Broken Brooks

Repairing Past Wrongs

A Clean Annapolis River Project Initiative

By Katie Taylor, Ecological Restoration Technician

December 2010

Broken Brooks

Repairing Past Wrongs

Funded in part by the Nova Scotia Salmon Association / **NSLC Adopt-A-Stream** and the Nova Scotia Sportfish Habitat Fund as well as the Government of Canada provided through the Department of the Environment

Clean Annapolis River Project
Katie Taylor, Ecological Restoration Technician

Table of Contents

List of Figures

List of Tables

Acknowledgments

This project was undertaken with the financial support of the Government of Canada provided through the Department of the Environment. This project was also made possible with the support of the Nova Scotia Salmon Association / **NSLC Adopt-A-Stream** and the Nova Scotia Sportfish Habitat Fund. Assessment surveys would not have been possible if not for the Centre of Geographic Sciences who loaned Clean Annapolis River Project (CARP) survey equipment. Many thanks to Jillian Barteaux at the Mersey Tobeatic Research Institute (MTRI) who provided guidance throughout this project and who spent countless hours analyzing the data. Ellen McLaren from the Centre of Geographic Sciences provided additional support, with the set-up of the projects GIS database.

Finally, thank-you to the entire Clean Annapolis River Project staff that worked so hard assessing culverts and helping to restore the function of ten culverts. To Sondra Brehaut who initiated the research on this project. To the summer intern students: Jamie McCamon, Jessica MacSween and Joel Longmire. To the other staff members Chelsae Postma, Nora Spencer, Andy Sharpe, Levi Cliche, and Susan Lane this project would not have been possible if not for all of you.

Executive Summary

Culverts were designed to re-route water around roadways. It is now being recognized that culverts can be barriers to fish passage, preventing fish from accessing valuable resources upstream or downstream of the barrier culvert. As fish become trapped in isolated sections of streams their populations are severely affected over time. Culverts are barriers when they are installed improperly, not maintained, or poorly designed.

In 2007 and 2008, CARP took the initiative of analyzing culverts located within 21 sub-watersheds of the Annapolis River watershed. This project entailed assessing 60 culverts on fish bearing streams, in which 55% were shown to be barriers to fish passage. This project indicated that culverts were affecting aquatic connectivity, isolating populations of fish within small segments of stream (Hicks and Sullivan, 2008). Current research was carried out to see just how substantial culverts barriers are and to gain a better understanding as to how these barriers are affecting aquatic connectivity within the Annapolis River Watershed.

The Annapolis River watershed has over 1,615 culverts. Preliminary assessments began by assessing all culverts that directly feed into the Annapolis River and Annapolis Basin. Once completed, culverts on the North Mountain of Annapolis County were assessed, proceeded by culverts located on streams with an upstream habitat greater than 5 km.

By Fall 2010, 777 preliminary culvert assessments had been completed. 635 were identified as being located on fish bearing streams. Of the identified 635, 119 were identified as bridges; the remaining 516 were identified as culverts. Of the 516 culverts, 285 (55%) were found to be barriers to fish passage. These results were consistent with the findings by CARP in 2008.

The culverts identified as barrier culverts were prioritized based on their available upstream habitat. CARP identified 157 high priority culverts, 62 medium priorities, and 61 low priority culverts. Full assessments were carried out on priority culverts. In total 158 were completed, the majority of which were high priority barriers (112 assessments).

While performing full assessments on culverts, recommendations for remediation accompanied each culvert assessment. These recommendations varied from debris removals, tailwater control, retrofitting, baffle installation, fish ladder installation to complete removal and new installation. CARP carried out 10 remediations, including 9 debris removals, two of which were old (un-used) beaver dams and a tailwater control to reduce the velocity of the water at the outflow end of the culvert and eliminate the outflow drop.

It is the hope for this project that more research will be carried out, and that all of the culverts in the Annapolis River watershed will be assessed, therefore giving a better picture of the overall aquatic connectivity within the watercourse.

Introduction

From what was once undeveloped land, many towns and communities now surround the Annapolis River watershed. As communities have grown so have the roadways that connect those communities. Within the Annapolis River watershed there are three main roads that for the most part travel the length of the entire Annapolis River. These roads include Highway 1, Highway 201 and Highway 101. There is also an old rail bed found along both sides of the river. The Annapolis River watershed is composed of many sub-watersheds, all of which intersect a roadway at one point in time, if not multiple roadways (Figure 1). Research completed by Andrea Coombs in 2006, identified over 1,615 culverts in the Annapolis River watershed and Bay of Fundy shore.

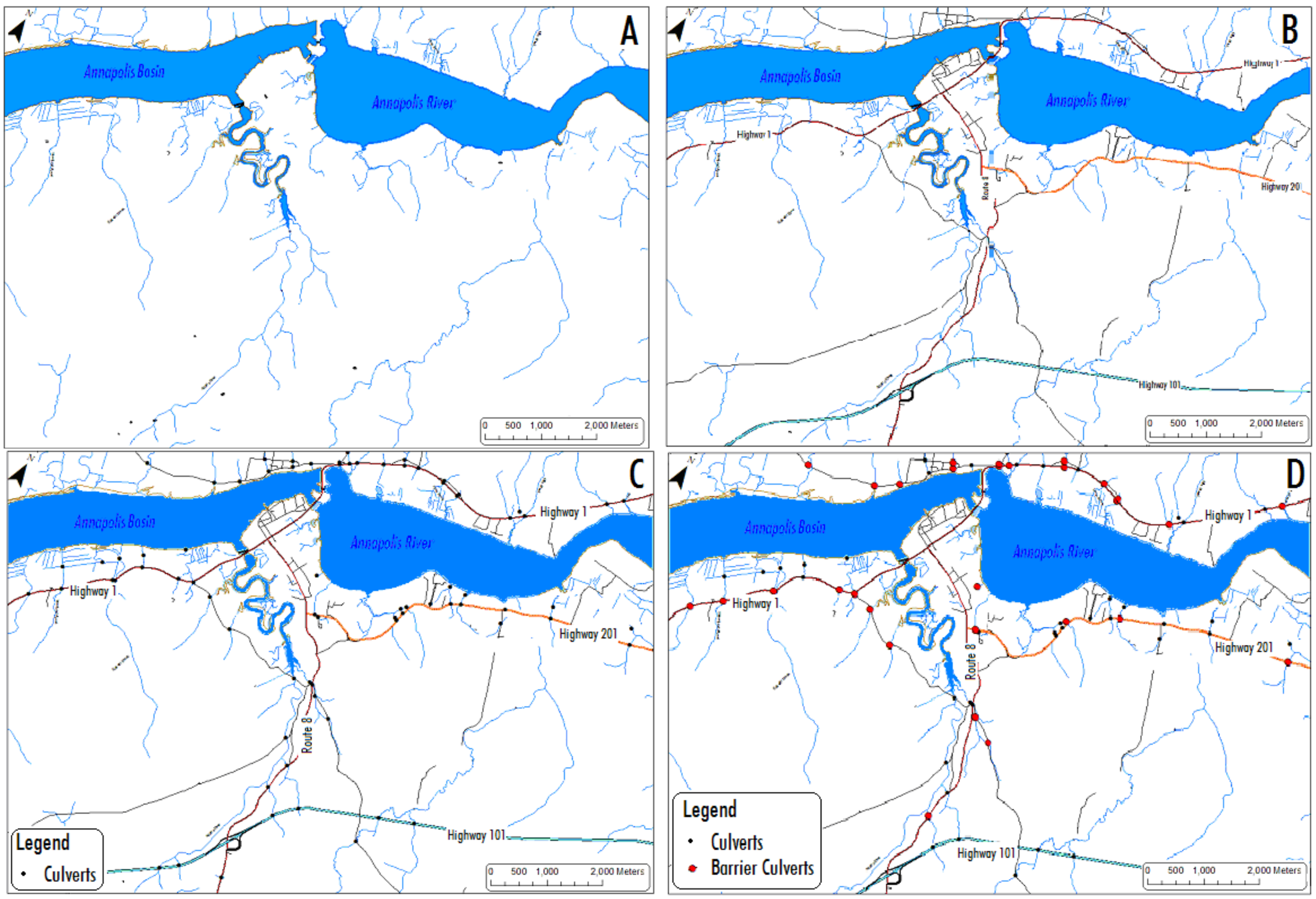

Figure 1: Infrastructure versus Aquatic Connectivity **A** Depicts a section of the Annapolis River Watershed in its natural form, before roads were installed. **B** Depicts how the implementation of roadways has intersected waterways. **C** Depicts all of the culverts, which were installed as a result of roadways. **D** Depicts the culverts that are barriers to fish passage and disrupting aquatic connectivity.

Clean Annapolis River project conducted research throughout 2007 and 2008, in which over 250 culverts within 21 sub-watersheds of the Annapolis River watershed were examined. Researchers completed assessments on 60 culverts, determined to be on fish bearing streams. Their results found 55% of culverts on fish bearing streams are barriers to fish passage (Hicks and Sullivan, 2008). When a culvert is a barrier to fish passage, it restricts the fish from accessing valuable resources upstream or downstream of that barrier. These barriers are disrupting the aquatic connectivity of the watershed. Aquatic connectivity is the network created by brooks, rivers and lakes as they interact before reaching the ocean.

Fish rely on access to brooks for spawning, feeding and for refuge from warmer waters. Research completed for this project focused on Brook trout (*Salvelinus fontinalis*), which migrate to brooks and steams to spawn in the fall. Eggs remain in the brook until spring when the fry emerge. Segmentation of brooks and streams leads to a decline in fish populations, as fish living in these areas are restricted to limited resources. CARP staff completed culvert assessments throughout spring, summer and early fall of 2010, assessing 777 culverts and bridges in the Annapolis River watershed and along the Bay of Fundy shore. CARP first assessed all of the culverts that directly feed into the Annapolis River and the Annapolis Basin. If barriers are found at these culverts, it means that significant upstream habitat is not accessible for Brook trout and other fish. It also means that fish living in the upstream are trapped within a small area of habitat and have no access to the river.

Culverts as barriers to fish passage are not only a problem within the Annapolis River watershed; these problems are found throughout North America. For a couple of years now, the Washington State Department of Transportation (WSDOT) has been conducting research on culverts as barriers to fish passage. As of February 2010, WSDOT has assessed 3,183 culverts on fish bearing streams. They discovered 903 total barriers and 1,001 partial barriers, that means 60% of culverts in the state route system are barriers to fish passage. Since assessments began, the WSDOT has restored 236 fish passage barriers (Wilder and Barber, 2010).

Culverts have been identified as barriers to fish passage when they are not installed properly, are poorly designed or not maintained. These culverts can have one or a combination of problems, such as a significant outflow drop, insufficient outflow pool size, a steep slope, rusted out bottom, broken baffles, insufficient water in the culvert or debris blocking either the inflow or outflow. There are several options available to re-establish fish passage at barrier culverts. Options available include but are not limited to, retro-fitting, installation of baffles, installation of a rock or concrete weir, installation of a fishway, creating a series of step-up pools, and channel roughening.

Methodology

In 2006, Andrea Coombs from Saint Mary's University identified over 1,615 culverts within the Annapolis River watershed and the Bay of Fundy shore (Figure 2). The results of Coombs' research were used to identify and locate the culverts for this study. All culverts/ bridges received a preliminary assessment. From the preliminary assessments, barrier culverts were prioritized as high, medium or low. Full culvert assessments were then completed on priority culverts.

Prioritizing the Watershed

In spring of 2010 it was decided that all culverts with direct connection to the Annapolis River and the Annapolis Basin would be surveyed first. These culverts have the potential to be the first barrier a fish encounters as it migrates out of the Annapolis Basin or Annapolis River. The North and South Mountains divide the watershed; all culverts on the North Mountain between Victoria Beach and Bridgetown were surveyed next. By late summer, in efforts to maximize habitat gain, only culverts located on streams/rivers larger than 5 km were assessed. These streams were located on both the North and South Mountains.

