4,000
S9	Seed	LB	$100	10	$1,000
S10	7-Gallon Container Plants	EA	$160	140	$22,400
S11	5-Gallon Container Plants	EA	$100	80	$8,000
			Construction Subtotal		$368,737
Alternate Items					
S12	Suncook Floodplain Sheetpile	SF	$35	9,100	$318,500
S13	Little Suncook Flow Management	LS	$15,000	1	$15,000
S14	Little Suncook Sheetpile	SF	$35	3,600	$126,000
				Subtotal	$459,500
Contingency & Construction Oversight					
S15	20% Contingency	20% Subtotal	20%	--	$165,647.38
S16	Construction Oversight	LS	$50,000	1	$50,000
			Construction Total		$1,043,884
				GRAND TOTAL	**$1,040,000**

Leighton Brook Restoration Cost Estimate

No.	Bid Item	Unit	Unit Price	Quantity	Subtotal
L1	Mobilization & Demobilization	LS	$35,000	1	$35,000
L2	Access & Traffic Control	LS	$5,000	1	$5,000
L3	Erosion & Pollution Control	LS	$10,000	1	$10,000
L4	Flow Management	LS	$15,000	1	$15,000
L5	Excavation (cut)	CY	$6	1,200	$7,200
L6	Excavation (fill)	CY	$6	1,200	$7,200
L7	Rock	TON	$65	2,143	$139,286
L8	Seed	LB	$100	25	$2,500
L9	Live Stakes	EA	$6	1,000	$6,000
L10	7-Gallon Container Plants	EA	$160	80	$12,800
L11	5-Gallon Container Plants	EA	$100	40	$4,000
			Construction Subtotal		$243,986
Contingency & Construction Oversight					
L12	20% Contingency	20% Subtotal	20%	--	$48,797
L13	Construction Oversight	LS	$30,000	1	$30,000
			Construction Total		$322,783
				GRAND TOTAL	**$320,000**

APPENDIX A:
Task 4 technical memo - Suncook River Design Survey

Inter-Fluve, Inc.
Technical Memorandum

TO:	Steve Landry, NH DES
FROM:	Nick Nelson, Inter-Fluve
DATE:	December 5, 2011
REGARDING:	Task 4: Suncook River Design Survey

Introduction

The avulsion that occurred on the Suncook River in 2006 caused incision and bank erosion as well as downstream deposition. As the Suncook River continues to adjust to the new planform, infrastructure in two locations has been identified by the NH Department of Environmental Services (NH DES) as being at risk of damage or failure: the Rt 4 bridge over the Suncook River and the Black Hall Rd crossing over Leighton Brook, both in Epsom, NH. Inter-Fluve was contracted to design and permit measures to stabilize the Suncook River and Leighton Brook in an effort to protect these two road crossings.

A topographic survey was completed to provide the necessary information to complete a hydraulic model and to complete design drawings sufficient for construction. Previous surveys completed were conducted by VHB in 2007 and the USGS in 2009. Inter-Fluve conducted the survey for this project in September 2011. A portion of this survey included the re-survey of 27 cross sections previously surveyed by VHB along the Suncook River: 10 in the vicinity of the avulsion site, 9 near the confluence with the abandoned primary channel, 6 in the abandoned primary channel, and 2 near the Short Falls Rd bridge (Figure 1). This technical memo provides a comparison of these two surveys along the cross sections that were repeated.

Control Points

VHB generally placed control points on the left and right extents of the surveyed cross sections. The cross sections typically extended to the top of the river bank. The control points consisted of either a spike or rebar hammered into the ground and marked by a 3' wooden stake with flagging. GPS coordinates were recorded for each control point location. Inter-Fluve staff used these coordinates loaded into a Trimble GeoXT handheld gps unit to relocate the controls. While many of the control points were relocated, some were not found for reasons including loss of the control point due to bank erosion and excessive deposition over the control point. A few control points were found leaning over the bank or loose on the ground surface below the bank due to bank erosion. Of the 46 total VHB controls, we were able to relocate 24.

Cross Section Comparison

Once the control points and cross sections were located, Inter-Fluve surveyed the control points and the cross section between the control points. In locations where control points were unable to be relocated, the cross section was resurveyed based on an estimated location from the GPS coordinates. The new survey data was imported into AutoCAD and an existing surface was created. Cross sections were created through this existing surface at each VHB cross section location. The Inter-Fluve and VHB cross sections were then exported to the same graph so that comparisons could be made.

In a number of locations, differences in elevation between the Inter-Fluve and VHB cross sections exceeded any apparent logical erosion and deposition. Differences of more than 2 ft appeared on banks that had not changed since the avulsion. On closer examination, it became apparent that the elevations for multiple VHB cross sections had not been accurately adjusted to a common datum. Many of the control points used in the VHB survey throughout the study area were surveyed with an RTK GPS unit that recorded horizontal and vertical data to within a few hundredths of a foot in accuracy. The Inter-Fluve surveys completed with the total station were tied into the RTK survey so that all Inter-Fluve data were on the same datum and coordinate system. When compared to the cross sections surveyed by the USGS, Inter-Fluve's survey data matched well throughout the study area. Because of this, we are confident that the Inter-Fluve survey and cross section data is accurate. As indicated in the appendix showing the cross section comparisons between the Inter-Fluve and VHB surveys, the following adjustments had to be made to the VHB cross sections to provide accurate comparisons:

Table 1: Adjustments made to the VHB cross sections that were necessary to match control point elevations or the elevation of land surfaces un-impacted by the avulsion and channel change.

Location	**Adjustment**
New Channel	No adjustment
Confluence Area	Section 1: no adjustment Sections 2-9: VHB sections raised 2.96 ft
Old Channel	All sections raised 3.12 ft
Short Falls Road	All sections raised 2.5 ft

Once these adjustments were made, the cross sections could be appropriately compared and evaluated for erosion and deposition.

Avulsion Site and New Channel - There were 10 cross sections in this reach that extended 860 feet upstream from the avulsion site to the confluence with the abandoned secondary channel (Figure 1). Comparisons between the VHB and Inter-Fluve cross sections suggests that significant channel adjustment occurred between 2007 and 2011 (Appendix A), as would be expected with the avulsion site being within this reach.

While cross section 1 appears generally stable, the left bank (facing downstream) has experienced significant erosion as was observed during the fieldwork. The left side of this steep portion of channel is rapidly undercutting the bank resulting in trees falling into the channel and

general bank destabilization. Downstream of this steep portion of the channel, comparison of cross section 2 suggests that the channel has moved to the left resulting in up to 6 ft of bed lowering on the left side of the channel, bank erosion on both banks, and more than 3 ft of deposition on the right side of the channel. In 2007, the channel at, and immediately upstream of the avulsion site, was primarily on the west side of the alluvial valley. Since then, the channel has been falling off of the large boulder deposits into the sand deposits to the east. This has resulted in substantial channel change in this area. Cross section 3, located at the avulsion site, has experienced up to 12 ft of vertical change since 2007. The changes at these locations should be evaluated with caution. Elevational changes at grade controls may indicate reach-wide incision or deposition, but changes in pools, runs, glides, or unstable locations may simply show changes due to mobilized sediment. The large sand bar that developed at the avulsion site and is visible in the 2007 cross section was mobilized and is now a deep scour pool below a riffle. The entire channel did not experience 12 ft of incision since 2007, but 12 ft of sand was mobilized from this location.

Downstream of the avulsion site, cross sections 4-10 show general channel instability as the channel migrates and continues to adjust to the new conditions. The Suncook River is migrating east near the mouth of Leighton Brook and sinuosity upstream and downstream of this location is causing frequent changes in planform. None of the control points were found along these cross sections because the sections have experienced so much change. The ends of some VHB cross sections, such as section 5, are in the middle of the Suncook River channel. Some of the differences in elevation may be due to slightly inaccurate relocation of the cross section. If the control points were not found, surveying the cross section a few feet upstream or downstream could have resulted in perceived, but not actual, changes.

Confluence of Suncook River with Abandoned Primary Channel - VHB surveyed nine cross sections in this reach that extended from 450 feet upstream of the confluence with the abandoned primary channel to 1550 ft downstream of the confluence. The channel through this reach has experienced some change since 2007, but the change is not as dramatic as in the reach near the avulsion site. Sections 2 and 3 indicate section-wide channel lowering of 2-4 ft (Appendix A), which suggests that the channel geometry upstream of the confluence is increasing to account for the increased hydrology due to the consolidation of flows into this one channel. Downstream of the confluence, the channel appears to be adjusting from a relatively flat, plane-bed channel to a deep thalweg with adjacent depositional bars. The channel bed in 2007 was likely higher in elevation than typical due to sand deposition from the upstream avulsion and erosion of the landscape. The subsequent erosion as indicated in cross sections 4-9 shows that a narrower, deeper channel is developing and may be approaching the pre-avulsion bed elevation.

Abandoned Primary Channel - There were six cross sections in this reach that extended 5,450 feet downstream of the avulsion site to 1,480 feet upstream of the confluence area. No deposition or erosion was observed along these cross sections. Any difference in elevation is likely due to slight deviations of surveyed sections and the amount of detail in each survey. This section of channel consists of a boulder bed with some water flowing through due to inputs from a tributary and ground water.

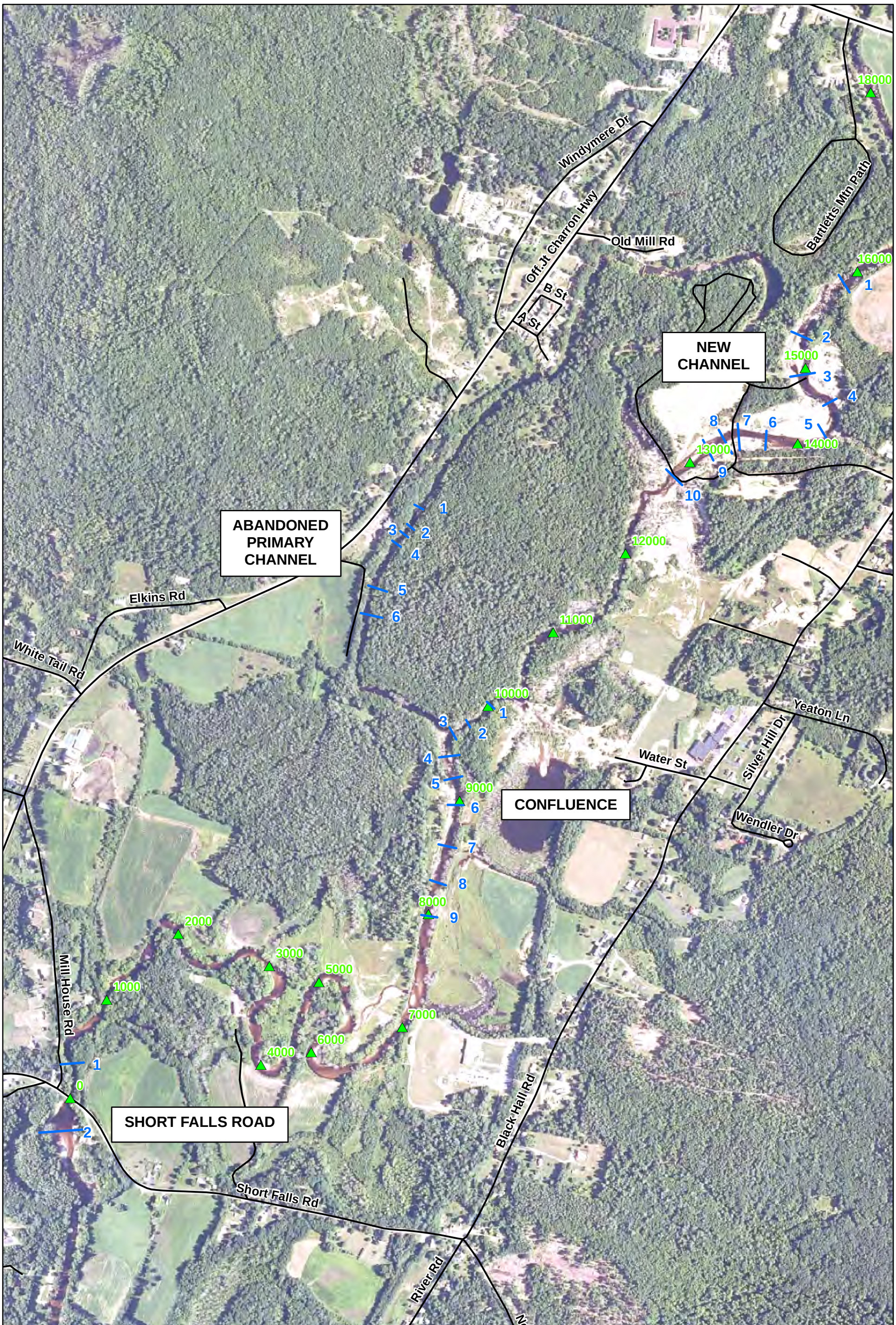
Short Falls Rd - The two cross sections in this reach are located 290 ft upstream and 270 ft downstream of the Short Falls Road bridge. While the upstream cross section is located at the top of a grade-controlling riffle, the downstream cross section is in the middle of a large scour pool formed by the combination of the upstream riffle and the constriction from the bridge. No significant erosion or deposition occurred along the upstream cross section, but more than 20 ft of deposition has occurred in the area around the downstream cross section (Appendix A). Once a deep scour hole, the channel downstream of the bridge is now narrow and elevated with sand bars on both sides that approach the top of the channel banks.

Summary

In 2011, Inter-Fluve resurveyed 27 cross sections originally surveyed by VHB in 2007 after the avulsion occurred on the Suncook River. Comparison of these cross sections shows areas of bed erosion and deposition, bank erosion and point bar development, and areas of little channel change. The channel immediately upstream of the avulsion site and the new channel between the avulsion site and the confluence with the abandoned secondary channel have experienced the most change. The channel planform has changed as the channel is eroding banks and attempting to increase its channel length by increasing channel sinuosity. As the channel falls off boulder deposits into sand deposits, deep pools are formed. Areas with sand bars in 2007 may be deep scour pools in 2011. This reach is still active in 2011.

The cross section comparisons also help explain the movement of sand throughout the study area. The avulsion occurred in 2006 creating a new channel and resulting in excessive erosion and sand mobilization. By 2007, some of this sand had migrated downstream to the confluence with the abandoned primary channel resulting in an elevated channel bed. In 2011, the channel at this location was narrowing and forming a distinct thalweg with adjacent sand bars and may be nearing the pre-avulsion channel bed elevation. In 2007, significant amounts of mobilized sand had not reached Short Falls Rd, but by 2011 sand had filled in the 20-ft scour hole downstream of the bridge.

The Suncook River will continue to adjust vertically and horizontally from this extreme event for many years. Near the avulsion site, the channel will continue to migrate, increase sinuosity, and may change locations multiple times. Downstream, the volumes of sand in the channel will continue to change resulting in channel elevation changes.



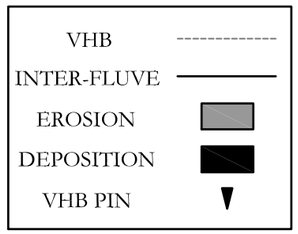
Suncook River, Epsom, NH
FIGURE 1:
Cross Section Locations
VHB 2007

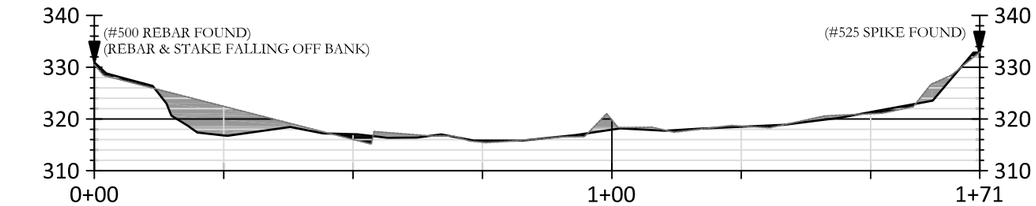
Inter-Fluve, Inc.
220 Concord Ave., 2nd Floor
Cambridge, MA 02138
www.interfluve.com

1000 ft river stations
VHB XS
Roads

APPENDIX A: Comparison of cross sections surveyed by VHB in 2007 and Inter-Fluve in 2011.

NEW CHANNEL 1-5





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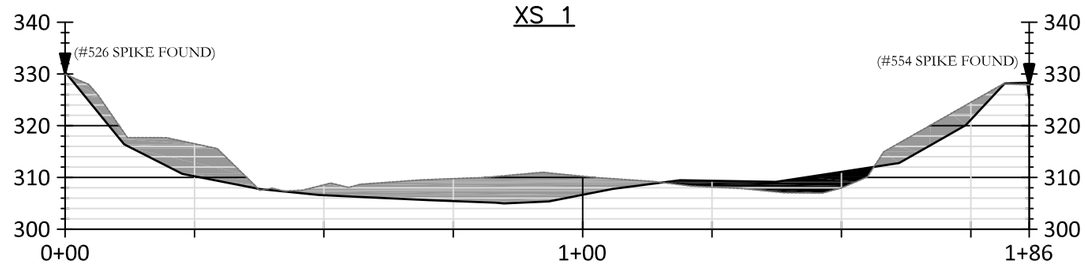

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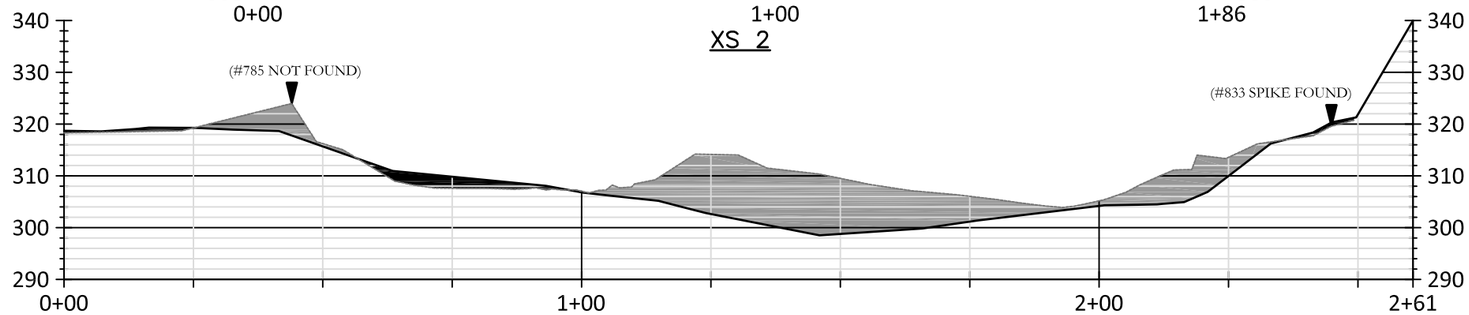

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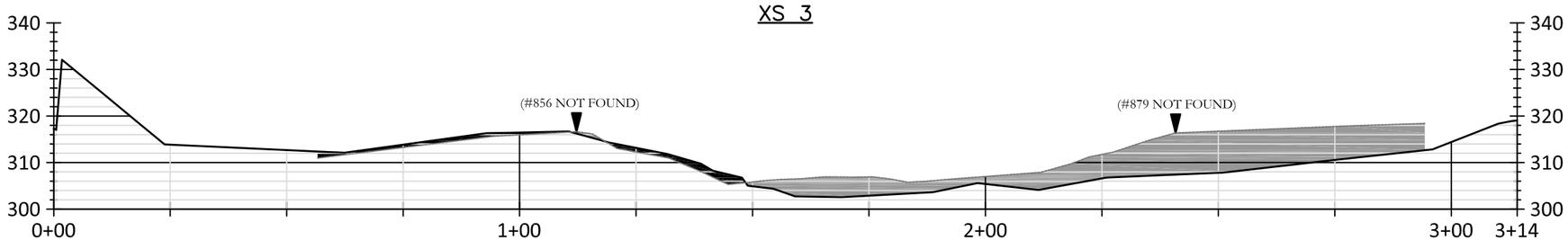

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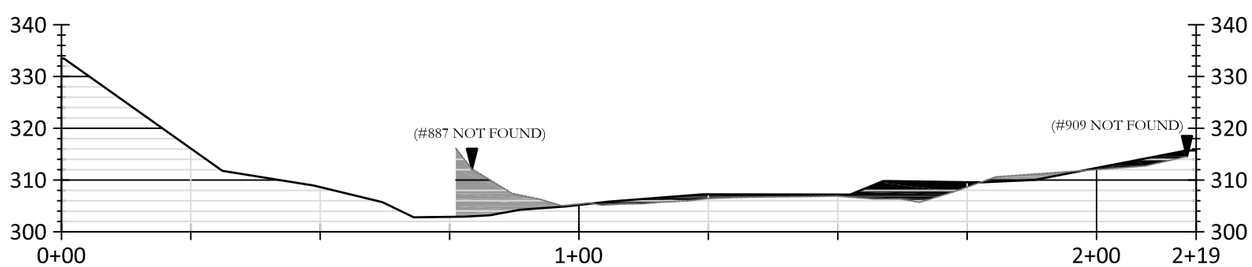
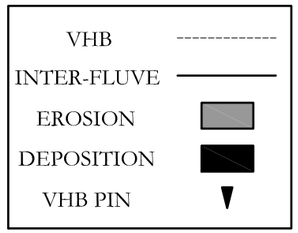


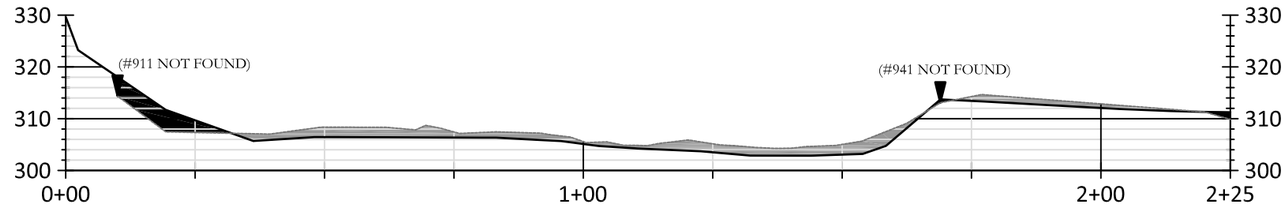
XS 5

MAY 2007 VHB SURVEY &
SEPTEMBER 2011 INTER-FLUVE SURVEY
COMPARISON

inter·fluve INC.
220 Concord Ave., Floor #2
Cambridge, MA 02138
617.714.5537
www.interfluve.com

NEW CHANNEL 6-10





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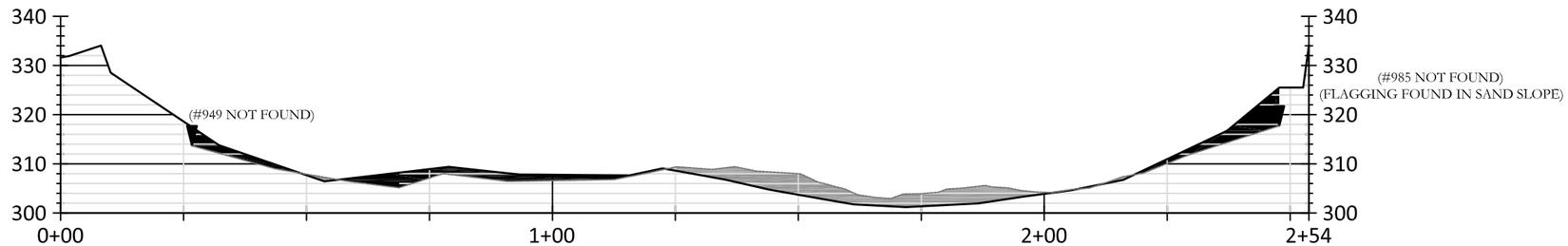

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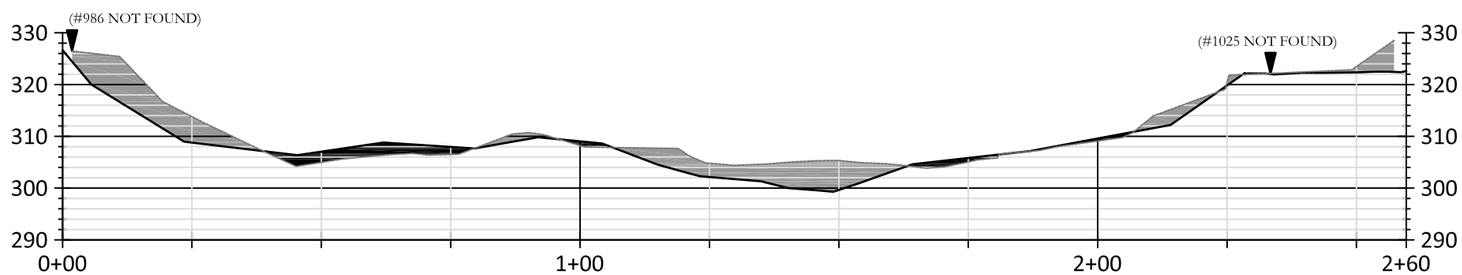

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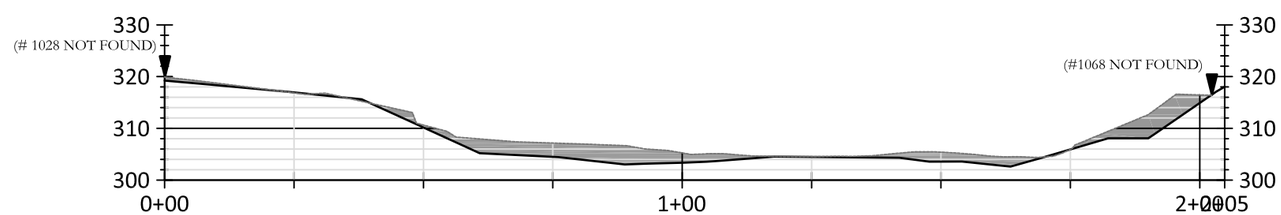

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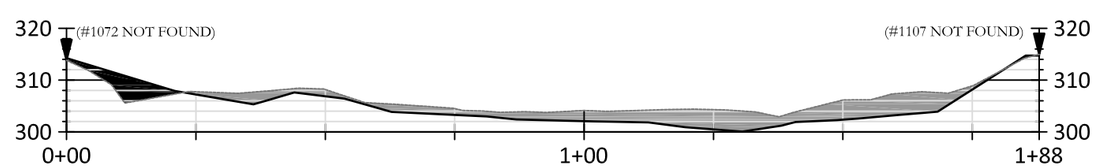


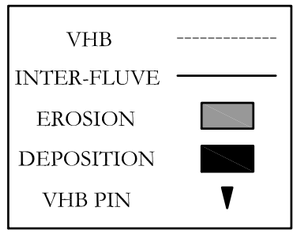
XS 10

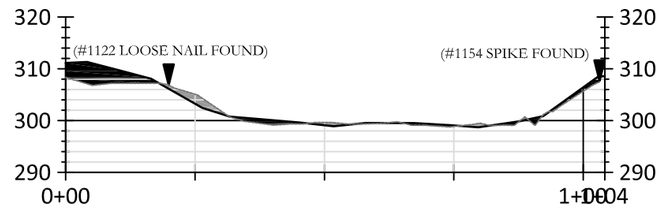
MAY 2007 VHB SURVEY &
SEPTEMBER 2011 INTER-FLUVE SURVEY
COMPARISON

inter·fluve INC.
220 Concord Ave., Floor #2
Cambridge, MA 02138
617.714.5537
www.interfluve.com

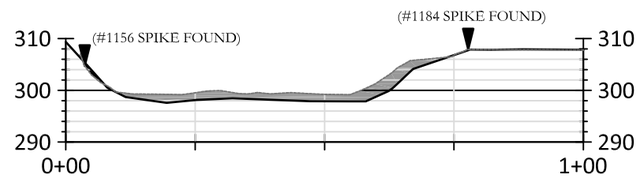
CONFLUENCE AREA 1-5

VHB SECTIONS 2-9 MOVED UP 2.96' TO MATCH LOCATED PIN ELEVATIONS





XS 1



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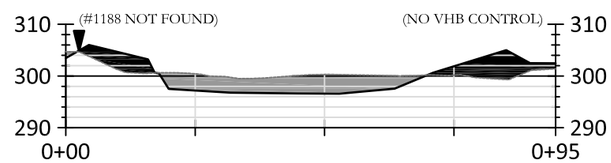
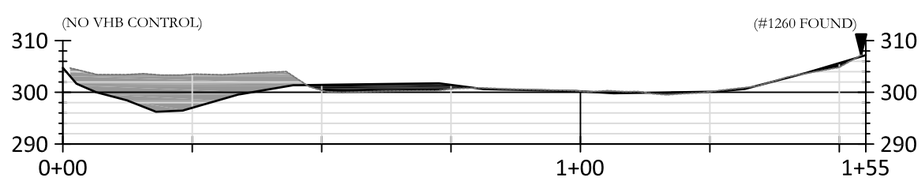
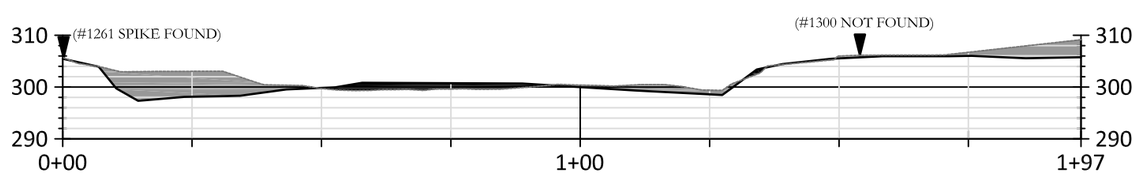


XS 3



XS 4



XS 5

MAY 2007 VHB SURVEY &
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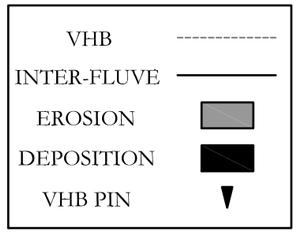
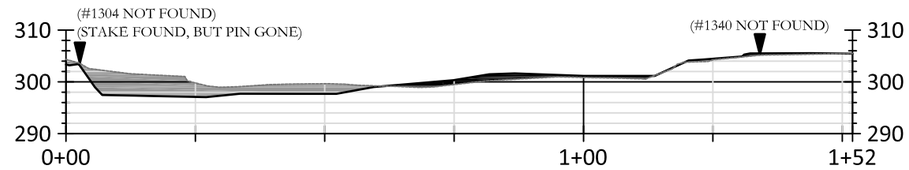
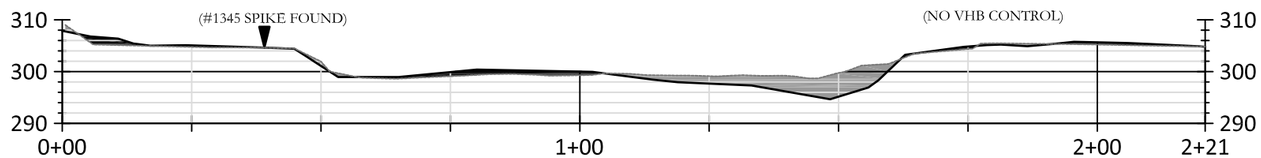
CONFLUENCE AREA 6-9

VHB SECTIONS 2-9 MOVED UP 2.96' TO MATCH LOCATED PIN ELEVATIONS

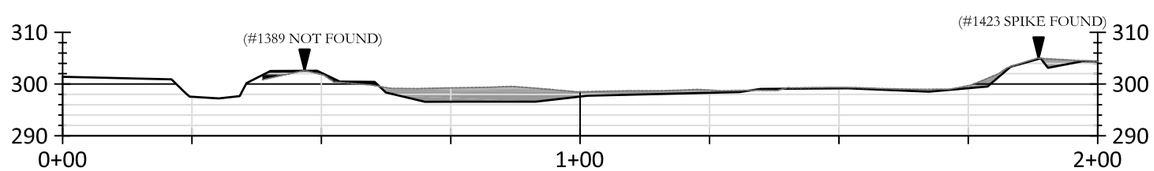




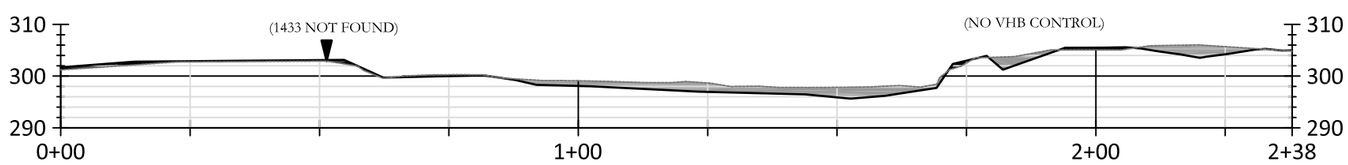
XS 6



XS 7



XS 8



XS 9

MAY 2007 VHB SURVEY &
SEPTEMBER 2011 INTER-FLUVE SURVEY
COMPARISON

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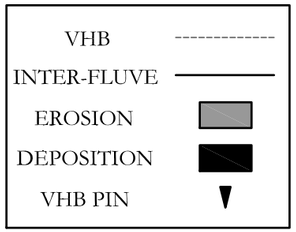
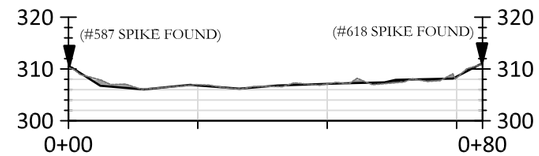
617.714.5537
www.interfluve.com

OLD CHANNEL 1-6

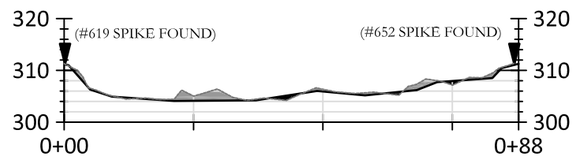
VHB SECTIONS MOVED UP 3.12' TO MATCH LOCATED PIN ELEVATIONS



XS–1



XS–2



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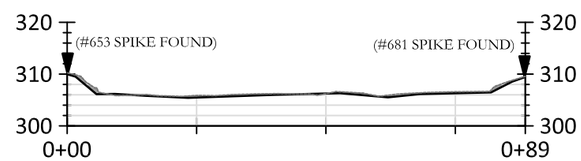
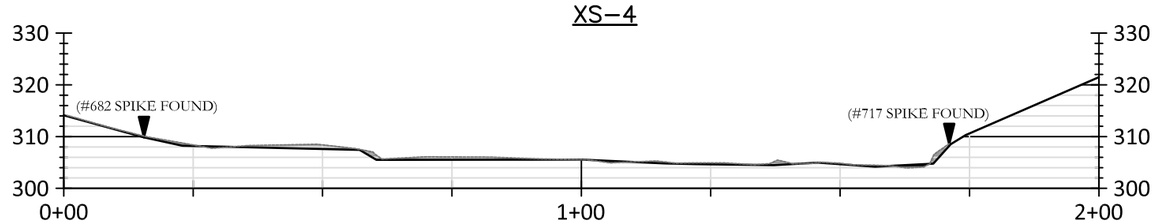
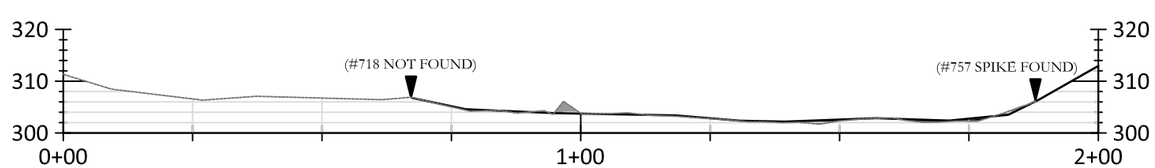


XS–4



XS–5



XS–6

MAY 2007 VHB SURVEY &
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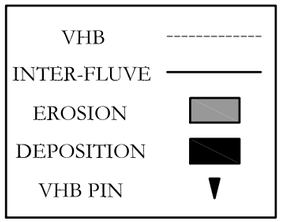
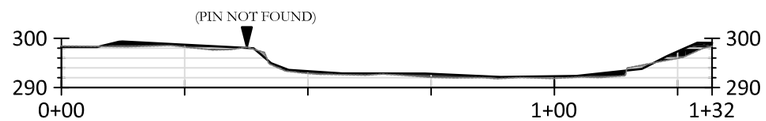
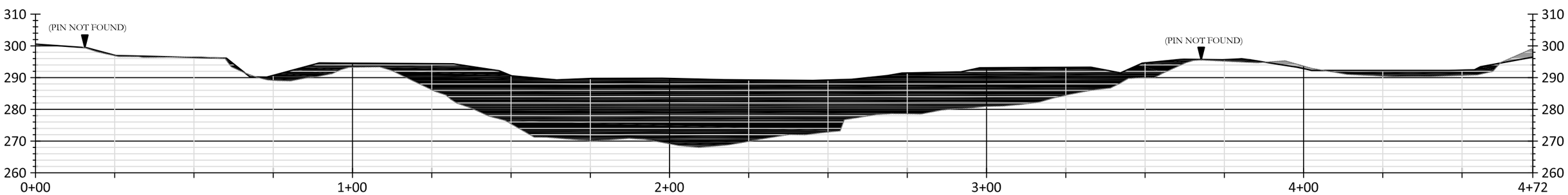
SHORT FALLS ROAD BRIDGE

VHB SECTIONS MOVED UP 2.5' TO MATCH GRADE OUTSIDE OF CHANNEL





XS_BRIDGE_UPSTREAM



XS_BRIDGE_DOWNSTREAM

MAY 2007 VHB SURVEY &
SEPTEMBER 2011 INTER-FLUVE SURVEY
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APPENDIX B:
Hydrologic results from the USGS StreamStats program for the Little Suncook River and Leighton Brook, respectively.

