
RENNIE'S RIVER WATERSHED

RIPARIAN ASSESSMENT



ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Rennie's River / Leary's Brook watershed is one of the largest watersheds in St. John's. This project examined the human impacts to the riparian and the instream areas throughout the watershed in order to identify areas needing future remediation efforts. The rivers were divided into sections referred to as reaches for assessment. For each reach, a Visual Stream Assessment Protocol adopted from the United States Department of Agriculture's Stream Visual Assessment Protocol Version 2 was used to score nine assessment factors, which were then averaged to give a ranking of poor, good, fair or excellent. This method presents basic, descriptive assessment of the physical conditions affecting stream health. Additionally, the location of garbage and debris and the presence of non-native invasive plants were also recorded.

A total of 25 reaches were assessed and ranked, there were none that received a ranking of excellent, while the distribution of the other rankings was similar. Geographically, the reaches that ranked as good were mainly near the headwater sections with the exceptions being some reaches along Rennie's River and the daylighted section of Kellys Brook. The Visual Stream Assessment Protocol assessment factors most commonly found to be problematic throughout the watershed were a lack of pools, lack of canopy cover, channel condition and bank stability. In addition to the conditions included in the assessment factors, noticeable issues also included the presence of garbage and debris and invasive plants. While these issues were found throughout, there were some areas where their presence was heavier.

Based on the findings of this project and the issues found during the assessment, recommendations were made to improve the ecological integrity and increase the value of the river system for recreational purposes. Recommendations included the removal of invasive plants, the planting of native plants, developing solutions for areas with severe bank erosion, removal and source control of garbage and debris, the development of riverside walking trails, the maintenance of stream crossing structures, and the engagement of business owners in watershed stewardship.



INTRODUCTION

The purpose of this project was to examine the riparian and associated riverine ecosystems along Rennie's River and its tributaries. Specifically, impacts from a variety of sources such as human activities and installations, non-native alien plant invasion and erosion.

Ultimately, the goal was to identify and map problematic areas requiring future remediation and enhancement of the riparian zone and bring these areas to the attention of local community groups and governments.

About a Riparian Zone

Simply defined, the riparian zone is the area along the sides of a river. The exact extent or size can be hard to define, but the riparian zone can be thought of as a transition zone between the water's edge and drier upland areas. Natural riparian zones contain various native flora species and provide many benefits to the aquatic ecosystem and the animals (including humans) that live within watersheds.

Healthy riparian zones contribute to fish habitat and water quality. The canopy cover provided by riparian plants controls water temperature by shielding water from direct sunlight, and detritus from riparian plants provides food to aquatic organisms and nutrients to the waterway. Riparian vegetation also stabilizes riverbanks and helps to prevent excessive erosion. The riparian zone can also act as a buffer, holding water, reducing the velocity and removing contaminants from overland runoff before it reaches a waterway. Riparian zones can also serve as habitat for small animals and birds.

Human activity can disturb the natural composition of the riparian zone. As land becomes urbanized, the vegetation within a buffer zone may be removed or altered. The result is that natural services of the riparian zone, which urban dwellers rely on, are compromised or even lost completely. For example, stabilization of riverbanks or water capture within the riparian zone protects human developments nearby and lack of these services places properties at risk of flood damage. Another manner in which humans disturb riparian zones is through the introduction of non-native plant species. Many of these non-native species can be considered invasive as they out-compete native species, decreasing the biodiversity of the riparian ecosystem. Black knapweed (*Centaurea nigra*) is a non-native plant common in disturbed areas which releases toxins into the soil around it, creating unsuitable growing conditions for native plant species. Coltsfoot (*Tussilago farfara*) flourish in areas where limestone gravels or concrete have been put in place (Hermanutz, personal communication, October 17, 2013) and are commonly found in riparian areas as these materials are often part of road crossing infrastructure like culverts or bridges.

Located on the Northeast Avalon Peninsula, the Rennie's River / Learys Brook watershed covers approximately 35 square kilometers, and is one of the largest drainage basins in St. John's. The watershed ultimately drains into the western shore of Quidi Vidi Lake via Rennie's River, which flows out of Long Pond. There are many tributaries that make up the watershed, including Kenmount Brook, Yellow Marsh Stream, Learys Brook, Cartys Stream, Nagels Brook and some smaller unnamed streams (Figure 1). The watershed serves as habitat to fish species, including brook trout and brown trout. It is also the location of recent Atlantic salmon reintroduction.