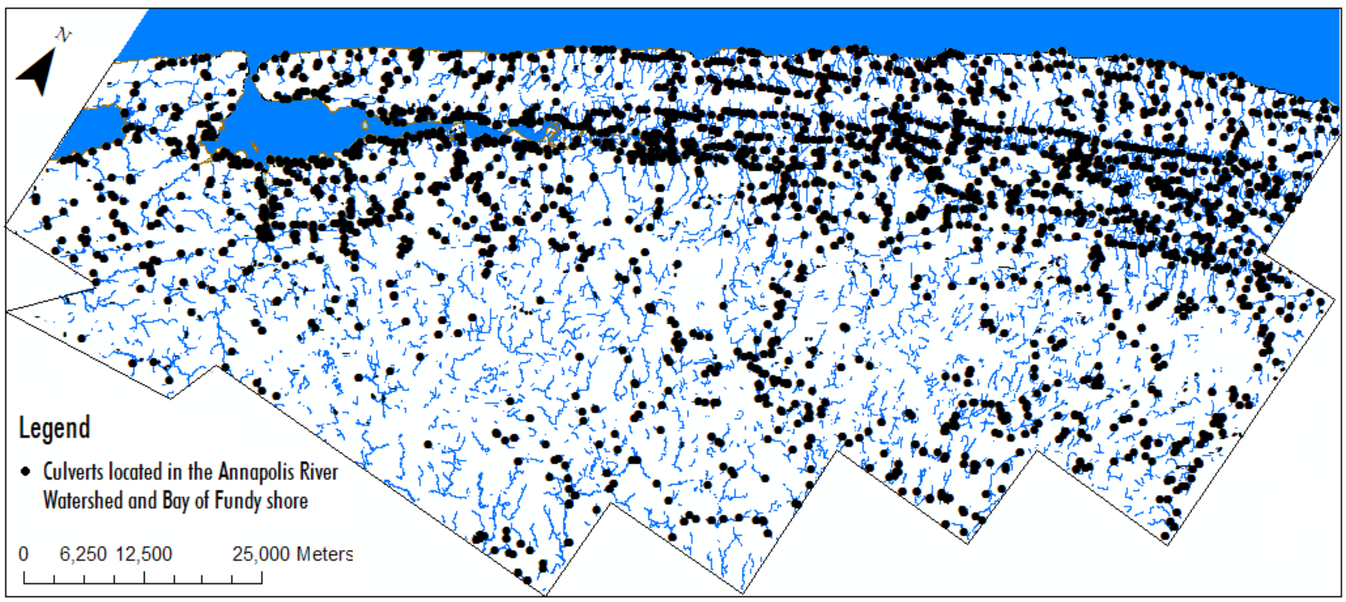

Figure 2: Culverts identified in the Annapolis River watershed and Bay of Fundy shore by Andrea Coombs in 2006

Preliminary Assessments

All culverts and bridges examined in this study received a preliminary assessment. This entailed recording of the researcher's name(s), the culvert identification, the date of assessment, and UTM coordinates for the culvert's location. The first decision made was whether or not the stream is fish habitat. Ideal fish habitat is a gravel bottom stream with undercut banks and the capacity to retain water all year long. If determined that the stream is fish habitat, it was next determined if the culvert is passable, partially passable or not passable for fish. Indicators that the culvert is partially passable or not passable include: debris blocking the inflow or outflow, a significant outflow drop, outflow pool is not deep enough to support a fish jumping into the culvert, insufficient water in the culvert, culvert has a very steep slope, and high water velocity in the culvert.

<u>Culvert slope guidelines for fish passage:</u>
$\leq$ 0.5 % for culverts with a length greater than 24 metres, unless baffles are present.
$\leq$ 1.0% for culverts with a length less than 24 metres.
$\leq$ 5.0% for any culvert, even if baffles are present.

<u>Culvert velocity guidelines for fish passage:</u>
$\leq$ 1.2 m/s for culverts with a length less than 24 metres.
$\leq$0.9 m/s for culverts with a length greater than 24 metres (BC Ministry of Transportation and Highway, 2000).

If the culvert was deemed partially or completely impassable, it was then prioritized based on the upstream habitat availability. A low priority culvert has an upstream habitat availability of less than 500 metres, a medium priority culvert has an upstream habitat availability of 500 to 1000 metres, and a high priority culvert has an upstream habitat availability of greater than 1000 metres (Figure 3). Finally, pictures of both the inflow and outflow are taken, as well as upstream and downstream pictures if there are natural barriers such as a beaver dam or an unnatural barrier such as a man-made dam present. A copy of the preliminary assessment data sheet can be found in Appendix A.

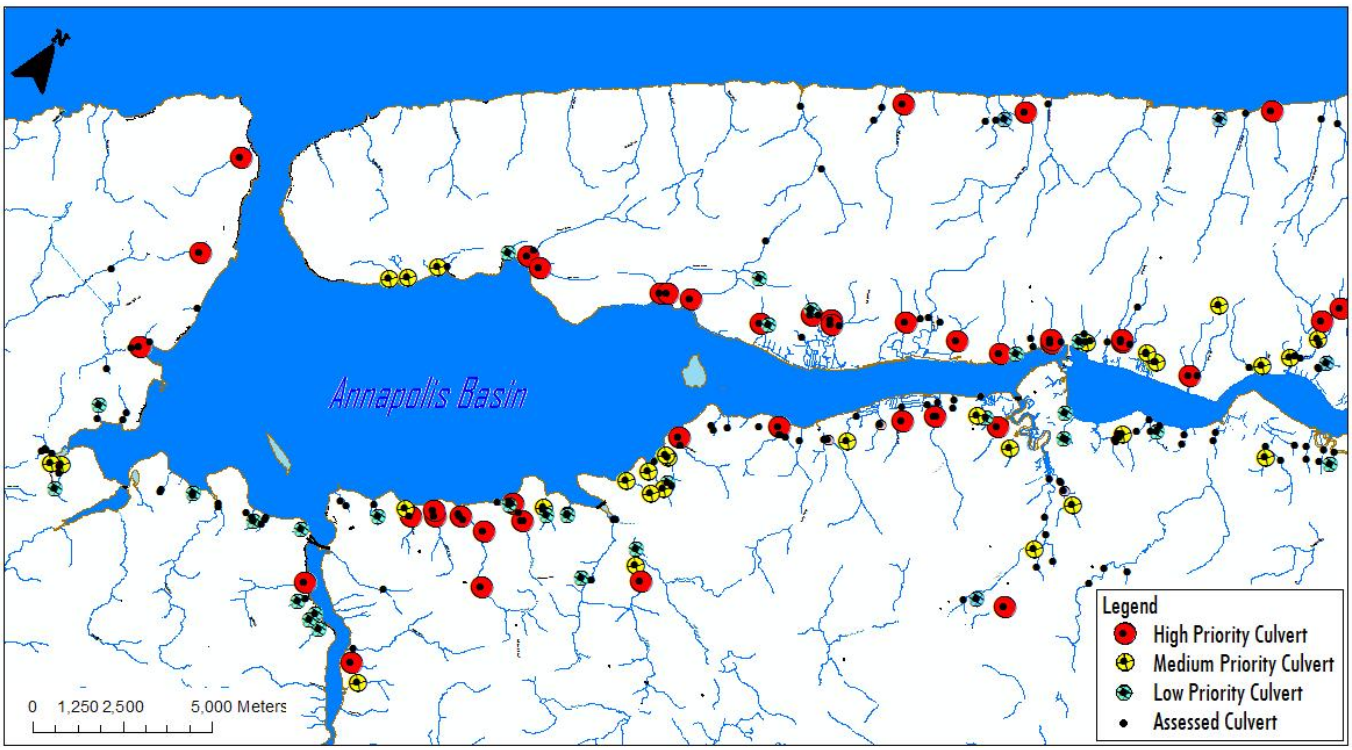

Figure 3: Prioritized culverts located along the Annapolis Basin

Full Assessments

A culvert deemed as either a partial or full barrier to fish passage requires a full culvert assessment. A full culvert assessment survey provides a more detailed documentation of the problems facing a culvert. Better understanding of the problems a culvert has allows for a more accurate recommendation for the culverts restoration. A copy of the full culvert assessment data sheet can be found in Appendix B. The full assessment order of operations can be found in Appendix C. The equipment required to complete a full culvert assessment is listed below.

Full Culvert Assessment Equipment:

- Survey Level	- 30 Metre Tape	- Pencils	- Phone
- Tripod	- 8 Metre Tape	- Calculator	- GPS
- Grade Rod	- Metre Stick	- Camera	- String/ Stakes/ Hammer
- Flow Metre	- Protocol Book	- Safety Vests	- Flashlight
- Hydro Lab	- Data Sheets	- First Aid Kits	- Range Finder

A full culvert assessment survey requires a minimum of two fieldworkers, though three works best. This also complies with the Safe Work Practices Document for working along roadways, which can be found in Appendix D.

Data collected during a full culvert assessment survey included:

1. Site information: culvert ID, stream name, road name, UTM coordinates, date, time, and ownership of culvert

2. Culvert Measurements: shape, material, entrance type, substrate present, embedded depth, diameter, wetted width/height, high water mark width/height, culvert length and corrugation spacing.

3. Outflow Measurements: Water depth in culvert, water velocity in culvert, outflow drop, outflow elevation at culvert edge, distance from culvert to 1st riffle, downstream elevation at 1st riffle, distance from 1st riffle to 2nd riffle, and downstream elevation at 2nd riffle.

4. Inflow Measurements: Water depth in culvert, water velocity in culvert, inflow elevation at culvert edge, distance from culvert to 1st riffle, and upstream elevation at 1st riffle.

5. Tailwater Control: Pool depth and pool surface elevation

6. Water Quality: pH, water temperature, air temperature, conductivity, turbidity, DO (mg/L), DO (% Saturation), and salinity

7. Stream Measurements: downstream wetted width, downstream bankfull width, and downstream channel cross-section.

8. Sketch of culvert

9. Recommendations for remediation

More detailed descriptions of full assessment variables can be found in Appendix E.

Results

Throughout spring, summer and early fall of 2010, 777 culverts and bridges in the Annapolis River watershed and the Bay of Fundy shore where assessed for fish passability. It was determined that 635 culverts and bridges were located on fish bearing streams.

Table 1: Barrier culverts and bridges in the Annapolis River watershed and Bay of Fundy coast

Type	Total	Barrier	% Barrier
Bridge	119	5	4%
Culvert	516	285	55%
Total	635	290	46%

Of the 119 identified bridges, five were found to be barriers to fish passage. Reasons as to why these bridges are barriers are listed in Table 2.

Table 2: Priority bridges

Culvert ID	Stream Name	X	Y	Priority	Notes
THO002	Thornes Brook	287807	4953095	High	Bridge installed, with wooden culvert bottom left behind.
DEE001	Deep Brook	290045	4946416	High	1.5m fall at outlet end.
DIG006	Digby	280578	4945580	High	Bridge with dam and 1.5m drop onto rock.
SSB001	Shearer Brook	326214	4982870	High	Rock waterfall before bridge preventing fish passage.
WIS016	Wiswal Brook	342888	4983258	High	Large fish ladder under the bridge is non-functional.

Of the 285 culverts identified as barriers to fish passage, 162 were classified as high priority culverts, 62 were classified as medium priority culverts and 61 were classified as low priority culverts. In total CARP carried out 158 full culvert assessment surveys.

A table containing all high priority culverts can be found in Appendix F. A table containing all medium priority culverts can be found in Appendix G. Tables containing all low priority culverts and easy to fix culverts can be found in Appendix H.

Table 3: Summary of priority culverts and bridges

Priority	Number of Barrier Culverts/ Bridges	Full Assessments Completed
High	157	112
Medium	62	38
Low	61	8
Easy to Fix	5	0
Total	285	158

A table identifying all priority culverts, which received a full culvert assessment survey, can be found in Appendix I.

Culverts were found to be barriers to fish passage for a variety of reasons. Most barrier culverts displayed more than one problem. Table 4 below groups and summarizes the majority of priority culverts according to the most significant barrier present. It can be seen that outflow drops are the most common barriers to fish passage.

Table 4: Types of barriers for the priority culverts

Barrier Type	Total
Outflow Drops/ Outflow onto Rocks	149
Debris	35
Insufficient Water in Culvert	33
Broken/ Rusted out Bottom	31
Beaver Dam	8
Velocity	6

While performing preliminary assessments CARP staff identified 14 dams upstream of culverts on fish bearing streams. Four of the 14 dams were identified on Clarence Rd. While speaking with a the land owner of the dam at LEO013, he informed CARP staff that the dam was built by the fire department years ago, and is no longer in use. A complete list of upstream dams is listed below in Table 5.

Table 5: Identified dams upstream of the culvert

Culvert ID	Stream Name	Road Name	Community	X	Y
PUR001	Purdy Brook	Highway #1	Deep Brook	289492	4946046
MUN002	Munros Brook	Highway #1	Bridgetown East	323027	4969748
DIG006	Digby	Raquette Road	Digby	280578	4945580
TUM001	Turnbulls Brook	Lighthouse Road	Bay View, Digby	280090	4951167
ROC009	Rockland Brook	Cleveland Road	Windermere	363381	4986756
BLO005	Unknown	Brickyard Road	Carleton Corner	317988	4967046
PET004	Petes Brook	Highway #201	South Williamston	331698	4971162
REW002	Andrews Brook	Highway #362	Victoria Vale	335990	4987348
LEO013	Leonard Brook	Clarence Road	Central Clarence	324553	4974572
GAS005	Gaskill Brook	Hampton Mountain Rd.	Hampton	317089	4971618
SOL016	Solomon Chute Brook	Clarence Road	Clarence West	319518	4970994
MUN007	Munros Brook	Clarence Road	Clarence	322345	4973452
SHE008	Shearer Brook	Clarence Road	Clarence	323231	4973874
MOR017	Morton Brook	Highway #362	Victoria Vale	336911	4983556

Restoration Efforts: Debris Removals

Recommendations for culvert restorations were made during full assessment surveys on priority culverts. These notes were then used to narrow down a group of culverts for which CARP could restore fish passage. In total CARP performed nine debris removals and one tailwater control. Some debris blockages were naturally occurring events such as fallen trees, a build up of branches and leaves or a beaver dam. Un-naturally occurring debris was also found and included garbage that people had thrown off the side of the road, rocks that had fallen from the headwall of the culvert, and debris cages that had become clogged with debris.