USGS New Hampshire StreamStats

Streamstats Ungaged Site Report

Date: Tue Oct 18 2011 14:17:20 Mountain Daylight Time
Site Location: New_Hampshire
NAD27 Latitude: 43.2238 (43 13 26)
NAD27 Longitude: -71.3560 (-71 21 22)
NAD83 Latitude: 43.2239 (43 13 26)
NAD83 Longitude: -71.3556 (-71 21 20)
Drainage Area: 39.62 mi2

Peak Flows Region Grid Basin Characteristics

100% Peak Flow Statewide SIR2008 5206 (39.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	39.6	0.7	1290
Mean April Precipitation (inches)	3.800	2.79	6.23
Percent Wetlands (dimensionless)	10.6873	0	21.8
Stream Slope 10 and 85 Method (feet per mi)	28.8	5.43	543

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	713	30	3.2		
PK5	1100	31	4.7		
PK10	1420	32	6.2		
PK25	1820	34	8		
PK50	2150	36	9		
PK100	2530	39	9.8		
PK500	3440	44	11		

USGS New Hampshire StreamStats

Streamstats Ungaged Site Report

Date: Tue Oct 18 2011 14:04:45 Mountain Daylight Time
Site Location: New_Hampshire
NAD27 Latitude: 43.2172 (43 13 02)
NAD27 Longitude: -71.3580 (-71 21 29)
NAD83 Latitude: 43.2173 (43 13 02)
NAD83 Longitude: -71.3575 (-71 21 27)
Drainage Area: 0.74 mi2

Peak Flows Region Grid Basin Characteristics

100% Peak Flow Statewide SIR2008 5206 (0.74 mi2)

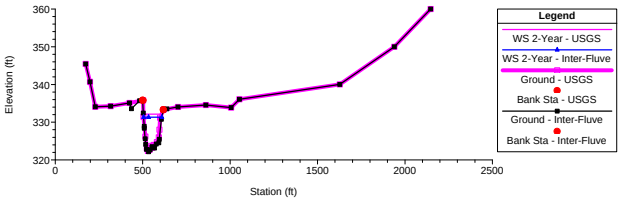
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.74	0.7	1290
Mean April Precipitation (inches)	3.403	2.79	6.23
Percent Wetlands (dimensionless)	0.4899	0	21.8
Stream Slope 10 and 85 Method (feet per mi)	322	5.43	543

Peak Flows Region Grid Streamflow Statistics

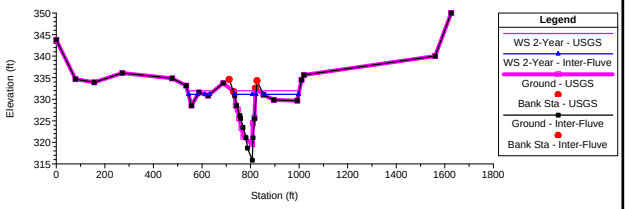
Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	38.9	30	3.2		
PK5	66.8	31	4.7		
PK10	91.2	32	6.2		
PK25	126	34	8		
PK50	154	36	9		
PK100	189	39	9.8		
PK500	276	44	11		

APPENDIX C:
HEC-RAS cross sections comparing the USGS cross sections with the Inter-Fluve cross sections.

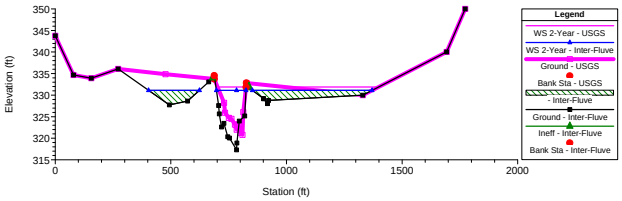
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 140 DO: Sec Goss4A Gossville - 061008.1



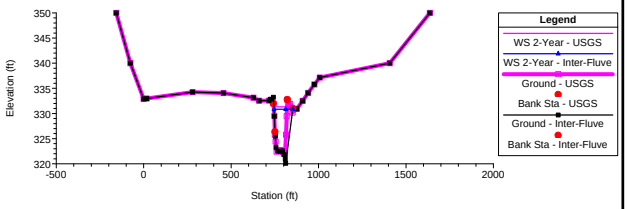
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 139 DN: Sec Goss4B Gossville - 061008.2



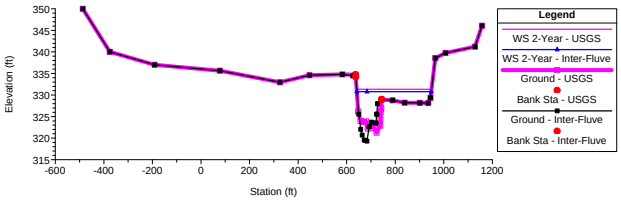
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 138 DM: Sec Goss4C Gossville - 061008.2



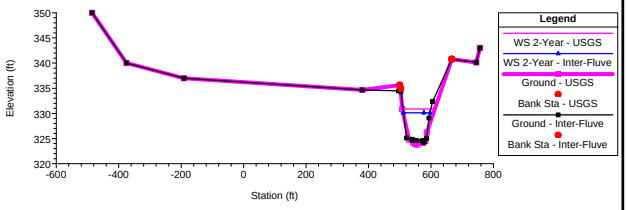
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 137 DL: Sec Goss4D Gossville - 061008.3



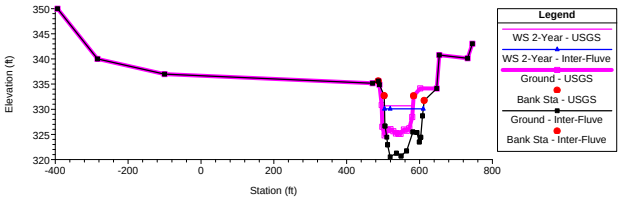
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 136 DK: Sec TP2B Gossville - 061108.1



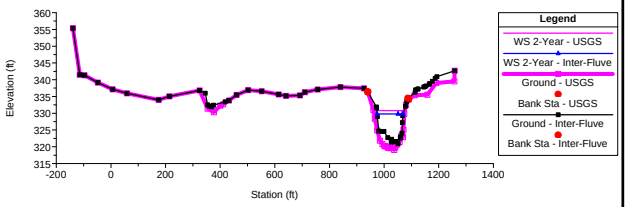
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 135 DJ: Sec USCH - 061108.2 - Moved USGS locatoin 93 feet upstream t



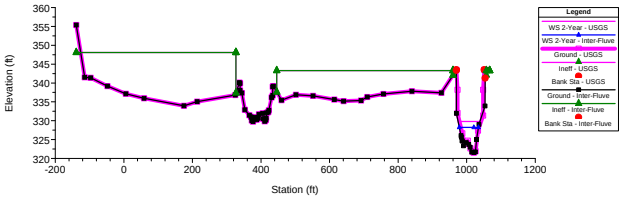
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 134 Sec TP2C - 061108.2



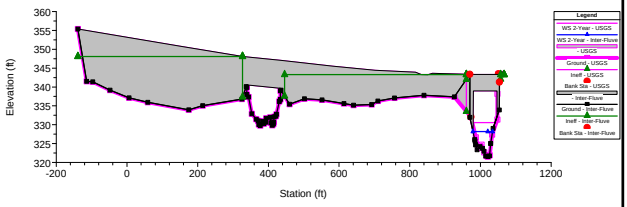
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 133 DI: Sec TP2D Appr Rte. 4 - 061108.3 and Appr 062708.1 (SAO) and



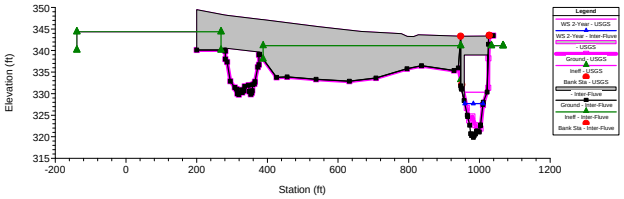
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 132 USFACE Rte. 4 Primary and Relief Bridges



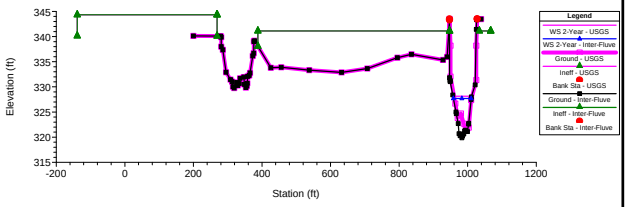
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 131.5 MO Rte. 4 Primary (west) and Relief (east) Bridges



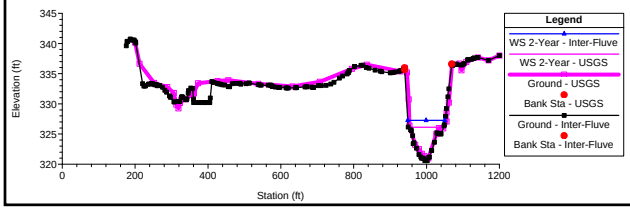
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 131.5 MO Rte. 4 Primary (west) and Relief (east) Bridges



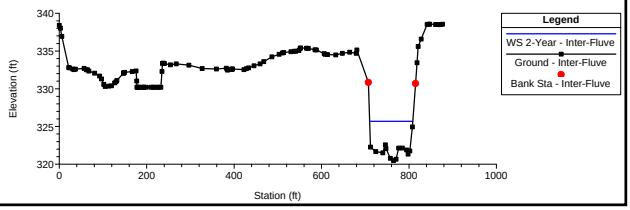
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 131 DSFACE Rte. 4 Primary and Relief Bridges



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 130 DH: Exit Rte. 4 (SAO) - Job#062708.2 (corrected to NGVD29 - +0.



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 129.9



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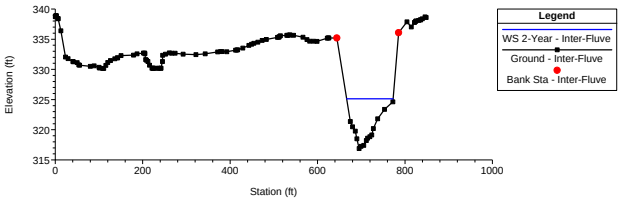
RS = 129.8



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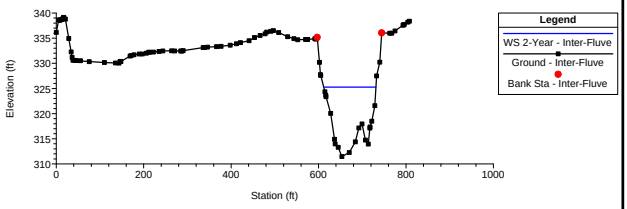
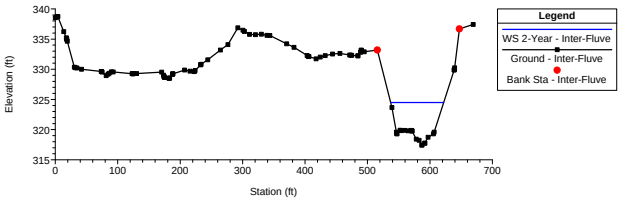
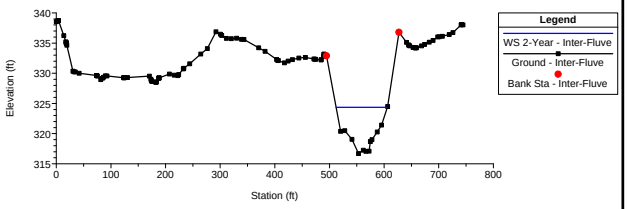
RS = 129.7



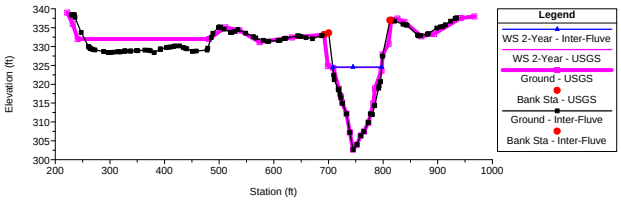
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 129.6



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 129.3



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 129 DG: Race2 (SAO) - 071108.1



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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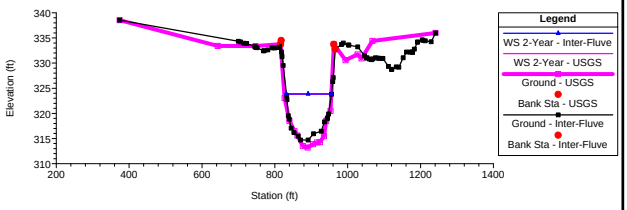
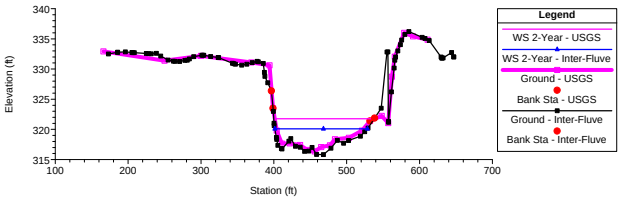
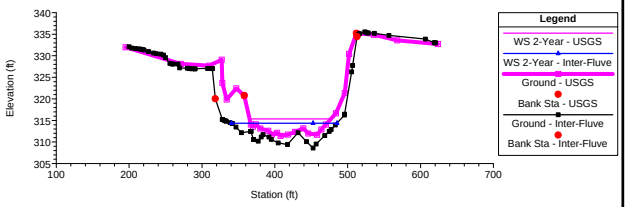


IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 127 DE: SecRT1 - 061608.1



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 126 DD: SecRT3 - 061808.1



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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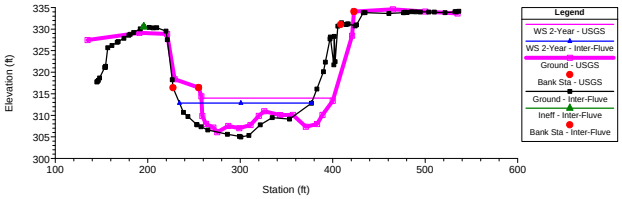
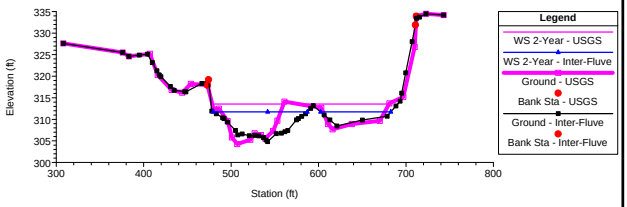


IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 124 DB: SecRT4C - 061808.2



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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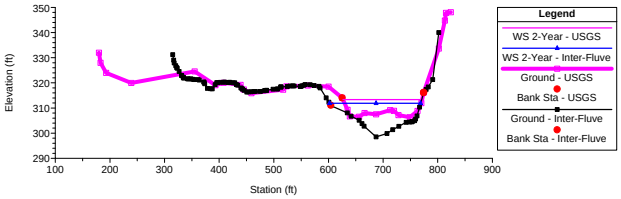
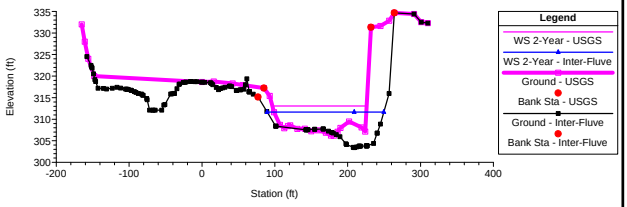


IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 122 CZ: SecESP1 w/UPRDG - 061908.2



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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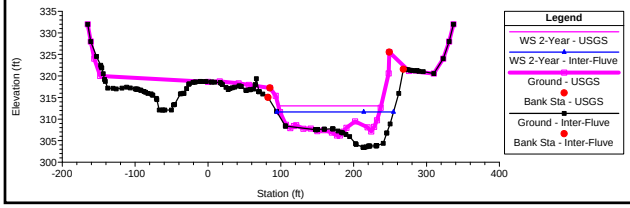

IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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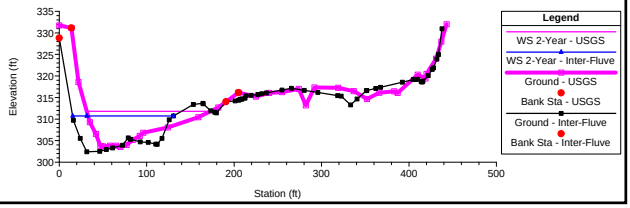
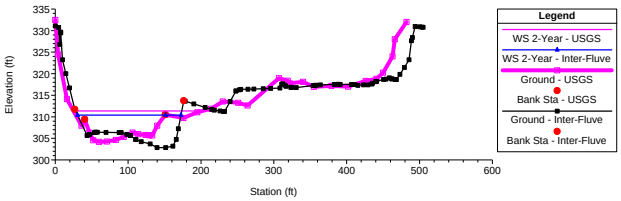
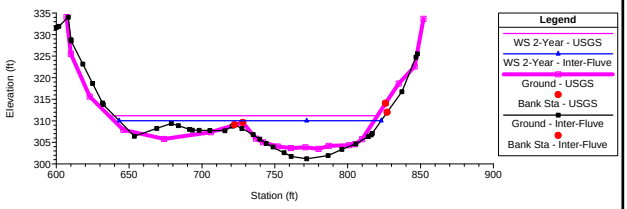


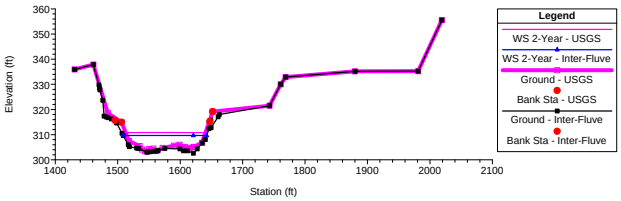
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 119 CW: SecESP3 - 061908.2



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 118 CV: SPA (SAO) - 061208.1



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 117 CU: SPB (SAO) - 061208.1



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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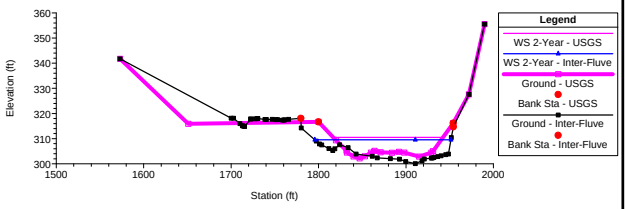
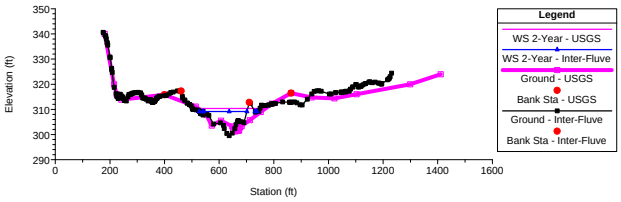
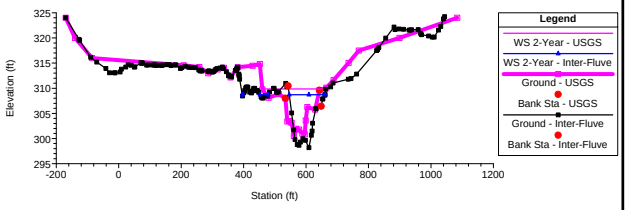


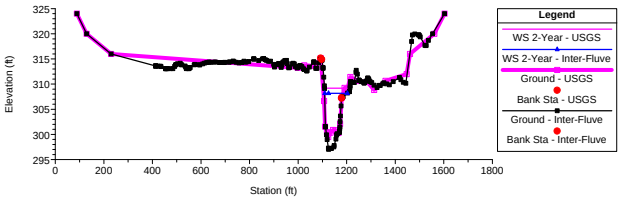
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 115 CS: SPD (SAO) - 061208.2



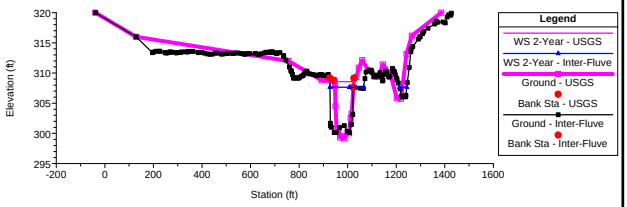
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 114 CR: Bear1 (SAO) - 062508.1



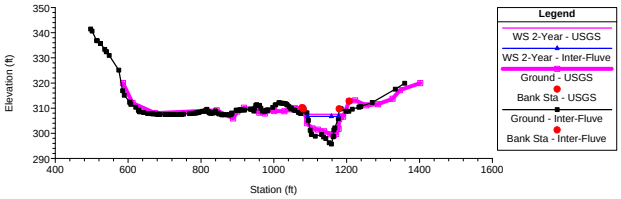
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 113 CQ: Bear2 (SAO) - 062508.2



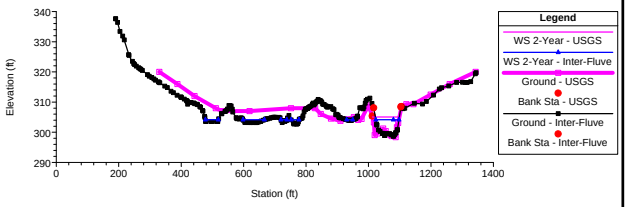
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 112 CP: Bear3 (SAO) - 062508.3



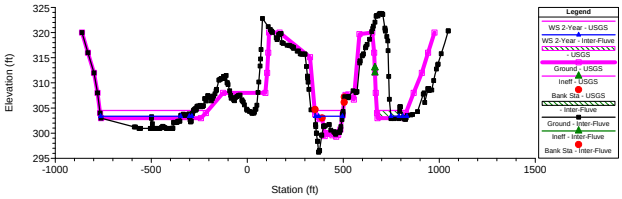
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 111 CO: Bear4 (SAO) - 062608.1



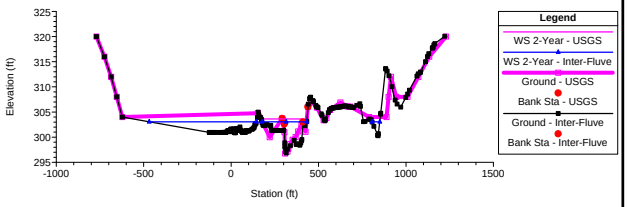
IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 110 CN: Bear5 (SAO) - 062608.2



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 109 CM: SecY2A - Job 052808.2



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 108 CL: SecY2B - Job 052808.3



IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
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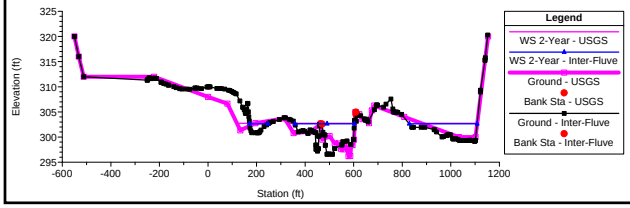
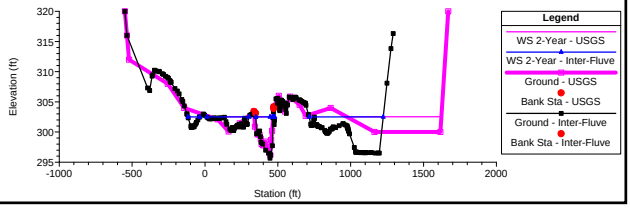


IFI Suncook River Plan: 1) Inter-Fluve 2) USGS
RS = 106 CJ: SecY3B - Job 052808.5



Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
131	2-Year	IFI Ext	2228	319.86	327.68	0.008498	8.55	260.73	51.82	0.67	2.5
131	2-Year	IFI prop	2228	319.86	327.9	0.007548	8.19	272.16	52.73	0.64	2.27
131	5-Year	IFI Ext	3555	319.86	329.05	0.011292	10.53	337.5	60.81	0.79	3.67
131	5-Year	IFI prop	3555	319.86	329.74	0.008366	9.33	380.91	65.85	0.68	2.84
131	10-Year	IFI Ext	4680	319.86	330.19	0.011938	11.37	413.99	81.17	0.82	4.17
131	10-Year	IFI prop	4680	319.86	331.14	0.007568	9.63	504.92	105.43	0.66	2.9
131	25-Year	IFI Ext	6427	319.86	331.82	0.010402	11.8	580.28	121.24	0.78	4.26
131	25-Year	IFI prop	6427	319.86	332.71	0.00676	10.15	701.38	143.31	0.64	3.05
131	50-Year	IFI Ext	7994	319.86	333.05	0.008894	11.91	751.04	200.37	0.73	4.15
131	50-Year	IFI prop	7994	319.86	333.86	0.006163	10.41	870.88	421.9	0.61	3.1
131	100-Year	IFI Ext	9819	319.86	334.16	0.008199	12.21	915.06	456.46	0.7	4.22
131	100-Year	IFI prop	9819	319.86	334.89	0.006062	10.92	1028.3	496.78	0.61	3.31
131	500-Year	IFI Ext	15290	319.86	336.59	0.007943	13.52	1298.62	703.99	0.7	4.88
131	500-Year	IFI prop	15290	319.86	337.33	0.006217	12.33	1421.3	713.65	0.62	4
131	Apr-07	IFI Ext	10600	319.86	334.54	0.008154	12.43	973.19	477.27	0.7	4.33
131	Apr-07	IFI prop	10600	319.86	335.3	0.006043	11.12	1091.28	518.82	0.61	3.4
131	1.8-Year	IFI Ext	2060	319.86	327.5	0.008032	8.19	251.45	51.06	0.65	2.31
131	1.8-Year	IFI prop	2060	319.86	327.66	0.007341	7.93	259.75	51.74	0.62	2.15
130	2-Year	IFI Ext	2320	320.59	327.27	0.005008	5.76	402.57	101.97	0.51	1.21
130	2-Year	IFI prop	2320	320.59	327.61	0.003846	5.3	437.9	103.04	0.45	1
130	5-Year	IFI Ext	3702	320.59	328.83	0.004402	6.54	566.11	106.81	0.5	1.42
130	5-Year	IFI prop	3702	320.59	329.66	0.002797	5.64	655.85	109.38	0.41	1.01
130	10-Year	IFI Ext	4873	320.59	330.12	0.003871	6.9	705.8	110.78	0.48	1.49
130	10-Year	IFI prop	4873	320.59	331.16	0.002335	5.81	889.96	207.87	0.38	1.01
130	25-Year	IFI Ext	6693	320.59	331.93	0.003041	6.99	1056.13	224.79	0.44	1.43
130	25-Year	IFI prop	6693	320.59	332.83	0.002023	6.02	1281.86	364.87	0.36	1.03
130	50-Year	IFI Ext	8325	320.59	333.27	0.002524	6.89	1476.68	538.77	0.41	1.34
130	50-Year	IFI prop	8325	320.59	334.13	0.001488	5.54	2026.93	662.88	0.32	0.84
130	100-Year	IFI Ext	10225	320.59	334.63	0.001626	5.94	2365.33	678.8	0.33	0.96
130	100-Year	IFI prop	10225	320.59	335.33	0.001054	4.94	2853.49	742.18	0.27	0.65
130	500-Year	IFI Ext	15922	320.59	337.5	0.000754	4.67	4697.42	948.72	0.23	0.55
130	500-Year	IFI prop	15922	320.59	338.1	0.000549	4.11	5286.03	992.98	0.2	0.42
130	Apr-07	IFI Ext	11038	320.59	335.1	0.001417	5.67	2686.7	694.84	0.31	0.86
130	Apr-07	IFI prop	11038	320.59	335.8	0.000931	4.74	3210.5	800.69	0.25	0.59
130	1.8-Year	IFI Ext	2145	320.59	327.07	0.005026	5.61	382.57	101.36	0.51	1.16
130	1.8-Year	IFI prop	2145	320.59	327.34	0.004056	5.24	409.54	102.18	0.46	1

Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
129.9	2-Year	IFI Ext	2320	320.5	325.69	0.008494	6.03	385.01	98.62	0.54	2
129.9	2-Year	IFI prop	2320	320.5	326.75	0.003943	4.73	490.12	100.52	0.38	1.15
129.9	5-Year	IFI Ext	3702	320.5	327.67	0.005808	6.35	583.09	102.18	0.47	1.96
129.9	5-Year	IFI prop	3702	320.5	329.05	0.002929	5.1	725.97	104.66	0.34	1.19
129.9	10-Year	IFI Ext	4873	320.5	329.13	0.0049	6.64	734.27	104.81	0.44	2.01
129.9	10-Year	IFI prop	4873	320.5	330.61	0.00267	5.45	919.36	184.9	0.33	1.28
129.9	25-Year	IFI Ext	6693	320.5	331.06	0.004182	7.04	1004.32	198.6	0.42	2.11
129.9	25-Year	IFI prop	6693	320.5	332.3	0.002505	5.95	1282.58	275.76	0.33	1.44
129.9	50-Year	IFI Ext	8325	320.5	332.41	0.003735	7.32	1314.82	288.01	0.41	2.18
129.9	50-Year	IFI prop	8325	320.5	333.54	0.002321	6.2	1837.29	575.18	0.33	1.51
129.9	100-Year	IFI Ext	10225	320.5	333.82	0.003037	7.21	2000.34	586.56	0.37	2.02
129.9	100-Year	IFI prop	10225	320.5	334.85	0.001832	5.93	2644.08	725.57	0.3	1.33
129.9	500-Year	IFI Ext	15922	320.5	337.12	0.00149	5.97	4470.14	826.37	0.27	1.27
129.9	500-Year	IFI prop	15922	320.5	337.83	0.001082	5.25	5062.12	833.63	0.24	0.97
129.9	Apr-07	IFI Ext	11038	320.5	334.38	0.002674	6.98	2335.57	612.26	0.35	1.86
129.9	Apr-07	IFI prop	11038	320.5	335.35	0.001685	5.84	3024.06	790.49	0.29	1.27
129.9	1.8-Year	IFI Ext	2145	320.5	325.43	0.009092	5.98	358.87	98.14	0.55	2.01
129.9	1.8-Year	IFI prop	2145	320.5	326.41	0.004233	4.7	456.13	99.91	0.39	1.16
129.8	2-Year	IFI Ext	2320	316.89	325.13	0.005191	5.08	456.52	106.12	0.43	1.37
129.8	2-Year	IFI prop	2320	316.89	326.55	0.002118	3.81	609.61	110.92	0.29	0.71
129.8	5-Year	IFI Ext	3702	316.89	327.34	0.003549	5.3	698.77	113.62	0.38	1.32
129.8	5-Year	IFI prop	3702	316.89	328.91	0.001754	4.2	881.44	118.97	0.27	0.78
129.8	10-Year	IFI Ext	4873	316.89	328.88	0.003081	5.55	877.45	118.85	0.36	1.37
129.8	10-Year	IFI prop	4873	316.89	330.5	0.001677	4.53	1085.38	169.89	0.27	0.87
129.8	25-Year	IFI Ext	6693	316.89	330.86	0.00278	5.95	1159.03	219.51	0.35	1.48
129.8	25-Year	IFI prop	6693	316.89	332.19	0.001713	5	1502.65	295.25	0.28	1.01
129.8	50-Year	IFI Ext	8325	316.89	332.25	0.002591	6.17	1520.72	296.93	0.34	1.54
129.8	50-Year	IFI prop	8325	316.89	333.45	0.001658	5.21	2064.22	539.83	0.28	1.07
129.8	100-Year	IFI Ext	10225	316.89	333.68	0.002261	6.14	2191.48	549.23	0.33	1.48
129.8	100-Year	IFI prop	10225	316.89	334.75	0.001428	5.1	2805.81	617.02	0.26	0.99
129.8	500-Year	IFI Ext	15922	316.89	336.99	0.001341	5.48	4460.74	784.26	0.26	1.09
129.8	500-Year	IFI prop	15922	316.89	337.74	0.000978	4.85	5053.72	809.47	0.22	0.84
129.8	Apr-07	IFI Ext	11038	316.89	334.24	0.002065	6.01	2506.92	570.68	0.31	1.4
129.8	Apr-07	IFI prop	11038	316.89	335.25	0.001362	5.07	3128.99	704.69	0.26	0.98
129.8	1.8-Year	IFI Ext	2145	316.89	324.81	0.005683	5.09	421.78	105	0.45	1.4
129.8	1.8-Year	IFI prop	2145	316.89	326.19	0.002223	3.76	570.35	109.71	0.29	0.7

Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
129.7	2-Year	IFI Ext	2320	311.45	325.27	0.000356	2.13	1089.37	119.62	0.12	0.19
129.7	2-Year	IFI prop	2320	311.45	326.61	0.000237	1.85	1252.8	124.53	0.1	0.14
129.7	5-Year	IFI Ext	3702	311.45	327.46	0.000477	2.72	1359.51	127.63	0.15	0.3
129.7	5-Year	IFI prop	3702	311.45	328.97	0.000323	2.38	1558.14	133.65	0.12	0.22
129.7	10-Year	IFI Ext	4873	311.45	328.99	0.000558	3.12	1560.26	133.71	0.16	0.38
129.7	10-Year	IFI prop	4873	311.45	330.56	0.000383	2.74	1805.64	245.98	0.14	0.28
129.7	25-Year	IFI Ext	6693	311.45	330.97	0.000651	3.63	1910.93	262.33	0.18	0.49
129.7	25-Year	IFI prop	6693	311.45	332.26	0.000471	3.24	2279.21	331.6	0.15	0.38
129.7	50-Year	IFI Ext	8325	311.45	332.35	0.000712	4	2311.25	340.38	0.19	0.58
129.7	50-Year	IFI prop	8325	311.45	333.49	0.000531	3.59	2802.84	499.61	0.16	0.46
129.7	100-Year	IFI Ext	10225	311.45	333.73	0.000749	4.3	2925.24	517.57	0.19	0.66
129.7	100-Year	IFI prop	10225	311.45	334.76	0.000557	3.83	3481.83	587.15	0.17	0.51
129.7	500-Year	IFI Ext	15922	311.45	336.94	0.000704	4.64	4981.86	760.34	0.19	0.72
129.7	500-Year	IFI prop	15922	311.45	337.68	0.000553	4.22	5556.7	775.54	0.17	0.59
129.7	Apr-07	IFI Ext	11038	311.45	334.27	0.000749	4.37	3209.5	544.34	0.19	0.67
129.7	Apr-07	IFI prop	11038	311.45	335.24	0.000562	3.9	3783.82	642.54	0.17	0.53
129.7	1.8-Year	IFI Ext	2145	311.45	324.95	0.000338	2.04	1050.95	118.44	0.12	0.18
129.7	1.8-Year	IFI prop	2145	311.45	326.25	0.000225	1.77	1208.83	123.23	0.1	0.13
129.6	2-Year	IFI Ext	2320	317.43	324.49	0.006639	5.96	389.3	84.93	0.49	1.85
129.6	2-Year	IFI prop	2320	317.43	326.21	0.002529	4.27	543.34	94.44	0.31	0.88
129.6	5-Year	IFI Ext	3702	317.43	326.58	0.005367	6.39	579.03	96.51	0.46	1.95
129.6	5-Year	IFI prop	3702	317.43	328.5	0.002354	4.78	773.89	107.12	0.31	1.02
129.6	10-Year	IFI Ext	4873	317.43	328.06	0.004857	6.7	727.5	104.69	0.45	2.03
129.6	10-Year	IFI prop	4873	317.43	330.06	0.002227	5.05	1058.63	301.76	0.31	1.1
129.6	25-Year	IFI Ext	6693	317.43	330.02	0.00428	6.99	1045.97	299.77	0.43	2.1
129.6	25-Year	IFI prop	6693	317.43	331.8	0.001902	5.12	1626.44	346.91	0.29	1.08
129.6	50-Year	IFI Ext	8325	317.43	331.59	0.003243	6.61	1551.81	338.5	0.38	1.8
129.6	50-Year	IFI prop	8325	317.43	333.1	0.001674	5.1	2161.27	483.95	0.28	1.03
129.6	100-Year	IFI Ext	10225	317.43	333.15	0.002471	6.21	2185.27	490.23	0.34	1.53
129.6	100-Year	IFI prop	10225	317.43	334.42	0.001406	5.01	2843.26	536.42	0.26	0.96
129.6	500-Year	IFI Ext	15922	317.43	336.59	0.001448	5.61	4099.33	627.48	0.27	1.15
129.6	500-Year	IFI prop	15922	317.43	337.42	0.001095	5.07	4631.85	659.7	0.24	0.92
129.6	Apr-07	IFI Ext	11038	317.43	333.74	0.002208	6.06	2484.92	513.81	0.32	1.44
129.6	Apr-07	IFI prop	11038	317.43	334.93	0.001324	4.98	3117.38	551.09	0.25	0.94
129.6	1.8-Year	IFI Ext	2145	317.43	324.18	0.006949	5.9	363.27	83.21	0.5	1.84
129.6	1.8-Year	IFI prop	2145	317.43	325.86	0.002576	4.2	511.2	92.54	0.31	0.86

Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
129.3	2-Year	IFI Ext	2320	316.71	324.35	0.004808	5.21	445.54	93.84	0.42	1.39
129.3	2-Year	IFI prop	2320	319	325.67	0.006705	6.32	367.23	73.78	0.5	2.02
129.3	5-Year	IFI Ext	3702	316.71	326.49	0.003815	5.64	656.01	102.12	0.39	1.48
129.3	5-Year	IFI prop	3702	319	327.97	0.005483	6.71	551.5	86.6	0.47	2.1
129.3	10-Year	IFI Ext	4873	316.71	327.98	0.003502	6	812.42	107.7	0.38	1.59
129.3	10-Year	IFI prop	4873	319	329.52	0.005036	7.01	718.83	206.72	0.46	2.2
129.3	25-Year	IFI Ext	6693	316.71	329.94	0.003221	6.42	1119.19	291.94	0.38	1.72
129.3	25-Year	IFI prop	6693	319	331.41	0.003803	6.67	1268.28	319.98	0.41	1.9
129.3	50-Year	IFI Ext	8325	316.71	331.5	0.002641	6.26	1618.1	336.45	0.35	1.58
129.3	50-Year	IFI prop	8325	319	332.83	0.002952	6.24	1791.69	443.93	0.36	1.61
129.3	100-Year	IFI Ext	10225	316.71	333.06	0.002119	6	2239.11	467.27	0.32	1.4
129.3	100-Year	IFI prop	10225	319	334.25	0.002274	5.76	2472.25	511.11	0.32	1.34
129.3	500-Year	IFI Ext	15922	316.71	336.53	0.001337	5.54	4194.1	697.32	0.26	1.11
129.3	500-Year	IFI prop	15922	319	337.34	0.001483	5.33	4414.75	723.61	0.27	1.07
129.3	Apr-07	IFI Ext	11038	316.71	333.66	0.001928	5.89	2525.66	489.24	0.3	1.33
129.3	Apr-07	IFI prop	11038	319	334.78	0.002061	5.63	2752.2	550.68	0.31	1.27
129.3	1.8-Year	IFI Ext	2145	316.71	324.02	0.005045	5.16	415.53	92	0.43	1.39
129.3	1.8-Year	IFI prop	2145	319	325.32	0.007022	6.28	341.72	71.82	0.51	2.02
129	2-Year	IFI Ext	2320	302.68	324.55	0.000241	2.07	1123.48	89.71	0.1	0.16
129	2-Year	IFI prop	2320	310.25	325.65	0.002205	4.62	501.74	65.17	0.29	0.96
129	5-Year	IFI Ext	3702	302.68	326.69	0.000384	2.81	1318.73	92.57	0.13	0.29
129	5-Year	IFI prop	3702	310.25	327.88	0.002729	5.63	657.58	74.61	0.33	1.36
129	10-Year	IFI Ext	4873	302.68	328.18	0.0005	3.34	1458.31	95.22	0.15	0.41
129	10-Year	IFI prop	4873	310.25	329.4	0.002944	6.18	869.12	248.16	0.35	1.59
129	25-Year	IFI Ext	6693	302.68	330.14	0.000643	3.97	1881.97	311.35	0.17	0.56
129	25-Year	IFI prop	6693	310.25	331.29	0.002555	6.13	1428.72	316	0.33	1.52
129	50-Year	IFI Ext	8325	302.68	331.63	0.000697	4.28	2371.84	361.98	0.18	0.64
129	50-Year	IFI prop	8325	310.25	332.72	0.002146	5.87	1962.91	444.63	0.31	1.36
129	100-Year	IFI Ext	10225	302.68	333.13	0.000719	4.48	3004.34	496.08	0.18	0.69
129	100-Year	IFI prop	10225	310.25	334.16	0.001764	5.5	2693.1	561.97	0.28	1.17
129	500-Year	IFI Ext	15922	302.68	336.53	0.000685	4.75	5029.72	668.96	0.18	0.74
129	500-Year	IFI prop	15922	310.25	337.28	0.00121	5.07	4677.74	692.52	0.24	0.95
129	Apr-07	IFI Ext	11038	302.68	333.71	0.000717	4.53	3303.66	532.24	0.18	0.7
129	Apr-07	IFI prop	11038	310.25	334.69	0.001632	5.41	3002.47	593.92	0.27	1.12
129	1.8-Year	IFI Ext	2145	302.68	324.23	0.000222	1.96	1094.74	89.28	0.1	0.15
129	1.8-Year	IFI prop	2145	310.25	325.31	0.002123	4.47	479.85	63.73	0.29	0.9

Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
128	2-Year	IFI Ext	2854	314.71	323.88	0.001351	3.28	869.42	123.55	0.22	0.58
128	2-Year	IFI prop	2854	314.71	324.05	0.001254	3.2	890.99	124.08	0.21	0.55
128	5-Year	IFI Ext	4553	314.71	325.72	0.001672	4.13	1101.99	129.2	0.25	0.86
128	5-Year	IFI prop	4553	314.71	325.92	0.001561	4.04	1127.42	129.8	0.24	0.82
128	10-Year	IFI Ext	5994	314.71	326.98	0.001903	4.73	1267.24	133.07	0.27	1.09
128	10-Year	IFI prop	5994	314.71	327.2	0.001777	4.62	1296.47	133.71	0.26	1.03
128	25-Year	IFI Ext	8232	314.71	328.63	0.002201	5.52	1490.62	137.39	0.3	1.42
128	25-Year	IFI prop	8232	314.71	328.88	0.002056	5.4	1525.36	144.3	0.29	1.35
128	50-Year	IFI Ext	10239	314.71	329.92	0.002417	6.12	1697.47	179.46	0.31	1.7
128	50-Year	IFI prop	10239	314.71	330.16	0.002271	5.99	1741.78	184	0.3	1.62
128	100-Year	IFI Ext	12576	314.71	331.22	0.002638	6.73	1961.06	248.65	0.33	2.01
128	100-Year	IFI prop	12576	314.71	331.5	0.002463	6.57	2030.47	254.73	0.32	1.9
128	500-Year	IFI Ext	19583	314.71	334.37	0.002851	7.9	3056.14	509.45	0.35	2.6
128	500-Year	IFI prop	19583	314.71	334.66	0.002637	7.69	3212.95	555.92	0.34	2.45
128	Apr-07	IFI Ext	13576	314.71	331.74	0.002701	6.95	2093.73	259.88	0.34	2.11
128	Apr-07	IFI prop	13576	314.71	332.03	0.002519	6.78	2168.62	265.84	0.33	2
128	1.8-Year	IFI Ext	2638	314.71	323.6	0.001305	3.16	835.03	122.57	0.21	0.54
128	1.8-Year	IFI prop	2638	314.71	323.76	0.001213	3.08	855.33	123.17	0.21	0.51
127	2-Year	IFI Ext	2854	315.83	320.08	0.03416	8.6	331.67	127.12	0.94	5.5
127	2-Year	IFI prop	2854	315.83	320.21	0.037728	9.16	311.63	117.34	0.99	6.19
127	5-Year	IFI Ext	4553	315.83	320.92	0.03594	10.33	440.67	133.01	1	7.32
127	5-Year	IFI prop	4553	315.83	321.17	0.036004	10.62	428.7	124.57	1.01	7.64
127	10-Year	IFI Ext	5994	315.83	321.62	0.034195	11.21	534.78	137.56	1	8.18
127	10-Year	IFI prop	5994	315.83	321.91	0.034233	11.48	522.28	130.73	1.01	8.48
127	25-Year	IFI Ext	8232	315.83	322.56	0.031776	12.36	667.68	143.91	1	9.3
127	25-Year	IFI prop	8232	315.83	322.9	0.031453	12.62	655.86	138.96	1	9.56
127	50-Year	IFI Ext	10239	315.83	323.31	0.030322	13.26	778.15	149.12	0.99	10.21
127	50-Year	IFI prop	10239	315.83	323.75	0.028931	13.33	776.87	144.97	0.98	10.17
127	100-Year	IFI Ext	12576	315.83	324.17	0.02829	14.04	907.96	152.2	0.98	10.92
127	100-Year	IFI prop	12576	315.83	324.59	0.027779	14.2	900.46	148.09	0.98	11.06
127	500-Year	IFI Ext	19583	315.83	326.3	0.026189	16.18	1237.35	157.52	0.98	13.26
127	500-Year	IFI prop	19583	315.83	326.78	0.025586	16.27	1234.4	157.24	0.98	13.3
127	Apr-07	IFI Ext	13576	315.83	324.5	0.027927	14.39	957.62	153.01	0.98	11.3
127	Apr-07	IFI prop	13576	315.83	324.91	0.027666	14.58	947.94	149.27	0.99	11.5
127	1.8-Year	IFI Ext	2638	315.83	319.99	0.032762	8.26	319.41	126.19	0.91	5.12
127	1.8-Year	IFI prop	2638	315.83	320.11	0.035938	8.77	300.65	116.41	0.96	5.73

Appendix D: Suncook River mainstem HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Rt 4 bridge to the avulsion site.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
126	2-Year	IFI Ext	2854	308.59	314.37	0.013356	6.16	463.61	144.96	0.61	2.63
126	2-Year	IFI prop	2854	308.59	314.37	0.013349	6.15	463.7	144.97	0.61	2.63
126	5-Year	IFI Ext	4553	308.59	315.87	0.010327	6.49	701.37	166.97	0.56	2.67
126	5-Year	IFI prop	4553	308.59	315.85	0.010218	6.62	688.18	157.72	0.56	2.74
126	10-Year	IFI Ext	5994	308.59	316.97	0.008505	6.75	888	171.84	0.52	2.7
126	10-Year	IFI prop	5994	308.59	316.95	0.008629	6.92	865.95	162.88	0.53	2.81
126	25-Year	IFI Ext	8232	308.59	318.4	0.007326	7.24	1136.59	176.08	0.5	2.89
126	25-Year	IFI prop	8232	308.59	318.38	0.007595	7.47	1102.35	167.32	0.51	3.05
126	50-Year	IFI Ext	10239	308.59	319.51	0.006834	7.67	1334.64	179.38	0.5	3.09
126	50-Year	IFI prop	10239	308.59	319.5	0.007172	7.93	1290.69	170.77	0.51	3.29
126	100-Year	IFI Ext	12576	308.59	320.62	0.006609	8.2	1534.12	181.86	0.5	3.39
126	100-Year	IFI prop	12576	308.59	320.61	0.007045	8.49	1481.71	174.21	0.51	3.63
126	500-Year	IFI Ext	19583	308.59	323.22	0.006674	9.74	2013.27	185.94	0.52	4.4
126	500-Year	IFI prop	19583	308.59	323.23	0.007343	10.04	1949.98	182.35	0.54	4.72
126	Apr-07	IFI Ext	13576	308.59	321.04	0.006563	8.42	1611.78	182.53	0.5	3.53
126	Apr-07	IFI prop	13576	308.59	321.03	0.007046	8.72	1556.82	175.54	0.52	3.78
126	1.8-Year	IFI Ext	2638	308.59	314.15	0.013956	6.1	432.56	141.75	0.62	2.62
126	1.8-Year	IFI prop	2638	308.59	314.15	0.013952	6.1	432.6	141.76	0.62	2.62
125	2-Year	IFI Ext	2854	304.99	312.85	0.003547	4.16	685.24	142.87	0.34	1.05
125	2-Year	IFI prop	2854	304.99	312.85	0.003547	4.16	685.24	142.87	0.34	1.05
125	5-Year	IFI Ext	4553	304.99	314.45	0.003605	4.95	919.22	148.85	0.35	1.37
125	5-Year	IFI prop	4553	304.99	314.45	0.003605	4.95	919.22	148.85	0.35	1.37
125	10-Year	IFI Ext	5994	304.99	315.66	0.003583	5.45	1100.6	153.33	0.36	1.58
125	10-Year	IFI prop	5994	304.99	315.66	0.003583	5.45	1100.6	153.33	0.36	1.58
125	25-Year	IFI Ext	8232	304.99	317.11	0.003766	6.2	1326.96	157.66	0.38	1.94
125	25-Year	IFI prop	8232	304.99	317.11	0.003766	6.2	1326.96	157.66	0.38	1.94
125	50-Year	IFI Ext	10239	304.99	318.21	0.003927	6.82	1502.5	161.88	0.39	2.26
125	50-Year	IFI prop	10239	304.99	318.21	0.003927	6.82	1502.5	161.88	0.39	2.26
125	100-Year	IFI Ext	12576	304.99	319.25	0.004242	7.54	1670.28	166.83	0.41	2.67
125	100-Year	IFI prop	12576	304.99	319.25	0.004242	7.54	1670.28	166.83	0.41	2.67
125	500-Year	IFI Ext	19583	304.99	321.58	0.005359	9.56	2053.26	176.14	0.48	4.05
125	500-Year	IFI prop	19583	304.99	321.58	0.005359	9.56	2053.26	176.14	0.48	4.05
125	Apr-07	IFI Ext	13576	304.99	319.65	0.004393	7.84	1734.3	168.62	0.42	2.86
125	Apr-07	IFI prop	13576	304.99	319.65	0.004393	7.84	1734.3	168.62	0.42	2.86
125	1.8-Year	IFI Ext	2638	304.99	312.64	0.003474	4.03	654.8	141.35	0.33	0.99
125	1.8-Year	IFI prop	2638	304.99	312.64	0.003474	4.03	654.8	141.35	0.33	0.99

Appendix E: Little Suncook River HEC-RAS output data for existing conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
		(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
207	2-Year	713	337.78	341.8	342.28	0.00927	6.42	164.08	70.63	0.57	2.24
207	5-Year	1100	337.78	342.52	343.15	0.010346	7.59	214.81	70.63	0.62	2.97
207	10-Year	1420	337.78	343.07	343.8	0.010605	8.29	253.66	70.63	0.64	3.4
207	25-Year	1820	337.78	343.59	344.49	0.011619	9.25	290.59	70.63	0.68	4.11
207	50-Year	2150	337.78	344.11	345.08	0.01133	9.69	327.22	70.63	0.69	4.37
207	100-Year	2530	337.78	344.66	345.72	0.011165	10.17	365.89	70.63	0.69	4.69
207	500-Year	3440	337.78	345.71	347.04	0.01168	11.47	440.39	70.63	0.72	5.67
207	Apr-07	2700	337.78	344.88	345.99	0.011166	10.4	381.75	70.63	0.69	4.85
207	1.8-Year	650	337.78	341.67	342.12	0.009018	6.19	154.8	70.63	0.56	2.11
206	2-Year	713	328.11	332.17	332.54	0.007988	5.23	172.28	81.38	0.52	1.59
206	5-Year	1100	328.11	333.04	333.47	0.007281	5.85	243.48	83.97	0.51	1.84
206	10-Year	1420	328.11	333.61	334.11	0.007213	6.36	291.81	85.69	0.52	2.08
206	25-Year	1820	328.11	334.36	334.9	0.006586	6.72	356.98	87.96	0.51	2.2
206	50-Year	2150	328.11	334.78	335.4	0.00686	7.21	394.29	88.8	0.53	2.48
206	100-Year	2530	328.11	335.24	335.94	0.007084	7.71	435.33	89.54	0.54	2.76
206	500-Year	3440	328.11	336.39	337.24	0.006874	8.5	539.56	90.42	0.55	3.17
206	Apr-07	2700	328.11	335.44	336.18	0.007127	7.9	453.87	89.87	0.55	2.87
206	1.8-Year	650	328.11	332.01	332.37	0.008197	5.12	159.15	80.89	0.52	1.55
205	2-Year	713	324.97	328.98	329.23	0.004849	4.55	220.21	94.24	0.41	1.14
205	5-Year	1100	324.97	329.67	330.02	0.005671	5.5	285.23	94.62	0.46	1.58
205	10-Year	1420	324.97	330.23	330.64	0.005776	6.01	338.75	94.94	0.47	1.81
205	25-Year	1820	324.97	330.98	331.49	0.00613	6.8	411.8	115.66	0.5	2.2
205	50-Year	2150	324.97	331.58	332.09	0.0055	6.88	481.38	115.66	0.48	2.18
205	100-Year	2530	324.97	332.33	332.81	0.004725	6.86	567.38	115.66	0.45	2.09
205	500-Year	3440	324.97	334.17	334.62	0.003371	6.76	780.73	115.66	0.4	1.88
205	Apr-07	2700	324.97	332.67	333.15	0.004412	6.84	606.94	115.66	0.44	2.05
205	1.8-Year	650	324.97	328.85	329.08	0.004694	4.37	207.84	94.16	0.4	1.06
204	2-Year	713	323.09	326.87	327.19	0.008185	4.59	172.1	104.47	0.5	1.32
204	5-Year	1100	323.09	327.99	328.27	0.004879	4.45	301.26	119.25	0.41	1.1
204	10-Year	1420	323.09	328.89	329.14	0.003471	4.34	416.63	140.24	0.36	0.98
204	25-Year	1820	323.09	329.96	330.18	0.002466	4.21	586	179.17	0.31	0.85
204	50-Year	2150	323.09	330.81	331.01	0.001881	4.03	738.7	179.39	0.28	0.75
204	100-Year	2530	323.09	331.75	331.92	0.001476	3.91	906.24	179.39	0.25	0.67
204	500-Year	3440	323.09	333.83	333.99	0.000994	3.78	1280.45	179.39	0.22	0.58
204	Apr-07	2700	323.09	332.15	332.32	0.001349	3.87	978.79	179.39	0.24	0.65
204	1.8-Year	650	323.09	326.68	327	0.008911	4.58	152.8	99.86	0.52	1.34

Appendix E: Little Suncook River HEC-RAS output data for existing conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
		(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
203	2-Year	713	321.13	324.74	326.1	0.030843	9.46	107.78	54.93	0.98	5.42
203	5-Year	1100	321.13	325.67	327.45	0.02814	10.89	160.25	58.25	0.99	6.55
203	10-Year	1420	321.13	326.32	328.44	0.027285	11.92	198.95	60.58	1	7.44
203	25-Year	1820	321.13	327.11	329.57	0.025708	12.9	247.54	63.13	0.99	8.24
203	50-Year	2150	321.13	327.68	330.43	0.025201	13.68	284.02	64.91	1	8.96
203	100-Year	2530	321.13	328.32	331.37	0.024305	14.42	326.76	66.94	1	9.61
203	500-Year	3440	321.13	329.71	333.44	0.023169	16.02	422.09	71.06	1.01	11.12
203	Apr-07	2700	321.13	328.6	331.78	0.023962	14.72	345.52	67.78	1	9.88
203	1.8-Year	650	321.13	324.57	325.86	0.03157	9.19	98.5	53.68	0.99	5.22
202	2-Year	713	318.35	324.37	324.59	0.004268	4.55	217.83	66.98	0.38	1.1
202	5-Year	1100	318.35	325.09	325.44	0.005588	5.77	267.73	71.24	0.45	1.68
202	10-Year	1420	318.35	325.59	326.04	0.006481	6.61	304.01	74.45	0.49	2.14
202	25-Year	1820	318.35	326.13	326.72	0.007414	7.53	345.62	77.97	0.54	2.69
202	50-Year	2150	318.35	326.54	327.22	0.008012	8.17	377.74	78.94	0.56	3.11
202	100-Year	2530	318.35	326.98	327.77	0.008602	8.84	412.39	79.83	0.59	3.56
202	500-Year	3440	318.35	327.91	328.95	0.009755	10.24	487.72	81.77	0.64	4.58
202	Apr-07	2700	318.35	327.16	328	0.00884	9.12	427.24	80.22	0.6	3.75
202	1.8-Year	650	318.35	324.23	324.43	0.00402	4.32	208.74	66.41	0.37	1
201	2-Year	713	320.86	324.05	324.25	0.005001	3.7	217.03	102.82	0.4	0.84
201	5-Year	1100	320.86	324.77	325.04	0.005003	4.33	292.58	107.15	0.41	1.07
201	10-Year	1420	320.86	325.28	325.59	0.005001	4.75	347.63	108.84	0.42	1.22
201	25-Year	1820	320.86	325.85	326.22	0.005001	5.2	409.95	110.05	0.43	1.4
201	50-Year	2150	320.86	326.28	326.69	0.005005	5.53	457.45	110.98	0.44	1.54
201	100-Year	2530	320.86	326.74	327.21	0.005004	5.87	509.11	111.99	0.45	1.68
201	500-Year	3440	320.86	327.74	328.32	0.005009	6.58	622.47	114.16	0.46	2
201	Apr-07	2700	320.86	326.94	327.43	0.005003	6.01	531.35	112.42	0.45	1.74
201	1.8-Year	650	320.86	323.92	324.11	0.005001	3.57	203.43	102.01	0.39	0.8

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
313	2-Year	LB Int Ext	38.9	341.8	342.82	0.05156	5.1	7.65	9.76	1.01	2.44
313	2-Year	LB Int Pro	38.9	341.8	343.48	0.007184	2.72	14.58	11.08	0.41	0.58
313	5-Year	LB Int Ext	66.8	341.8	342.95	0.091373	7.46	9.01	10.03	1.37	4.98
313	5-Year	LB Int Pro	66.8	341.8	343.85	0.009965	3.65	18.8	11.82	0.49	0.98
313	10-Year	LB Int Ext	91.2	341.8	343.21	0.077754	7.93	11.64	10.54	1.3	5.24
313	10-Year	LB Int Pro	91.2	341.8	344.11	0.011579	4.32	21.89	12.39	0.54	1.31
313	25-Year	LB Int Ext	126	341.8	343.54	0.06629	8.44	15.23	11.19	1.24	5.53
313	25-Year	LB Int Pro	126	341.8	344.41	0.013531	5.13	25.74	13.07	0.6	1.76
313	50-Year	LB Int Ext	154	341.8	343.79	0.059621	8.73	18.1	11.69	1.19	5.67
313	50-Year	LB Int Pro	154	341.8	344.61	0.014972	5.72	28.48	13.53	0.64	2.13
313	100-Year	LB Int Ext	189	341.8	344.1	0.050531	8.99	21.78	12.37	1.13	5.68
313	100-Year	LB Int Pro	189	341.8	344.84	0.016717	6.4	31.55	14.03	0.69	2.59
313	500-Year	LB Int Ext	276	341.8	344.9	0.032939	9.12	32.42	14.17	0.97	5.22
313	500-Year	LB Int Pro	276	341.8	345.24	0.02173	8.02	37.46	14.94	0.8	3.87
313	Apr-07	LB Int Ext	200	341.8	344.19	0.048253	9.06	22.94	12.58	1.11	5.69
313	Apr-07	LB Int Pro	200	341.8	344.9	0.017265	6.61	32.44	14.17	0.7	2.74
313	1.8-Year	LB Int Ext	35	341.8	342.76	0.051794	4.91	7.14	9.66	1	2.31
313	1.8-Year	LB Int Pro	35	341.8	343.42	0.006685	2.56	13.92	10.96	0.39	0.52
312	2-Year	LB Int Ext	38.9	341.31	342.27	0.027827	3.86	10.32	13.86	0.76	1.38
312	2-Year	LB Int Pro	38.9	341.31	343.5	0.00111	1.44	29.43	17.17	0.18	0.14
312	5-Year	LB Int Ext	66.8	341.31	342.56	0.028579	4.81	14.43	14.63	0.81	1.93
312	5-Year	LB Int Pro	66.8	341.31	343.89	0.001756	2.03	36.35	18.22	0.23	0.26
312	10-Year	LB Int Ext	91.2	341.31	342.76	0.029999	5.51	17.37	15.17	0.86	2.39
312	10-Year	LB Int Pro	91.2	341.31	344.18	0.002214	2.46	41.57	18.98	0.26	0.37
312	25-Year	LB Int Ext	126	341.31	342.79	0.05246	7.4	17.88	15.25	1.14	4.29
312	25-Year	LB Int Pro	126	341.31	344.52	0.00276	2.97	48.2	19.9	0.3	0.52
312	50-Year	LB Int Ext	154	341.31	342.88	0.062153	8.43	19.28	15.5	1.25	5.43
312	50-Year	LB Int Pro	154	341.31	344.76	0.003136	3.33	53.05	20.54	0.32	0.64
312	100-Year	LB Int Ext	189	341.31	342.99	0.071766	9.53	21.04	15.8	1.36	6.77
312	100-Year	LB Int Pro	189	341.31	345.02	0.003554	3.74	58.64	21.26	0.35	0.78
312	500-Year	LB Int Ext	276	341.31	343.28	0.084283	11.58	25.64	16.57	1.52	9.44
312	500-Year	LB Int Pro	276	341.31	345.57	0.004493	4.62	70.64	22.73	0.4	1.14
312	Apr-07	LB Int Ext	200	341.31	343.04	0.072944	9.79	21.72	15.92	1.38	7.08
312	Apr-07	LB Int Pro	200	341.31	345.1	0.003676	3.86	60.31	21.47	0.36	0.83
312	1.8-Year	LB Int Ext	35	341.31	342.23	0.027163	3.67	9.73	13.74	0.75	1.27
312	1.8-Year	LB Int Pro	35	341.31	343.44	0.001004	1.34	28.35	17	0.17	0.12