Allains River- ALL022

Allains River runs into the Annapolis Basin, the outflow runs along Fort Anne National Historic Site in Annapolis Royal. The river system is over ten kilometres long with multiple stream branches, anywhere from 400 to 1,600 metres in length. Allains River intersects six roadways: Route 8, Highway 101, Highway 1, Dugway Road, Clementsvale Road, and West Dalhousie Road. There also exist two bridges and at least 14 culverts. All 14 culverts located on Allains River were assessed and four were deemed barriers to fish passage; one high priority culvert and three medium priority culverts. ALL022 that intersects West Dalhousie Road was determined to be a medium priority culvert (Figure 4). There are two steel culverts encompassed in a cement wingwall. Branches, leaves and sand had built up in front of the first culvert, which in turn is also obstructing fish passage to the second culvert (Figure 5). The debris was removed using a shovel, and placed further in on the bank so as not to wash back into the stream. With the debris cleared, water is now flowing freely through both culverts and over 650m of upstream habitat was gained (Figure 6).

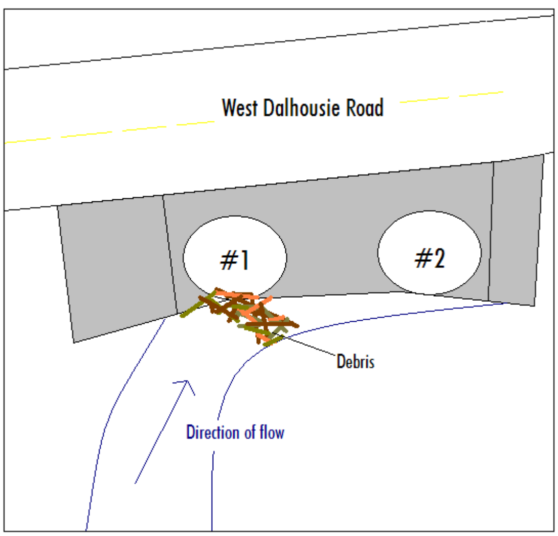

Figure 4: ALL022 Inflow


Figure 5: ALL022 Inflow of culvert #1 pre-restoration

Figure 6: ALL022 Inflow of culvert #1 post-restoration

Unknown- BLO011

BLO011 is located on an unnamed stream, which is in the vicinity of Bloody Creek Brook. This un-named brook is just over three kilometres in length. Four roads intersect the brook: the old rail bed, Brickyard Road, Highway 201 and Highway 101. There are four culverts located on this brook; BLO011, which is located on Highway 101, is a high priority culvert and the only barrier culvert on this stream. A combination of rocks from the headwall, and rocks that have been carried downstream, have collected at the inflow side of the culvert causing a barrier to fish passage (Figure 7). It is hard to see from the image below, but the rocks located in front of the culvert are creating a drop as the water falls into the culvert. For a fish swimming up the culvert, it would be difficult to make the jump over the rocks and into the upstream due to the velocity of the upstream water and the lack of a pool at the base of the fallen rocks (Figure 8).

Figure 7: BLO011 Inflow

Figure 8: BLO011 Inflow highlighting barrier rocks

The objective for this culvert was to remove some of the barrier rocks and re-arrange them in the streambed, allowing for fish passage. The only equipment needed for this restoration was work gloves and steel-toed boots. The first step was to remove all of the barrier rocks. Next, the rocks were placed in the stream, creating a pool behind the large rock (Figure 9). This pool is to provide the fish a place to rest, after swimming the length of the culvert (31.1 metres), and before swimming up the remainder of the stream, which has a natural slope of 25.0%. Eliminating this barrier resulted in an upstream habitat gain of over 1.5 kilometres (Figure 10).

Figure 9: BLO011 Inflow post-restoration (a)

Figure 10: BLO011 Inflow post-restoration (b)

Mumford Brook- JTM001

Mumford Brook, which is over five kilometres in length, flows into the Annapolis River. Mumford Brook intersects three roads, resulting in ten culverts. The JT Morse Road accounts for six of the ten culverts on this brook. Hicks and Sullivan identified one of those six culverts as a barrier culvert in 2008. They identified this culvert as having a debris buildup at the inflow that was obstructing fish passage (Hicks and Sullivan, 2008).

Figure 11: JTM001 Inflow with debris cage

Figure 12: JTM001 Outflow

The debris cage located at the inflow side of the culvert was clogged with debris, therefore creating a barrier to fish passage (Figure 11). As a means of restoration, the debris cage and debris (branches and leaves) were removed. Water and fish can now move freely through the culvert, resulting in an upstream habitat gain of approximately 570 metres (Figure 12).

Unknown- LEO003

This unknown brook is located in Paradise, Nova Scotia. The brook is approximately 1.5 kilometres in length, and runs into the Annapolis River near Leonard Brook. This brook has only one culvert (LEO003), found where the brook intersects Highway 1. Large rocks from the headwall had fallen in front of the culvert inflow, creating a barrier to fish passage (Figures 13 and 14).


Figure 13: LEO003 Inflow


Figure 14: LEO003 Inflow pre-restoration

Equipment used for this remediation included: work gloves, steel-toed boots and a shovel. All rocks that were manageable by hand were removed and placed out of the way, so as not to become a barrier later on. The removal of these barrier rocks resulted in an upstream habitat gain of approximately 1.1 kilometres (Figure 15).


Figure 15: LEO003 Inflow post-restoration

Woodland Brook- WDL001

Woodland Brook can be found in Upper Clements, Nova Scotia. The brook is approximately 2.0 kilometres in length and is intersected by the old rail bed and Highway 1. There is a culvert at each intersection; WDL001 is located on Highway 1 and is a high priority culvert (Figure 16). At this location a tree has fallen across the stream, upstream of the culvert (Figure 17). Normally trees that have fallen into streams tend to have no adverse effects and provide habitat for fish. In this case, over time the tree has collected other tree branches, leaves and sand have built up in front of the tree. This tree has now become a barrier to fish passage.


Figure 16: WDL001 Inflow


Figure 17: WDL001 Tree debris pre-restoration

Equipment required to carry out this restoration included: work gloves, handsaw, shovel and steel-toed boots. Remediation efforts involved clearing away the debris that was collecting in front of the tree and to remove some branches from the tree that are causing debris to build up (Figure 18). Removal of this debris resulted in an upstream habitat gain of approximately 1.3 kilometres (Figure 19).


Figure 18: CARP employees working to remove debris


Figure 19: WDL001 Post-restoration

Lake La Rose- LAR002

A small-unnamed brook joins Lake La Rose and Jerry Lake. There are two roads that intersect this brook, Eastside Drive on the Lake La Rose side and Lakeview Drive on the Jerry Lake side (Figure 20).

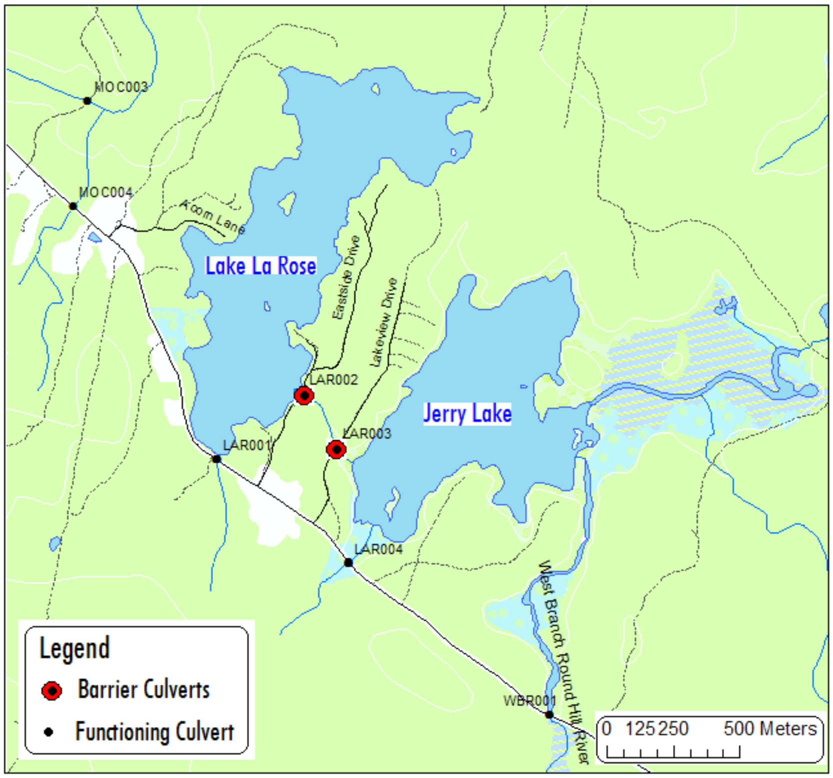

Figure 20: ArcMAP image of LAR002 and LAR003

The culvert named LAR002 was properly installed and is functioning although a beaver at one point in time made a dam upstream of the culvert (Figure 21). This beaver dam is old and does not appear to be currently in use. This was determined based on the condition of the branches used to build the dam. These branches are not fresh and have been subjected to decay. There is also evidence that other beaver dams have been removed from this same location in the past. The current beaver dam is a barrier to fish passage, with water flowing over the top of a small section of the dam (Figure 22).


Figure 21: LAR002 Inflow


Figure 22: LAR002 Upstream beaver dam

Using work gloves, an extendable hook and a shovel, the beaver dam was dismantled and the branches moved to the side of the stream. With the beaver dam removed, fish now have access to this brook and thus Jerry Lake (Figure 23.

Figure 23: LAR002 Upstream, post-restoration

Jerry Lake- LAR003

The culvert identified as LAR003 was also properly installed (Figure 24); it has become a barrier to fish passage due to debris that has built-up at the inflow. Debris consisted of several large tree branches and leaves (Figure 25).

Figure 24: LAR003 Outflow

Figure 25: LAR003 Inflow pre-restoration

Using work gloves and an extendable hook, debris was slowly removed from the culvert and relocated higher up on the bank (Figure 26). Once the debris was removed a small fish was observed swimming through the culvert.

Figure 26: LAR003 Inflow post-restoration

Troop Brook- TRO012

Troop Brook is located in the Granville Ferry/ Granville Centre area of Annapolis County, Nova Scotia. The brook runs off of the Annapolis Valley's North Mountain and constitutes over 8.0 kilometres of fish habitat. As seen in figure 27 below, four roads intersect Troop Brook: Highway 1, Parker Mountain Road, Post Road and Riverview Lane. Six culverts were identified on Troop Brook; three were determined to be barriers to fish passage.

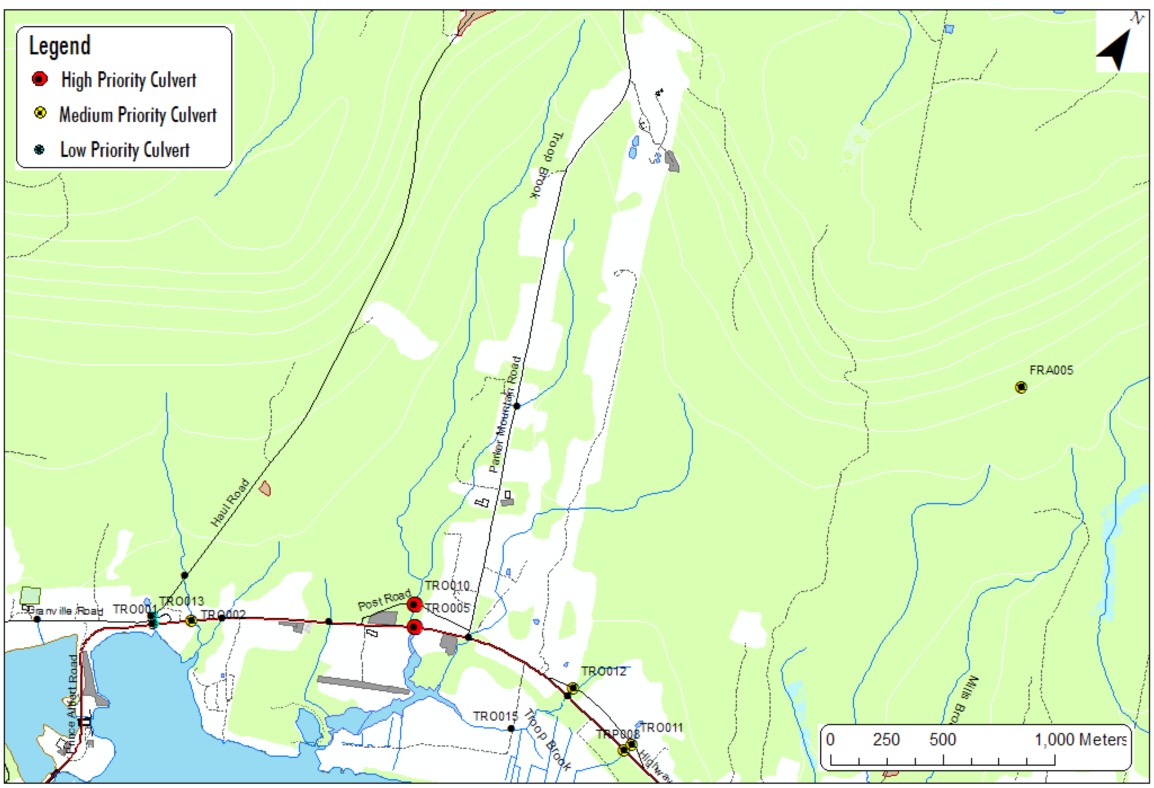

Figure 27: ArcMAP image of Troop Brook

The culvert identified as TRO012 is located on Riverview Lane. Garbage (large sheets of plastics, containers, paint cans, etc.) was found at the inflow of this culvert and throughout the downstream area (Figures 28 and 28).

Figure 28: TRO012 Inflow pre-restoration (a)

Figure 29: TRO012 Inflow pre-restoration (b)

Equipment required to carry out this remediation entailed rubber gloves, garbage bags, and masks. The garbage was picked up and placed in a garbage bag, which was later disposed of properly (Figures 30, 31 and 32). Removing the garbage from this section of brook provided fish with an additional 250 metres of upstream habitat (Figure 33).

Figure 30: CARP staff clearing the garbage from TRO012

Figure 31: Garbage recovered from Troop Brook


Figure 32: CARP staff Jamie McCamon with garbage


Figure 33: TRO012 Inflow post-restoration

Troop Brook- TRO005

The culvert identified as TRO005, is a large wooden double-mitered box culvert, located on Highway 1 (Figure 34). A very large beaver dam was obstructing the inflow side of this culvert (Figure 35). Based on the conditions of the beaver dam (eroding away) it was concluded that the beaver dam was no longer in use. There was also evidence that this beaver dam had been there for a substantial period of time. The streambed is loaded with fine sand and there was a significant build up of this sand upstream of the beaver dam. So much so that there was nearly a metre drop downstream of the beaver dam (Figures 36 and 37).


Figure 34: TRO005 Outflow


Figure 35: TRO005 Inflow with beaver dam

Equipment used to remove the beaver dam included: safety rope (due to high velocity water), work gloves, waders, shovel, extendable hook and steel-toed boots. The removal process was broken into two days. The first day was used to remove the top half of the dam and the second day to remove the bottom half. It took five CARP staff one and a half hours to remove the top half of the dam.

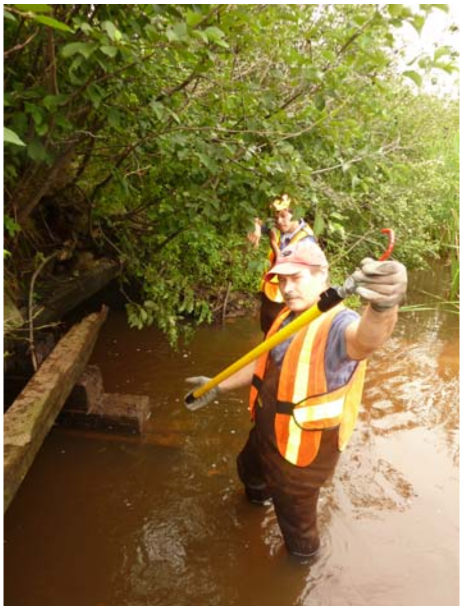

Figure 36: CARP staff demonstrating the length of the extendable pole

Figure 37: CARP staff indicating the drop behind the beaver dam

After day one, the stream was left alone for a few days so that the substrate would have time to settle after such a dramatic change (Figure 38). When CARP staff returned a few days later, the significance of the sediment build up was much more evident. The sediment had shifted further into the culvert. It was decided that as opposed to digging into the sediment pile to remove the remaining beaver dam, that it would be left as is to settle out on its own. During the high flow season, the stream will likely reach equilibrium (Figure 39).

Figure 38: TRO005 pre-restoration

Figure 39: TRO005 post-restoration

Restoration Efforts: Tailwater Control

The majority of barrier culverts display outflow drops which can range anywhere from a few centimeters to over a metre. If the outflow drop is not too severe and there is a sufficient outflow pool bank height, then a tailwater control weir can be used to reduce the outflow drop. Some barrier culverts were not installed at the appropriate slope, steep slopes lead to an increase in water velocity. In some situations the velocity exceeds the swim capabilities of fish. A tailwater control weir can also be used to reduce the velocity of the water running through the culvert.

Troop Brook- TRO010

The culvert identified as TRO010 is located approximately 100 metres upstream of TRO005 (beaver dam). This culvert consists of two large steel culverts approximately 16.2 metres in length. Culvert #1 was calculated to have a slope of 1.6% and culvert #2 to have a slope of 1.9%. The slopes for both culverts are almost double what they should be for a culvert of that length ($\leq$1.0% for culvert lengths less than 24m). Additionally, there are inflow drops present with both culverts as well as an internal drop half way through each culvert. The combination of these problems, leads to a high velocity of water traveling down these culverts (Table 6). These velocities greatly exceed the swim speeds for juvenile Brook trout (*Salvelinus fontinalis*), which can be found in Table 7 below. If Brook trout are unable to swim past these culverts then over 4.5 km of upstream habitat is lost.

Table 6: Velocity of the water running through culvert TRO010

Culvert Outflow Velocities				Culvert Inflow Velocities			
		Velocity				**Velocity**	
Conditions	**Date**	**Culvert #1**	**Culvert #2**	**Conditions**	**Date**	**Culvert #1**	**Culvert #2**
Low Flow	22-Jun-10	0.75	1.03	Low Flow	22-Jun-10	0.45	0.49
High Flow (Rain Event)	17-Sep-10	2.24	2.59	High Flow	17-Sep-10	1.3 (upstream culvert #2)	

As Table 6 indicates, the culvert is significantly altering the velocity of the water as it travels along the stream. Velocity measurements at the outflow of the culvert are nearly double what they are coming into the culvert. It should also be noted that during the high flow event a velocity reading was taken downstream approximately one metre past the end of the outflow pool and found to be roughly 1.4 m/s, indicating that a vast majority of the energy generated through the culvert dissipates in the outflow pool.

Table 7: Swim speeds for Brook trout (*Salvelinus fontinalis*), taken from the FishXing software

Size	**Prolonged Speed** (10 minutes to exhaustion)	**Burst Speed** (10 seconds to exhaustion)
5cm	0.26 m/s	0.93 m/s
10cm	0.49 m/s	0.93 m/s
15cm	0.71 m/s	0.93 m/s
20cm	0.93 m/s	0.93 m/s

Coupled with the extreme velocity of the water are outflow drops present with both culverts (Figure 40). During low flow conditions culvert #1 displays an outflow drop of 8 cm and culvert #2 an outflow drop of 10 cm (Figure 41).

Figure 40: TRO010 Outflow of culvert #2 at high flow

Figure 41: TRO010 Outflow image taken during low flow

Rock Weir Design

The tailwater control is located downstream of the outflow pool. It is the highest elevation point leading into the natural downstream channel. The objective is to increase the height of the existing tailwater control or establish a new one. Increasing the height will thus increase the depth of the outflow pool reducing or eliminating the outflow drop. After extensive research it was decided that a vortex rock weir design would be used as means of a tailwater control. This is a U-shaped design, where the apex points upstream. The weir can be designed either on a 20° or 30° angle from the base of the weir. For our design, a 30° angle from the base of the weir was used (Figure 42).

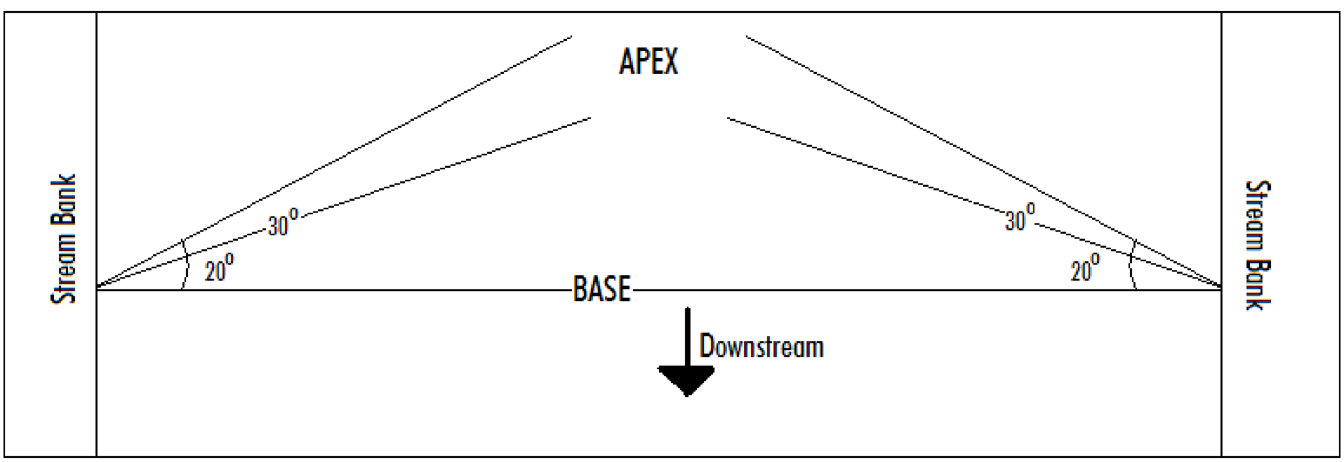

Figure 42: Vortex rock weir design

Footer stones, which are large, flat stones, make up the first layer of the rock weir. Weir stones, which are a thicker type of rock, are used to build the remainder of the weir. Smaller rocks can be used as fill throughout the construction. It is recommended that the weir be tied into the sides of the bank 15 cm. When constructing the weir, a rock stabilization ratio of 1:1.5 was used. For example: For every centimeter high you build the weir, the total base width is three times that (3 cm). The apex of the structure is also the lowest point of elevation, referred to as the low flow notch (an area along the weir where water can flow through during low flow conditions). The elevation of the low flow notch should be at or slightly higher than the elevation of the outflow end of the culvert (Figure 43). If the purpose of the weir is to reduce an outflow drop then the elevation of the low flow notch should be par with the elevation of the outflow end of the culvert. If the purpose is to reduce the velocity of the water in the culvert, then the elevation should be slightly higher then the elevation of the outflow end of the culvert. The ends of the weir should be at or above bank full height.

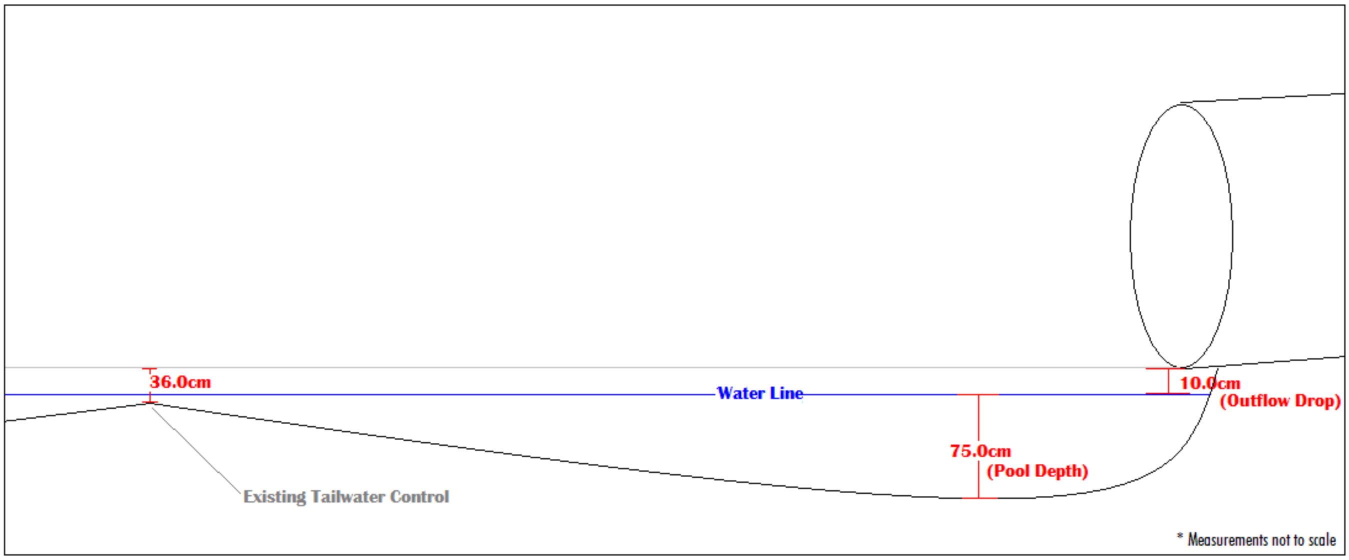

Figure 43: Longitudinal profile of TRO010, culvert #2

Rock Volume and Sizing

To determine the amount of rock that would be required to build the rock weir, the following formula was used:

Volume (V) = Length (l) x Width (w) x Height (h)

The largest change in elevations between the outflow end of the culvert and the existing tailwater control was 36 cm (height). With a height of 36cm and a rock stabilization ratio of 1:1.5, a width of 108 cm was used. The bank full width at the existing tailwater control is 600cm (length). Inputting these values into the above formula gives resulting volume of 2.33 m^3. To prevent a shortage of rock, we round the volume up to 3.0 m^3.

$$V = 6.0 \text{ m} \times 1.08 \text{ m} \times 0.36 \text{ m}$$
$$V = \mathbf{2.33\ m^3}$$

In determining the minimum size of rock that would be required to construct a rock weir sturdy enough to withstand the velocity of the water traveling off of the North Mountain the incipient diameter of bed material was calculated (Cummings et al., 2004).

$$\tau\ (kg/m^2) = \text{Incipient Diameter (cm)}$$

Where, τ represents tractive force. The equation for tractive force is:

$$\tau = 1000 \times d \times s$$

Where, d is depth of flow in metres and s is the slope of water surface

Based on the measurements recorded during the full culvert assessment survey, the downstream slope at TRO010 is 0.016; the average water depth in the down stream (based on the cross-section results) is 0.54 m. Based on these measurements, the tractive force can be calculated:

$$\tau = 1000 \text{ X } 0.54 \text{ m X } 0.016$$

$$\tau = \mathbf{8.64 \text{ cm}}$$

An incipient diameter of 8.64 cm was calculated, using a safety factor of 2, gives a minimum rock size (diameter) of 17.28 cm or 7 inches. To be on the safe side, a rock size of 8 to 15 inches was used.