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
311.5*	2-Year	LB Int Ext	38.9	340.55	341.5	0.052979	4.68	8.32	12.46	1.01	2.16
311.5*	2-Year	LB Int Pro	38.9	340.55	343.5	0.000421	0.99	41.33	19.62	0.11	0.06
311.5*	5-Year	LB Int Ext	66.8	340.55	341.81	0.048772	5.4	12.37	13.9	1.01	2.62
311.5*	5-Year	LB Int Pro	66.8	340.55	343.9	0.000743	1.45	49.23	20.62	0.15	0.13
311.5*	10-Year	LB Int Ext	91.2	340.55	342.03	0.046268	5.85	15.6	14.97	1.01	2.91
311.5*	10-Year	LB Int Pro	91.2	340.55	344.18	0.000995	1.79	55.16	21.34	0.18	0.19
311.5*	25-Year	LB Int Ext	126	340.55	342.29	0.042981	6.44	19.65	16.03	1	3.31
311.5*	25-Year	LB Int Pro	126	340.55	344.52	0.001315	2.21	62.65	22.22	0.21	0.28
311.5*	50-Year	LB Int Ext	154	340.55	342.48	0.040303	6.84	22.76	16.69	0.99	3.56
311.5*	50-Year	LB Int Pro	154	340.55	344.76	0.001546	2.5	68.1	22.84	0.23	0.35
311.5*	100-Year	LB Int Ext	189	340.55	342.7	0.037912	7.27	26.49	17.44	0.99	3.85
311.5*	100-Year	LB Int Pro	189	340.55	345.03	0.001811	2.84	74.39	23.53	0.25	0.44
311.5*	500-Year	LB Int Ext	276	340.55	343.19	0.033833	8.14	35.33	18.82	0.97	4.43
311.5*	500-Year	LB Int Pro	276	340.55	345.59	0.002418	3.57	87.84	24.95	0.29	0.67
311.5*	Apr-07	LB Int Ext	200	340.55	342.77	0.037081	7.39	27.69	17.67	0.98	3.92
311.5*	Apr-07	LB Int Pro	200	340.55	345.11	0.00189	2.93	76.26	23.74	0.26	0.47
311.5*	1.8-Year	LB Int Ext	35	340.55	341.45	0.053923	4.54	7.7	12.23	1.01	2.08
311.5*	1.8-Year	LB Int Pro	35	340.55	343.44	0.000373	0.92	40.09	19.45	0.1	0.05
311	2-Year	LB Int Ext	38.9	339.8	340.88	0.024289	3.57	10.89	13.51	0.7	1.19
311	2-Year	LB Int Pro	38.9	342.5	343.16	0.053676	4.4	8.83	14.65	1	1.98
311	5-Year	LB Int Ext	66.8	339.8	341.19	0.026136	4.4	15.18	14.36	0.75	1.65
311	5-Year	LB Int Pro	66.8	342.5	343.43	0.049477	5.17	12.91	15.73	1.01	2.47
311	10-Year	LB Int Ext	91.2	339.8	341.41	0.027533	4.96	18.37	14.96	0.79	2
311	10-Year	LB Int Pro	91.2	342.5	343.63	0.046974	5.65	16.15	16.53	1.01	2.78
311	25-Year	LB Int Ext	126	339.8	341.67	0.029189	5.62	22.42	15.68	0.83	2.45
311	25-Year	LB Int Pro	126	342.5	343.88	0.04468	6.17	20.42	17.53	1.01	3.13
311	50-Year	LB Int Ext	154	339.8	341.86	0.030402	6.07	25.36	16.19	0.85	2.78
311	50-Year	LB Int Pro	154	342.5	344.06	0.043295	6.51	23.66	18.26	1.01	3.37
311	100-Year	LB Int Ext	189	339.8	342.06	0.03194	6.58	28.71	16.74	0.89	3.17
311	100-Year	LB Int Pro	189	342.5	344.27	0.041921	6.86	27.54	19.09	1.01	3.62
311	500-Year	LB Int Ext	276	339.8	342.18	0.055743	9	30.68	17.06	1.18	5.83
311	500-Year	LB Int Pro	276	342.5	344.75	0.035466	7.43	38.01	24.73	0.96	3.9
311	Apr-07	LB Int Ext	200	339.8	341.83	0.053553	8	24.99	16.12	1.13	4.84
311	Apr-07	LB Int Pro	200	342.5	344.33	0.041496	6.96	28.73	19.34	1.01	3.68
311	1.8-Year	LB Int Ext	35	339.8	340.83	0.024101	3.44	10.19	13.37	0.69	1.12
311	1.8-Year	LB Int Pro	35	342.5	343.12	0.055479	4.29	8.16	14.47	1.01	1.92

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
310.75*	2-Year	LB Int Ext	38.9	339.45	340.54	0.023024	3.36	11.59	15.3	0.68	1.07
310.75*	2-Year	LB Int Pro	38.9	339.45	341.51	0.001602	1.39	27.94	18.24	0.2	0.15
310.75*	5-Year	LB Int Ext	66.8	339.45	340.83	0.024552	4.14	16.15	16.2	0.73	1.48
310.75*	5-Year	LB Int Pro	66.8	339.45	341.9	0.002301	1.89	35.31	19.13	0.24	0.25
310.75*	10-Year	LB Int Ext	91.2	339.45	341.03	0.025712	4.67	19.54	16.84	0.76	1.79
310.75*	10-Year	LB Int Pro	91.2	339.45	342.19	0.002739	2.24	40.84	19.99	0.27	0.34
310.75*	25-Year	LB Int Ext	126	339.45	341.28	0.02748	5.31	23.73	17.59	0.81	2.21
310.75*	25-Year	LB Int Pro	126	339.45	342.53	0.003135	2.65	48.06	21.75	0.3	0.45
310.75*	50-Year	LB Int Ext	154	339.45	341.45	0.028684	5.75	26.76	18.1	0.83	2.53
310.75*	50-Year	LB Int Pro	154	339.45	342.78	0.003389	2.94	53.55	23.24	0.32	0.54
310.75*	100-Year	LB Int Ext	189	339.45	341.63	0.029725	6.26	30.2	18.52	0.86	2.89
310.75*	100-Year	LB Int Pro	189	339.45	343.05	0.003651	3.25	60.15	24.91	0.33	0.64
310.75*	500-Year	LB Int Ext	276	339.45	342.04	0.031853	7.31	37.83	19.42	0.92	3.71
310.75*	500-Year	LB Int Pro	276	339.45	343.58	0.004347	3.96	74.12	27.59	0.37	0.9
310.75*	Apr-07	LB Int Ext	200	339.45	341.69	0.030009	6.4	31.24	18.65	0.87	3
310.75*	Apr-07	LB Int Pro	200	339.45	343.13	0.003721	3.34	62.19	25.39	0.34	0.67
310.75*	1.8-Year	LB Int Ext	35	339.45	340.49	0.022755	3.22	10.86	15.15	0.67	1
310.75*	1.8-Year	LB Int Pro	35	339.45	341.45	0.001481	1.31	26.77	18.1	0.19	0.13
310.5*	2-Year	LB Int Ext	38.9	339.1	340.22	0.021341	3.13	12.41	17.22	0.65	0.94
310.5*	2-Year	LB Int Pro	38.9	339.1	341.5	0.000717	1.04	37.3	20.87	0.14	0.08
310.5*	5-Year	LB Int Ext	66.8	339.1	340.49	0.022803	3.87	17.28	18.28	0.7	1.31
310.5*	5-Year	LB Int Pro	66.8	339.1	341.9	0.001098	1.47	45.86	22.86	0.18	0.14
310.5*	10-Year	LB Int Ext	91.2	339.1	340.68	0.024209	4.38	20.81	19.01	0.74	1.61
310.5*	10-Year	LB Int Pro	91.2	339.1	342.18	0.001351	1.77	52.49	23.75	0.2	0.2
310.5*	25-Year	LB Int Ext	126	339.1	340.91	0.02544	4.99	25.24	19.65	0.78	1.98
310.5*	25-Year	LB Int Pro	126	339.1	342.53	0.001645	2.13	60.9	24.73	0.22	0.28
310.5*	50-Year	LB Int Ext	154	339.1	341.07	0.026217	5.43	28.4	19.98	0.8	2.26
310.5*	50-Year	LB Int Pro	154	339.1	342.77	0.001842	2.38	67.05	25.43	0.24	0.34
310.5*	100-Year	LB Int Ext	189	339.1	341.25	0.027169	5.91	32.01	20.35	0.83	2.59
310.5*	100-Year	LB Int Pro	189	339.1	343.05	0.002054	2.67	74.37	27.64	0.26	0.41
310.5*	500-Year	LB Int Ext	276	339.1	341.61	0.029843	6.98	39.61	21.26	0.89	3.41
310.5*	500-Year	LB Int Pro	276	339.1	343.59	0.002577	3.3	90.34	31.86	0.3	0.6
310.5*	Apr-07	LB Int Ext	200	339.1	341.3	0.027445	6.05	33.09	20.45	0.84	2.69
310.5*	Apr-07	LB Int Pro	200	339.1	343.13	0.002113	2.75	76.65	28.3	0.26	0.43
310.5*	1.8-Year	LB Int Ext	35	339.1	340.17	0.021201	3.01	11.62	17.04	0.64	0.89
310.5*	1.8-Year	LB Int Pro	35	339.1	341.44	0.000649	0.97	35.97	20.74	0.13	0.07

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
310.25*	2-Year	LB Int Ext	38.9	338.76	339.96	0.016075	2.72	14.29	19.8	0.56	0.71
310.25*	2-Year	LB Int Pro	38.9	338.76	341.5	0.000344	0.82	48.37	25.07	0.1	0.04
310.25*	5-Year	LB Int Ext	66.8	338.76	340.22	0.017894	3.41	19.58	20.92	0.62	1.02
310.25*	5-Year	LB Int Pro	66.8	338.76	341.89	0.000571	1.18	58.42	26.1	0.13	0.09
310.25*	10-Year	LB Int Ext	91.2	338.76	340.39	0.01922	3.92	23.25	21.24	0.66	1.29
310.25*	10-Year	LB Int Pro	91.2	338.76	342.18	0.000737	1.44	65.95	26.85	0.15	0.13
310.25*	25-Year	LB Int Ext	126	338.76	340.61	0.020682	4.53	27.83	21.65	0.7	1.63
310.25*	25-Year	LB Int Pro	126	338.76	342.53	0.000941	1.75	75.43	27.76	0.17	0.18
310.25*	50-Year	LB Int Ext	154	338.76	340.76	0.02175	4.96	31.1	21.93	0.73	1.89
310.25*	50-Year	LB Int Pro	154	338.76	342.77	0.001082	1.98	82.34	28.41	0.19	0.22
310.25*	100-Year	LB Int Ext	189	338.76	340.92	0.023154	5.45	34.73	22.24	0.77	2.21
310.25*	100-Year	LB Int Pro	189	338.76	343.05	0.00124	2.23	90.32	29.13	0.2	0.28
310.25*	500-Year	LB Int Ext	276	338.76	341.21	0.028451	6.73	41.24	23.5	0.87	3.19
310.25*	500-Year	LB Int Pro	276	338.76	343.59	0.00163	2.8	107.49	34.78	0.24	0.42
310.25*	Apr-07	LB Int Ext	200	338.76	340.97	0.023539	5.6	35.82	22.33	0.78	2.31
310.25*	Apr-07	LB Int Pro	200	338.76	343.13	0.001286	2.3	92.73	29.85	0.21	0.29
310.25*	1.8-Year	LB Int Ext	35	338.76	339.92	0.015603	2.6	13.46	19.56	0.55	0.66
310.25*	1.8-Year	LB Int Pro	35	338.76	341.44	0.000308	0.76	46.78	24.73	0.09	0.04
310	2-Year	LB Int Ext	38.9	338.41	339.41	0.057753	3.91	9.94	20.87	1	1.69
310	2-Year	LB Int Pro	38.9	340.5	341.16	0.054115	4.42	8.81	14.64	1	1.99
310	5-Year	LB Int Ext	66.8	338.41	339.61	0.054447	4.64	14.41	22.45	1.02	2.14
310	5-Year	LB Int Pro	66.8	340.5	341.43	0.049499	5.17	12.91	15.73	1.01	2.47
310	10-Year	LB Int Ext	91.2	338.41	339.76	0.05056	5.11	17.84	22.69	1.01	2.44
310	10-Year	LB Int Pro	91.2	340.5	341.63	0.0473	5.66	16.12	16.52	1.01	2.79
310	25-Year	LB Int Ext	126	338.41	339.96	0.046937	5.66	22.29	23	1.01	2.79
310	25-Year	LB Int Pro	126	340.5	341.89	0.044305	6.15	20.48	17.55	1	3.11
310	50-Year	LB Int Ext	154	338.41	340.1	0.044392	6.01	25.69	23.24	1	3
310	50-Year	LB Int Pro	154	340.5	342.07	0.042936	6.49	23.73	18.27	1	3.35
310	100-Year	LB Int Ext	189	338.41	340.28	0.041166	6.34	29.89	23.53	0.99	3.2
310	100-Year	LB Int Pro	189	340.5	342.28	0.041629	6.85	27.6	19.1	1	3.6
310	500-Year	LB Int Ext	276	338.41	340.76	0.030293	6.69	41.63	25.49	0.89	3.21
310	500-Year	LB Int Pro	276	340.5	342.81	0.030754	7.07	41.49	31.44	0.9	3.5
310	Apr-07	LB Int Ext	200	338.41	340.34	0.040411	6.44	31.14	23.61	0.98	3.26
310	Apr-07	LB Int Pro	200	340.5	342.33	0.041506	6.96	28.73	19.34	1.01	3.69
310	1.8-Year	LB Int Ext	35	338.41	339.37	0.058533	3.84	9.13	19.96	1	1.64
310	1.8-Year	LB Int Pro	35	340.5	341.12	0.055377	4.29	8.17	14.47	1.01	1.91

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
309.666*	2-Year	LB Int Ext	38.9	337.6	338.66	0.036841	3.7	10.52	17.24	0.83	1.39
309.666*	2-Year	LB Int Pro	38.9	337.6	339.52	0.001971	1.5	26.37	20.39	0.22	0.17
309.666*	5-Year	LB Int Ext	66.8	337.6	338.93	0.033152	4.39	15.24	17.8	0.83	1.75
309.666*	5-Year	LB Int Pro	66.8	337.6	339.91	0.002506	2	34.85	22.04	0.26	0.28
309.666*	10-Year	LB Int Ext	91.2	337.6	339.11	0.032673	4.92	18.59	18.36	0.85	2.06
309.666*	10-Year	LB Int Pro	91.2	337.6	340.2	0.002809	2.33	41.33	23.01	0.28	0.36
309.666*	25-Year	LB Int Ext	126	337.6	339.35	0.030999	5.51	23.14	19.57	0.86	2.41
309.666*	25-Year	LB Int Pro	126	337.6	340.55	0.003127	2.72	49.6	24.18	0.31	0.47
309.666*	50-Year	LB Int Ext	154	337.6	339.53	0.029814	5.89	26.68	20.46	0.86	2.64
309.666*	50-Year	LB Int Pro	154	337.6	340.8	0.003327	2.99	55.7	25.01	0.32	0.55
309.666*	100-Year	LB Int Ext	189	337.6	339.73	0.028933	6.32	30.85	21.43	0.87	2.92
309.666*	100-Year	LB Int Pro	189	337.6	341.08	0.003534	3.29	62.82	25.95	0.33	0.65
309.666*	500-Year	LB Int Ext	276	337.6	340.08	0.031495	7.51	38.61	22.61	0.93	3.85
309.666*	500-Year	LB Int Pro	276	337.6	341.68	0.003908	3.91	78.98	28.13	0.36	0.86
309.666*	Apr-07	LB Int Ext	200	337.6	339.79	0.028453	6.43	32.21	21.64	0.87	2.98
309.666*	Apr-07	LB Int Pro	200	337.6	341.16	0.003592	3.38	64.96	26.22	0.34	0.68
309.666*	1.8-Year	LB Int Ext	35	337.6	338.62	0.037073	3.56	9.84	17.16	0.83	1.31
309.666*	1.8-Year	LB Int Pro	35	337.6	339.45	0.001866	1.42	25.06	20.06	0.21	0.16
309.333*	2-Year	LB Int Ext	38.9	336.79	337.82	0.051134	4.67	8.39	13.04	1	2.13
309.333*	2-Year	LB Int Pro	38.9	336.79	339.51	0.000595	1.16	39.08	22.65	0.13	0.09
309.333*	5-Year	LB Int Ext	66.8	336.79	338.11	0.044621	5.54	12.41	14.47	0.99	2.67
309.333*	5-Year	LB Int Pro	66.8	336.79	339.91	0.000961	1.64	48.16	23.29	0.17	0.16
309.333*	10-Year	LB Int Ext	91.2	336.79	338.35	0.039048	6	16.04	16.14	0.96	2.9
309.333*	10-Year	LB Int Pro	91.2	336.79	340.19	0.001225	1.97	54.9	23.82	0.2	0.23
309.333*	25-Year	LB Int Ext	126	336.79	338.63	0.034963	6.54	20.93	17.98	0.94	3.21
309.333*	25-Year	LB Int Pro	126	336.79	340.54	0.001543	2.38	63.33	24.46	0.23	0.32
309.333*	50-Year	LB Int Ext	154	336.79	338.83	0.033185	6.93	24.63	19.25	0.94	3.46
309.333*	50-Year	LB Int Pro	154	336.79	340.79	0.001764	2.67	69.43	24.92	0.25	0.4
309.333*	100-Year	LB Int Ext	189	336.79	339.06	0.0313	7.32	29.21	20.72	0.93	3.7
309.333*	100-Year	LB Int Pro	189	336.79	341.07	0.00201	2.99	76.42	25.43	0.27	0.49
309.333*	500-Year	LB Int Ext	276	336.79	339.57	0.027325	7.99	40.35	22.73	0.9	4.08
309.333*	500-Year	LB Int Pro	276	336.79	341.66	0.002515	3.67	91.87	26.53	0.3	0.7
309.333*	Apr-07	LB Int Ext	200	336.79	339.12	0.031126	7.46	30.51	21.12	0.93	3.8
309.333*	Apr-07	LB Int Pro	200	336.79	341.15	0.002082	3.08	78.5	25.58	0.27	0.51
309.333*	1.8-Year	LB Int Ext	35	336.79	337.77	0.053269	4.53	7.75	12.81	1.01	2.06
309.333*	1.8-Year	LB Int Pro	35	336.79	339.45	0.000536	1.08	37.62	22.56	0.13	0.08

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
309	2-Year	LB Int Ext	38.9	335.99	337.07	0.03253	4.51	10.58	15.42	0.84	1.81
309	2-Year	LB Int Pro	38.9	338.5	339.16	0.054354	4.44	8.75	14.43	1.01	2.01
309	5-Year	LB Int Ext	66.8	335.99	337.38	0.029599	5.26	15.5	15.8	0.84	2.23
309	5-Year	LB Int Pro	66.8	338.5	339.44	0.049037	5.19	12.87	15.44	1	2.47
309	10-Year	LB Int Ext	91.2	335.99	337.61	0.028695	5.82	19.15	16.08	0.85	2.57
309	10-Year	LB Int Pro	91.2	338.5	339.64	0.046882	5.68	16.05	16.18	1.01	2.8
309	25-Year	LB Int Ext	126	335.99	337.91	0.027167	6.42	24.02	16.44	0.86	2.94
309	25-Year	LB Int Pro	126	338.5	339.89	0.044417	6.21	20.3	17.12	1	3.16
309	50-Year	LB Int Ext	154	335.99	338.09	0.028244	6.99	27.02	16.66	0.89	3.37
309	50-Year	LB Int Pro	154	338.5	340.08	0.043017	6.55	23.51	17.79	1	3.39
309	100-Year	LB Int Ext	189	335.99	337.86	0.068508	9.99	23.15	16.38	1.35	7.18
309	100-Year	LB Int Pro	189	338.5	340.29	0.041788	6.92	27.32	18.56	1.01	3.66
309	500-Year	LB Int Ext	276	335.99	338.82	0.028521	8.7	39.45	17.54	0.94	4.69
309	500-Year	LB Int Pro	276	338.5	340.73	0.03853	7.73	35.84	20.29	1	4.23
309	Apr-07	LB Int Ext	200	335.99	337.92	0.067262	10.13	24.16	16.45	1.35	7.3
309	Apr-07	LB Int Pro	200	338.5	340.35	0.04146	7.02	28.48	18.79	1.01	3.73
309	1.8-Year	LB Int Ext	35	335.99	337.02	0.032644	4.36	9.86	15.36	0.83	1.72
309	1.8-Year	LB Int Pro	35	338.5	339.12	0.055299	4.3	8.13	14.27	1	1.92
308.75*	2-Year	LB Int Ext	38.9	335.21	336.28	0.042541	5.21	8.26	11.46	0.96	2.4
308.75*	2-Year	LB Int Pro	38.9	335.21	337.5	0.00167	1.82	26.37	16.93	0.22	0.22
308.75*	5-Year	LB Int Ext	66.8	335.21	336.66	0.035237	5.98	13.09	14.16	0.93	2.82
308.75*	5-Year	LB Int Pro	66.8	335.21	337.89	0.002537	2.51	33.07	17.45	0.28	0.4
308.75*	10-Year	LB Int Ext	91.2	335.21	336.91	0.03312	6.52	16.75	15.2	0.93	3.16
308.75*	10-Year	LB Int Pro	91.2	335.21	338.17	0.003141	3	38.01	17.82	0.32	0.55
308.75*	25-Year	LB Int Ext	126	335.21	337.19	0.032851	7.27	21.16	16.21	0.95	3.71
308.75*	25-Year	LB Int Pro	126	335.21	338.51	0.003869	3.59	44.13	18.27	0.36	0.75
308.75*	50-Year	LB Int Ext	154	335.21	337.42	0.030664	7.6	24.97	16.83	0.94	3.9
308.75*	50-Year	LB Int Pro	154	335.21	338.75	0.004383	4.01	48.5	18.58	0.39	0.92
308.75*	100-Year	LB Int Ext	189	335.21	337.64	0.030732	8.15	28.71	17.12	0.95	4.33
308.75*	100-Year	LB Int Pro	189	335.21	339.01	0.004969	4.49	53.45	18.93	0.42	1.12
308.75*	500-Year	LB Int Ext	276	335.21	338.12	0.030748	9.28	37.16	17.76	0.99	5.26
308.75*	500-Year	LB Int Pro	276	335.21	339.55	0.006302	5.55	63.9	19.64	0.48	1.64
308.75*	Apr-07	LB Int Ext	200	335.21	337.7	0.030792	8.31	29.83	17.2	0.96	4.46
308.75*	Apr-07	LB Int Pro	200	335.21	339.09	0.005144	4.64	54.9	19.03	0.42	1.19
308.75*	1.8-Year	LB Int Ext	35	335.21	336.22	0.044396	5.08	7.56	11.01	0.97	2.34
308.75*	1.8-Year	LB Int Pro	35	335.21	337.44	0.001527	1.71	25.29	16.85	0.21	0.2

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
308.5*	2-Year	LB Int Ext	38.9	334.43	335.34	0.061118	5.6	7.42	10.73	1.12	2.93
308.5*	2-Year	LB Int Pro	38.9	334.43	337.5	0.000496	1.23	38.81	17.72	0.13	0.09
308.5*	5-Year	LB Int Ext	66.8	334.43	335.6	0.066318	7.07	10.31	11.68	1.23	4.24
308.5*	5-Year	LB Int Pro	66.8	334.43	337.89	0.00091	1.81	45.88	18.55	0.18	0.19
308.5*	10-Year	LB Int Ext	91.2	334.43	335.82	0.062451	7.81	12.97	12.47	1.23	4.85
308.5*	10-Year	LB Int Pro	91.2	334.43	338.17	0.001247	2.24	51.15	19.16	0.21	0.28
308.5*	25-Year	LB Int Ext	126	334.43	336.12	0.055061	8.48	16.9	13.56	1.2	5.31
308.5*	25-Year	LB Int Pro	126	334.43	338.51	0.001687	2.76	57.76	19.76	0.25	0.41
308.5*	50-Year	LB Int Ext	154	334.43	336.33	0.052325	8.98	19.78	14.3	1.19	5.72
308.5*	50-Year	LB Int Pro	154	334.43	338.75	0.002013	3.14	62.5	20.11	0.27	0.52
308.5*	100-Year	LB Int Ext	189	334.43	336.58	0.048143	9.43	23.53	15.22	1.17	6.03
308.5*	100-Year	LB Int Pro	189	334.43	339.01	0.002399	3.57	67.87	20.57	0.3	0.66
308.5*	500-Year	LB Int Ext	276	334.43	337.12	0.042189	10.35	32.27	16.9	1.14	6.71
308.5*	500-Year	LB Int Pro	276	334.43	339.56	0.003303	4.52	79.54	22.26	0.36	1.03
308.5*	Apr-07	LB Int Ext	200	334.43	336.67	0.046444	9.51	24.81	15.52	1.16	6.06
308.5*	Apr-07	LB Int Pro	200	334.43	339.09	0.002518	3.7	69.47	20.81	0.31	0.71
308.5*	1.8-Year	LB Int Ext	35	334.43	335.3	0.059523	5.33	6.99	10.61	1.1	2.7
308.5*	1.8-Year	LB Int Pro	35	334.43	337.44	0.000436	1.14	37.68	17.58	0.12	0.08
308.25*	2-Year	LB Int Ext	38.9	333.65	334.47	0.069008	5.58	7.38	11.46	1.18	3
308.25*	2-Year	LB Int Pro	38.9	336.5	337.16	0.054362	4.42	8.8	14.64	1.01	2
308.25*	5-Year	LB Int Ext	66.8	333.65	334.84	0.046865	6.12	11.85	12.5	1.04	3.13
308.25*	5-Year	LB Int Pro	66.8	336.5	337.43	0.049449	5.17	12.91	15.73	1.01	2.47
308.25*	10-Year	LB Int Ext	91.2	333.65	335.08	0.044022	6.77	14.85	13.17	1.04	3.58
308.25*	10-Year	LB Int Pro	91.2	336.5	337.63	0.047079	5.65	16.14	16.53	1.01	2.78
308.25*	25-Year	LB Int Ext	126	333.65	335.28	0.050975	8.01	17.54	13.75	1.15	4.79
308.25*	25-Year	LB Int Pro	126	336.5	337.88	0.044611	6.17	20.43	17.53	1.01	3.13
308.25*	50-Year	LB Int Ext	154	333.65	335.44	0.053121	8.75	19.81	14.21	1.19	5.52
308.25*	50-Year	LB Int Pro	154	336.5	338.06	0.043238	6.51	23.67	18.26	1.01	3.36
308.25*	100-Year	LB Int Ext	189	333.65	335.63	0.055142	9.56	22.48	14.74	1.24	6.37
308.25*	100-Year	LB Int Pro	189	336.5	338.27	0.041885	6.86	27.54	19.09	1.01	3.61
308.25*	500-Year	LB Int Ext	276	333.65	336.09	0.053013	10.87	29.59	16.06	1.26	7.65
308.25*	500-Year	LB Int Pro	276	336.5	338.73	0.036695	7.51	37.22	23.34	0.98	4.01
308.25*	Apr-07	LB Int Ext	200	333.65	335.69	0.055058	9.76	23.38	14.91	1.24	6.57
308.25*	Apr-07	LB Int Pro	200	336.5	338.33	0.041454	6.96	28.74	19.34	1.01	3.68
308.25*	1.8-Year	LB Int Ext	35	333.65	334.42	0.074504	5.48	6.73	11.31	1.21	2.98
308.25*	1.8-Year	LB Int Pro	35	336.5	337.12	0.054594	4.27	8.21	14.48	1	1.89

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
308	2-Year	LB Int Ext	38.9	332.88	333.84	0.028063	4.08	10.2	13.03	0.78	1.5
308	2-Year	LB Int Pro	38.9	332.88	335.26	0.000936	1.43	31.49	17.04	0.17	0.13
308	5-Year	LB Int Ext	66.8	332.88	334.17	0.027314	5	14.6	13.95	0.81	2.02
308	5-Year	LB Int Pro	66.8	332.88	335.65	0.001555	2.05	38.41	18.16	0.22	0.26
308	10-Year	LB Int Ext	91.2	332.88	334.4	0.026953	5.61	18	14.63	0.83	2.39
308	10-Year	LB Int Pro	91.2	332.88	335.93	0.002012	2.49	43.65	18.96	0.26	0.37
308	25-Year	LB Int Ext	126	332.88	334.7	0.026516	6.31	22.46	15.47	0.85	2.84
308	25-Year	LB Int Pro	126	332.88	336.27	0.00257	3.03	50.31	19.93	0.29	0.53
308	50-Year	LB Int Ext	154	332.88	334.91	0.026323	6.79	25.79	16.06	0.86	3.17
308	50-Year	LB Int Pro	154	332.88	336.51	0.002962	3.41	55.18	20.61	0.32	0.65
308	100-Year	LB Int Ext	189	332.88	334.75	0.053787	9.17	23.26	15.61	1.21	5.94
308	100-Year	LB Int Pro	189	332.88	336.78	0.003401	3.84	60.81	21.37	0.35	0.81
308	500-Year	LB Int Ext	276	332.88	335.12	0.058239	10.84	29.28	16.67	1.3	7.79
308	500-Year	LB Int Pro	276	332.88	337.34	0.004362	4.76	73.07	22.94	0.4	1.19
308	Apr-07	LB Int Ext	200	332.88	334.81	0.054141	9.38	24.11	15.77	1.22	6.16
308	Apr-07	LB Int Pro	200	332.88	336.86	0.003529	3.96	62.5	21.59	0.35	0.85
308	1.8-Year	LB Int Ext	35	332.88	333.79	0.027956	3.91	9.54	12.88	0.77	1.41
308	1.8-Year	LB Int Pro	35	332.88	335.19	0.000839	1.33	30.41	16.86	0.16	0.12
307.75*	2-Year	LB Int Ext	38.9	332.29	333.34	0.028268	4.16	9.91	12.58	0.78	1.55
307.75*	2-Year	LB Int Pro	38.9	332.29	335.25	0.000468	1.16	39.94	18.84	0.12	0.08
307.75*	5-Year	LB Int Ext	66.8	332.29	333.67	0.027672	5.09	14.23	13.66	0.82	2.08
307.75*	5-Year	LB Int Pro	66.8	332.29	335.64	0.000848	1.7	47.56	20.13	0.17	0.17
307.75*	10-Year	LB Int Ext	91.2	332.29	333.91	0.027488	5.72	17.56	14.44	0.84	2.48
307.75*	10-Year	LB Int Pro	91.2	332.29	335.92	0.00115	2.09	53.33	20.97	0.2	0.25
307.75*	25-Year	LB Int Ext	126	332.29	334.19	0.027611	6.47	21.84	15.38	0.87	2.98
307.75*	25-Year	LB Int Pro	126	332.29	336.26	0.001538	2.58	60.66	21.95	0.23	0.36
307.75*	50-Year	LB Int Ext	154	332.29	334.4	0.027647	6.97	25.06	16.05	0.88	3.34
307.75*	50-Year	LB Int Pro	154	332.29	336.5	0.001817	2.92	65.99	22.49	0.26	0.46
307.75*	100-Year	LB Int Ext	189	332.29	334.63	0.027735	7.53	28.86	16.81	0.9	3.75
307.75*	100-Year	LB Int Pro	189	332.29	336.77	0.002138	3.3	72.1	23.06	0.28	0.57
307.75*	500-Year	LB Int Ext	276	332.29	335.15	0.02693	8.56	38.08	18.52	0.92	4.51
307.75*	500-Year	LB Int Pro	276	332.29	337.33	0.002866	4.15	85.19	24.19	0.33	0.87
307.75*	Apr-07	LB Int Ext	200	332.29	334.7	0.027746	7.69	30.02	17.03	0.91	3.87
307.75*	Apr-07	LB Int Pro	200	332.29	336.85	0.002234	3.42	73.92	23.23	0.29	0.61
307.75*	1.8-Year	LB Int Ext	35	332.29	333.28	0.028575	4.01	9.22	12.4	0.78	1.47
307.75*	1.8-Year	LB Int Pro	35	332.29	335.19	0.000412	1.07	38.75	18.64	0.11	0.07