Tailwater Control Installation

The recommended size of the outflow pool is a width 2 times the culverts diameter, and if it's a double culvert, then 2 times the combined diameter. The recommended length is 3 times the culverts diameter, and for a double culvert, 3 times the combined diameter. The recommended depth of the outflow pool is 1.0 metre.

Figure 44: Rough sketch of TRO010 and tailwater control

For TRO010, each culvert has a diameter of 1.85m, giving a combined diameter of 3.7m. By following the recommended pool size specifications, the outflow pool size should be 7.4m wide by 11.1m long (Figure 44).

Procedure for installing a rock weir:

1. Using a measuring tape, measure off the distance to the base of the rock weir from the culvert outflow.

2. Using a compass, stake out a 30° angle from the base of the weir.

3. Survey the outflow elevation at culvert edge (culvert #2 is elevated higher than #1). Survey the ground elevation at the proposed Apex.

4. Determine the difference in elevation between the apex and the culvert outflow edge.

5. Height to base ratio is 1:1.5, determine the width of the apex base (stake it out)

6. Clear the area as much as possible, to ensure that the footer rocks can be placed flat to the ground.

7. Arrange footer rocks within the staked area, using weir rocks, build the apex slightly higher than the culvert outflow elevation. Use the automatic level to check elevations of the apex, ensuring that it is not too high or too low. Remember that this is the low flow notch.

8. Using an automatic level and the 1:1.5 rock stabilization ratio stake out the remainder of the rock weir.

9. Clear the area of any unstable rocks before laying the footer rocks.

10. As the weir rocks are laid in place, remember that the weir is built higher as it approaches the steam bank. Use smaller rocks to fill the interstitial spaces between larger rocks.

11. Tie the rocks a minimum of 15cm into the bank.

The rock weir will not function right away (Figure 45); it will take time for the interstitial spaces between the rocks to fill in (Figure 46).

Figure 45: Rock weir following its installation

Figure 46: Rock weir functioning 2 weeks post-installation

Some of the left over rocks were strategically placed in the outflow pool, to provide shelter for fish (Figures 47 and 48).

Figure 47: Rock structures in the outflow pool (a)

Figure 48: Rock structures in the outflow pool (b)

Follow-up

In the weeks following the tailwater control installation, the rock weir was monitored periodically. The rock weir was installed from September 22nd to 24th, 2010. On October 2nd, 2010 there was heavy rainfall in the area. As a result of the rain event the interstitial spaces between the larger rocks started to fill in, allowing the weir to function properly. The outflow drops were eliminated (Figures 49, 50 and 51), the outflow pool elevation had risen nearly 20 centimetres and the velocity of the water coming through the culverts appears to have been reduced (Table 8). The exact effect on water velocity is unknown due to the constantly changing volume of water coming through the culverts.

Table 8: Velocity of the water running through culvert TRO010 post- tailwater control installation

Culvert Outflow Velocities				Culvert Inflow Velocities			
		Velocity				**Velocity**	
Conditions	**Date**	**Culvert #1**	**Culvert #2**	**Conditions**	**Date**	**Culvert #1**	**Culvert #2**
Moderate Flow	13-Oct-10	0.68	0.83	Moderate Flow	13-Oct-10	0.46	0.48

Figure 49: Culvert #1 at low flow

Figure 50: Culvert #1 at high flow

Figure 51: Culvert #1 after tailwater Control

The heavy rain event also caused the weir to shift, and stabilize further. The strong water velocities resulted in displaced rocks that were relocated downstream. The structure of the weir will be continually monitored to ensure that it remains intact, more so after fall high flows and spring freshet.

Future Recommendations

Four weeks post installation the rock weir was still intact and functioning properly. While the velocity of the water coming though the culvert has been reduced, it has not been reduced enough. Currently only Brook trout (*Salvelinus fontinalis*) 15 cm or larger will easily be able to swim the length of the culvert, Brook trout any smaller will have difficulty given their prolonged swim speed (see Table 7). It is recommended that future remediation of this culvert be to backwater the culvert at least half of its length. To accomplish this, the rock weir will need to be built higher and a second rock weir installed further downstream. Another option is to install baffles in both culverts.

References and Further Reading

Barteaux, J., 2010. *Surveying Culverts for Barriers to Fish Passage: A Restoration Prioritization Tool*. Mersey Tobeatic Research Institute, Maitland Bridge, Nova Scotia.

British Columbia Ministry of Transportation and Highways, 2000. *Culverts and Fish Passage*. Environmental Management Section, Engineering Branch, Victoria, British Columbia.

California Department of Transportation (Caltrans), 2007. *Fish Passage Design for Road Crossings: An Engineering Document Providing Fish Passage Design Guidance for Caltrans Projects*. Sacramento, California.

Castro, J., 2000. *Design of Rock Weirs*. US Department of Agriculture, Natural Resources Conservation Service, Portland, Oregon.

Coombs, A., 2006. *Identifying Potential Fish Movement Barriers in the Annapolis River Watershed*. Report in partial fulfillment for ENVS 4999. Saint Mary's University, Halifax, Nova Scotia.

Cummings et al., 2004. *Stream Restoration and Stabilization In an Urban System*. [Online] Accessed on September 9, 2010. Available at: http://streams.osu.edu/streams_pdf/Ludwig.pdf

Fisheries and Oceans Canada (DFO), 2007. *Practitioners Guide to Fish Passage for DFO Habitat Management Staff*. Version 1.1

Forest Service Stream-Simulation Working Group, 2008. *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings*. U.S. Department of Agriculture, Forest Service, National Technology and Development Program, San Dimas, California.

Hicks and Sullivan, 2008. *Broken Brooks: Culvert assessments in the Annapolis River watershed*. Clean Annapolis River Project, Annapolis Royal, Nova Scotia.

Maryland's Guidelines for Waterway Construction (MGCW), 2000. *Maryland Department of the Environment Waterway Construction Guidelines*. Baltimore, Maryland.

Noel and Westrich, 2008. *Rehabilitation and Relining of Culverts*. CONTECH Construction Products Inc., Professional Development Series, West Chester, Ohio.

Nova Scotia Department of Agriculture and Fisheries, 2005. *Nova Scotia Trout Management Plan*. Inland Fisheries Division, Halifax, Nova Scotia.

Rosgen, D.L., 2001. *The Cross-Vane, W-Weir and J-Hook Vane Structures…Their Description, Design and Application for Stream Stabilization and River Restoration.* Wildland Hydrology Inc., Pagosa Springs, Colorado.

Stormwater Center. *Stream Restoration: Grade Control Practices*. [Online] Accessed on: August 3, 2010. Available at: http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Restoration/grade_control.htm

Wilder and Barber, 2010. *WSDOT Fish Passage Inventory: Progress performance report*. Washington State Department of Transportation (WSDOT), Habitat Program Technical Applications Division, Olympia, Washington.

Appendices

Appendix A: Preliminary Culvert Assessment Data Sheet

Preliminary Culvert Assessment Data Sheet 2010

Name	Date	Culvert ID ABC000 Stream Name	Coordinates UTM X, Y	Fish Habitat YES/NO	Passable YES/NO/ Partial	Recommendations	Assessment Priority		
							Low	Med	High

Appendix B: Full Culvert Assessment Data Collection Sheet

Full Culvert Assessment Data Collection Sheet 2010

Collectors: ____

Site Info

Culvert ID		Date (dd/mm/yyyy)	
Stream Name		Time	
Road Name		UTM Easting	
Photo Files		UTM Northing	
Ownership of Barrier	Public Road ROW	Rail Bed ROW	Private

Culvert Measurements

			Width	Height
Culvert Shape		Culvert Diameter (m)		
Culvert Material		Wetted Width (m)		
Entrance Type		High Water Mark (m)		
Culvert Bottom Material		Culvert Length (m)		
Substrate in Culvert		**Corrugation (m)**		
Embedded Depth (cm)				

Outflow Measurements			**Inflow Measurements**		
Water Depth in culvert (cm)			Water Depth in culvert (cm)		
Water Velocity in culvert (m/s)			Water Velocity in culvert (m/s)		
Outflow Drop (cm)					
Outflow Elevation at culvert edge (m)			Inflow Elevation at culvert edge (m)		
Distance from culvert to 1st riffle (m)			Distance from culvert to 1st riffle (m)		
Outflow Elevation at 1st riffle (m)			Inflow Elevation at 1st riffle (m)		
Distance from 1st riffle to 2nd riffle (m)					
Outflow Elevation at 2nd riffle (m)					
Tailwater Control					
Pool Depth (m)					
Pool Surface Elevation (m)			**Culvert Slope (%)**		

Crossing: Fully Passable / Partial Barrier / Impassable

Water Quality

pH		DO (mg/L)	
Temp (Celsius)		DO (% saturation)	
Conductivity		Salinity	
Turbidity		Air Temperature (Celsius)	

Stream Measurements		
Downstream Wetted Width (m)		
Downstream Bankfull Width (m)		

***Channel Cross Section**

This section is required if there is a tailwater pool present at the outlet of the culvert or if the culvert is a high priority. Water depth and Velocity must be done regardless. Number of records will vary.

Bankfull Width Stations (m)	Elevation (m)	Wetted Water Depth (m)	Velocity (m/s)	Roughness Coefficient
		Avg	**Avg**	

Notes:

Sketch:

Appendix C: Full Assessment Order of Operations

Full Assessment Order of Operations

1. Secure safe parking
2. Perform visual survey of the culvert and adjacent area
3. Gather tools required from vehicle and return to culvert
4. Culvert information and measurements recorded at outflow (shape, size, water depth, wetted depth, wetted width, high water mark (width and height), substrate depth (if any), outflow drop, and outflow pool depth
5. Measure downstream wetted width and bank full width
6. Stake tape at bank full width for cross-section elevations
7. Set-up surveyor's level while velocity and hydro lab readings are taken
8. Record elevations (Outflow culvert bottom, outflow pool surface, stream cross section, first and second riffle downstream)- include distances to riffles
9. Measure the culvert length and water depth at inflow
10. Record elevations (Inflow culvert bottom and first riffle)- include distance to first riffle
11. Measure velocity at inflow
12. Note recommendations for the culvert
13. Gather tools and return to vehicle

Appendix D: Safe Work Practices Document

Broken Brooks Project	
Hazards Identified	Falling, working over water, slippery surfaces, unstable slopes, traffic, dust, noise, air quality in culvert, loss of balance (damaged culverts, beaver dams, loose sediment), face injury (branches), insects, poison ivy, animals (wild & domestic), falling rocks, electric fence, barbwire fence, farming equipment, sunburn, discharge of firearms during hunting season.
Hazard Specific Personal Protective Equipment	As required, life preservers, approved boots with aggressive & ankle support, hearing protection, orange safety vest, respiratory protection (mask), eye protection, insect repellant, sunscreen, long pants, waders
Hazard Specific Training	Job-specific training

Safe Work Practices

- A #2 First Aid Kit is required
- No less then 2 persons must be present for culvert inspection and subsequent stream inspections
- Evaluate area before starting the culvert inspections to identify any possible hazards
- If birds nest are present in culvert, take necessary respiratory actions (where mask).
- Be aware of unstable slopes and weather conditions, like rain, which may increase the chance of slipping or falling
- Ensure a mobile phone will be present and powered on at all times
- Ensure that office is aware of culvert inspection locations before leaving to perform the fieldwork
- Take precautions around unstable terrain, like; river banks, damaged culverts and boulders
- Review the UV index before leaving the field and wear sunscreen at all times
- Wear hunter's orange during autumn hunting season
- When carrying gear make sure that one hand remains free to brace a fall, backpacks will be used when appropriate
- Park vehicle completely off the shoulder
- Set up a yellow flashing light on top of truck during all inspections for increased visibility
- Walk off the shoulder of the road in the direction of on coming traffic
- A reflective vest will be worn at all times when working near the road
- Stay hydrated and stay aware of extremes in temperature
- Always be alert of others and traffic that is near your area of work

Note, where necessary, refer to:

- CARP Health and Safety Policy
- CARP Remote Location Plan

Clean Annapolis River Project
P.O. Box 395, Annapolis Royal, NS, B0S 1A0, 902 532 7533

Appendix E: Description of Full Assessment Parameters

No.	Variable	Units	Description
1	Collectors		The researchers collecting the data
2	Culvert ID		An identification code unique to each culvert. This is a six-digit code; the first three digits are letters. These letters relate to the stream name or geographical location of the culvert. The last three digits are numbers, which relate to the culverts identification within the stream or geographical area
3	Road Name		The name of the road that the culvert is located on
4	Ownership of Barrier		The person or organization responsible for the culvert
5	Date		The date on which the culvert assessment was completed
6	Time		The time that the culvert assessment began
7	UTM Coordinates		The location of the culvert relative to NAD83 UTM Zone 20
8	Culvert Shape		The shape of the culvert being surveyed (box, round, egg)
9	Culvert Material		The material that the culvert is made of (wood, steel, cement, stone)
10	Entrance Type		The design of the culvert inflow (projecting, wingwall, headwall)
11	Culvert Bottom Material		Material found in the bottom of the culvert. Ex. Natural bottom
12	Substrate in Culvert		Any substances in the culvert. Ex. Algae
13	Embedded Depth	cm	The depth in which the culvert is placed in the ground
14	Culvert Diameter	m	The width and height of the culvert
15	Wetted Width	m	The width of the water in the culvert
16	High Water Mark	m	The depth and width of the high water mark, usually identified by a change in colour or rust
17	Culvert Length	m	The length of the culvert being assessed
18	Corrugation	m	The height and spacing between corrugations of a steel culvert
19	Water Depth in Culvert	cm	The depth of the water in the culvert
20	Water Velocity in Culvert	m/s	The velocity of the water in the culvert
21	Outflow Drop	cm	The distance between the bottom of the culvert outflow and the surface water of the outflow pool
22	Elevation at Culvert Edge	m	An elevation measurement taken at either end of the culvert
23	Distance from Culvert to 1st Riffle	m	Distance measured in metres from the culvert to the 1st riffle,
24	Elevation at 1st Riffle	m	An elevation measurement taken at the end of the outflow pool or at an identified location upstream/ downstream of the culvert (a 1st riffle measurement is taken both upstream and downstream)
25	Distance from 1st to 2nd Riffle	m	Distance measured in metres between two identifiable changes in elevation downstream
26	Elevation at 2nd Riffle	m	A second change in elevation downstream of the outflow pool
27	Pool Depth	m	The depth of the water in the outflow pool
28	Pool Surface Elevation	m	An elevation measurement taken at the surface of the water in the outflow pool
29	Culvert Slope	%	The slope of the culvert, calculated by subtracting the inflow elevation from the outflow elevation and dividing that value by the length of

			the culvert.
30	pH		The acidity of the water in the stream
31	Water Temperature	Celcius	Downstream water temperature
32	Conductivity	mS/cm	The ability of a solution (water) to carry an electrical current
33	Turbidity	NTU	The cloudiness of the water, as a result of suspended solids
34	DO	mg/L	The amount of dissolved oxygen in the water
35	DO (SAT)	% (SAT)	The amount of dissolved oxygen saturation in the water
36	Salinity	g/L	The dissolved salt content in a body of water
37	Air Temperature	Celcius	The temperature of the air on the day of the survey
38	Downstream Wetted Width	m	A measurement in metres of the width of the water column in a downstream section which best represents the true character of the stream
39	Downstream Bankfull Width	m	A measurement in metres of the full bank width in a downstream section which best represents the true character of the stream
40	Bankfull Width Station	m	Based on the bankfull width, the cross section is divided into segments, usually at intervals of 0.5m or 1.0m, depending of the width of the stream
41	Elevation (Cross Section)	m	An elevation which is taken at each bankfull width station
42	Wetted Water Depth (Cross Section)	m	A measurement of the water depth at each bankfull width station
43	Velocity (Cross Section)	m/s	A measurement of the velocity at each bankfull width station

Appendix F: High Priority Culverts

#	Culvert ID	Priority	Stream Name	X	Y	Problem
1	SHE002	High	Shearer Brook	324413	4970594	
2	CHE001	High	Chesley Brook	314532	4966287	Insufficient water
3	MOR001	High	Morton Brook	337847	4979650	Insufficient water
4	EVA001	High	Evans Brook	339443	4979946	Insufficient water/Small pool
5	WAT001	High	Watton Brook	340131	4979991	Outflow drop
6	DIT001	High	Ditmars Brook	291008	4947423	Insufficient water
7	BAL001	High	Balcom Brook	299033	4955387	Outflow drop
8	WDL001	High	Woodland Brook	298397	4954798	Insufficient water
9	POT007	High	Potter Brook	293708	4951272	Outflow drop
10	TRO005	High	Troop Brook	302094	4959662	Beaver Dam
11	TRO010	High	Troop Brook	302044	4959738	Outflow drop
12	MIL001	High	Mill Brook	304056	4959887	Broken
13	FRA001	High	Fraser Brook	306150	4962984	Insufficient water
14	EAT002	High	East Troop Brook	308447	4963730	Outflow onto rocks/ Debris
15	RAY001	High	Ray Brook	313126	4964847	Outflow drop
16	RAY002	High	Ray Brook	313124	4964861	Insufficient water
17	SOL001	High	Solomon Chute Brook	318021	4967915	Insufficient water
18	SOL003	High	Solomon Chute Brook	318889	4968307	
19	SOL004	High	Solomon Chute Brook	318753	4968332	Beaver Dam
20	MRV012	High	Moose River	294941	4947548	Outflow onto rocks
21	DIT007	High	Ditmars Brook	291461	4947206	Outflow onto rocks
22	THO001	High	Thornes Brook	288228	4953003	Insufficient water/ Debris
23	CRO002	High	Croscup Brook	291253	4954163	Outflow drop
24	CRO001	High	Croscup Brook	291396	4954259	Outflow onto rocks
25	DIX001	High	Dixon Brook	292004	4954463	Slope/ velocity
26	KEN006	High	Kennedy Brook	293880	4954923	Outflow onto rocks
27	KEN004	High	Kennedy Brook	294896	4955834	Outflow onto rocks
28	KEN002	High	Kennedy Brook	295392	4956012	Insufficient water
29	KEN009	High	Kennedy Brook	295458	4955922	Debris
30	BOY001	High	Boyce Brook	288951	4945705	Inflow drop/ Outflow drop
31	BEA002	High	Bear River	289752	4941640	Outflow onto rocks
32	PUR001	High	Purdy Brook	289492	4946046	Dam
33	PUR002	High	Purdy Brook	289380	4946149	Debris/ Rusted bottom
34	DEE002	High	Deep Brook	290772	4946402	Inverted slope/ Outflow drop
35	DEE003	High	Deep Brook	291511	4945170	Outflow drop
36	WOR005	High	Worchester Brook	297056	4957038	Outflow drop
37	GRF006	High	Granville Ferry	298456	4957338	Insufficient water/ Outflow drop
38	GRF005	High	Granville Ferry	299573	4957683	Insufficient water/ Outflow drop
39	GRF002	High	Granville Ferry	300536	4958615	Insufficient water/ Outflow drop

40	GRF007	High	Granville Ferry	300487	4958695	Outflow onto rocks
41	SHE004	High	Shearer Brook	324184	4970825	Insufficient water/ Outflow drop
42	PAR001	High	Paradise Brook	325650	4970865	Insufficient water/ Outflow drop
43	PAR004	High	Paradise Brook	325809	4971239	Rusted bottom
44	PAR005	High	Paradise Brook	325509	4972189	
45	LEO002	High	Leonard Brook	327434	4972164	Insufficient water/ Outflow onto rocks
46	PET002	High	Petes Brook	330433	4973042	Debris
47	MCE002	High	McEwan Brook	332060	4974946	Insufficient water
48	ROO002	High	Roop Brook	287564	4942746	Debris
49	TUM001	High	Turnbulls Brook	280090	4951167	Dam/ Outflow onto rocks
50	HAN001	High	Handspiker Brook	280551	4948498	Outflow drop
51	EVA002	High	Evans Brook	339496	4980058	Outflow onto rocks
52	WAT006	High	Watton Brook	340135	4980070	Debris
53	WAL005	High	Walker Brook	345409	4983025	
54	AVE004	High	Avery Brook	352534	4987225	Outflow drop
55	AVE005	High	Avery Brook	352429	4987509	Outflow onto rocks
56	ROC004	High	Rockland Brook	360765	4985776	Outflow drop
57	ROC012	High	Rockland Brook	362802	4985699	Outflow drop
58	BLO007	High	Bloody Creek Brook	317530	4966703	Broken
59	BLO005	High	Bloody Creek Brook	317988	4967046	Dam
60	BLK006	High	Black River	344036	4978754	Outflow drop
61	BLK007	High	Black River	344840	4978781	Outflow onto rocks
62	BLK008	High	Black River	344571	4978768	Debris
63	NIC003	High	Nictaux River	339431	4977461	Beaver Dam
64	NIC002	High	Nictaux River	339406	4977435	Velocity/ Outflow Drop
65	BLO011	High	Bloody Creek Brook	318987	4965976	Debris
66	PET004	High	Petes Brook	331698	4971162	Dam/ Outflow drop
67	DEL002	High	Delanceys Brook	334408	4974591	Insufficient water
68	BEN003	High	Bent Brook	311601	4962914	Broken
69	TUP005	High	Tupper Brook	313966	4964373	Broken
70	BUT005	High	Button Brook	320899	4966806	Broken Baffle, Inflow drop
71	ALL008	High	Allians Creek	300560	4956036	Rusted bottom/ Outflow drop
72	ALL015	High	Allains River	303274	4952193	Debris/ Outflow drop
73	AND001	High	Anderson Brook	296679	4963363	Velocity
74	LIT002	High	Litchfield Brook	293868	4961781	Outflow drop
75	SRW006	High	n/a Shore Road West	302066	4966880	Outflow drop
76	STD001	High	Streadmans Brook	304846	4968671	Outflow drop
77	EBY001	High	Eben Young Brook	306226	4970259	Outflow drop
78	JOE001	High	Joe Brook	307140	4970834	Beaver Dam/ Outflow drop
79	LON002	High	n/a Longley Mountain Rd	308534	4971643	Outflow drop
80	PEK001	High	Peck Brook	309050	4972086	Debris/ Outflow drop
81	PEK002	High	Peck Brook	309565	4972412	Outflow drop

82	PHI001	High	Phinneys Brook	310777	4972882	Outflow drop
83	HPT005	High	n/a Hampton area	314547	4974845	Outflow drop
84	HPT003	High	n/a Hampton area	313247	4973744	Outflow drop
85	HPT002	High	n/a Hampton area	312768	4973481	Velocity/ Outflow Drop
86	HAM002	High	Hampton Brook	315158	4975133	Velocity/ Outflow Drop
87	HAM006	High	Hampton Brook	316195	4973614	Insufficient water
88	CHU002	High	Chute Brook	316942	4973586	Rusted bottom/ Outflow drop
89	POO002	High	Poole Brook	319210	4975216	Outflow drop
90	GRL003	High	Granville Line Brook	321109	4976020	Debris
91	SAB008	High	Sabeans Brook	322319	4977356	Insufficient water
92	STA005	High	Starratt Brook	325791	4978036	Outflow drop
93	CHU001	High	Chute Brook	315798	4975285	Outflow drop
94	SNW001	High	Snow Brook	317192	4975679	Outflow drop
95	POO001	High	Poole Brook	318177	4976232	Outflow drop
96	GRL001	High	Granville Line Brook	320029	4977646	Outflow onto rocks
97	SAB001	High	Sabeans Brook	320354	4979216	Outflow drop
98	NUM002	High	Number Five Brook	325419	4980336	Outflow drop
99	SSB002	High	Shearer Brook	326803	4983135	Insufficient water
100	SSB006	High	Shearer Brook	328642	4981259	Broken
101	SSB007	High	Shearer Brook	328778	4980914	Outflow drop
102	NUM004	High	Number Five Brook	325656	4980311	Insufficient water
103	POR002	High	Port George Brook	329601	4985464	
104	NEI002	High	Neily Brook	330543	4985619	
105	WAR002	High	Warner Brook	332360	4985207	Outflow drop
106	MOH004	High	Mosher Brook	334158	4985877	Debris/ Outflow drop
107	MOH005	High	Mosher Brook	334425	4985933	Outflow drop
108	REW002	High	Andrews Brook	335990	4987348	Dam
109	GAR002	High	n/a Seaman Street	337571	4988950	Debris/ Broken
110	BRO007	High	Brown Brook	329637	4982263	Outflow onto rocks
111	BRO008	High	Brown Brook	330091	4982449	
112	FRA004	High	Fraser Brook	306391	4963508	Debris/ Outflow drop
113	RAY004	High	Ray Brook	312523	4966844	Debris
114	BAT003	High	Bath Brook	315604	4969192	Outflow drop
115	FAS011	High	Fash Brook	318704	4970711	Outflow drop
116	SOL014	High	Solomon Chute Brook	318953	4970795	Broken
117	FAS013	High	Fash Brook	317815	4969897	Outflow drop
118	SOL012	High	Solomon Chute Brook	318750	4967957	Debris
119	GAS005	High	Gaskill Brook	317089	4971618	Dam
120	SOL016	High	Solomon Chute Brook	319518	4970994	Outflow onto rocks
121	MUN007	High	Munros Brook	322345	4973452	Dam
122	SHE008	High	Shearer Brook	323231	4973874	Dam
123	SHE010	High	Shearer Brook	324183	4974389	No outflow pool/ Outflow Drop