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
307.5*	2-Year	LB Int Ext	38.9	331.7	332.84	0.028015	4.2	9.7	12.14	0.78	1.56
307.5*	2-Year	LB Int Pro	38.9	334.25	334.91	0.054362	4.42	8.8	14.64	1.01	2
307.5*	5-Year	LB Int Ext	66.8	331.7	333.18	0.027351	5.13	14.01	13.45	0.81	2.1
307.5*	5-Year	LB Int Pro	66.8	334.25	335.18	0.049482	5.17	12.91	15.73	1.01	2.47
307.5*	10-Year	LB Int Ext	91.2	331.7	333.43	0.026853	5.73	17.44	14.44	0.83	2.47
307.5*	10-Year	LB Int Pro	91.2	334.25	335.38	0.047119	5.65	16.14	16.53	1.01	2.78
307.5*	25-Year	LB Int Ext	126	331.7	333.74	0.025655	6.37	22.19	15.71	0.84	2.86
307.5*	25-Year	LB Int Pro	126	334.25	335.63	0.044621	6.17	20.43	17.53	1.01	3.13
307.5*	50-Year	LB Int Ext	154	331.7	333.97	0.024859	6.79	25.86	16.62	0.84	3.12
307.5*	50-Year	LB Int Pro	154	334.25	335.82	0.043211	6.5	23.68	18.26	1.01	3.36
307.5*	100-Year	LB Int Ext	189	331.7	334.19	0.025711	7.39	29.58	17.5	0.87	3.58
307.5*	100-Year	LB Int Pro	189	334.25	336.02	0.041854	6.86	27.55	19.09	1.01	3.61
307.5*	500-Year	LB Int Ext	276	331.7	334.62	0.028317	8.73	37.57	19.23	0.94	4.71
307.5*	500-Year	LB Int Pro	276	334.25	336.49	0.036369	7.49	37.45	23.63	0.97	3.98
307.5*	Apr-07	LB Int Ext	200	331.7	334.25	0.026231	7.59	30.59	17.73	0.88	3.74
307.5*	Apr-07	LB Int Pro	200	334.25	336.08	0.041464	6.96	28.74	19.34	1.01	3.68
307.5*	1.8-Year	LB Int Ext	35	331.7	332.79	0.02817	4.04	9.04	11.95	0.77	1.48
307.5*	1.8-Year	LB Int Pro	35	334.25	334.87	0.055479	4.29	8.16	14.47	1.01	1.92
307.25*	2-Year	LB Int Ext	38.9	331.11	332.39	0.025307	4.1	9.85	11.89	0.74	1.47
307.25*	2-Year	LB Int Pro	38.9	331.11	333.03	0.004098	2.33	18.42	15.12	0.33	0.4
307.25*	5-Year	LB Int Ext	66.8	331.11	332.73	0.025746	5.07	14.1	13.45	0.79	2.03
307.25*	5-Year	LB Int Pro	66.8	331.11	333.43	0.005311	3.08	24.84	17.3	0.39	0.65
307.25*	10-Year	LB Int Ext	91.2	331.11	332.96	0.026431	5.74	17.39	14.74	0.82	2.47
307.25*	10-Year	LB Int Pro	91.2	331.11	333.71	0.00595	3.56	29.95	18.54	0.42	0.83
307.25*	25-Year	LB Int Ext	126	331.11	333.22	0.028645	6.63	21.33	16.14	0.88	3.12
307.25*	25-Year	LB Int Pro	126	331.11	334.05	0.0066	4.12	36.55	19.88	0.45	1.06
307.25*	50-Year	LB Int Ext	154	331.11	333.4	0.029757	7.22	24.36	17.15	0.91	3.58
307.25*	50-Year	LB Int Pro	154	331.11	334.3	0.006979	4.5	41.43	20.55	0.47	1.23
307.25*	100-Year	LB Int Ext	189	331.11	333.63	0.029415	7.73	28.45	18.22	0.92	3.96
307.25*	100-Year	LB Int Pro	189	331.11	334.57	0.007364	4.91	47.06	21.06	0.49	1.42
307.25*	500-Year	LB Int Ext	276	331.11	334.09	0.030149	8.89	37.21	19.97	0.96	4.91
307.25*	500-Year	LB Int Pro	276	331.11	335.12	0.008353	5.83	58.91	22.09	0.54	1.89
307.25*	Apr-07	LB Int Ext	200	331.11	333.7	0.029204	7.87	29.73	18.49	0.92	4.05
307.25*	Apr-07	LB Int Pro	200	331.11	334.65	0.007481	5.03	48.73	21.21	0.5	1.48
307.25*	1.8-Year	LB Int Ext	35	331.11	332.33	0.025328	3.93	9.19	11.67	0.74	1.38
307.25*	1.8-Year	LB Int Pro	35	331.11	332.97	0.003862	2.2	17.44	14.76	0.31	0.36

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
307	2-Year	LB Int Ext	38.9	330.51	331.85	0.031918	4.41	9.04	11.52	0.82	1.74
307	2-Year	LB Int Pro	38.9	330.51	333.02	0.001554	1.7	26.87	19.33	0.21	0.2
307	5-Year	LB Int Ext	66.8	330.51	332.2	0.030288	5.34	13.31	13.39	0.85	2.29
307	5-Year	LB Int Pro	66.8	330.51	333.41	0.00228	2.31	34.68	20.08	0.26	0.34
307	10-Year	LB Int Ext	91.2	330.51	332.45	0.028972	5.91	16.97	15.59	0.85	2.64
307	10-Year	LB Int Pro	91.2	330.51	333.7	0.00276	2.74	40.47	20.62	0.29	0.46
307	25-Year	LB Int Ext	126	330.51	332.79	0.025473	6.36	22.68	17.9	0.83	2.85
307	25-Year	LB Int Pro	126	330.51	334.04	0.003319	3.25	47.68	21.27	0.33	0.62
307	50-Year	LB Int Ext	154	330.51	333.05	0.022786	6.57	27.55	19.39	0.8	2.91
307	50-Year	LB Int Pro	154	330.51	334.28	0.003702	3.61	52.86	21.72	0.35	0.75
307	100-Year	LB Int Ext	189	330.51	333.36	0.019939	6.74	33.6	19.98	0.77	2.92
307	100-Year	LB Int Pro	189	330.51	334.55	0.004126	4.01	58.78	22.23	0.37	0.91
307	500-Year	LB Int Ext	276	330.51	333.97	0.017433	7.33	46.18	21.13	0.74	3.21
307	500-Year	LB Int Pro	276	330.51	335.1	0.005105	4.9	71.22	23.26	0.42	1.29
307	Apr-07	LB Int Ext	200	330.51	333.44	0.019609	6.83	35.21	20.13	0.76	2.97
307	Apr-07	LB Int Pro	200	330.51	334.63	0.004251	4.13	60.53	22.38	0.38	0.95
307	1.8-Year	LB Int Ext	35	330.51	331.8	0.03247	4.25	8.38	11.2	0.82	1.66
307	1.8-Year	LB Int Pro	35	330.51	332.95	0.001425	1.59	25.63	18.99	0.2	0.17
306	2-Year	LB Int Ext	38.9	330.09	331.27	0.041377	5.29	8.05	10.4	0.95	2.44
306	2-Year	LB Int Pro	38.9	330.09	333.01	0.000838	1.5	32.89	17.84	0.16	0.14
306	5-Year	LB Int Ext	66.8	330.09	331.64	0.036901	6.22	12.24	12.05	0.95	3.03
306	5-Year	LB Int Pro	66.8	330.09	333.4	0.001432	2.15	40.05	18.78	0.22	0.27
306	10-Year	LB Int Ext	91.2	330.09	331.91	0.034407	6.81	15.7	13.25	0.95	3.4
306	10-Year	LB Int Pro	91.2	330.09	333.68	0.001886	2.62	45.39	19.45	0.25	0.39
306	25-Year	LB Int Ext	126	330.09	332.25	0.032226	7.47	20.35	14.72	0.95	3.85
306	25-Year	LB Int Pro	126	330.09	334.02	0.00246	3.18	52.08	20.26	0.29	0.56
306	50-Year	LB Int Ext	154	330.09	332.49	0.030652	7.88	24.04	15.79	0.94	4.11
306	50-Year	LB Int Pro	154	330.09	334.25	0.002875	3.58	56.92	20.82	0.32	0.7
306	100-Year	LB Int Ext	189	330.09	332.76	0.029292	8.33	28.47	16.98	0.94	4.42
306	100-Year	LB Int Pro	189	330.09	334.52	0.00335	4.04	62.47	21.45	0.35	0.87
306	500-Year	LB Int Ext	276	330.09	333.3	0.027788	9.28	38.24	18.54	0.94	5.13
306	500-Year	LB Int Pro	276	330.09	335.05	0.004455	5.04	74.19	22.73	0.41	1.3
306	Apr-07	LB Int Ext	200	330.09	332.86	0.02815	8.38	30.15	17.41	0.93	4.42
306	Apr-07	LB Int Pro	200	330.09	334.59	0.003492	4.17	64.12	21.64	0.36	0.92
306	1.8-Year	LB Int Ext	35	330.09	331.21	0.041417	5.09	7.48	10.16	0.94	2.3
306	1.8-Year	LB Int Pro	35	330.09	332.95	0.000748	1.4	31.76	17.69	0.15	0.12

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
305.75*	2-Year	LB Int Ext	38.9	329.38	330.52	0.042266	5.18	8.05	10.65	0.96	2.38
305.75*	2-Year	LB Int Pro	38.9	332	332.66	0.053743	4.41	8.83	14.65	1	1.98
305.75*	5-Year	LB Int Ext	66.8	329.38	330.8	0.047665	6.58	11.21	11.87	1.06	3.51
305.75*	5-Year	LB Int Pro	66.8	332	332.93	0.049017	5.16	12.95	15.74	1	2.45
305.75*	10-Year	LB Int Ext	91.2	329.38	331.01	0.049346	7.46	13.79	12.78	1.11	4.27
305.75*	10-Year	LB Int Pro	91.2	332	333.13	0.047097	5.65	16.14	16.53	1.01	2.78
305.75*	25-Year	LB Int Ext	126	329.38	331.28	0.049132	8.38	17.4	13.95	1.14	5.07
305.75*	25-Year	LB Int Pro	126	332	333.38	0.044659	6.17	20.43	17.53	1.01	3.13
305.75*	50-Year	LB Int Ext	154	329.38	331.47	0.049103	9	20.13	14.77	1.16	5.65
305.75*	50-Year	LB Int Pro	154	332	333.56	0.043223	6.5	23.68	18.26	1.01	3.36
305.75*	100-Year	LB Int Ext	189	329.38	331.69	0.048581	9.64	23.47	15.72	1.18	6.24
305.75*	100-Year	LB Int Pro	189	332	333.77	0.041896	6.86	27.54	19.09	1.01	3.62
305.75*	500-Year	LB Int Ext	276	329.38	332.19	0.045621	10.77	31.79	17.91	1.18	7.26
305.75*	500-Year	LB Int Pro	276	332	334.25	0.035428	7.43	37.92	24.98	0.96	3.9
305.75*	Apr-07	LB Int Ext	200	329.38	331.75	0.04909	9.86	24.37	15.97	1.19	6.48
305.75*	Apr-07	LB Int Pro	200	332	333.83	0.041454	6.96	28.74	19.34	1.01	3.68
305.75*	1.8-Year	LB Int Ext	35	329.38	330.48	0.040565	4.91	7.6	10.46	0.93	2.17
305.75*	1.8-Year	LB Int Pro	35	332	332.62	0.054795	4.27	8.2	14.48	1	1.9
305.5*	2-Year	LB Int Ext	38.9	328.68	329.81	0.039618	4.9	8.47	11.53	0.92	2.15
305.5*	2-Year	LB Int Pro	38.9	328.68	331.51	0.00075	1.38	34.99	19.94	0.15	0.12
305.5*	5-Year	LB Int Ext	66.8	328.68	330.13	0.039591	6	12.29	13.01	0.97	2.92
305.5*	5-Year	LB Int Pro	66.8	328.68	331.9	0.001265	1.97	43.2	21.97	0.2	0.23
305.5*	10-Year	LB Int Ext	91.2	328.68	330.36	0.038307	6.66	15.48	14.12	0.98	3.38
305.5*	10-Year	LB Int Pro	91.2	328.68	332.18	0.001643	2.39	49.58	23.43	0.23	0.33
305.5*	25-Year	LB Int Ext	126	328.68	330.61	0.040655	7.63	19.09	15.28	1.04	4.2
305.5*	25-Year	LB Int Pro	126	328.68	332.52	0.002083	2.87	57.87	25.01	0.27	0.46
305.5*	50-Year	LB Int Ext	154	328.68	330.78	0.041653	8.26	21.89	16.18	1.07	4.77
305.5*	50-Year	LB Int Pro	154	328.68	332.76	0.002375	3.2	63.99	25.87	0.29	0.56
305.5*	100-Year	LB Int Ext	189	328.68	330.95	0.045485	9.14	24.63	17.04	1.13	5.67
305.5*	100-Year	LB Int Pro	189	328.68	333.04	0.00269	3.57	71.11	26.77	0.31	0.68
305.5*	500-Year	LB Int Ext	276	328.68	331.34	0.049488	10.72	31.61	19.04	1.22	7.35
305.5*	500-Year	LB Int Pro	276	328.68	333.53	0.003563	4.43	84.82	28.41	0.36	1.01
305.5*	Apr-07	LB Int Ext	200	328.68	331.02	0.044515	9.25	25.88	17.41	1.13	5.75
305.5*	Apr-07	LB Int Pro	200	328.68	333.11	0.002782	3.68	73.23	27.03	0.32	0.72
305.5*	1.8-Year	LB Int Ext	35	328.68	329.75	0.042844	4.83	7.68	11.2	0.95	2.15
305.5*	1.8-Year	LB Int Pro	35	328.68	331.45	0.00067	1.28	33.73	19.6	0.14	0.1

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
305.25*	2-Year	LB Int Ext	38.9	327.97	329.07	0.044669	4.89	8.55	12.88	0.96	2.21
305.25*	2-Year	LB Int Pro	38.9	330.5	331.16	0.054047	4.41	8.81	14.65	1	1.99
305.25*	5-Year	LB Int Ext	66.8	327.97	329.33	0.048049	6.12	12.1	14.44	1.05	3.15
305.25*	5-Year	LB Int Pro	66.8	330.5	331.43	0.049454	5.17	12.91	15.73	1.01	2.47
305.25*	10-Year	LB Int Ext	91.2	327.97	329.51	0.051411	7.01	14.71	15.49	1.11	3.93
305.25*	10-Year	LB Int Pro	91.2	330.5	331.63	0.04693	5.64	16.16	16.53	1.01	2.77
305.25*	25-Year	LB Int Ext	126	327.97	329.74	0.051968	7.91	18.53	17.26	1.15	4.72
305.25*	25-Year	LB Int Pro	126	330.5	331.88	0.044522	6.16	20.45	17.54	1.01	3.12
305.25*	50-Year	LB Int Ext	154	327.97	329.9	0.05239	8.52	21.43	18.48	1.18	5.29
305.25*	50-Year	LB Int Pro	154	330.5	332.07	0.043146	6.5	23.69	18.26	1.01	3.36
305.25*	100-Year	LB Int Ext	189	327.97	330.07	0.053748	9.23	24.73	19.79	1.21	6
305.25*	100-Year	LB Int Pro	189	330.5	332.27	0.041806	6.86	27.56	19.09	1.01	3.61
305.25*	500-Year	LB Int Ext	276	327.97	330.43	0.0568	10.69	32.25	22.48	1.28	7.59
305.25*	500-Year	LB Int Pro	276	330.5	332.84	0.02865	6.91	43.33	35.54	0.87	3.32
305.25*	Apr-07	LB Int Ext	200	327.97	330.12	0.054028	9.42	25.76	20.18	1.22	6.2
305.25*	Apr-07	LB Int Pro	200	330.5	332.33	0.041457	6.96	28.74	19.34	1.01	3.68
305.25*	1.8-Year	LB Int Ext	35	327.97	329.06	0.038255	4.48	8.39	12.81	0.89	1.86
305.25*	1.8-Year	LB Int Pro	35	330.5	331.12	0.055498	4.29	8.16	14.47	1.01	1.92
305	2-Year	LB Int Ext	38.9	327.26	328.27	0.07204	5.4	7.9	15	1.18	2.89
305	2-Year	LB Int Pro	38.9	327.26	329.86	0.000474	1	52.13	35.06	0.12	0.07
305	5-Year	LB Int Ext	66.8	327.26	328.64	0.04064	5.49	14.58	21.5	0.96	2.57
305	5-Year	LB Int Pro	66.8	327.26	330.21	0.000748	1.39	64.52	36.25	0.15	0.12
305	10-Year	LB Int Ext	91.2	327.26	328.8	0.043387	6.24	18.18	24.62	1.01	3.16
305	10-Year	LB Int Pro	91.2	327.26	330.46	0.000936	1.65	73.84	37.12	0.17	0.16
305	25-Year	LB Int Ext	126	327.26	328.94	0.052057	7.38	21.9	27.47	1.13	4.26
305	25-Year	LB Int Pro	126	327.26	330.77	0.001151	1.96	85.69	38.19	0.19	0.23
305	50-Year	LB Int Ext	154	327.26	329.04	0.057763	8.15	24.69	29.43	1.21	5.07
305	50-Year	LB Int Pro	154	327.26	331	0.001294	2.18	94.37	38.96	0.21	0.27
305	100-Year	LB Int Ext	189	327.26	329.14	0.064549	9.04	27.86	31.51	1.29	6.09
305	100-Year	LB Int Pro	189	327.26	331.26	0.001446	2.42	104.44	39.83	0.22	0.33
305	500-Year	LB Int Ext	276	327.26	329.34	0.077702	10.78	34.55	33.31	1.45	8.31
305	500-Year	LB Int Pro	276	327.26	331.81	0.001743	2.91	126.89	41.71	0.25	0.45
305	Apr-07	LB Int Ext	200	327.26	329.17	0.066564	9.29	28.81	32.1	1.31	6.4
305	Apr-07	LB Int Pro	200	327.26	331.33	0.001489	2.49	107.47	40.09	0.23	0.34
305	1.8-Year	LB Int Ext	35	327.26	328.3	0.047305	4.55	8.49	15.36	0.97	2.01
305	1.8-Year	LB Int Pro	35	327.26	329.8	0.000429	0.94	50.17	34.87	0.11	0.06

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
304.666*	2-Year	LB Int Ext	38.9	326.43	327.57	0.045409	4.75	9	16.79	0.96	2.13
304.666*	2-Year	LB Int Pro	38.9	329	329.55	0.056538	4.11	9.46	18.21	1.01	1.81
304.666*	5-Year	LB Int Ext	66.8	326.43	327.82	0.045085	5.7	14.44	26.31	1	2.79
304.666*	5-Year	LB Int Pro	66.8	329	329.79	0.050958	4.84	13.8	19.14	1	2.25
304.666*	10-Year	LB Int Ext	91.2	326.43	327.97	0.046489	6.34	18.62	30	1.04	3.3
304.666*	10-Year	LB Int Pro	91.2	329	329.96	0.047631	5.29	17.25	19.85	1	2.53
304.666*	25-Year	LB Int Ext	126	326.43	328.15	0.045069	6.88	24.22	31.49	1.05	3.7
304.666*	25-Year	LB Int Pro	126	329	330.18	0.045108	5.81	21.69	20.72	1	2.87
304.666*	50-Year	LB Int Ext	154	326.43	328.28	0.043719	7.22	28.47	32.58	1.05	3.94
304.666*	50-Year	LB Int Pro	154	329	330.34	0.04367	6.15	25.03	21.36	1	3.1
304.666*	100-Year	LB Int Ext	189	326.43	328.42	0.043383	7.65	33.18	33.76	1.06	4.29
304.666*	100-Year	LB Int Pro	189	329	330.52	0.042233	6.52	29	22.09	1	3.35
304.666*	500-Year	LB Int Ext	276	326.43	328.73	0.042248	8.49	44.07	36.34	1.08	4.98
304.666*	500-Year	LB Int Pro	276	329	330.92	0.039872	7.23	38.17	23.69	1	3.86
304.666*	Apr-07	LB Int Ext	200	326.43	328.46	0.043398	7.78	34.57	34.11	1.07	4.4
304.666*	Apr-07	LB Int Pro	200	329	330.58	0.042018	6.63	30.18	22.3	1	3.43
304.666*	1.8-Year	LB Int Ext	35	326.43	327.46	0.063967	5.1	7.3	14.74	1.11	2.58
304.666*	1.8-Year	LB Int Pro	35	329	329.52	0.05698	3.96	8.83	18.07	1	1.71
304.333*	2-Year	LB Int Ext	38.9	325.59	326.83	0.037915	4.51	9.64	26.91	0.88	1.88
304.333*	2-Year	LB Int Pro	38.9	325.59	328.02	0.000599	1.03	51.07	39.06	0.13	0.07
304.333*	5-Year	LB Int Ext	66.8	325.59	327.02	0.044655	5.6	15.36	32.55	0.98	2.71
304.333*	5-Year	LB Int Pro	66.8	325.59	328.41	0.000805	1.34	67.03	41.53	0.15	0.12
304.333*	10-Year	LB Int Ext	91.2	325.59	327.15	0.046657	6.19	19.55	33.39	1.02	3.18
304.333*	10-Year	LB Int Pro	91.2	325.59	328.7	0.000919	1.54	79.15	42.73	0.17	0.15
304.333*	25-Year	LB Int Ext	126	325.59	327.29	0.050412	6.96	24.34	34.33	1.09	3.87
304.333*	25-Year	LB Int Pro	126	325.59	329.05	0.001029	1.77	94.36	43.52	0.18	0.19
304.333*	50-Year	LB Int Ext	154	325.59	327.39	0.051843	7.44	27.94	35	1.12	4.3
304.333*	50-Year	LB Int Pro	154	325.59	329.3	0.001099	1.93	105.34	44.08	0.19	0.22
304.333*	100-Year	LB Int Ext	189	325.59	327.51	0.052831	7.93	32.17	35.77	1.14	4.76
304.333*	100-Year	LB Int Pro	189	325.59	329.59	0.001173	2.11	117.94	44.72	0.2	0.25
304.333*	500-Year	LB Int Ext	276	325.59	327.76	0.056057	9.04	41.15	37.35	1.21	5.88
304.333*	500-Year	LB Int Pro	276	325.59	330.13	0.0014	2.53	142.74	45.94	0.22	0.35
304.333*	Apr-07	LB Int Ext	200	325.59	327.55	0.052938	8.07	33.47	36	1.15	4.89
304.333*	Apr-07	LB Int Pro	200	325.59	329.67	0.001194	2.16	121.69	44.91	0.2	0.26
304.333*	1.8-Year	LB Int Ext	35	325.59	326.72	0.050921	4.81	7.31	12.56	1	2.23
304.333*	1.8-Year	LB Int Pro	35	325.59	327.95	0.00056	0.97	48.57	38.64	0.12	0.07

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
304	2-Year	LB Int Ext	38.9	324.76	325.96	0.049289	5.05	8.45	23.79	0.98	2.37
304	2-Year	LB Int Pro	38.9	327	327.66	0.054388	4.42	8.79	14.64	1.01	2
304	5-Year	LB Int Ext	66.8	324.76	326.21	0.047321	5.54	15.97	35.56	0.99	2.7
304	5-Year	LB Int Pro	66.8	327	327.93	0.049221	5.16	12.93	15.73	1	2.46
304	10-Year	LB Int Ext	91.2	324.76	326.34	0.047174	6	20.6	36.35	1.01	3.04
304	10-Year	LB Int Pro	91.2	327	328.13	0.047	5.65	16.15	16.53	1.01	2.78
304	25-Year	LB Int Ext	126	324.76	326.49	0.046337	6.5	26.4	37.37	1.02	3.42
304	25-Year	LB Int Pro	126	327	328.38	0.044611	6.17	20.43	17.53	1.01	3.13
304	50-Year	LB Int Ext	154	324.76	326.6	0.046244	6.86	30.5	38.07	1.03	3.7
304	50-Year	LB Int Pro	154	327	328.57	0.043211	6.5	23.68	18.26	1.01	3.36
304	100-Year	LB Int Ext	189	324.76	326.72	0.046363	7.27	35.19	38.85	1.05	4.05
304	100-Year	LB Int Pro	189	327	328.77	0.04187	6.86	27.55	19.09	1.01	3.61
304	500-Year	LB Int Ext	276	324.76	326.99	0.046415	8.11	45.67	40.55	1.08	4.77
304	500-Year	LB Int Pro	276	327	329.38	0.02669	6.76	45.23	43.62	0.85	3.16
304	Apr-07	LB Int Ext	200	324.76	326.75	0.047276	7.44	36.35	39.04	1.06	4.21
304	Apr-07	LB Int Pro	200	327	328.83	0.041464	6.96	28.74	19.34	1.01	3.68
304	1.8-Year	LB Int Ext	35	324.76	325.97	0.037801	4.45	8.76	24.44	0.86	1.84
304	1.8-Year	LB Int Pro	35	327	327.62	0.055155	4.28	8.18	14.47	1	1.91
303.666*	2-Year	LB Int Ext	38.9	322.67	323.67	0.166262	7.92	4.91	7.7	1.75	6.33
303.666*	2-Year	LB Int Pro	38.9	322.67	325.76	0.000513	1.09	47.48	32.56	0.12	0.08
303.666*	5-Year	LB Int Ext	66.8	322.67	324.04	0.122604	8.24	8.11	9.45	1.57	6.22
303.666*	5-Year	LB Int Pro	66.8	322.67	326.16	0.000789	1.49	61.15	36.23	0.15	0.14
303.666*	10-Year	LB Int Ext	91.2	322.67	324.31	0.094577	8.37	11.25	15.39	1.42	5.97
303.666*	10-Year	LB Int Pro	91.2	322.67	326.45	0.000955	1.75	71.93	38.19	0.17	0.18
303.666*	25-Year	LB Int Ext	126	322.67	324.59	0.075504	8.74	16.18	19.6	1.32	6.02
303.666*	25-Year	LB Int Pro	126	322.67	326.8	0.001126	2.03	85.72	39.9	0.19	0.24
303.666*	50-Year	LB Int Ext	154	322.67	324.78	0.066628	8.96	20.2	22.45	1.27	6.06
303.666*	50-Year	LB Int Pro	154	322.67	327.05	0.001233	2.23	95.87	41.1	0.2	0.28
303.666*	100-Year	LB Int Ext	189	322.67	324.99	0.060167	9.25	25.03	25.06	1.23	6.19
303.666*	100-Year	LB Int Pro	189	322.67	327.34	0.001343	2.44	107.72	42.45	0.21	0.32
303.666*	500-Year	LB Int Ext	276	322.67	325.4	0.051553	9.85	36.18	29.17	1.18	6.55
303.666*	500-Year	LB Int Pro	276	322.67	327.8	0.00178	3.01	127.77	44.65	0.25	0.48
303.666*	Apr-07	LB Int Ext	200	322.67	325.05	0.058253	9.31	26.58	25.73	1.22	6.2
303.666*	Apr-07	LB Int Pro	200	322.67	327.42	0.001374	2.5	111.28	42.85	0.22	0.34
303.666*	1.8-Year	LB Int Ext	35	322.67	323.56	0.218788	8.47	4.13	7.22	1.97	7.5
303.666*	1.8-Year	LB Int Pro	35	322.67	325.7	0.000466	1.02	45.39	31.97	0.11	0.07

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
303.333*	2-Year	LB Int Ext	38.9	320.59	321.89	0.071535	5.88	6.61	8.52	1.18	3.28
303.333*	2-Year	LB Int Pro	38.9	324.75	325.41	0.054311	4.42	8.8	14.64	1.01	2
303.333*	5-Year	LB Int Ext	66.8	320.59	322.16	0.085707	7.29	9.17	10.24	1.33	4.74
303.333*	5-Year	LB Int Pro	66.8	324.75	325.68	0.0491	5.16	12.94	15.73	1	2.45
303.333*	10-Year	LB Int Ext	91.2	320.59	322.31	0.09939	8.59	10.83	13.36	1.46	6.28
303.333*	10-Year	LB Int Pro	91.2	324.75	325.88	0.047048	5.65	16.15	16.53	1.01	2.78
303.333*	25-Year	LB Int Ext	126	320.59	322.51	0.101675	9.74	14.11	18.63	1.52	7.63
303.333*	25-Year	LB Int Pro	126	324.75	326.13	0.044621	6.17	20.43	17.53	1.01	3.13
303.333*	50-Year	LB Int Ext	154	320.59	322.65	0.101889	10.43	16.75	20.01	1.55	8.47
303.333*	50-Year	LB Int Pro	154	324.75	326.31	0.043223	6.5	23.68	18.26	1.01	3.36
303.333*	100-Year	LB Int Ext	189	320.59	322.8	0.100512	11.11	19.96	21.4	1.56	9.27
303.333*	100-Year	LB Int Pro	189	324.75	326.52	0.041937	6.86	27.53	19.09	1.01	3.62
303.333*	500-Year	LB Int Ext	276	320.59	323.14	0.095308	12.31	27.67	24.39	1.57	10.67
303.333*	500-Year	LB Int Pro	276	324.75	327.15	0.023666	6.41	50.75	48.84	0.8	2.83
303.333*	Apr-07	LB Int Ext	200	320.59	322.85	0.100033	11.3	20.95	21.81	1.57	9.49
303.333*	Apr-07	LB Int Pro	200	324.75	326.58	0.041538	6.96	28.72	19.33	1.01	3.69
303.333*	1.8-Year	LB Int Ext	35	320.59	321.86	0.063955	5.49	6.37	8.37	1.11	2.88
303.333*	1.8-Year	LB Int Pro	35	324.75	325.37	0.05534	4.28	8.17	14.47	1	1.91
303	2-Year	LB Int Ext	38.9	318.5	319.73	0.12207	7.29	5.33	7.35	1.51	5.18
303	2-Year	LB Int Pro	38.9	318.5	320.76	0.002748	1.81	29.53	35.77	0.26	0.25
303	5-Year	LB Int Ext	66.8	318.5	320.09	0.109824	7.91	9.02	18.27	1.48	5.7
303	5-Year	LB Int Pro	66.8	318.5	321.17	0.002565	2.04	44.46	37.11	0.26	0.29
303	10-Year	LB Int Ext	91.2	318.5	320.24	0.112164	8.73	12.45	26.74	1.53	6.64
303	10-Year	LB Int Pro	91.2	318.5	321.47	0.002486	2.21	55.56	38.03	0.26	0.33
303	25-Year	LB Int Ext	126	318.5	320.37	0.122101	9.9	16.22	29.84	1.63	8.18
303	25-Year	LB Int Pro	126	318.5	321.83	0.002438	2.42	69.49	39.16	0.26	0.37
303	50-Year	LB Int Ext	154	318.5	320.46	0.128621	10.67	18.96	31.89	1.69	9.28
303	50-Year	LB Int Pro	154	318.5	322.08	0.00243	2.57	79.55	39.96	0.27	0.41
303	100-Year	LB Int Ext	189	318.5	320.55	0.13694	11.56	22.04	34.06	1.77	10.63
303	100-Year	LB Int Pro	189	318.5	322.37	0.002437	2.74	91.12	40.86	0.27	0.45
303	500-Year	LB Int Ext	276	318.5	320.73	0.152972	13.31	28.44	35.59	1.91	13.51
303	500-Year	LB Int Pro	276	318.5	322.9	0.002726	3.21	113.07	42.51	0.3	0.59
303	Apr-07	LB Int Ext	200	318.5	320.58	0.139182	11.81	22.97	34.69	1.79	11.03
303	Apr-07	LB Int Pro	200	318.5	322.46	0.002439	2.79	94.6	41.12	0.27	0.46
303	1.8-Year	LB Int Ext	35	318.5	319.64	0.134559	7.41	4.73	6.86	1.57	5.43
303	1.8-Year	LB Int Pro	35	318.5	320.7	0.00278	1.77	27.15	35.39	0.26	0.24