124	LEO016	High	Leonard Brook	325545	4975034	Broken
125	LEO017	High	Leonard Brook	326225	4975518	Ddebris
126	OHB012	High	Oak Hallow Brook	327301	4976268	Debris
127	OHB013	High	Oak Hallow Brook	327981	4975411	Outflow drop
128	OHB011a	High	Oak Hallow Brook	328086	4976591	Rusted bottom/ Outflow drop
129	OHB009	High	Oak Hallow Brook	328708	4976839	Rusted Bottom
130	MCE012	High	McEwan Brook	330512	4978274	Outflow drop
131	MCE014	High	McEwan Brook	331078	4978418	
132	MCE015	High	McEwan Brook	331251	4978404	Outflow drop
133	BUR010	High	Burbrudge Brook	332293	4978357	Outflow drop
134	OHB001	High	Oak Hallow Brook	328973	4972989	Insufficient water
135	OHB006	High	Oak Hallow Brook	329755	4975338	Outflow drop
136	OHB007	High	Oak Hallow Brook	329648	4976109	Debris
137	MCE008	High	McEwan Brook	331368	4977129	Broken
138	MOR014	High	Morton Brook	337156	4982221	Outflow drop
139	WAT010	High	Watton Brook	340467	4983339	Outflow drop
140	SAW011	High	Saunders West Brook	321026	4970704	Culvert Submerged
141	LAR003	High	Lake Larose	307155	4953401	Debris
142	LAR002	High	Lake Larose	306954	4953495	Beaver Dam
143	WBR002	High	West Branch Round Hill River	309175	4952465	Rusted Bottom/ Outflow onto rocks
144	WBR003	High	West Branch Round Hill River	309179	4951816	Broken
145	MOR016	High	Morton Brook	337332	4982543	Outflow onto rocks
146	MOR017	High	Morton Brook	336911	4983556	Outflow drop
147	EVA007	High	Evans Brook	338715	4982851	Outflow drop
148	WIS005	High	Wiswal Brook	341448	4985417	Outflow onto rocks
149	WIS017	High	Wiswal Brook	342743	4982822	Debris
150	WIS019	High	Wiswal Brook	342570	4982500	Debris
151	WAT008	High	Watton Brook	340226	4981638	Outflow drop
152	WIS002b	High	Wiswal Brook	339443	4986281	Broken
153	WIS002c	High	Wiswal Brook	339464	4986282	Broken
154	LEO013	High	Leonard Brook	324553	4974572	Dam
155	JTM001	High	Mumford Brook	353002	4979489	Debris
156	MEA001	High	Unknown	349041	4979896	Velocity
157	OAK001	High	Oakes Brook	339607	4963782	No Culvert

Appendix G: Medium Priority Culverts

#	Culvert ID	Priority	Stream Name	X	Y	Problem
1	MOR002	Medium	Morton Brook	338470	4979816	Outflow drop/ Debris
2	DIT003	Medium	Ditmars Brook	291754	4947820	Outflow drop
3	MRV005	Medium	Moose River	293538	4950104	Outflow drop/ Insufficient water
4	ALL002	Medium	Allains Creek	299951	4956001	
5	WDL003	Medium	Woodland Brook	297466	4953604	Insufficient water
6	POT002	Medium	Potter Brook	293757	4950671	Outflow drop/ Insufficient water
7	POT008	Medium	Potter Brook	293678	4950695	Broken/ Outflow drop
8	MRV007	Medium	Moose River	294096	4949926	Outflow onto rocks/ Debris
9	MRV008	Medium	Moose River	293904	4949655	Outflow drop
10	MRV006	Medium	Moose River	293166	4949572	Insufficient water
11	TRO002	Medium	Troop Brook	301301	4959179	Outflow drop/ Debris
12	TRO008	Medium	Troop Brook	303111	4959709	Insufficient water
13	TRO011	Medium	Troop Brook	303124	4959748	Broken
14	TRO012	Medium	Troop Brook	302791	4959811	Debris
15	ETN002	Medium	Eaton Brook	305497	4961159	Outflow Drop
16	HOL001	Medium	Hollow Brook	305992	4961746	Broken
17	EAT003	Medium	East Troop Brook	307913	4963407	Insufficient water
18	PRK003	Medium	Parker Brook	309128	4963911	Outflow drop
19	MRV011	Medium	Moose River	294600	4947849	Outflow onto rocks
20	THO008	Medium	Thornes Brook	285077	4950630	Outflow onto rocks/ Rusted bottom
21	THO007	Medium	Thornes Brook	285488	4950936	Broken
22	THO005	Medium	Thornes Brook	285981	4951591	Outflow onto rocks
23	BOY003	Medium	Boyce Brook	288738	4945825	Outflow drop/ Rusted bottom
24	BEA003	Medium	Bear River	290177	4941302	Outflow onto rocks
25	SAW004	Medium	Saunders West brook	320943	4968726	Outflow onto rocks
26	SAW003	Medium	Saunders West brook	320894	4968685	
27	SAW008	Medium	Saunders West brook	320978	4968610	Broken
28	LEO003	Medium	Leonard Brook	327686	4972343	Outflow drop/ Debris
29	BAC005	Medium	Bacon Brook	280541	4941870	Debris
30	BAC007	Medium	Bacon Brook	280298	4941770	Outflow onto rocks
31	ROC010	Medium	Rockland Brook	363704	4984453	Outflow drop
32	ROC011	Medium	Rockland Brook	362994	4984111	Outflow drop
33	DAN004	Medium	Daniels Brook	321231	4967544	Rusted bottom
34	BUT001	Medium	ButtoBrook	319435	4966697	Debris
35	BUT005	Medium	Button Brook	319456	4966146	Outflow onto rocks
36	ANR008	Medium	Annapolis Royal	303409	4957684	Rusted bottom
37	SMC004	Medium	Sawmill Creek	306885	4959188	Outflow onto rocks
38	NIC004	Medium	Nictaux River	339624	4977741	Insufficient water
39	ANN004	Medium	Annapolis River	336449	4976964	Outflow drop

40	LEO006	Medium	Leonard Brook	324708	4974503	
41	LEO007	Medium	Leonard Brook	324674	4974478	Insufficient water
42	ALL009	Medium	Allians Creek	301129	4955762	Outflow drop
43	ALL022	Medium	Allians Creek	303329	4955392	Debris
44	ALL014	Medium	Allains River	303108	4953892	Outflow drop
45	HPT004	Medium	n/a Hampton area	313657	4974001	Outflow drop
46	PHI002	Medium	Phinneys Brook	310888	4972858	Outflow onto rocks
47	SNW002	Medium	Snow Brook	318403	4974538	Outflow drop
48	SAB003	Medium	Sabeans Brook	321686	4976260	Insufficient water
49	SAB004	Medium	Sabeans Brook	322150	4976451	Beaver Dam/ Debris
50	SAB007	Medium	Sabeans Brook	322397	4977169	Beaver Dam
51	SAB006	Medium	Sabeans Brook	323044	4976822	Outflow drop
52	STA002	Medium	Starratt Brook	324646	4977577	Rusted Bottom
53	STC002	Medium	St. Croix Cove Road	318771	4977036	Outflow drop
54	STC003	Medium	St. Croix Cove Road	319167	4977257	Broken/ Outflow drop
55	BRI003	Medium	n/a Brintin Road area	322085	4978956	Rusted Bottom
56	NUM003	Medium	Number Five Brook	325493	4980245	
57	LEY003	Medium	Healeys Brook	326703	4980742	Outflow drop
58	MOH006	Medium	Mosher Brook	335196	4986175	Outflow drop
59	FRA002	Medium	Fraser Brook	306340	4962554	Debris/ Outflow drop
60	FRA005	Medium	Fraser Brook	303677	4961884	Outflow drop
61	FAS007	Medium	Fash Brook	317180	4970000	Outflow drop
62	FAS008	Medium	Fash Brook	317393	4970106	Debris/ Outflow drop

Appendix H: Low Priority Culverts and Easy Fix Culverts

#	Culvert ID	Priority	Stream Name	X	Y	Problem
1	SAU002	Low	Saunders brook	324020	4970469	
2	ALL001	Low	Allains creek	300192	4956091	Insufficient water
3	DIT002	Low	Ditmars brook	290967	4947375	Insufficient water
4	MRV001	Low	Moose river	292372	4948003	Broken/ Slope/ Insufficient Water
5	MRV002	Low	Moose river	292400	4947977	Insufficient water
6	POT009	Low	Potter brook	294139	4950120	Rusted bottom
7	TRO001	Low	Troop brook	301173	4959078	Insufficient water
8	EAT004	Low	East Troop brook	307756	4965125	Slope
9	FOS004	Low	Foster brook	313399	4965217	Beaver Dam
10	FOS003	Low	Foster brook	313465	4965328	Insufficient water
11	MRV013	Low	Moose river	294393	4948221	Debris
12	MRV015	Low	Moose river	293615	4946797	
13	DIT005	Low	Ditmars brook	291950	4947690	Broken
14	SOL005	Low	Solomon chute brook	319516	4967653	Insufficient water
15	SOL007	Low	Solomon chute brook	319716	4967352	Debris
16	THO003	Low	Thornes brook	287344	4952907	Outflow onto rocks
17	KEN005	Low	Kennedy brook	294101	4955033	Insufficient water
18	BOY002	Low	Boyce brook	288252	4945255	Outflow onto rocks
19	GRF004	Low	Granville Ferry	299926	4957927	Insufficient water
20	ROO005	Low	Roop brook	288566	4941934	Outflow onto rocks/ Debris
21	ROO004	Low	Roop brook	288291	4942214	Outflow onto rocks/ Debris
22	ROO006	Low	Roop brook	287725	4942245	Outflow onto rocks
23	ROO007	Low	Roop brook	288234	4942008	Outflow onto rocks/ Debris
24	ROO008	Low	Roop brook	286768	4943881	Debris
25	DIG003	Low	Digby	280536	4943733	Debris/ Outflow drop
26	MID001	Low	Middleton	334260	4977465	Debris
27	MID002	Low	Middleton	335923	4978038	Outflow drop
28	MOR003	Low	Morton brook	338847	4979678	Outflow drop
29	KIN003	Low	Kingston	347894	4984119	Outflow onto rocks
30	GOU005	Low	Gould brook	359402	4984499	Outflow onto rocks
31	GOU006	Low	Gould brook	359152	4984469	Outflow onto rocks
32	ANR001	Low	Annapolis Royal	302189	4956739	Outflow onto rocks
33	ANR006	Low	Annapolis Royal	301863	4957310	Outflow drop
34	SMC001	Low	Saw Mill Creek	304148	4958216	Outflow onto rocks
35	RHR003	Low	Round Hill River	308420	4959974	Outflow onto rocks
36	BEN001	Low	Bent Brook	311536	4962351	Outflow onto rocls
37	PAR007	Low	Paradise brook	327787	4970434	Broken
38	PAR008	Low	Paradise brook	327937	4970520	Broken
39	GEH004	Low	Gehues brook	333813	4972629	Debris

40	TRO013	Low	Troop brook	301150	4959103	Outflow drop
41	KEN010	Low	Kennedy brook	294815	4955972	Debris
42	DIX002	Low	Dixon brook	293226	4955915	Debris/ Outflow drop
43	ROA007	Low	Roach brook	285596	4943365	Rusted bottom/ Outflow drop
44	ROA004	Low	Roach brook	283869	4943131	Outflow onto rocks
45	BAC009	Low	Bacon Brook	280768	4941272	Debris
46	GES005	Low	Gesner brook	311246	4965569	Broken
47	EVA005	Low	Evans brook	339341	4981206	Insufficient water
48	ALL018	Low	Allains River	302577	4951982	Outflow drop
49	BUT004	Low	Button brook	319431	4966182	Outflow onto rocks
50	SRW004	Low	n/a Shore Road West	296349	4962923	Debris
51	SRW005	Low	n/a Shore Road West	301063	4965982	Debris/ Outflow drop
52	PHI003	Low	Phinneys Brook	311090	4972687	Outflow drop
53	GAS003	Low	Gaskill Brook	315386	4971771	Insufficient water
54	POO004	Low	Poole Brook	320167	4975233	Debris/ Rusted bottom
55	GRL002	Low	Granville Line Brook	320755	4975878	Debris
56	SCH004	Low	Schoolhouse Brook	323895	4977207	Debris/ Outflow drop
57	BRO003	Low	Brown Brook	328221	4982312	Outflow drop
58	LEY002	Low	Healeys Brook	326304	4980581	Rusted Bottom/ Debris
59	NEI001	Low	Neily Brook	330349	4985801	Outflow drop
60	GAR004	Low	n/a Seaman Street	337525	4989931	Insufficient water
61	FRA007	Low	Fraser Brook	306889	4962142	Broken

#	Culvert ID	Priority	Stream Name	X	Y	Problem
1	WDL002	Easy Fix	Woodland Brook	297987	4954423	Debris
2	RYE001	Easy Fix	Ryerson Brook	297025	4953351	Beaver Dam
3	BUT003	Easy Fix	Button Brook	320199	4967020	Beaver Dam/ Debris
4	POT010	Easy Fix	Potter Book	295757	4952907	Debris
5	ALL023	Easy Fix	Allians Creek	302940	4955601	Debris/ Broken