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
302.8*	2-Year	LB Int Ext	38.9	317.35	318.74	0.051673	5.14	7.57	9.44	1.01	2.47
302.8*	2-Year	LB Int Pro	38.9	317.35	320.76	0.000381	1	50.96	31.06	0.11	0.06
302.8*	5-Year	LB Int Ext	66.8	317.35	319.14	0.040642	5.71	12.13	14.29	0.95	2.73
302.8*	5-Year	LB Int Pro	66.8	317.35	321.16	0.000623	1.4	64.01	34.21	0.14	0.12
302.8*	10-Year	LB Int Ext	91.2	317.35	319.42	0.03393	6.05	16.67	18.42	0.9	2.84
302.8*	10-Year	LB Int Pro	91.2	317.35	321.45	0.00079	1.68	74.25	36.44	0.16	0.16
302.8*	25-Year	LB Int Ext	126	317.35	319.73	0.029284	6.43	23.16	22.49	0.86	3
302.8*	25-Year	LB Int Pro	126	317.35	321.81	0.000979	1.99	87.67	39.14	0.18	0.22
302.8*	50-Year	LB Int Ext	154	317.35	319.95	0.026799	6.65	28.28	24.62	0.84	3.09
302.8*	50-Year	LB Int Pro	154	317.35	322.06	0.001084	2.19	97.63	39.94	0.19	0.26
302.8*	100-Year	LB Int Ext	189	317.35	320.13	0.027327	7.15	33.02	26.1	0.86	3.45
302.8*	100-Year	LB Int Pro	189	317.35	322.34	0.001195	2.4	109.1	40.84	0.2	0.31
302.8*	500-Year	LB Int Ext	276	317.35	320.57	0.0261	7.91	45.22	29.56	0.87	3.98
302.8*	500-Year	LB Int Pro	276	317.35	322.86	0.001528	2.93	130.72	42.48	0.23	0.44
302.8*	Apr-07	LB Int Ext	200	317.35	320.2	0.027136	7.26	34.62	26.58	0.86	3.53
302.8*	Apr-07	LB Int Pro	200	317.35	322.43	0.001226	2.47	112.55	41.11	0.21	0.32
302.8*	1.8-Year	LB Int Ext	35	317.35	318.69	0.049411	4.92	7.12	9.16	0.98	2.28
302.8*	1.8-Year	LB Int Pro	35	317.35	320.7	0.000342	0.94	48.95	30.54	0.1	0.05
302.6*	2-Year	LB Int Ext	38.9	316.21	317.49	0.054705	5.11	7.61	10.17	1.04	2.49
302.6*	2-Year	LB Int Pro	38.9	319.75	320.41	0.05432	4.42	8.8	14.64	1.01	2
302.6*	5-Year	LB Int Ext	66.8	316.21	317.75	0.063367	6.43	10.51	11.99	1.16	3.64
302.6*	5-Year	LB Int Pro	66.8	319.75	320.68	0.049432	5.17	12.92	15.73	1.01	2.47
302.6*	10-Year	LB Int Ext	91.2	316.21	317.91	0.069969	7.47	12.53	13.55	1.25	4.67
302.6*	10-Year	LB Int Pro	91.2	319.75	320.88	0.046939	5.64	16.16	16.53	1.01	2.77
302.6*	25-Year	LB Int Ext	126	316.21	318.14	0.068887	8.41	15.91	15.86	1.28	5.55
302.6*	25-Year	LB Int Pro	126	319.75	321.13	0.044528	6.16	20.45	17.54	1.01	3.12
302.6*	50-Year	LB Int Ext	154	316.21	318.31	0.066679	8.96	18.74	17.43	1.29	6.06
302.6*	50-Year	LB Int Pro	154	319.75	321.32	0.043167	6.5	23.69	18.26	1.01	3.36
302.6*	100-Year	LB Int Ext	189	316.21	318.53	0.060153	9.32	22.76	18.89	1.25	6.26
302.6*	100-Year	LB Int Pro	189	319.75	321.53	0.041568	6.84	27.62	19.1	1	3.59
302.6*	500-Year	LB Int Ext	276	316.21	318.99	0.052019	10.13	32.07	21.91	1.21	6.85
302.6*	500-Year	LB Int Pro	276	319.75	322.11	0.027031	6.75	45.41	39.03	0.85	3.16
302.6*	Apr-07	LB Int Ext	200	316.21	318.6	0.058328	9.41	24.03	19.33	1.24	6.31
302.6*	Apr-07	LB Int Pro	200	319.75	321.58	0.041506	6.96	28.73	19.34	1.01	3.69
302.6*	1.8-Year	LB Int Ext	35	316.21	317.45	0.05208	4.87	7.19	9.91	1.01	2.28
302.6*	1.8-Year	LB Int Pro	35	319.75	320.37	0.054621	4.27	8.2	14.48	1	1.89

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
302.4*	2-Year	LB Int Ext	38.9	315.06	316.2	0.065965	5.35	7.29	10.76	1.13	2.78
302.4*	2-Year	LB Int Pro	38.9	315.06	317.24	0.002694	1.92	22.15	18.25	0.26	0.27
302.4*	5-Year	LB Int Ext	66.8	315.06	316.53	0.055012	6.07	11.17	12.42	1.09	3.22
302.4*	5-Year	LB Int Pro	66.8	315.06	317.66	0.003427	2.52	30.27	20.75	0.31	0.43
302.4*	10-Year	LB Int Ext	91.2	315.06	316.83	0.04165	6.25	15.17	15.01	0.99	3.14
302.4*	10-Year	LB Int Pro	91.2	315.06	317.96	0.003803	2.91	36.77	22.54	0.33	0.55
302.4*	25-Year	LB Int Ext	126	315.06	317.09	0.040713	7	19.35	17.31	1.01	3.7
302.4*	25-Year	LB Int Pro	126	315.06	318.33	0.004132	3.33	45.32	24.14	0.36	0.69
302.4*	50-Year	LB Int Ext	154	315.06	317.24	0.042349	7.63	22.12	18.24	1.05	4.25
302.4*	50-Year	LB Int Pro	154	315.06	318.58	0.004328	3.62	51.67	25.25	0.37	0.79
302.4*	100-Year	LB Int Ext	189	315.06	317.39	0.045976	8.43	24.97	19.15	1.11	5.04
302.4*	100-Year	LB Int Pro	189	315.06	318.86	0.004597	3.96	58.79	26.44	0.39	0.91
302.4*	500-Year	LB Int Ext	276	315.06	317.74	0.050797	9.95	31.91	21.22	1.2	6.63
302.4*	500-Year	LB Int Pro	276	315.06	319.36	0.00557	4.79	72.48	28.58	0.43	1.27
302.4*	Apr-07	LB Int Ext	200	315.06	317.44	0.046887	8.66	25.86	19.43	1.12	5.27
302.4*	Apr-07	LB Int Pro	200	315.06	318.93	0.004726	4.07	60.68	26.74	0.39	0.96
302.4*	1.8-Year	LB Int Ext	35	315.06	316.22	0.048874	4.67	7.51	10.86	0.98	2.11
302.4*	1.8-Year	LB Int Pro	35	315.06	317.17	0.002546	1.82	20.91	17.84	0.25	0.25
302.2*	2-Year	LB Int Ext	38.9	313.92	315.02	0.050888	4.83	8.11	11.68	1	2.24
302.2*	2-Year	LB Int Pro	38.9	313.92	317.26	0.000291	0.92	50.69	24.88	0.1	0.05
302.2*	5-Year	LB Int Ext	66.8	313.92	315.33	0.046541	5.66	11.99	12.92	1.01	2.78
302.2*	5-Year	LB Int Pro	66.8	313.92	317.68	0.000502	1.32	61.58	26.43	0.13	0.1
302.2*	10-Year	LB Int Ext	91.2	313.92	315.45	0.060709	6.87	13.54	13.4	1.17	3.98
302.2*	10-Year	LB Int Pro	91.2	313.92	317.99	0.000662	1.61	69.81	27.54	0.15	0.15
302.2*	25-Year	LB Int Ext	126	313.92	315.68	0.059492	7.75	16.95	16.2	1.19	4.73
302.2*	25-Year	LB Int Pro	126	313.92	318.36	0.000861	1.96	80.27	28.9	0.17	0.21
302.2*	50-Year	LB Int Ext	154	313.92	315.86	0.056212	8.21	20.04	17.87	1.19	5.09
302.2*	50-Year	LB Int Pro	154	313.92	318.62	0.001002	2.21	87.93	29.86	0.19	0.26
302.2*	100-Year	LB Int Ext	189	313.92	316.05	0.054648	8.77	23.59	19.31	1.19	5.58
302.2*	100-Year	LB Int Pro	189	313.92	318.9	0.001173	2.49	96.42	30.89	0.21	0.32
302.2*	500-Year	LB Int Ext	276	313.92	316.44	0.053494	9.97	31.61	21.89	1.22	6.73
302.2*	500-Year	LB Int Pro	276	313.92	319.41	0.001637	3.16	112.65	32.76	0.25	0.5
302.2*	Apr-07	LB Int Ext	200	313.92	316.11	0.054206	8.93	24.68	19.74	1.2	5.72
302.2*	Apr-07	LB Int Pro	200	313.92	318.97	0.001233	2.58	98.67	31.15	0.21	0.35
302.2*	1.8-Year	LB Int Ext	35	313.92	314.97	0.05202	4.68	7.51	11.47	1.01	2.15
302.2*	1.8-Year	LB Int Pro	35	313.92	317.19	0.00026	0.85	48.98	24.62	0.09	0.04

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
302	2-Year	LB Int Ext	38.9	312.77	313.96	0.02421	3.74	10.55	12.84	0.71	1.27
302	2-Year	LB Int Pro	38.9	316.15	316.88	0.053386	4.59	8.47	13.08	1.01	2.1
302	5-Year	LB Int Ext	66.8	312.77	314.3	0.024064	4.5	15.16	14.01	0.74	1.67
302	5-Year	LB Int Pro	66.8	316.15	317.18	0.048153	5.32	12.57	14.34	1	2.55
302	10-Year	LB Int Ext	91.2	312.77	314.51	0.02492	5.14	18.55	17.79	0.78	2.06
302	10-Year	LB Int Pro	91.2	316.15	317.4	0.046303	5.8	15.73	15.24	1.01	2.88
302	25-Year	LB Int Ext	126	312.77	314.76	0.02614	5.88	23.42	21.42	0.82	2.55
302	25-Year	LB Int Pro	126	316.15	317.67	0.044089	6.31	19.98	16.37	1.01	3.23
302	50-Year	LB Int Ext	154	312.77	314.67	0.048111	7.68	21.56	20.56	1.1	4.43
302	50-Year	LB Int Pro	154	316.15	317.86	0.042622	6.63	23.24	17.18	1	3.44
302	100-Year	LB Int Ext	189	312.77	314.83	0.04982	8.36	24.98	21.66	1.14	5.08
302	100-Year	LB Int Pro	189	316.15	318.16	0.034504	6.61	29.41	28.75	0.93	3.25
302	500-Year	LB Int Ext	276	312.77	315.16	0.053052	9.74	32.38	22.78	1.21	6.49
302	500-Year	LB Int Pro	276	316.15	318.61	0.028898	7.14	42.89	31.24	0.88	3.5
302	Apr-07	LB Int Ext	200	312.77	314.87	0.051018	8.6	25.84	21.8	1.16	5.32
302	Apr-07	LB Int Pro	200	316.15	318.23	0.032529	6.62	31.65	29.18	0.91	3.22
302	1.8-Year	LB Int Ext	35	312.77	313.9	0.024261	3.6	9.84	12.65	0.71	1.2
302	1.8-Year	LB Int Pro	35	316.15	316.84	0.053831	4.44	7.88	12.89	1	2.01
301.8*	2-Year	LB Int Ext	38.9	312	313.25	0.024638	3.76	10.47	12.83	0.72	1.28
301.8*	2-Year	LB Int Pro	38.9	312	313.71	0.005551	2.35	17.83	19.32	0.36	0.44
301.8*	5-Year	LB Int Ext	66.8	312	313.56	0.025788	4.66	14.97	18.17	0.77	1.79
301.8*	5-Year	LB Int Pro	66.8	312	314.16	0.005325	2.81	27.06	21.55	0.38	0.56
301.8*	10-Year	LB Int Ext	91.2	312	313.77	0.026474	5.26	18.82	19.7	0.8	2.17
301.8*	10-Year	LB Int Pro	91.2	312	314.48	0.005224	3.11	34.04	22.63	0.38	0.65
301.8*	25-Year	LB Int Ext	126	312	314.01	0.0267	5.92	23.89	21.04	0.83	2.59
301.8*	25-Year	LB Int Pro	126	312	314.86	0.005186	3.47	42.89	23.92	0.39	0.77
301.8*	50-Year	LB Int Ext	154	312	314.19	0.026728	6.35	27.63	21.64	0.84	2.88
301.8*	50-Year	LB Int Pro	154	312	315.12	0.005199	3.72	49.38	24.83	0.4	0.86
301.8*	100-Year	LB Int Ext	189	312	314.39	0.026771	6.82	31.97	22.32	0.86	3.2
301.8*	100-Year	LB Int Pro	189	312	315.42	0.00525	4.01	56.87	25.84	0.41	0.96
301.8*	500-Year	LB Int Ext	276	312	314.81	0.026742	7.77	41.82	23.77	0.89	3.9
301.8*	500-Year	LB Int Pro	276	312	315.93	0.006082	4.79	70.61	27.59	0.45	1.3
301.8*	Apr-07	LB Int Ext	200	312	314.44	0.026769	6.96	33.28	22.52	0.86	3.3
301.8*	Apr-07	LB Int Pro	200	312	315.48	0.005412	4.13	58.56	26.06	0.42	1.01
301.8*	1.8-Year	LB Int Ext	35	312	313.2	0.024627	3.62	9.77	12.62	0.71	1.21
301.8*	1.8-Year	LB Int Pro	35	312	313.64	0.005572	2.26	16.42	18.76	0.36	0.41

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
301.6*	2-Year	LB Int Ext	38.9	311.24	312.57	0.02353	3.71	10.81	17.29	0.7	1.25
301.6*	2-Year	LB Int Pro	38.9	311.24	313.7	0.001032	1.36	33.39	22.11	0.17	0.13
301.6*	5-Year	LB Int Ext	66.8	311.24	312.85	0.024502	4.58	15.97	18.81	0.75	1.72
301.6*	5-Year	LB Int Pro	66.8	311.24	314.14	0.001424	1.82	43.49	23.65	0.21	0.21
301.6*	10-Year	LB Int Ext	91.2	311.24	313.05	0.025264	5.17	19.77	19.82	0.78	2.08
301.6*	10-Year	LB Int Pro	91.2	311.24	314.45	0.001678	2.14	51.06	24.73	0.23	0.28
301.6*	25-Year	LB Int Ext	126	311.24	313.28	0.026138	5.85	24.55	20.68	0.82	2.53
301.6*	25-Year	LB Int Pro	126	311.24	314.83	0.001964	2.52	60.65	26.04	0.25	0.38
301.6*	50-Year	LB Int Ext	154	311.24	313.46	0.026381	6.29	28.16	21.28	0.84	2.83
301.6*	50-Year	LB Int Pro	154	311.24	315.09	0.002153	2.79	67.66	26.96	0.27	0.45
301.6*	100-Year	LB Int Ext	189	311.24	313.66	0.026377	6.76	32.47	21.97	0.85	3.15
301.6*	100-Year	LB Int Pro	189	311.24	315.39	0.00236	3.09	75.74	27.98	0.28	0.53
301.6*	500-Year	LB Int Ext	276	311.24	314.09	0.026428	7.73	42.24	23.46	0.88	3.85
301.6*	500-Year	LB Int Pro	276	311.24	315.9	0.003069	3.83	90.4	29.74	0.33	0.79
301.6*	Apr-07	LB Int Ext	200	311.24	313.72	0.026393	6.9	33.77	22.17	0.86	3.25
301.6*	Apr-07	LB Int Pro	200	311.24	315.45	0.002475	3.2	77.54	28.2	0.29	0.57
301.6*	1.8-Year	LB Int Ext	35	311.24	312.52	0.023151	3.55	10	17.03	0.69	1.16
301.6*	1.8-Year	LB Int Pro	35	311.24	313.62	0.000963	1.28	31.78	21.86	0.16	0.11
301.4*	2-Year	LB Int Ext	38.9	310.47	311.79	0.029933	3.98	10.55	16.98	0.78	1.47
301.4*	2-Year	LB Int Pro	38.9	312.5	313.26	0.052961	4.67	8.34	12.47	1.01	2.15
301.4*	5-Year	LB Int Ext	66.8	310.47	312.07	0.029492	4.81	15.44	18.35	0.81	1.94
301.4*	5-Year	LB Int Pro	66.8	312.5	313.57	0.048484	5.42	12.33	13.69	1.01	2.63
301.4*	10-Year	LB Int Ext	91.2	310.47	312.27	0.028618	5.32	19.33	19.23	0.83	2.24
301.4*	10-Year	LB Int Pro	91.2	312.5	313.79	0.046073	5.88	15.52	14.6	1	2.94
301.4*	25-Year	LB Int Ext	126	310.47	312.53	0.027675	5.91	24.37	20.14	0.84	2.6
301.4*	25-Year	LB Int Pro	126	312.5	314.07	0.043891	6.39	19.73	15.71	1	3.29
301.4*	50-Year	LB Int Ext	154	310.47	312.71	0.027164	6.31	28.12	20.79	0.85	2.86
301.4*	50-Year	LB Int Pro	154	312.5	314.27	0.042639	6.72	22.92	16.51	1	3.52
301.4*	100-Year	LB Int Ext	189	310.47	312.92	0.026716	6.75	32.54	21.53	0.85	3.15
301.4*	100-Year	LB Int Pro	189	312.5	314.5	0.040736	7.03	26.9	18.62	1	3.72
301.4*	500-Year	LB Int Ext	276	310.47	313.37	0.026068	7.66	42.61	23.15	0.87	3.79
301.4*	500-Year	LB Int Pro	276	312.5	315.04	0.029152	7.25	41.83	29.07	0.89	3.59
301.4*	Apr-07	LB Int Ext	200	310.47	312.98	0.026606	6.88	33.88	21.76	0.86	3.24
301.4*	Apr-07	LB Int Pro	200	312.5	314.65	0.033293	6.75	30.77	27.63	0.92	3.33
301.4*	1.8-Year	LB Int Ext	35	310.47	311.75	0.029814	3.82	9.81	16.76	0.77	1.38
301.4*	1.8-Year	LB Int Pro	35	312.5	313.22	0.053362	4.51	7.76	12.28	1	2.05

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
301.2*	2-Year	LB Int Ext	38.9	309.7	311.17	0.019329	3.37	12.7	16.91	0.64	1.03
301.2*	2-Year	LB Int Pro	38.9	309.7	311.83	0.002505	1.77	24.99	19.77	0.25	0.23
301.2*	5-Year	LB Int Ext	66.8	309.7	311.47	0.01948	4.13	18.08	18.42	0.67	1.39
301.2*	5-Year	LB Int Pro	66.8	309.7	312.23	0.00319	2.33	33.21	21.26	0.29	0.38
301.2*	10-Year	LB Int Ext	91.2	309.7	311.7	0.01934	4.62	22.3	19.26	0.69	1.65
301.2*	10-Year	LB Int Pro	91.2	309.7	312.51	0.003632	2.72	39.33	22.3	0.32	0.49
301.2*	25-Year	LB Int Ext	126	309.7	311.96	0.019823	5.24	27.49	20.23	0.72	2
301.2*	25-Year	LB Int Pro	126	309.7	312.85	0.004126	3.19	47.07	23.55	0.35	0.64
301.2*	50-Year	LB Int Ext	154	309.7	312.14	0.020173	5.68	31.31	20.92	0.74	2.27
301.2*	50-Year	LB Int Pro	154	309.7	313.09	0.004445	3.51	52.76	24.43	0.37	0.75
301.2*	100-Year	LB Int Ext	189	309.7	312.35	0.020538	6.15	35.78	21.7	0.76	2.57
301.2*	100-Year	LB Int Pro	189	309.7	313.35	0.004787	3.87	59.36	25.41	0.39	0.89
301.2*	500-Year	LB Int Ext	276	309.7	312.81	0.021093	7.13	46.04	23.39	0.79	3.22
301.2*	500-Year	LB Int Pro	276	309.7	313.91	0.005467	4.62	74.09	27.47	0.43	1.2
301.2*	Apr-07	LB Int Ext	200	309.7	312.42	0.020594	6.29	37.16	21.93	0.76	2.66
301.2*	Apr-07	LB Int Pro	200	309.7	313.43	0.004884	3.97	61.35	25.69	0.4	0.93
301.2*	1.8-Year	LB Int Ext	35	309.7	311.12	0.019427	3.25	11.84	16.63	0.63	0.97
301.2*	1.8-Year	LB Int Pro	35	309.7	311.77	0.00238	1.68	23.69	19.52	0.24	0.21
301	2-Year	LB Int Ext	38.9	308.93	310.18	0.050025	4.71	9.1	14.05	0.98	2.15
301	2-Year	LB Int Pro	38.9	310.66	311.37	0.050027	4.3	9.05	14.78	0.97	1.87
301	5-Year	LB Int Ext	66.8	308.93	310.46	0.050034	5.41	13.36	15.97	1.02	2.65
301	5-Year	LB Int Pro	66.8	310.66	311.63	0.049462	5.16	12.95	15.87	1.01	2.46
301	10-Year	LB Int Ext	91.2	308.93	310.65	0.050056	6.05	16.39	17.2	1.05	3.13
301	10-Year	LB Int Pro	91.2	310.66	311.83	0.047019	5.63	16.21	16.72	1.01	2.76
301	25-Year	LB Int Ext	126	308.93	310.9	0.045961	6.69	20.83	18.41	1.04	3.56
301	25-Year	LB Int Pro	126	310.66	312.08	0.044646	6.14	20.53	17.78	1.01	3.11
301	50-Year	LB Int Ext	154	308.93	311.08	0.043287	7.1	24.28	19.12	1.03	3.84
301	50-Year	LB Int Pro	154	310.66	312.26	0.043271	6.47	23.8	18.55	1.01	3.34
301	100-Year	LB Int Ext	189	308.93	311.29	0.041187	7.56	28.33	19.92	1.03	4.17
301	100-Year	LB Int Pro	189	310.66	312.47	0.041925	6.82	27.7	19.42	1.01	3.59
301	500-Year	LB Int Ext	276	308.93	311.75	0.037172	8.46	37.97	21.7	1.02	4.8
301	500-Year	LB Int Pro	276	310.66	312.91	0.039598	7.5	36.79	21.32	1.01	4.07
301	Apr-07	LB Int Ext	200	308.93	311.35	0.040655	7.7	29.57	20.15	1.03	4.26
301	Apr-07	LB Int Pro	200	310.66	312.53	0.041569	6.92	28.89	19.68	1.01	3.66
301	1.8-Year	LB Int Ext	35	308.93	310.13	0.050027	4.59	8.44	13.73	0.98	2.07
301	1.8-Year	LB Int Pro	35	310.66	311.33	0.050032	4.14	8.45	14.61	0.96	1.77

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
305	2-Year	LB Int Ext	38.9	327.26	328.27	0.07204	5.4	7.9	15	1.18	2.89
305	2-Year	LB Int Pro	38.9	327.26	329.86	0.000474	1	52.13	35.06	0.12	0.07
305	5-Year	LB Int Ext	66.8	327.26	328.64	0.04064	5.49	14.58	21.5	0.96	2.57
305	5-Year	LB Int Pro	66.8	327.26	330.21	0.000748	1.39	64.52	36.25	0.15	0.12
305	10-Year	LB Int Ext	91.2	327.26	328.8	0.043387	6.24	18.18	24.62	1.01	3.16
305	10-Year	LB Int Pro	91.2	327.26	330.46	0.000936	1.65	73.84	37.12	0.17	0.16
305	25-Year	LB Int Ext	126	327.26	328.94	0.052057	7.38	21.9	27.47	1.13	4.26
305	25-Year	LB Int Pro	126	327.26	330.77	0.001151	1.96	85.69	38.19	0.19	0.23
305	50-Year	LB Int Ext	154	327.26	329.04	0.057763	8.15	24.69	29.43	1.21	5.07
305	50-Year	LB Int Pro	154	327.26	331	0.001294	2.18	94.37	38.96	0.21	0.27
305	100-Year	LB Int Ext	189	327.26	329.14	0.064549	9.04	27.86	31.51	1.29	6.09
305	100-Year	LB Int Pro	189	327.26	331.26	0.001446	2.42	104.44	39.83	0.22	0.33
305	500-Year	LB Int Ext	276	327.26	329.34	0.077702	10.78	34.55	33.31	1.45	8.31
305	500-Year	LB Int Pro	276	327.26	331.81	0.001743	2.91	126.89	41.71	0.25	0.45
305	Apr-07	LB Int Ext	200	327.26	329.17	0.066564	9.29	28.81	32.1	1.31	6.4
305	Apr-07	LB Int Pro	200	327.26	331.33	0.001489	2.49	107.47	40.09	0.23	0.34
305	1.8-Year	LB Int Ext	35	327.26	328.3	0.047305	4.55	8.49	15.36	0.97	2.01
305	1.8-Year	LB Int Pro	35	327.26	329.8	0.000429	0.94	50.17	34.87	0.11	0.06
304.666*	2-Year	LB Int Ext	38.9	326.43	327.57	0.045409	4.75	9	16.79	0.96	2.13
304.666*	2-Year	LB Int Pro	38.9	329	329.55	0.056538	4.11	9.46	18.21	1.01	1.81
304.666*	5-Year	LB Int Ext	66.8	326.43	327.82	0.045085	5.7	14.44	26.31	1	2.79
304.666*	5-Year	LB Int Pro	66.8	329	329.79	0.050958	4.84	13.8	19.14	1	2.25
304.666*	10-Year	LB Int Ext	91.2	326.43	327.97	0.046489	6.34	18.62	30	1.04	3.3
304.666*	10-Year	LB Int Pro	91.2	329	329.96	0.047631	5.29	17.25	19.85	1	2.53
304.666*	25-Year	LB Int Ext	126	326.43	328.15	0.045069	6.88	24.22	31.49	1.05	3.7
304.666*	25-Year	LB Int Pro	126	329	330.18	0.045108	5.81	21.69	20.72	1	2.87
304.666*	50-Year	LB Int Ext	154	326.43	328.28	0.043719	7.22	28.47	32.58	1.05	3.94
304.666*	50-Year	LB Int Pro	154	329	330.34	0.04367	6.15	25.03	21.36	1	3.1
304.666*	100-Year	LB Int Ext	189	326.43	328.42	0.043383	7.65	33.18	33.76	1.06	4.29
304.666*	100-Year	LB Int Pro	189	329	330.52	0.042233	6.52	29	22.09	1	3.35
304.666*	500-Year	LB Int Ext	276	326.43	328.73	0.042248	8.49	44.07	36.34	1.08	4.98
304.666*	500-Year	LB Int Pro	276	329	330.92	0.039872	7.23	38.17	23.69	1	3.86
304.666*	Apr-07	LB Int Ext	200	326.43	328.46	0.043398	7.78	34.57	34.11	1.07	4.4
304.666*	Apr-07	LB Int Pro	200	329	330.58	0.042018	6.63	30.18	22.3	1	3.43
304.666*	1.8-Year	LB Int Ext	35	326.43	327.46	0.063967	5.1	7.3	14.74	1.11	2.58
304.666*	1.8-Year	LB Int Pro	35	329	329.52	0.05698	3.96	8.83	18.07	1	1.71

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
304.333*	2-Year	LB Int Ext	38.9	325.59	326.83	0.037915	4.51	9.64	26.91	0.88	1.88
304.333*	2-Year	LB Int Pro	38.9	325.59	328.02	0.000599	1.03	51.07	39.06	0.13	0.07
304.333*	5-Year	LB Int Ext	66.8	325.59	327.02	0.044655	5.6	15.36	32.55	0.98	2.71
304.333*	5-Year	LB Int Pro	66.8	325.59	328.41	0.000805	1.34	67.03	41.53	0.15	0.12
304.333*	10-Year	LB Int Ext	91.2	325.59	327.15	0.046657	6.19	19.55	33.39	1.02	3.18
304.333*	10-Year	LB Int Pro	91.2	325.59	328.7	0.000919	1.54	79.15	42.73	0.17	0.15
304.333*	25-Year	LB Int Ext	126	325.59	327.29	0.050412	6.96	24.34	34.33	1.09	3.87
304.333*	25-Year	LB Int Pro	126	325.59	329.05	0.001029	1.77	94.36	43.52	0.18	0.19
304.333*	50-Year	LB Int Ext	154	325.59	327.39	0.051843	7.44	27.94	35	1.12	4.3
304.333*	50-Year	LB Int Pro	154	325.59	329.3	0.001099	1.93	105.34	44.08	0.19	0.22
304.333*	100-Year	LB Int Ext	189	325.59	327.51	0.052831	7.93	32.17	35.77	1.14	4.76
304.333*	100-Year	LB Int Pro	189	325.59	329.59	0.001173	2.11	117.94	44.72	0.2	0.25
304.333*	500-Year	LB Int Ext	276	325.59	327.76	0.056057	9.04	41.15	37.35	1.21	5.88
304.333*	500-Year	LB Int Pro	276	325.59	330.13	0.0014	2.53	142.74	45.94	0.22	0.35
304.333*	Apr-07	LB Int Ext	200	325.59	327.55	0.052938	8.07	33.47	36	1.15	4.89
304.333*	Apr-07	LB Int Pro	200	325.59	329.67	0.001194	2.16	121.69	44.91	0.2	0.26
304.333*	1.8-Year	LB Int Ext	35	325.59	326.72	0.050921	4.81	7.31	12.56	1	2.23
304.333*	1.8-Year	LB Int Pro	35	325.59	327.95	0.00056	0.97	48.57	38.64	0.12	0.07
304	2-Year	LB Int Ext	38.9	324.76	325.96	0.049289	5.05	8.45	23.79	0.98	2.37
304	2-Year	LB Int Pro	38.9	327	327.66	0.054388	4.42	8.79	14.64	1.01	2
304	5-Year	LB Int Ext	66.8	324.76	326.21	0.047321	5.54	15.97	35.56	0.99	2.7
304	5-Year	LB Int Pro	66.8	327	327.93	0.049221	5.16	12.93	15.73	1	2.46
304	10-Year	LB Int Ext	91.2	324.76	326.34	0.047174	6	20.6	36.35	1.01	3.04
304	10-Year	LB Int Pro	91.2	327	328.13	0.047	5.65	16.15	16.53	1.01	2.78
304	25-Year	LB Int Ext	126	324.76	326.49	0.046337	6.5	26.4	37.37	1.02	3.42
304	25-Year	LB Int Pro	126	327	328.38	0.044611	6.17	20.43	17.53	1.01	3.13
304	50-Year	LB Int Ext	154	324.76	326.6	0.046244	6.86	30.5	38.07	1.03	3.7
304	50-Year	LB Int Pro	154	327	328.57	0.043211	6.5	23.68	18.26	1.01	3.36
304	100-Year	LB Int Ext	189	324.76	326.72	0.046363	7.27	35.19	38.85	1.05	4.05
304	100-Year	LB Int Pro	189	327	328.77	0.04187	6.86	27.55	19.09	1.01	3.61
304	500-Year	LB Int Ext	276	324.76	326.99	0.046415	8.11	45.67	40.55	1.08	4.77
304	500-Year	LB Int Pro	276	327	329.38	0.02669	6.76	45.23	43.62	0.85	3.16
304	Apr-07	LB Int Ext	200	324.76	326.75	0.047276	7.44	36.35	39.04	1.06	4.21
304	Apr-07	LB Int Pro	200	327	328.83	0.041464	6.96	28.74	19.34	1.01	3.68
304	1.8-Year	LB Int Ext	35	324.76	325.97	0.037801	4.45	8.76	24.44	0.86	1.84
304	1.8-Year	LB Int Pro	35	327	327.62	0.055155	4.28	8.18	14.47	1	1.91

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
303.666*	2-Year	LB Int Ext	38.9	322.67	323.67	0.166262	7.92	4.91	7.7	1.75	6.33
303.666*	2-Year	LB Int Pro	38.9	322.67	325.76	0.000513	1.09	47.48	32.56	0.12	0.08
303.666*	5-Year	LB Int Ext	66.8	322.67	324.04	0.122604	8.24	8.11	9.45	1.57	6.22
303.666*	5-Year	LB Int Pro	66.8	322.67	326.16	0.000789	1.49	61.15	36.23	0.15	0.14
303.666*	10-Year	LB Int Ext	91.2	322.67	324.31	0.094577	8.37	11.25	15.39	1.42	5.97
303.666*	10-Year	LB Int Pro	91.2	322.67	326.45	0.000955	1.75	71.93	38.19	0.17	0.18
303.666*	25-Year	LB Int Ext	126	322.67	324.59	0.075504	8.74	16.18	19.6	1.32	6.02
303.666*	25-Year	LB Int Pro	126	322.67	326.8	0.001126	2.03	85.72	39.9	0.19	0.24
303.666*	50-Year	LB Int Ext	154	322.67	324.78	0.066628	8.96	20.2	22.45	1.27	6.06
303.666*	50-Year	LB Int Pro	154	322.67	327.05	0.001233	2.23	95.87	41.1	0.2	0.28
303.666*	100-Year	LB Int Ext	189	322.67	324.99	0.060167	9.25	25.03	25.06	1.23	6.19
303.666*	100-Year	LB Int Pro	189	322.67	327.34	0.001343	2.44	107.72	42.45	0.21	0.32
303.666*	500-Year	LB Int Ext	276	322.67	325.4	0.051553	9.85	36.18	29.17	1.18	6.55
303.666*	500-Year	LB Int Pro	276	322.67	327.8	0.00178	3.01	127.77	44.65	0.25	0.48
303.666*	Apr-07	LB Int Ext	200	322.67	325.05	0.058253	9.31	26.58	25.73	1.22	6.2
303.666*	Apr-07	LB Int Pro	200	322.67	327.42	0.001374	2.5	111.28	42.85	0.22	0.34
303.666*	1.8-Year	LB Int Ext	35	322.67	323.56	0.218788	8.47	4.13	7.22	1.97	7.5
303.666*	1.8-Year	LB Int Pro	35	322.67	325.7	0.000466	1.02	45.39	31.97	0.11	0.07
303.333*	2-Year	LB Int Ext	38.9	320.59	321.89	0.071535	5.88	6.61	8.52	1.18	3.28
303.333*	2-Year	LB Int Pro	38.9	324.75	325.41	0.054311	4.42	8.8	14.64	1.01	2
303.333*	5-Year	LB Int Ext	66.8	320.59	322.16	0.085707	7.29	9.17	10.24	1.33	4.74
303.333*	5-Year	LB Int Pro	66.8	324.75	325.68	0.0491	5.16	12.94	15.73	1	2.45
303.333*	10-Year	LB Int Ext	91.2	320.59	322.31	0.09939	8.59	10.83	13.36	1.46	6.28
303.333*	10-Year	LB Int Pro	91.2	324.75	325.88	0.047048	5.65	16.15	16.53	1.01	2.78
303.333*	25-Year	LB Int Ext	126	320.59	322.51	0.101675	9.74	14.11	18.63	1.52	7.63
303.333*	25-Year	LB Int Pro	126	324.75	326.13	0.044621	6.17	20.43	17.53	1.01	3.13
303.333*	50-Year	LB Int Ext	154	320.59	322.65	0.101889	10.43	16.75	20.01	1.55	8.47
303.333*	50-Year	LB Int Pro	154	324.75	326.31	0.043223	6.5	23.68	18.26	1.01	3.36
303.333*	100-Year	LB Int Ext	189	320.59	322.8	0.100512	11.11	19.96	21.4	1.56	9.27
303.333*	100-Year	LB Int Pro	189	324.75	326.52	0.041937	6.86	27.53	19.09	1.01	3.62
303.333*	500-Year	LB Int Ext	276	320.59	323.14	0.095308	12.31	27.67	24.39	1.57	10.67
303.333*	500-Year	LB Int Pro	276	324.75	327.15	0.023666	6.41	50.75	48.84	0.8	2.83
303.333*	Apr-07	LB Int Ext	200	320.59	322.85	0.100033	11.3	20.95	21.81	1.57	9.49
303.333*	Apr-07	LB Int Pro	200	324.75	326.58	0.041538	6.96	28.72	19.33	1.01	3.69
303.333*	1.8-Year	LB Int Ext	35	320.59	321.86	0.063955	5.49	6.37	8.37	1.11	2.88
303.333*	1.8-Year	LB Int Pro	35	324.75	325.37	0.05534	4.28	8.17	14.47	1	1.91

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
303	2-Year	LB Int Ext	38.9	318.5	319.73	0.12207	7.29	5.33	7.35	1.51	5.18
303	2-Year	LB Int Pro	38.9	318.5	320.76	0.002748	1.81	29.53	35.77	0.26	0.25
303	5-Year	LB Int Ext	66.8	318.5	320.09	0.109824	7.91	9.02	18.27	1.48	5.7
303	5-Year	LB Int Pro	66.8	318.5	321.17	0.002565	2.04	44.46	37.11	0.26	0.29
303	10-Year	LB Int Ext	91.2	318.5	320.24	0.112164	8.73	12.45	26.74	1.53	6.64
303	10-Year	LB Int Pro	91.2	318.5	321.47	0.002486	2.21	55.56	38.03	0.26	0.33
303	25-Year	LB Int Ext	126	318.5	320.37	0.122101	9.9	16.22	29.84	1.63	8.18
303	25-Year	LB Int Pro	126	318.5	321.83	0.002438	2.42	69.49	39.16	0.26	0.37
303	50-Year	LB Int Ext	154	318.5	320.46	0.128621	10.67	18.96	31.89	1.69	9.28
303	50-Year	LB Int Pro	154	318.5	322.08	0.00243	2.57	79.55	39.96	0.27	0.41
303	100-Year	LB Int Ext	189	318.5	320.55	0.13694	11.56	22.04	34.06	1.77	10.63
303	100-Year	LB Int Pro	189	318.5	322.37	0.002437	2.74	91.12	40.86	0.27	0.45
303	500-Year	LB Int Ext	276	318.5	320.73	0.152972	13.31	28.44	35.59	1.91	13.51
303	500-Year	LB Int Pro	276	318.5	322.9	0.002726	3.21	113.07	42.51	0.3	0.59
303	Apr-07	LB Int Ext	200	318.5	320.58	0.139182	11.81	22.97	34.69	1.79	11.03
303	Apr-07	LB Int Pro	200	318.5	322.46	0.002439	2.79	94.6	41.12	0.27	0.46
303	1.8-Year	LB Int Ext	35	318.5	319.64	0.134559	7.41	4.73	6.86	1.57	5.43
303	1.8-Year	LB Int Pro	35	318.5	320.7	0.00278	1.77	27.15	35.39	0.26	0.24
302.8*	2-Year	LB Int Ext	38.9	317.35	318.74	0.051673	5.14	7.57	9.44	1.01	2.47
302.8*	2-Year	LB Int Pro	38.9	317.35	320.76	0.000381	1	50.96	31.06	0.11	0.06
302.8*	5-Year	LB Int Ext	66.8	317.35	319.14	0.040642	5.71	12.13	14.29	0.95	2.73
302.8*	5-Year	LB Int Pro	66.8	317.35	321.16	0.000623	1.4	64.01	34.21	0.14	0.12
302.8*	10-Year	LB Int Ext	91.2	317.35	319.42	0.03393	6.05	16.67	18.42	0.9	2.84
302.8*	10-Year	LB Int Pro	91.2	317.35	321.45	0.00079	1.68	74.25	36.44	0.16	0.16
302.8*	25-Year	LB Int Ext	126	317.35	319.73	0.029284	6.43	23.16	22.49	0.86	3
302.8*	25-Year	LB Int Pro	126	317.35	321.81	0.000979	1.99	87.67	39.14	0.18	0.22
302.8*	50-Year	LB Int Ext	154	317.35	319.95	0.026799	6.65	28.28	24.62	0.84	3.09
302.8*	50-Year	LB Int Pro	154	317.35	322.06	0.001084	2.19	97.63	39.94	0.19	0.26
302.8*	100-Year	LB Int Ext	189	317.35	320.13	0.027327	7.15	33.02	26.1	0.86	3.45
302.8*	100-Year	LB Int Pro	189	317.35	322.34	0.001195	2.4	109.1	40.84	0.2	0.31
302.8*	500-Year	LB Int Ext	276	317.35	320.57	0.0261	7.91	45.22	29.56	0.87	3.98
302.8*	500-Year	LB Int Pro	276	317.35	322.86	0.001528	2.93	130.72	42.48	0.23	0.44
302.8*	Apr-07	LB Int Ext	200	317.35	320.2	0.027136	7.26	34.62	26.58	0.86	3.53
302.8*	Apr-07	LB Int Pro	200	317.35	322.43	0.001226	2.47	112.55	41.11	0.21	0.32
302.8*	1.8-Year	LB Int Ext	35	317.35	318.69	0.049411	4.92	7.12	9.16	0.98	2.28
302.8*	1.8-Year	LB Int Pro	35	317.35	320.7	0.000342	0.94	48.95	30.54	0.1	0.05

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
302.6*	2-Year	LB Int Ext	38.9	316.21	317.49	0.054705	5.11	7.61	10.17	1.04	2.49
302.6*	2-Year	LB Int Pro	38.9	319.75	320.41	0.05432	4.42	8.8	14.64	1.01	2
302.6*	5-Year	LB Int Ext	66.8	316.21	317.75	0.063367	6.43	10.51	11.99	1.16	3.64
302.6*	5-Year	LB Int Pro	66.8	319.75	320.68	0.049432	5.17	12.92	15.73	1.01	2.47
302.6*	10-Year	LB Int Ext	91.2	316.21	317.91	0.069969	7.47	12.53	13.55	1.25	4.67
302.6*	10-Year	LB Int Pro	91.2	319.75	320.88	0.046939	5.64	16.16	16.53	1.01	2.77
302.6*	25-Year	LB Int Ext	126	316.21	318.14	0.068887	8.41	15.91	15.86	1.28	5.55
302.6*	25-Year	LB Int Pro	126	319.75	321.13	0.044528	6.16	20.45	17.54	1.01	3.12
302.6*	50-Year	LB Int Ext	154	316.21	318.31	0.066679	8.96	18.74	17.43	1.29	6.06
302.6*	50-Year	LB Int Pro	154	319.75	321.32	0.043167	6.5	23.69	18.26	1.01	3.36
302.6*	100-Year	LB Int Ext	189	316.21	318.53	0.060153	9.32	22.76	18.89	1.25	6.26
302.6*	100-Year	LB Int Pro	189	319.75	321.53	0.041568	6.84	27.62	19.1	1	3.59
302.6*	500-Year	LB Int Ext	276	316.21	318.99	0.052019	10.13	32.07	21.91	1.21	6.85
302.6*	500-Year	LB Int Pro	276	319.75	322.11	0.027031	6.75	45.41	39.03	0.85	3.16
302.6*	Apr-07	LB Int Ext	200	316.21	318.6	0.058328	9.41	24.03	19.33	1.24	6.31
302.6*	Apr-07	LB Int Pro	200	319.75	321.58	0.041506	6.96	28.73	19.34	1.01	3.69
302.6*	1.8-Year	LB Int Ext	35	316.21	317.45	0.05208	4.87	7.19	9.91	1.01	2.28
302.6*	1.8-Year	LB Int Pro	35	319.75	320.37	0.054621	4.27	8.2	14.48	1	1.89
302.4*	2-Year	LB Int Ext	38.9	315.06	316.2	0.065965	5.35	7.29	10.76	1.13	2.78
302.4*	2-Year	LB Int Pro	38.9	315.06	317.24	0.002694	1.92	22.15	18.25	0.26	0.27
302.4*	5-Year	LB Int Ext	66.8	315.06	316.53	0.055012	6.07	11.17	12.42	1.09	3.22
302.4*	5-Year	LB Int Pro	66.8	315.06	317.66	0.003427	2.52	30.27	20.75	0.31	0.43
302.4*	10-Year	LB Int Ext	91.2	315.06	316.83	0.04165	6.25	15.17	15.01	0.99	3.14
302.4*	10-Year	LB Int Pro	91.2	315.06	317.96	0.003803	2.91	36.77	22.54	0.33	0.55
302.4*	25-Year	LB Int Ext	126	315.06	317.09	0.040713	7	19.35	17.31	1.01	3.7
302.4*	25-Year	LB Int Pro	126	315.06	318.33	0.004132	3.33	45.32	24.14	0.36	0.69
302.4*	50-Year	LB Int Ext	154	315.06	317.24	0.042349	7.63	22.12	18.24	1.05	4.25
302.4*	50-Year	LB Int Pro	154	315.06	318.58	0.004328	3.62	51.67	25.25	0.37	0.79
302.4*	100-Year	LB Int Ext	189	315.06	317.39	0.045976	8.43	24.97	19.15	1.11	5.04
302.4*	100-Year	LB Int Pro	189	315.06	318.86	0.004597	3.96	58.79	26.44	0.39	0.91
302.4*	500-Year	LB Int Ext	276	315.06	317.74	0.050797	9.95	31.91	21.22	1.2	6.63
302.4*	500-Year	LB Int Pro	276	315.06	319.36	0.00557	4.79	72.48	28.58	0.43	1.27
302.4*	Apr-07	LB Int Ext	200	315.06	317.44	0.046887	8.66	25.86	19.43	1.12	5.27
302.4*	Apr-07	LB Int Pro	200	315.06	318.93	0.004726	4.07	60.68	26.74	0.39	0.96
302.4*	1.8-Year	LB Int Ext	35	315.06	316.22	0.048874	4.67	7.51	10.86	0.98	2.11
302.4*	1.8-Year	LB Int Pro	35	315.06	317.17	0.002546	1.82	20.91	17.84	0.25	0.25

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
302.2*	2-Year	LB Int Ext	38.9	313.92	315.02	0.050888	4.83	8.11	11.68	1	2.24
302.2*	2-Year	LB Int Pro	38.9	313.92	317.26	0.000291	0.92	50.69	24.88	0.1	0.05
302.2*	5-Year	LB Int Ext	66.8	313.92	315.33	0.046541	5.66	11.99	12.92	1.01	2.78
302.2*	5-Year	LB Int Pro	66.8	313.92	317.68	0.000502	1.32	61.58	26.43	0.13	0.1
302.2*	10-Year	LB Int Ext	91.2	313.92	315.45	0.060709	6.87	13.54	13.4	1.17	3.98
302.2*	10-Year	LB Int Pro	91.2	313.92	317.99	0.000662	1.61	69.81	27.54	0.15	0.15
302.2*	25-Year	LB Int Ext	126	313.92	315.68	0.059492	7.75	16.95	16.2	1.19	4.73
302.2*	25-Year	LB Int Pro	126	313.92	318.36	0.000861	1.96	80.27	28.9	0.17	0.21
302.2*	50-Year	LB Int Ext	154	313.92	315.86	0.056212	8.21	20.04	17.87	1.19	5.09
302.2*	50-Year	LB Int Pro	154	313.92	318.62	0.001002	2.21	87.93	29.86	0.19	0.26
302.2*	100-Year	LB Int Ext	189	313.92	316.05	0.054648	8.77	23.59	19.31	1.19	5.58
302.2*	100-Year	LB Int Pro	189	313.92	318.9	0.001173	2.49	96.42	30.89	0.21	0.32
302.2*	500-Year	LB Int Ext	276	313.92	316.44	0.053494	9.97	31.61	21.89	1.22	6.73
302.2*	500-Year	LB Int Pro	276	313.92	319.41	0.001637	3.16	112.65	32.76	0.25	0.5
302.2*	Apr-07	LB Int Ext	200	313.92	316.11	0.054206	8.93	24.68	19.74	1.2	5.72
302.2*	Apr-07	LB Int Pro	200	313.92	318.97	0.001233	2.58	98.67	31.15	0.21	0.35
302.2*	1.8-Year	LB Int Ext	35	313.92	314.97	0.05202	4.68	7.51	11.47	1.01	2.15
302.2*	1.8-Year	LB Int Pro	35	313.92	317.19	0.00026	0.85	48.98	24.62	0.09	0.04
302	2-Year	LB Int Ext	38.9	312.77	313.96	0.02421	3.74	10.55	12.84	0.71	1.27
302	2-Year	LB Int Pro	38.9	316.15	316.88	0.053386	4.59	8.47	13.08	1.01	2.1
302	5-Year	LB Int Ext	66.8	312.77	314.3	0.024064	4.5	15.16	14.01	0.74	1.67
302	5-Year	LB Int Pro	66.8	316.15	317.18	0.048153	5.32	12.57	14.34	1	2.55
302	10-Year	LB Int Ext	91.2	312.77	314.51	0.02492	5.14	18.55	17.79	0.78	2.06
302	10-Year	LB Int Pro	91.2	316.15	317.4	0.046303	5.8	15.73	15.24	1.01	2.88
302	25-Year	LB Int Ext	126	312.77	314.76	0.02614	5.88	23.42	21.42	0.82	2.55
302	25-Year	LB Int Pro	126	316.15	317.67	0.044089	6.31	19.98	16.37	1.01	3.23
302	50-Year	LB Int Ext	154	312.77	314.67	0.048111	7.68	21.56	20.56	1.1	4.43
302	50-Year	LB Int Pro	154	316.15	317.86	0.042622	6.63	23.24	17.18	1	3.44
302	100-Year	LB Int Ext	189	312.77	314.83	0.04982	8.36	24.98	21.66	1.14	5.08
302	100-Year	LB Int Pro	189	316.15	318.16	0.034504	6.61	29.41	28.75	0.93	3.25
302	500-Year	LB Int Ext	276	312.77	315.16	0.053052	9.74	32.38	22.78	1.21	6.49
302	500-Year	LB Int Pro	276	316.15	318.61	0.028898	7.14	42.89	31.24	0.88	3.5
302	Apr-07	LB Int Ext	200	312.77	314.87	0.051018	8.6	25.84	21.8	1.16	5.32
302	Apr-07	LB Int Pro	200	316.15	318.23	0.032529	6.62	31.65	29.18	0.91	3.22
302	1.8-Year	LB Int Ext	35	312.77	313.9	0.024261	3.6	9.84	12.65	0.71	1.2
302	1.8-Year	LB Int Pro	35	316.15	316.84	0.053831	4.44	7.88	12.89	1	2.01

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
301.8*	2-Year	LB Int Ext	38.9	312	313.25	0.024638	3.76	10.47	12.83	0.72	1.28
301.8*	2-Year	LB Int Pro	38.9	312	313.71	0.005551	2.35	17.83	19.32	0.36	0.44
301.8*	5-Year	LB Int Ext	66.8	312	313.56	0.025788	4.66	14.97	18.17	0.77	1.79
301.8*	5-Year	LB Int Pro	66.8	312	314.16	0.005325	2.81	27.06	21.55	0.38	0.56
301.8*	10-Year	LB Int Ext	91.2	312	313.77	0.026474	5.26	18.82	19.7	0.8	2.17
301.8*	10-Year	LB Int Pro	91.2	312	314.48	0.005224	3.11	34.04	22.63	0.38	0.65
301.8*	25-Year	LB Int Ext	126	312	314.01	0.0267	5.92	23.89	21.04	0.83	2.59
301.8*	25-Year	LB Int Pro	126	312	314.86	0.005186	3.47	42.89	23.92	0.39	0.77
301.8*	50-Year	LB Int Ext	154	312	314.19	0.026728	6.35	27.63	21.64	0.84	2.88
301.8*	50-Year	LB Int Pro	154	312	315.12	0.005199	3.72	49.38	24.83	0.4	0.86
301.8*	100-Year	LB Int Ext	189	312	314.39	0.026771	6.82	31.97	22.32	0.86	3.2
301.8*	100-Year	LB Int Pro	189	312	315.42	0.00525	4.01	56.87	25.84	0.41	0.96
301.8*	500-Year	LB Int Ext	276	312	314.81	0.026742	7.77	41.82	23.77	0.89	3.9
301.8*	500-Year	LB Int Pro	276	312	315.93	0.006082	4.79	70.61	27.59	0.45	1.3
301.8*	Apr-07	LB Int Ext	200	312	314.44	0.026769	6.96	33.28	22.52	0.86	3.3
301.8*	Apr-07	LB Int Pro	200	312	315.48	0.005412	4.13	58.56	26.06	0.42	1.01
301.8*	1.8-Year	LB Int Ext	35	312	313.2	0.024627	3.62	9.77	12.62	0.71	1.21
301.8*	1.8-Year	LB Int Pro	35	312	313.64	0.005572	2.26	16.42	18.76	0.36	0.41
301.6*	2-Year	LB Int Ext	38.9	311.24	312.57	0.02353	3.71	10.81	17.29	0.7	1.25
301.6*	2-Year	LB Int Pro	38.9	311.24	313.7	0.001032	1.36	33.39	22.11	0.17	0.13
301.6*	5-Year	LB Int Ext	66.8	311.24	312.85	0.024502	4.58	15.97	18.81	0.75	1.72
301.6*	5-Year	LB Int Pro	66.8	311.24	314.14	0.001424	1.82	43.49	23.65	0.21	0.21
301.6*	10-Year	LB Int Ext	91.2	311.24	313.05	0.025264	5.17	19.77	19.82	0.78	2.08
301.6*	10-Year	LB Int Pro	91.2	311.24	314.45	0.001678	2.14	51.06	24.73	0.23	0.28
301.6*	25-Year	LB Int Ext	126	311.24	313.28	0.026138	5.85	24.55	20.68	0.82	2.53
301.6*	25-Year	LB Int Pro	126	311.24	314.83	0.001964	2.52	60.65	26.04	0.25	0.38
301.6*	50-Year	LB Int Ext	154	311.24	313.46	0.026381	6.29	28.16	21.28	0.84	2.83
301.6*	50-Year	LB Int Pro	154	311.24	315.09	0.002153	2.79	67.66	26.96	0.27	0.45
301.6*	100-Year	LB Int Ext	189	311.24	313.66	0.026377	6.76	32.47	21.97	0.85	3.15
301.6*	100-Year	LB Int Pro	189	311.24	315.39	0.00236	3.09	75.74	27.98	0.28	0.53
301.6*	500-Year	LB Int Ext	276	311.24	314.09	0.026428	7.73	42.24	23.46	0.88	3.85
301.6*	500-Year	LB Int Pro	276	311.24	315.9	0.003069	3.83	90.4	29.74	0.33	0.79
301.6*	Apr-07	LB Int Ext	200	311.24	313.72	0.026393	6.9	33.77	22.17	0.86	3.25
301.6*	Apr-07	LB Int Pro	200	311.24	315.45	0.002475	3.2	77.54	28.2	0.29	0.57
301.6*	1.8-Year	LB Int Ext	35	311.24	312.52	0.023151	3.55	10	17.03	0.69	1.16
301.6*	1.8-Year	LB Int Pro	35	311.24	313.62	0.000963	1.28	31.78	21.86	0.16	0.11

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
301.4*	2-Year	LB Int Ext	38.9	310.47	311.79	0.029933	3.98	10.55	16.98	0.78	1.47
301.4*	2-Year	LB Int Pro	38.9	312.5	313.26	0.052961	4.67	8.34	12.47	1.01	2.15
301.4*	5-Year	LB Int Ext	66.8	310.47	312.07	0.029492	4.81	15.44	18.35	0.81	1.94
301.4*	5-Year	LB Int Pro	66.8	312.5	313.57	0.048484	5.42	12.33	13.69	1.01	2.63
301.4*	10-Year	LB Int Ext	91.2	310.47	312.27	0.028618	5.32	19.33	19.23	0.83	2.24
301.4*	10-Year	LB Int Pro	91.2	312.5	313.79	0.046073	5.88	15.52	14.6	1	2.94
301.4*	25-Year	LB Int Ext	126	310.47	312.53	0.027675	5.91	24.37	20.14	0.84	2.6
301.4*	25-Year	LB Int Pro	126	312.5	314.07	0.043891	6.39	19.73	15.71	1	3.29
301.4*	50-Year	LB Int Ext	154	310.47	312.71	0.027164	6.31	28.12	20.79	0.85	2.86
301.4*	50-Year	LB Int Pro	154	312.5	314.27	0.042639	6.72	22.92	16.51	1	3.52
301.4*	100-Year	LB Int Ext	189	310.47	312.92	0.026716	6.75	32.54	21.53	0.85	3.15
301.4*	100-Year	LB Int Pro	189	312.5	314.5	0.040736	7.03	26.9	18.62	1	3.72
301.4*	500-Year	LB Int Ext	276	310.47	313.37	0.026068	7.66	42.61	23.15	0.87	3.79
301.4*	500-Year	LB Int Pro	276	312.5	315.04	0.029152	7.25	41.83	29.07	0.89	3.59
301.4*	Apr-07	LB Int Ext	200	310.47	312.98	0.026606	6.88	33.88	21.76	0.86	3.24
301.4*	Apr-07	LB Int Pro	200	312.5	314.65	0.033293	6.75	30.77	27.63	0.92	3.33
301.4*	1.8-Year	LB Int Ext	35	310.47	311.75	0.029814	3.82	9.81	16.76	0.77	1.38
301.4*	1.8-Year	LB Int Pro	35	312.5	313.22	0.053362	4.51	7.76	12.28	1	2.05
301.2*	2-Year	LB Int Ext	38.9	309.7	311.17	0.019329	3.37	12.7	16.91	0.64	1.03
301.2*	2-Year	LB Int Pro	38.9	309.7	311.83	0.002505	1.77	24.99	19.77	0.25	0.23
301.2*	5-Year	LB Int Ext	66.8	309.7	311.47	0.01948	4.13	18.08	18.42	0.67	1.39
301.2*	5-Year	LB Int Pro	66.8	309.7	312.23	0.00319	2.33	33.21	21.26	0.29	0.38
301.2*	10-Year	LB Int Ext	91.2	309.7	311.7	0.01934	4.62	22.3	19.26	0.69	1.65
301.2*	10-Year	LB Int Pro	91.2	309.7	312.51	0.003632	2.72	39.33	22.3	0.32	0.49
301.2*	25-Year	LB Int Ext	126	309.7	311.96	0.019823	5.24	27.49	20.23	0.72	2
301.2*	25-Year	LB Int Pro	126	309.7	312.85	0.004126	3.19	47.07	23.55	0.35	0.64
301.2*	50-Year	LB Int Ext	154	309.7	312.14	0.020173	5.68	31.31	20.92	0.74	2.27
301.2*	50-Year	LB Int Pro	154	309.7	313.09	0.004445	3.51	52.76	24.43	0.37	0.75
301.2*	100-Year	LB Int Ext	189	309.7	312.35	0.020538	6.15	35.78	21.7	0.76	2.57
301.2*	100-Year	LB Int Pro	189	309.7	313.35	0.004787	3.87	59.36	25.41	0.39	0.89
301.2*	500-Year	LB Int Ext	276	309.7	312.81	0.021093	7.13	46.04	23.39	0.79	3.22
301.2*	500-Year	LB Int Pro	276	309.7	313.91	0.005467	4.62	74.09	27.47	0.43	1.2
301.2*	Apr-07	LB Int Ext	200	309.7	312.42	0.020594	6.29	37.16	21.93	0.76	2.66
301.2*	Apr-07	LB Int Pro	200	309.7	313.43	0.004884	3.97	61.35	25.69	0.4	0.93
301.2*	1.8-Year	LB Int Ext	35	309.7	311.12	0.019427	3.25	11.84	16.63	0.63	0.97
301.2*	1.8-Year	LB Int Pro	35	309.7	311.77	0.00238	1.68	23.69	19.52	0.24	0.21

Appendix F: Leighton Brook HEC-RAS output data for existing and proposed conditions through multiple recurrence interval floods. Cross sections extend from the Black Hall Rd bridge to the Suncook River.

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
301	2-Year	LB Int Ext	38.9	308.93	310.18	0.050025	4.71	9.1	14.05	0.98	2.15
301	2-Year	LB Int Pro	38.9	310.66	311.37	0.050027	4.3	9.05	14.78	0.97	1.87
301	5-Year	LB Int Ext	66.8	308.93	310.46	0.050034	5.41	13.36	15.97	1.02	2.65
301	5-Year	LB Int Pro	66.8	310.66	311.63	0.049462	5.16	12.95	15.87	1.01	2.46
301	10-Year	LB Int Ext	91.2	308.93	310.65	0.050056	6.05	16.39	17.2	1.05	3.13
301	10-Year	LB Int Pro	91.2	310.66	311.83	0.047019	5.63	16.21	16.72	1.01	2.76
301	25-Year	LB Int Ext	126	308.93	310.9	0.045961	6.69	20.83	18.41	1.04	3.56
301	25-Year	LB Int Pro	126	310.66	312.08	0.044646	6.14	20.53	17.78	1.01	3.11
301	50-Year	LB Int Ext	154	308.93	311.08	0.043287	7.1	24.28	19.12	1.03	3.84
301	50-Year	LB Int Pro	154	310.66	312.26	0.043271	6.47	23.8	18.55	1.01	3.34
301	100-Year	LB Int Ext	189	308.93	311.29	0.041187	7.56	28.33	19.92	1.03	4.17
301	100-Year	LB Int Pro	189	310.66	312.47	0.041925	6.82	27.7	19.42	1.01	3.59
301	500-Year	LB Int Ext	276	308.93	311.75	0.037172	8.46	37.97	21.7	1.02	4.8
301	500-Year	LB Int Pro	276	310.66	312.91	0.039598	7.5	36.79	21.32	1.01	4.07
301	Apr-07	LB Int Ext	200	308.93	311.35	0.040655	7.7	29.57	20.15	1.03	4.26
301	Apr-07	LB Int Pro	200	310.66	312.53	0.041569	6.92	28.89	19.68	1.01	3.66
301	1.8-Year	LB Int Ext	35	308.93	310.13	0.050027	4.59	8.44	13.73	0.98	2.07
301	1.8-Year	LB Int Pro	35	310.66	311.33	0.050032	4.14	8.45	14.61	0.96	1.77

APPENDIX G:
Task 5 technical memo - Structural assessment of infrastructure

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Memorandum

To	Nick Nelson, Inter-Fluve	Page	1
CC	Nathan Henderson, AECOM, Pankaj Saharia, AECOM		
Subject	Suncook Structural Assessment Memo		

From	Nathan Johnson, AECOM
Date	October 31, 2011

This memo summarizes the results of the structural site assessment performed by AECOM for the Suncook River Restoration Project on September 15, 2011. As requested by Inter-Fluve, AECOM assessed the following bridges for structural stability and risk due to channel head-cutting.

- Rt. 4 Bridge over the Suncook River (NHDOT 086/127)
- Rt. 4 Bridge over the Suncook River overflow channel (NHDOT 088/126)
- Black Hall Road over Leighton Brook
- Black Hall Road over Little Suncook River
- Snowmobile bridge over Leighton Brook

Detailed assessments for each structure are provided as Appendix A.
AECOM reviewed the following documents provided by NHDOT:

- NHDOT correspondence related to avulsion and risk to bridge structures (December 2008)
- Record Drawings
  - Rt. 4 over Suncook River (1924)
  - Rt. 4 over Suncook River (1971)
  - Rt. 4 over Suncook River (1997)
  - Rt. 4 over Overflow Channel (1997)
- Bridge Inspection Report, Rt. 4 over the Suncook River (May 27, 2010)
- Bridge Inspection Report, Rt. 4 over Overflow Channel (May 27, 2010)
- Michie design plans for the Black Hall Rd. precast arch bridge over Leighton Brook (November 2008)

Suncook River provisional flow data was obtained from USGS Gage 01089500, located on the Suncook River approximately 2.25 miles north northwest of the Rt. 4 bridge over the Suncook River for September 15, 2011. Flow at the USGS gage was approximately 140 cubic feet per second (cfs) on the date of the structural assessment, which represents a significantly higher flow than the daily discharge mean of approximately 20 cfs for the date based on 52 years of record. However, structural elements of the structures were accessible and visible and not impeded by the flow. USGS Gage 01089500 information is available at the following link:

http://waterdata.usgs.gov/nwis/uv?cb_00060=on&cb_00065=on&cb_00021=on&cb_00011=on&format=gif_stats&period=30&site_no=01089500

Below are summaries of the structural assessment for each bridge structure.

Route 4 Bridge over the Suncook River

The bridge superstructure (i.e. roadway surface, deck slab, stringers, bridge rails) and the substructure (i.e. west and east abutments) are in good condition. An island with vegetation can be seen upstream of the structure. The riprap placed around the East and West Abutments are in good condition, although some scattered riprap was observed in the middle of the river bed. Displaced and poorly sorted riprap was also observed along the east abutment. On the day of inspection, the water level and flow were found to be above normal. There are visible signs of river bank erosion on both banks downstream from the bridge. Undercutting action on both sides of the river approximately 30'-200' downstream of the bridge structure has caused trees on the banks to topple. At present, the bridge structure is structurally safe as there are no visible signs of stress such as tilting/inclined abutments, or beams, rails bending as a result of abutment movement. However, with severe undercutting action taking place downstream, and the head cut or knick point migrating upstream, the structure is highly susceptible to undercutting action of the river. It is not clear at what rate the knick point is migrating upstream, but close monitoring of the river banks is highly recommended.

Rt. 4 Bridge over the Suncook River, upstream elevation

Route 4 Bridge over Suncook Overflow Channel

The bridge superstructure consists of 8 precast pre-stressed girders, 8" deck slab, bituminous pavement and T4 bridge rails. The substructure consists of two integral abutments supported on piles. The superstructure is in good condition with minor cracks developing along the joints and the approach slab ends on the roadway surface. The rest of the bituminous pavement was found to be in good condition. The substructure is in good condition with riprap placed around the abutments and no signs of scour in the immediate vicinity of the bridge. Vegetation can be seen both upstream and downstream of the structure. The riprap in general is in good condition, but poorly sorted. Concrete debris and rebar was observed throughout the channel bed. The water level was found to be very low during the inspection and the water in the channel was stagnant. No visible signs of

Rt. 4 Bridge over Suncook River Overflow Channel, channel bed and west abutment

erosion or undercutting were seen on the banks and the banks were covered with thick plant growth. A large scour hole downstream of the overflow bridge dating back to 2007 or before was reported in one of the correspondence with NHDOT. AECOM followed the channel course downstream from the bridge and no significant scour holes were observed.

Black Hall Road over Leighton Brook

The bridge superstructure consists of a precast culvert with an arched opening. The substructure consists of a precast footing as shown on the Michie Corporation design plans (November 2008) provided by NHDOT.The superstructure is in good condition. The substructure is in good condition with riprap placed around the headwalls, footings and channel. In general, the riprap is in good condition, but some stones require rearrangement. It was observed during inspection that the water main upstream of the structure is exposed as well as the right footing downstream of the structure. The 2008 Michie design plans show approximately 6-inches of riprap over the footings, indicating loss of riprap if properly installed. Proper riprap protection needs to be provided along the exposed face of the footing and the water main to minimize further erosion.

Black Hall Rd Bridge over Leighton Brook, upstream elevation

Black Hall Road over the Little Suncook River

The bridge superstructure consists of steel stringers, composite deck slab, bituminous pavement and W beam guard rails. The substructure consists of two abutments made of granite blocks widened at a later date by adding concrete to the original. The superstructure is in good condition. Minor cracks were observed on the roadway surface. Part of the guard rail was found to be damaged due to a vehicle collision. The substructure is in overall satisfactory condition with gaps developing and widening between the granite blocks, most notable at the downstream left abutment. No visible signs of erosion or undercutting were seen on the banks. Undermining was observed at the southeast corner of the south abutment. Riprap protection is recommended at the abutments as a countermeasure.