Appendix I: Full Culvert Assessments

Priority	Culvert ID	Stream Name	Road Name	Ownership of Barrier	UTM Easting	UTM Northing
High	BAL001	Balcom Brook	Hwy 1	Public Road ROW	299033	4955387
High	BAL001	Balcom Brook	Hwy 1	Public Road ROW	299033	4955387
High	WDL001	Woodland Brook	Hwy 1	Public Road ROW	298397	4954798
High	MRV012	Moose River	-	Public Road ROW	294941	4947548
High	DEE003	Deep Brook	-	Public Road ROW	291511	4946377
High	GRF002	-	Granville Rd	Public Road ROW	300536	4958615
High	GRF007	-	North St	Public Road ROW	300487	4958695
High	TRO010a	Troop Brook	Post Rd	Public Road ROW	302036	4959737
High	TRO010b	Troop Brook	Post Rd	Public Road ROW	301173	4959078
High	GRF006	-	Granville Rd	Public road ROW	298456	4957338
High	GRF005	-	Granville Rd	Public Road ROW	299573	4957683
High	WOR005	Worchester Brook	Granville Rd	Public Road ROW	297056	4957038
High	KEN004	Kennedy Brook	Granville Rd	Public Road ROW	294896	4955834
High	KEN006	Kennedy Brook	Granville Rd	Public Road ROW	293080	4954923
High	DIX001	Dixon Brook	Granville Rd	Public Road ROW	292004	4954463
High	CRO001	Croscup Brook	Granville Rd	Public Road ROW	291396	4954259
High	CRO002	Croscup Brook	Granville Rd	Public Road ROW	291253	4954163
High	MRV011	Moose River	Clementsport Rd	Public Road ROW	294600	4947849
High	THO001	Thornes Brook	Granville Rd	Public Road ROW	288228	4953003
High	THO002	Thornes Brook	Granville Rd	Public Road ROW	287807	4953095
High	PUR001	Purdy Brook	Hwy 1	Public Road ROW	289492	4946046
High	PUR002	Purdy Brook	Hwy 1	Rail bed ROW	289380	4946149
High	BOY001	Boyce Brook	Hwy 1	Public Road ROW	288951	4945705
High	BOY003	Boyce Brook	Hwy 1	Rail bed ROW	288738	4945825
High	DEE002	Deep Brook	Deep Brook Lane	Private	290772	4946402
High	EAT002	East Troop Brook	Hwy 1	Public Road ROW	308447	4963730
High	HAN001	Handspiker Brook	Lighthouse Rd	Public Road ROW	280551	4948498
High	TUM001	Turnbulls Brook	Lighthouse Rd	Public Road ROW	280090	4951167
High	JTM001	Mumford Brook	JT Morse Rd	Public Road ROW	353002	4979489
High	MEA001a	-	Meadowvale Rd	Public Road ROW	349041	4979896
High	MEA001b	-	Meadowvale Rd	Public Road ROW	349041	4979896
High	THO008	Thornes Brook	Granville Rd	Public Road ROW	285077	4950630
High	BLO005	Bloody Creek	Brickyard Rd	Rail bed ROW	318987	4965976
High	BLO011	Bloody Creek	Hwy 1	Public Road ROW	318987	4965976
High	BUT005	Button Brook	Hwy 1	Public Road ROW	320899	4966806
High	SHE004	Shearer Brook	Balcom Rd	Public Road ROW	323275	4968680
High	PAR001	Paradise Brook	Hwy 1	Public Road ROW	325650	4970865
High	PAR004	Paradise Brook	-	Rail bed ROW	325809	4971239
High	PAR005	Paradise Brook	Leonard Rd	Public Road ROW	325509	4972189

High	LEO002	Leonard Brook	Hwy 1	Public Road ROW	327434	4972164
High	PET002	Peters Brook	-	Rail bed ROW	330433	4973042
High	BEA002	Bear River	Chute Rd	Public Road ROW	289752	4941640
High	BEA003	Bear River	Chute Rd	Public Road ROW	290177	4941302
High	WDL003	Woodland Brook	Hwy 1	Public Road ROW	297466	4953604
High	POT002	Potter Brook	Hwy 1	Public Road ROW	293757	4950671
High	MRV007	Moose River	Old Post Rd	Public Road ROW	294096	4949926
High	MRV008	Moose River	Old Post Rd	Public Road ROW	294096	4949926
High	TRO012	Troop Brook	Riverview Lane	Public Road ROW	302791	4959811
High	TRO011	Troop Brook	Riverview Lane	Public Road ROW	303124	4959748
High	TRO008	Troop Brook	Hwy 1	Public Road ROW	303111	4959709
High	MOR001	Morton Brook	Hwy 1	Public Road ROW	337841	4979659
High	NIC002	Nictaux River	Hwy 201	Public Road ROW	339406	4977435
High	DEL002	Delanceys Brook	Keith Lane	Public Road ROW	334408	4974591
High	PET004	Pete's Brook	Hwy 201	Public Road ROW	331698	4971162
High	EVA002	Evans Brook	Ruggles Rd	Public Road ROW	339486	4980046
High	EVA001	Evans Brook	Hwy 1	Public Road ROW	339435	4979960
High	WAT006a	Watton Brook	-	Rail bed ROW	340135	4980070
High	WAT006b	Watton Brook	-	Rail bed ROW	340135	4980070
High	WAT001	Watton Brook	Hwy 1	Public Road ROW	340125	4979995
High	ALL008	Allains Creek	Dugway Rd	Public Road ROW	300560	4936036
High	SOL014	Soloman Chute Brook	Clarence Rd	Public Road ROW	318953	4970795
High	FAS011	Fash Brook	Clarence Rd	Public Road ROW	318704	4970711
High	FAS013	Fash Brook	Inglewood Rd	Public Road ROW	317815	4969897
High	ROC012	Rockland Brook	Windermere Rd	Public Road ROW	362802	4985699
High	ROC004a	Rockland Brook	Hall Rd	Public Road ROW	360765	4985776
High	ROC004b	Rockland Brook	Hall Rd	Public Road ROW	360765	4985776
High	BLK006	Black River	Meadowvale Rd	Public Road ROW	344036	4978754
High	FRA004a	Fraser Brook	Bent Rd	Public Road ROW	306391	4963508
High	FRA004b	Fraser Brook	Bent Rd	Public Road ROW	306391	4963508
High	FRA002	Fraser Brook	Fraser Rd	Public Road ROW	306340	4962554
High	AVE004	Avery Brook	Mordon Rd	Private	352534	4987225
High	AVE005	Avery Brook	Mordon Rd	Public Road ROW	352429	4987509
High	SAB008	Sabeans Brook	Port Lorne Rd	Public Road ROW	322319	4977356
High	SOL012	Solomon Chute Brook	Hwy 1	Public Road ROW	318750	4967957
High	SHE008	Shearer Brook	Clarence Rd	Public Road ROW	323231	4973874
High	LEO016	Leonard Brook	Clarence Rd	Public Road ROW	325545	4975034
High	OHB012	Oak Hallow Brook	Clarence Rd	Public Road ROW	327301	4976268
High	OHB011a	Oak Hallow Brook	Clarence Rd	Public Road ROW	328086	4976591
High	OHB011b	Oak Hallow Brook	Clarence Rd	Public Road ROW	328086	4976591
High	OHB009a	Oak Hallow Brook	Clarence Rd	Public Road ROW	328708	4976839
High	OHB009b	Oak Hallow Brook	Clarence Rd	Public Road ROW	328708	4976839

High	MCE012	McEwan Brook	Brooklyn Rd	Public Road ROW	330512	4978274
High	MCE014a	McEwan Brook	Brooklyn Rd	Public Road ROW	331018	4978418
High	MCE014b	McEwan Brook	Brooklyn Rd	Public Road ROW	331018	4978418
High	MCE015	McEwan Brook	Brooklyn Rd	Public Road ROW	331351	4978404
High	OHB013	Oak Hallow Brook	Elliot Rd	Public Road ROW	327981	4975411
High	OHB006	Oak Hallow Brook	Fitch Rd	Public Road ROW	329755	4975338
High	OHB007	Oak Hallow Brook	Fitch Rd	Public Road ROW	331368	4976109
High	MCE008	McEwan Brook	Moutn Hanley Rd	Public Road ROW	331368	4977129
High	WAT010	Walton Brook	Spa Springs Road	Public Road ROW	340467	4983339
High	MOR014	Morton Brook	Hwy 362	Public Road ROW	337156	4982221
Medium	MRV005	Moose River	Hwy 1	Public Road ROW	293538	4950104
Medium	MRV006	Moose River	Hwy 1	Public Road ROW	293166	4949572
Medium	DIT003	Ditmars Brook	Atlantic Ave	Public Road ROW	291754	4947820
Medium	PRK003	Parker Brook	Hwy 1	Public Road ROW	309128	4963911
Medium	ETN002	Eaton Brook	Hwy 1	Public Road ROW	305497	4961159
Medium	THO007	Thornes Brook	Granville Rd	Public Road ROW	285488	4950936
Medium	LEO003	Leonard Brook	Hwy 1	Public Road ROW	327686	4972343
Medium	ALL002	Allains Creek	Hwy 1	Public Road ROW	299951	4956001
Medium	SAW003a	Saudners West	Hwy 1	Public Road ROW	320894	4968685
Medium	SAW003b	Saudners West	Hwy 1	Public Road ROW	320894	4968685
Medium	SAW008	Saudners West	-	Rail bed ROW	320978	4968610
Medium	BAC007	Bacon Brook	-	Rail bed ROW	280310	4941791
Medium	BAC005	Bacon Brook	Robinson Weir Rd	Public Road ROW	280541	4941870
Medium	ALL009	Allains Creek	Dugway Rd	Public Road ROW	301129	4955762
Medium	ALL022a	Allains Creek	West Dalhousie Rd	Public Road ROW	303329	4955392
Medium	ALL022b	Allains Creek	West Dalhousie Rd	Public Road ROW	303329	4955392
Medium	FAS008	Fash Brook	Clarence Rd	Public Road ROW	317393	4970161
Medium	FAS007	Fash Brook	Clarence Rd	Public Road ROW	317180	4970000
Medium	ROC011	Rockland Brook	Prospect Rd	Public Road ROW	362994	4984111
Medium	ROC010	Rockland Brook	Prospect Rd	Public Road ROW	363704	4984453
Medium	NIC004	Nictaux River	Hwy 201	Public Road ROW	339634	497741
Medium	ANN004	Annapolis River	Middle Rd	Public Road ROW	336449	4976964
Medium	FRA005	Fraser Brook	South Shore Drive	Public Road ROW	306799	4961884
Medium	LEO013	Leonard Brook	Clarence Rd	Public Road ROW	324553	4974572
Medium	DAN004	Daniels Brook	Off of HWY 201	Private	321231	4967574
Medium	LEO006	Leonard Brook	-	Rail bed ROW	325626	4974747
Medium	SAB006	Sabeans Brook	Arlington Rd	Public Road ROW	323044	4976822
Medium	SAB007	Sabeans Brook	Port Lorne Rd	Public Road ROW	322397	4977169
Medium	SAB004	Sabeans Brook	Arlington Rd	Public Road ROW	322150	4976451
Medium	ALL014	Allains Creek	Hwy 8	Public Road ROW	303108	4953892
Medium	TRO002	Troop Brook	Hwy 1	Public Road ROW	301301	4959179
Low	EAT004	East Troop Brook	Young Mountain Rd	Public Road ROW	307756	4965125

Low	THO003	Thornes Brook	Granville Rd	Public Road ROW	287344	4952907
Low	GRF004	-	Granville Rd	Public Road ROW	299926	4957927
Low	ALL023a	Allains Creek	West Dalhousie Rd	Public Road ROW	302940	4955601
Low	ALL023b	Allains Creek	West Dalhousie Rd	Public Road ROW	302940	4955601

Partially Completed Full Assessments:

Priority	Culvert ID	Stream Name	Road Name	Ownership of Barrier	UTM Easting	UTM Northing
High	SHE002	Shearer Brook	Hwy 1	-	324413	4970594
High	CHE001	Chesley Brook	Shaw Rd	-	314532	4966287
High	POT007	Potter Brook	Railway	Rail bed ROW	293708	4951272
High	DIT001	Ditmar Brook	Hwy 1	Public road ROW	291008	4947423
High	DIT007	Ditmar Brook	Cornwallis	Public road ROW	291461	4947206
High	TRO005	Troop Brook	Hwy 1	Public road ROW	302094	4959662
High	MIL001	Mill Brook	Hwy 1	Public road ROW	304056	4959887
Medium	HOL001	Hollow Brook	Willow Lane	Public road ROW	305992	4961746
High	FRA001	Fraser Brook	Fraser Rd	Public road ROW	306150	4962984
Easy to fix	POT010	Potter Brook	Railway	Rail bed ROW	295757	4952907
High	KEN009	Kennedy Brook	Granville Rd	Rail bed ROW	295458	4955922
High	DEE001	Deep Brook	Hwy 1	Public road ROW	290045	4946416
Medium	EAT003	East Troop Brook	Hwy 1	Public Road ROW	307913	4963911
High	OAK001	Oakes Brook	Hwy 1	Rail bed ROW	339607	4963782
Medium	THO005	Thornes Brook	Granville Rd	Public Road ROW	285981	4951591
Low	DIX002	Dixon Brook	Hollow Mountain Rd	Public road ROW	293226	4955915
Low	KEN005	Kennedy Brook	Granville Rd	Public road ROW	294101	4955033
High	BEN003	Bent Brook	-	Rail bed ROW	311601	4962914
Medium	POT008	Potter Brook	Hwy 1	Rail bed ROW	293678	4950695
High	MCE002	McEwan Brook	Hwy 1	Public road ROW	332060	4974946
Medium	ANR008	-	-	Rail bed ROW	303409	4957684
Medium	SMC004	Sawmill Creek	Hwy 1	Public road ROW	306885	4959188
High	TUP005	-	-	Rail bed ROW	313966	4964373
High	DIG006	Digby	Raquette Road	Public road ROW	280578	4945580
High	BLK007	Black River	Meadowvale	Public road ROW	344840	4978781
Low	BLK008	Black River	Meadowvale	Public road ROW	344571	4978768
High	NIC003	Nictaux River	Hwy 201	Public road ROW	339431	4977461
High	WAL005	Walker Brook	Marshall Rd	Public road ROW	345409	4983025
Medium	LEO007	Leonard Brook	-	Rail bed ROW	324674	4974478
High	LEO017	Leonard Brook	Clarence Rd	Public road ROW	326225	4975518
High	LAR003	Lake Larose	Lakeview Drive	Public road ROW	307155	4953401
High	LAR002	Lake Larose	Eastside Drive	Public road ROW	306954	4953495