Black Hall Rd over Little Suncook River, upstream elevation

Snowmobile Bridge over Leighton Brook

The bridge superstructure consists of two wide flanged beams supporting a timber deck. The substructure consists of precast blocks stacked on top of each other. The abutments are well protected by large boulders at the front and the corners. The wide flanged beams, timber deck and the railings are all in good condition. A gap was observed at the north end of the bridge between the deck and abutment which should be covered with roadway fill. The substructure appears to be in good condition with no scour holes in the immediate vicinity of the bridge.

Snowmobile Bridge over Leighton Brook, north abutment

Conclusions

The stability of a series of three headcuts on the Suncook River are cause for concern for local transportation infrastructure in Epsom. The headcut that is of primary concern is over 10 feet high and located over 2700 feet downstream of the Rt. 4 bridge. The river could potentially move laterally off that 10 feet high headcut of primary concern in the next large flood. The next headcut upstream, that is presently backwatered, is approximately 750 feet downstream of the bridge and approximately 15 feet in height. If the headcut of primary concern migrates to this second headcut it may destabilize. The last existing feature providing grade control is the riffle crest located approximately 350 feet downstream of the bridge. In the event of headcut migration, the riffle crest located approximately 350 downstream of the bridge would be the last line of defense to provide vertical stability to the bridge abutments. It is possible that headcut migration could proceed rapidly during a large flood. It should also be noted that the existing riffle located approximately 2700 feet downstream of the Rt. 4 bridge is also providing vertical stability to the overflow channel and the Little Suncook River. In the event of headcut migration, the Rt. 4 Bridge over Suncook Overflow Channel and the Black Hall Road bridge over the Little Suncook River could also be impacted.

AECOM recommends elevated monitoring of river flow conditions and the migrating headcuts on the Suncook River and its tributaries by NHDOT and local officials. In particular, the Rt. 4 bridge over the Suncook River is at risk of failure during a flood event due to the proximity of the headcuts and the structure's spread footing foundations. AECOM recommends a scour plan of action (POA) be generated for this structure until a more permanent solution to mitigate the headcut migrations (i.e. engineered grade control structures) are installed downstream. A POA typically provides specific guidance regarding actions to be taken at scour critical bridges before, during, and after high flow events to protect the safety of the traveling public.

The Rt. 4 bridge over the Suncook River overflow is expected to be at lower risk of failure due to the lack of flow, pile foundation, and installed hydraulic countermeasures.

Hydraulic countermeasures should be improved at the Black Hall Road over Leighton Brook to minimize further erosion and potential stress on the bridge structure. AECOM also recommends

hydraulic and structural improvements be made to the Back Hall Road bridge over the Little Suncook River. However, due to the distance to the headcut s and presence of boulders in the river channel, it is not anticipated that actions are necessary as a direct result of the Suncook River avulsion event. In addition, roadway fill should be placed between the north end of the snowmobile bridge deck and the abutment over Leighton Brook.

Appendix A

Bridge Structural Assessment Reports

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

SITE INSPECTION FORM (PAGE 1)

Date of Inspection: Thursday, September 15, 2011	**Bridge No.:** 086/127	**BIN:** NA
AECOM Inspectors: Nate Johnson, Pankaj Saharia	**Bridge Location:** Rte. 4 over Suncook river, Epsom, NH	

GENERAL

Site Photos

- Verify inventory photos and retake if conditions are different from existing photos
- Detail new photos in the photo log at the end of this form

Stream Bank Condition

- Stability (evidence of erosion, vegetated, countermeasures in place, etc.):

  No erosion observed, Vegetation observed upstream, Rip-rap protection at East and West abutments.
- Islands or bars (upstream, under structure, downstream):

  Island observed upstream and bars downstream.
- Additional observations:
  The rip-rap is in good condition except some of them washed to the middle of the river bed.

PRESENT CONDITION AND ALIGNMENT OF PIERS, ABUTMENTS AND VISIBLE FOOTINGS

Evidence of Scour at Structure

- Substructure movement: The abutments have no signs of movement except Rip-rap placed around East Abutment exhibited slight displacement.
- Abutments tilting or moving in: No.
- Scour holes near abutments and/or piers: No.
- Bridge railing/deck sagging: No.
- Debris around piers/abutments: None
- Visible high water mark: No.
- Observed angle of attack: The river is flowing almost parallel to the length of the abutments
- Existing pier/abutment scour protection: Rip-rap placed at both abutments
- Additional observations: Tree fell due to possible undercutting action some 20’-30’ downstream of the East Abutment.

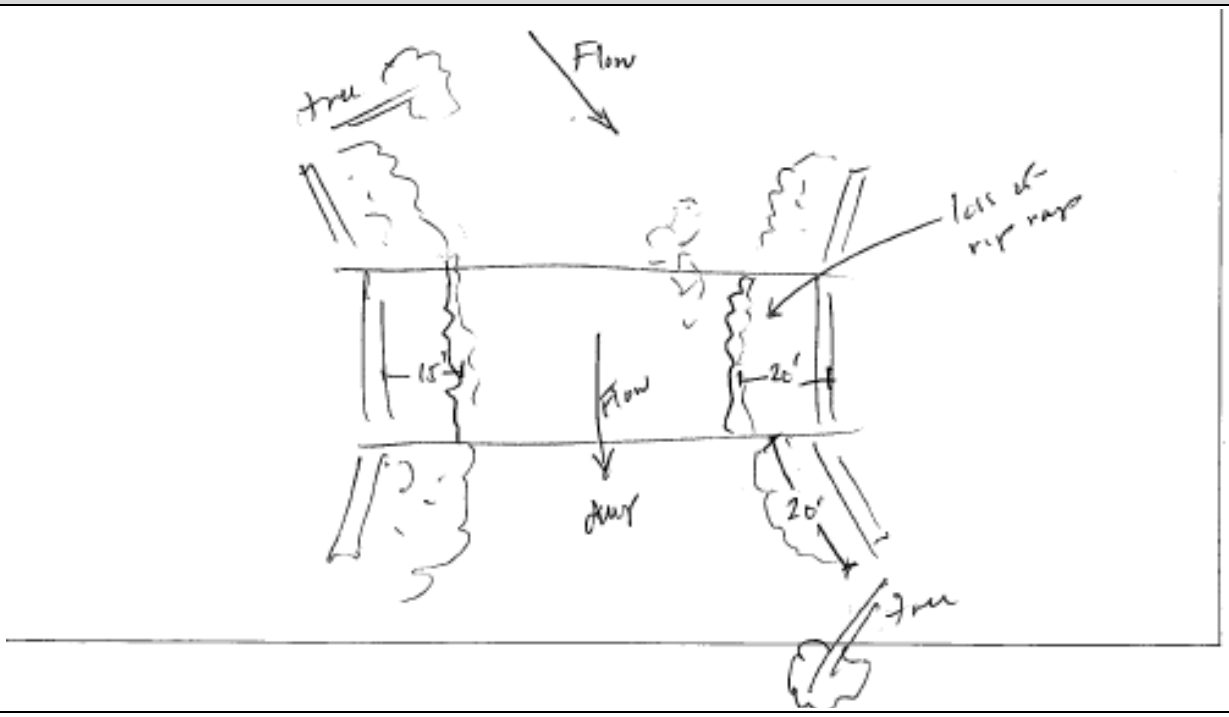
New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 2)

COUNTERMEASURE ASSESSMENT
Feasibility of Countermeasure Alternatives • Riprap/armoring at piers and abutments: Yes • Sheet pile/cofferdam: Yes • Fixed monitoring device: Yes • Portable monitoring device (physical probes, sonar probes): Yes • Substructure modification: Yes • Bridge replacement: Yes • Feasible staging areas near the bridge for emergency scour repair or bridge closure operations: Potential lay down areas on Northeast and Southwest corners of the bridge. • Other site conditions that could affect installation of temporary or permanent scour countermeasures: NA

SITE SKETCH (IN SUPPORT COUNTERMEASURE ASSESSMENT)


New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 3)

PHOTO LOG		
Photo No.	**Photo Location/Direction**	**Notes**
1	View of the bridge looking southwest	Riprap well placed at both abutments
2	Upstream northeast corner of the bridge	Vegetated growth
3	Downstream of the structure	Island bar forming
4	Looking at west abutment	Abutment with riprap around it
5	View from northeast corner of the structure	Some of the riprap scattered on the bed
6	Roadway surface along the west abutment	The crack along the expansion joint got repaired
7	View from the southeast corner of the bridge	The superstructure beams are in good condition
8	View of the railing along the south side	The railing and the sidewalk are in good condition
9	View of the bridge looking west	The roadway surface is in good condition except cracks appearing at the edge of approach slabs.
10	View from the southeast side of the bridge, about 100' downstream	Trees toppled as a result of possible undercutting action
11	View from the top of the bridge, looking at southeast corner of the bridge	See comment under 10
12	Looking at the southwest bank of the river	See comment under 10

OVERALL INSPECTION SUMMARY / CRITICAL ITEMS

The bridge superstructure (i.e. roadway surface, deck slab, stringers, bridge rails) and the substructure (i.e. west and east abutments) are in good condition. An island with vegetation can be seen upstream of the structure. The riprap placed around the East and West Abutments are in good condition, although some scattered riprap was observed in the middle of the river bed. Displaced and poorly sorted riprap was also observed along the east abutment. On the day of inspection, the water level and flow were found to be above normal. There are visible signs of river bank erosion on both banks downstream from the bridge. Undercutting action on both sides of the river approximately 30'-200' downstream of the bridge structure has caused trees on the banks to topple. At present, the bridge structure is structurally safe as there are no visible signs of stress such as tilting/inclined abutments, or beams, rails bending as a result of abutment movement. However, with severe undercutting action taking place downstream, and the head cut or knick point migrating upstream, the structure is highly susceptible to undercutting action of the river. It is not clear at what rate the knick point is migrating upstream, but close monitoring of the river banks is highly recommended.

AECOM

SITE INSPECTION FIELD PHOTOS

PROJECT LOCATION	Epsom, NH	DESCRIPTION	Rte.4 over Suncook river
BRIDGE NUMBER	086/127	DATE	15-Sep-11

Pic 1. View of the bridge looking southwest

Pic 2. Vegetated growth observed upstream of the bridge structure

Pic 3. Island bar forming downstream

Pic 4. View of the West Abutment

Pic 5. Riprap placed at both abutments

Pic 6. View of the bridge from roadway surface

AECOM	SITE INSPECTION FIELD PHOTOS		
PROJECT LOCATION	Epsom, NH	DESCRIPTION	Rte.4 over Suncook river
BRIDGE NUMBER	086/127	DATE	15-Sep-11

Pic 7. View of the bridge looking northwest

Pic 8. View of bridge rail and sidewalk

Pic 9. View of the bridge from roadway surface

Pic 10. Toppled trees downstream as a result of undercutting action

Pic 11. Fallen trees

Pic 12. Eroded river bank with fallen trees

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

SITE INSPECTION FORM (PAGE 1)

Date of Inspection: Thursday, September 15, 2011	**Bridge No.:** 088/126	**BIN:** NA
AECOM Inspectors: Nate Johnson, Pankaj Saharia	**Bridge Location:** Rte. 4 over overflow channel, Epsom, NH	

GENERAL

Site Photos

- Verify inventory photos and retake if conditions are different from existing photos
- Detail new photos in the photo log at the end of this form

Stream Bank Condition

- Stability (evidence of erosion, vegetated, countermeasures in place, etc.):

  Vegetation observed upstream and downstream, Rip-rap protection at East and West abutments, no signs of erosion observed.
- Islands or bars (upstream, under structure, downstream):

  Island observed upstream and downstream with vegetation growth.
- Additional observations:
  The channel bed is filled with concrete debris and rebars from demo of previous structure that needs to be cleaned up. The rip-rap is in good condition except some of them were washed to the middle of the channel bed and need to be rearranged and restacked.

PRESENT CONDITION AND ALIGNMENT OF PIERS, ABUTMENTS AND VISIBLE FOOTINGS

Evidence of Scour at Structure

- Substructure movement: No signs of movement observed
- Abutments tilting or moving in: No.
- Scour holes near abutments and/or piers: No.
- Bridge railing/deck sagging: No.
- Debris around piers/abutments: The abutments are mostly clean of debris, but large amount of debris are lying scattered on the river bed.
- Visible high water mark: No.
- Observed angle of attack: The water in the channel was found to be stagnant and not moving at all.
- Existing pier/abutment scour protection: Rip-rap placed at both abutments. However, as mentioned earlier, some of them need to be rearranged.
- Additional observations: No visible signs of undercutting, erosion or scour holes observed in the immediate vicinity of the bridge structure.

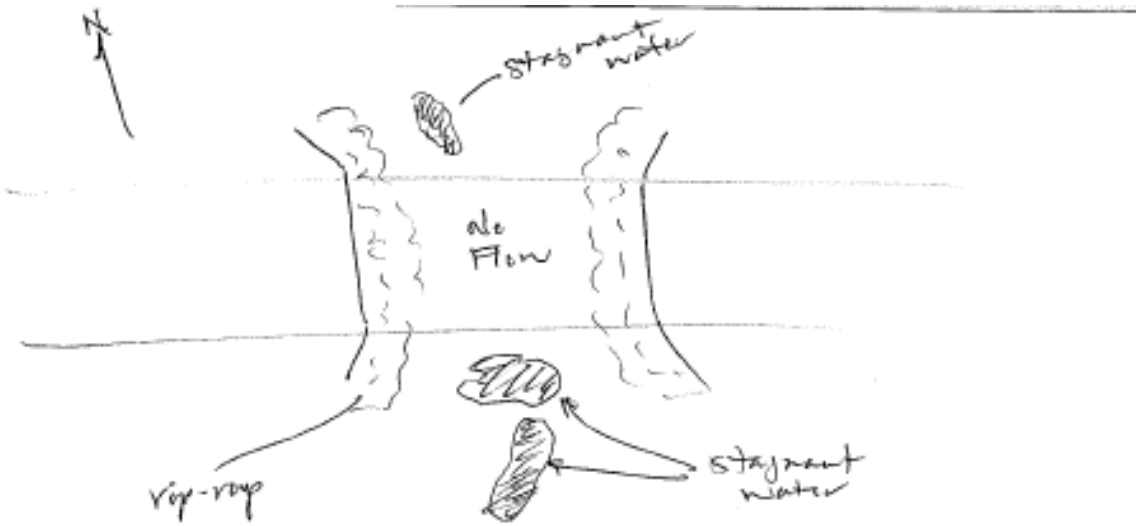
New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 2)

COUNTERMEASURE ASSESSMENT
Feasibility of Countermeasure Alternatives • Riprap/armoring at piers and abutments: Yes • Sheet pile/cofferdam: Yes • Fixed monitoring device: Yes • Portable monitoring device (physical probes, sonar probes): Yes • Substructure modification: Yes • Bridge replacement: Yes • Feasible staging areas near the bridge for emergency scour repair or bridge closure operations: Potential lay down areas on northwest and northeast corners of the bridge. • Other site conditions that could affect installation of temporary or permanent scour countermeasures: NA

SITE SKETCH (IN SUPPORT COUNTERMEASURE ASSESSMENT)


New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 3)

PHOTO LOG		
Photo No.	**Photo Location/Direction**	**Notes**
1	View of the bridge looking east	Cracks observed along the joints and end of approach slabs, weed growth along the curbs
2	View of the bridge looking west	See comment under 1
3	Riprap placed around abutments	Some of the riprap are scattered over the channel bed
4	Debris observed on the channel bed	Debris from previous demo, scattered rip-rap observed on the channel bed
5	Debris observed upstream of the structure	Debris from previous demo, vegetation growth observed upstream
6	Another view of the debris on the channel bed	See comment under 4
7	View of the debris filled channel bed	See comment under 4
8	Riprap at abutment	The abutments are well protected by riprap, but some of them need to be restacked
9	View of the debris filled channel bed	See comment under 4
10	Vegetation growth downstream of the structure	Plants, grass growth observed on the channel bed downstream of the structure
11	Vegetation growth downstream of the structure	Plants, grass growth observed on the channel bed upstream of the structure
12	Looking downstream of the structure	See comment under 10

OVERALL INSPECTION SUMMARY / CRITICAL ITEMS

The bridge superstructure consists of 8 precast pre-stressed girders, 8” deck slab, bituminous pavement and T4 bridge rails. The substructure consists of two integral abutments supported on piles. The superstructure is in good condition with minor cracks developing along the joints and the approach slab ends on the roadway surface. The rest of the bituminous pavement was found to be in good condition. The substructure is in good condition with riprap placed around the abutments and no signs of scour in the immediate vicinity of the bridge. Vegetation can be seen both upstream and downstream of the structure. The riprap in general is in good condition, but poorly sorted. Concrete debris and rebar was observed throughout the channel bed.water level was found to be very low during the inspection and the water in the channel was stagnant. No visible signs of erosion or undercutting were seen on the banks and the banks were covered with thick plant growth. A large scour hole downstream of the overflow bridge dating back to 2007 or before was reported in one of the correspondence with NHDOT. AECOM followed the channel course downstream from the bridge however no significant scour holes were observed.

AECOM	SITE INSPECTION FIELD PHOTOS		
PROJECT LOCATION	Epsom, NH	DESCRIPTION	Rte.4 over Overflow channel
BRIDGE NUMBER	088/126	DATE	15-Sep-11

Pic 1. View of the bridge looking east

Pic 2. View of the bridge looking west

Pic 3. Riprap placed around abutments

Pic 4. Debris observed on the channel bed

Pic 5. Debris observed upstream of the structure

Pic 6. Another view of the debris on the channel bed

AECOM	SITE INSPECTION FIELD PHOTOS		
PROJECT LOCATION	Epsom, NH	DESCRIPTION	Rte.4 over Overflow channel
BRIDGE NUMBER	088/126	DATE	15-Sep-11

Pic 7. View of the debris filled channel bed

Pic 8. Riprap at abutment

Pic 9. View of the debris filled channel bed

Pic 10. Vegetation growth downstream of the structure

Pic 11. Vegetation growth with debris upstream of the structure

Pic 12. Looking downstream of the bridge structure

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

SITE INSPECTION FORM (PAGE 1)

Date of Inspection: Thursday, September 15, 2011	**Bridge No.:**	**BIN:** NA
AECOM Inspectors: Nate Johnson, Pankaj Saharia	**Bridge Location:** Blackhall Rd over Leighton Brook, Epsom, NH	

GENERAL

Site Photos

- Verify inventory photos and retake if conditions are different from existing photos
- Detail new photos in the photo log at the end of this form

Stream Bank Condition

- Stability (evidence of erosion, vegetated, countermeasures in place, etc.):

  Rip-rap protection at all four corners of the culvert observed.

- Islands or bars (upstream, under structure, downstream):

  No

- Additional observations:
  The channel bed is filled with stone fill. But some of the riprap fell to the middle of the channel bed.

PRESENT CONDITION AND ALIGNMENT OF PIERS, ABUTMENTS AND VISIBLE FOOTINGS

Evidence of Scour at Structure

- Substructure movement: No signs of movement observed
- Abutments tilting or moving in: No.
- Scour holes near abutments and/or piers: No.
- Bridge railing/deck sagging: No.
- Debris around piers/abutments: The abutments are mostly clean of debris
- Visible high water mark: No.
- Observed angle of attack: The water in the channel was flowing perpendicular to the opening of the culvert.
- Existing pier/abutment scour protection: Rip-rap placed at both abutments. However, some of them need to be rearranged as they fell to the middle of the channel bed.
- Additional observations: No visible signs of undercutting, erosion or scour holes observed in the immediate vicinity of the structure.

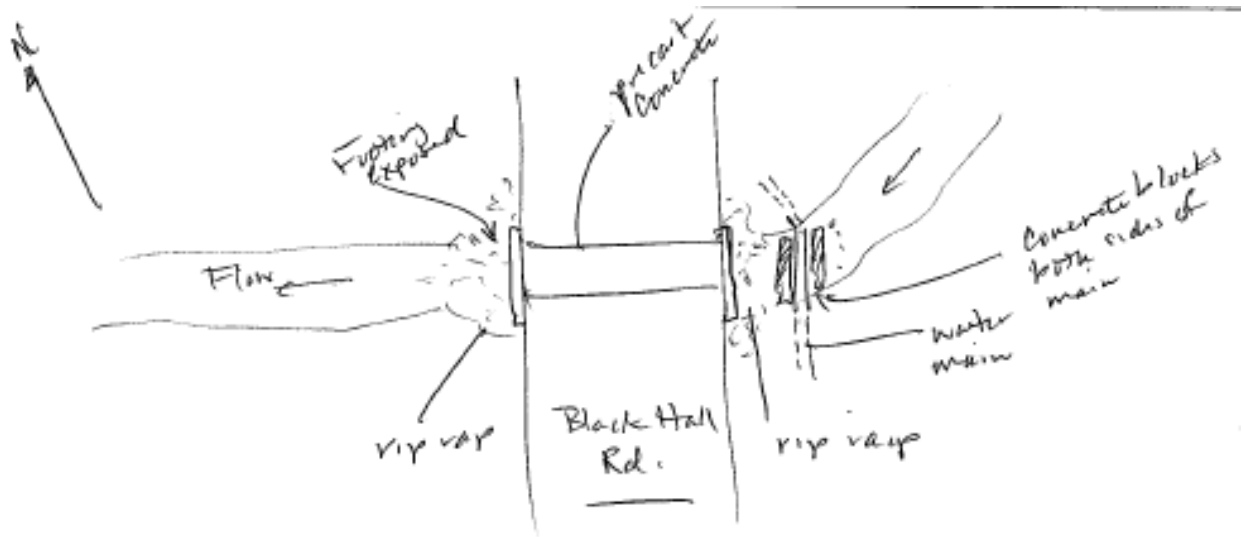
New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 2)

COUNTERMEASURE ASSESSMENT
Feasibility of Countermeasure Alternatives • Riprap/armoring at piers and abutments: Yes • Sheet pile/cofferdam: Yes • Fixed monitoring device: Yes • Portable monitoring device (physical probes, sonar probes): Yes • Substructure modification: Yes • Bridge replacement: Yes • Feasible staging areas near the bridge for emergency scour repair or bridge closure operations: Locally available • Other site conditions that could affect installation of temporary or permanent scour countermeasures: NA

SITE SKETCH (IN SUPPORT COUNTERMEASURE ASSESSMENT)


New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 3)

PHOTO LOG		
Photo No.	**Photo Location/Direction**	**Notes**
1	View of the culvert upstream	Water main exposed
2	View of the culvert downstream	
3	Exposed footing at abutment	The footing can be seen with no riprap around it
4	View of the brook downstream	

OVERALL INSPECTION SUMMARY / CRITICAL ITEMS

The bridge superstructure consists of a precast culvert with an arched opening. The substructure consists of the thickened part of the arched culvert. It appears the culvert is resting on rectangular footing/pad, however, bridge plans were not available to confirm. The superstructure is in good condition. The substructure is in good condition with riprap placed around each corner of the culvert. In general, the riprap is in good condition, but some stones require rearrangement. The water level was found to be above normal during inspection. It was observed during inspection that the water main upstream of the structure is exposed as well as the right footing downstream of the structure. Proper riprap protection needs to be provided along the exposed face of the footing and the water main to minimize further erosion.

AECOM

SITE INSPECTION FIELD PHOTOS

PROJECT LOCATION	Epsom, NH	DESCRIPTION	Blackhall Rd over Leighton Bk
BRIDGE NUMBER		DATE	15-Sep-11

Pic 1. View of the culvert upstream

Pic 2. View of the culvert downstream

Pic 3. Exposed footing at abutment

Pic 4. View of the brook downstream

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

SITE INSPECTION FORM (PAGE 1)

Date of Inspection: Thursday, September 15, 2011	**Bridge No.:**	**BIN:** NA
AECOM Inspectors: Nate Johnson, Pankaj Saharia	**Bridge Location:** Blackhall road over Little Suncook river, Epsom, NH	

GENERAL

Site Photos

- Verify inventory photos and retake if conditions are different from existing photos
- Detail new photos in the photo log at the end of this form

Stream Bank Condition

- Stability (evidence of erosion, vegetated, countermeasures in place, etc.):

  Undermining at South abutment observed, no countermeasures are in place.

- Islands or bars (upstream, under structure, downstream):

  No

- Additional observations:
  The South abutment at the southeast corner has some undermining.

PRESENT CONDITION AND ALIGNMENT OF PIERS, ABUTMENTS AND VISIBLE FOOTINGS

Evidence of Scour at Structure

- Substructure movement: No signs of movement observed
- Abutments tilting or moving in: No. But the gaps between the granite blocks have widened over the years.
- Scour holes near abutments and/or piers: No, but undermining is possible at the SE corner of the South abutment.
- Bridge railing/deck sagging: No. But part of the approach guard rail has some collision damage.
- Debris around piers/abutments: The abutments are mostly clean of debris.
- Visible high water mark: No.
- Observed angle of attack: The water is flowing almost parallel to the abutments.
- Existing pier/abutment scour protection: No
- Additional observations: No visible signs of undercutting, erosion or scour holes observed in the immediate vicinity of the bridge structure. As mentioned before, possible undermining at SE corner of the South abutment.

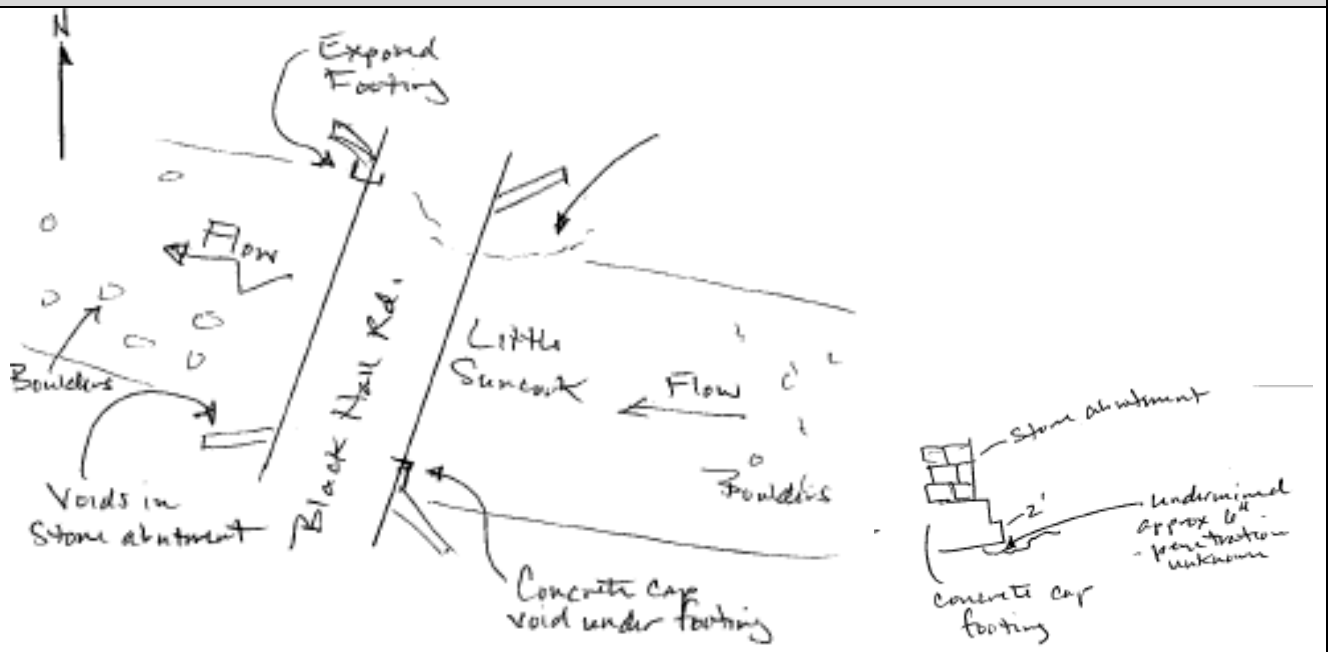
New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 2)

COUNTERMEASURE ASSESSMENT
Feasibility of Countermeasure Alternatives • Riprap/armoring at piers and abutments: Yes • Sheet pile/cofferdam: Yes • Fixed monitoring device: Yes • Portable monitoring device (physical probes, sonar probes): Yes • Substructure modification: Yes • Bridge replacement: Yes • Feasible staging areas near the bridge for emergency scour repair or bridge closure operations: Potential lay down areas on northwest and northeast corners of the bridge. • Other site conditions that could affect installation of temporary or permanent scour countermeasures: NA

SITE SKETCH (IN SUPPORT COUNTERMEASURE ASSESSMENT)


New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 3)

PHOTO LOG		
Photo No.	**Photo Location/Direction**	**Notes**
1	View of the bridge downstream	
2	View of the granite wingwall	The gaps in between blocks have widened
3	View of the bridge upstream	
4	View of the roadway	Some cracks were observed on the roadway surface
5	View of the bridge from the bridge	
6	View of damaged guard rail	Possible vehicle collision damage

OVERALL INSPECTION SUMMARY / CRITICAL ITEMS

The bridge superstructure consists of steel stringers, composite deck slab, bituminous pavement and W beam guard rails. The substructure consists of two abutments made of granite blocks widened at a later date by adding concrete to the original. The superstructure is in good condition. Minor cracks were observed on the roadway surface. Part of the guard rail was found to be damaged due to a vehicle collision. The substructure is in overall satisfactory condition with gaps developing and widening between the granite blocks, most notable at the downstream left abutment. The water level was found to be above normal during inspection. No visible signs of erosion or undercutting were seen on the banks. Undermining was observed at the southeast corner of the south abutment. Riprap protection is recommended at the abutments as a countermeasure.

AECOM

SITE INSPECTION FIELD PHOTOS

PROJECT LOCATION	Epsom, NH	DESCRIPTION	Blackhall Rd over Little Sunck
BRIDGE NUMBER	088/126	DATE	15-Sep-11

Pic 1. Upstream elevation (looking west)

Pic 2. View of downstream left granite wingwall

Pic 3. Downstream elevation (looking east)

Pic 4. View of the roadway

Pic 5. View granite wingwall from the bridge

Pic 6. View of damaged guard rail

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

SITE INSPECTION FORM (PAGE 1)

Date of Inspection: Thursday, September 15, 2011	**Bridge No.:**	**BIN:** NA
AECOM Inspectors: Nate Johnson, Pankaj Saharia	**Bridge Location:** Snowmobile bridge over Leighton Brook, Epsom, NH	

GENERAL

Site Photos

- Verify inventory photos and retake if conditions are different from existing photos
- Detail new photos in the photo log at the end of this form

Stream Bank Condition

- Stability (evidence of erosion, vegetated, countermeasures in place, etc.):

  Big boulders placed at the front and corners of both precast block abutments

- Islands or bars (upstream, under structure, downstream):

  No

- Additional observations:
  The channel bed is filled with native stones.

PRESENT CONDITION AND ALIGNMENT OF PIERS, ABUTMENTS AND VISIBLE FOOTINGS

Evidence of Scour at Structure

- Substructure movement: No signs of movement observed, except at one corner, a widened gap between boulders was noticed.
- Abutments tilting or moving in: No.
- Scour holes near abutments and/or piers: No.
- Bridge railing/deck sagging: No, however at one end of the bridge, there is a piece of wood with nails protruding out. Also there is a gap between approach road fill and bridge deck.
- Debris around piers/abutments: The abutments are mostly clean of debris
- Visible high water mark: No.
- Observed angle of attack: The water in the channel was flowing almost perpendicular to the bridge.
- Existing pier/abutment scour protection: Boulder sized riprap placed at both abutments.
- Additional observations: No visible signs of undercutting, erosion or scour holes observed in the immediate vicinity of the structure.

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 2)

COUNTERMEASURE ASSESSMENT
Feasibility of Countermeasure Alternatives • Riprap/armoring at piers and abutments: Yes • Sheet pile/cofferdam: Yes • Fixed monitoring device: Yes • Portable monitoring device (physical probes, sonar probes): Yes • Substructure modification: Yes • Bridge replacement: Yes • Feasible staging areas near the bridge for emergency scour repair or bridge closure operations: At all four corners of the bridge. • Other site conditions that could affect installation of temporary or permanent scour countermeasures: NA

SITE SKETCH (IN SUPPORT COUNTERMEASURE ASSESSMENT)
 North end of bridge – gap between deck and abutment

New Hampshire DES

Suncook River Structural Assessment

AECOM Contract No. 60221478

POA SITE INSPECTION FORM (PAGE 3)

PHOTO LOG		
Photo No.	**Photo Location/Direction**	**Notes**
1	Upstream elevation	
2	Bridge deck, looking south	

OVERALL INSPECTION SUMMARY / CRITICAL ITEMS

The bridge superstructure consists of two wide flanged beams supporting a timber deck. The substructure consists of precast blocks stacked on top of each other. The abutments are well protected by large boulders at the front and the corners. The wide flanged beams, timber deck and the railings are all in good condition. A gap was observed at the north end of the bridge between the deck and abutment which should be covered with roadway fill. The substructure appears to be in good condition with no scour holes in the immediate vicinity of the bridge.

Photo 1. Upstream elevation

Photo 2. Snowmobile bridge, looking south