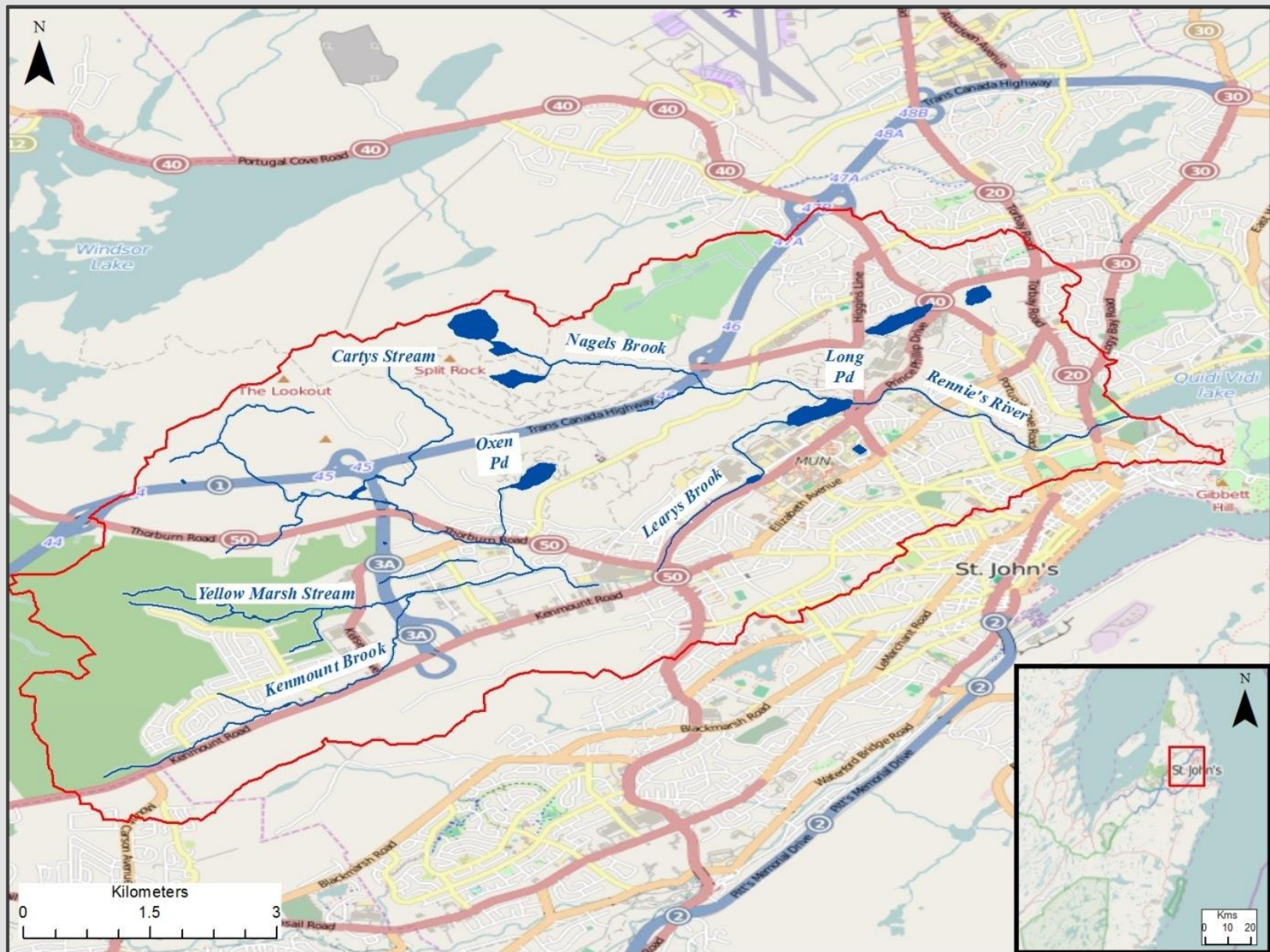


Figure 1. The Rennie's River / Learys Brook watershed, with the main tributaries labeled and the watershed boundary in red.

The Rennie's River / Learys Brook Watershed

The waterways have seen much degradation over time as a result of being buried underground in culverts, undergoing channelization, and being used as a depository for sewage. Historically, the lower (eastern) sections of Rennie's River were inhabited first, but as time progressed residential, commercial and industrial development spread into the upper (western) sections. Construction of two major highways (the Outer Ring Road and the Team Gushue Highway), a large industrial park, a commercial box store area and an expanding residential area known as Kenmount Terrace, have affected a number of waterways in this watershed, including Learys Brook, Yellow Marsh Stream and Kenmount Brook. Inevitably with this extent of human development, there is an abundance of sources of potential disruption to the natural condition of the riparian zone. Impacts such as road crossings, storm-sewer runoff, winter road salt use, sedimentation and runoff from land

developments, pollution, burial and river re-routing installations can all have negative effects on the natural riparian habitat biodiversity. However, there has been no study to date that has comprehensively examined specific stressors across the riparian zones of the Rennie's River / Leary's Brook watershed.

This project determined sources of physical degradation that exist in the riparian buffer zone of the Rennie's River watershed. Locations within the watershed impacted by degradation were identified and sections of the river were ranked based on the condition of the riparian and instream ecosystems. *This study aims to present an overview of the stressors that may be degrading the riparian zone and waters of Rennie's River watershed, and provide the specific locations within the watershed that require restorative attention.*



METHODS

During the summer of 2014 the Rennie's River / Learys Brook watershed was the subject of a stream health assessment, as detailed below. The river was divided into 27 sections (referred to as reaches), beginning at the mouth of Rennie's River where it runs into Quidi Vidi Lake and heading upstream. These 27 reaches of varying length are located along Rennie's River, Long Pond, Learys Brook, Yellow Marsh Stream, Nagels Brook, Kelly's Brook and the tributary from Oxen Pond.

With the assistance of a Conservation Corps Green Team, a Visual Stream Assessment Protocol (Appendix A) was used to assess each reach. The data collection methodology has been used by Geography 3226 students at Memorial University, and is an adaptation of the United States Department of Agriculture's Stream Visual Assessment Protocol Version 2. This protocol was developed for use by conservation authorities and landowners in the U.S. to provide a basic, descriptive assessment of the physical conditions affecting stream health, particularly in smaller waterways. It provides a general, qualitative assessment of the local conditions of stream health, but may not capture influences from outside the watershed. However, it is used widely to identify areas of concern and even assess trends in streams and riparian conditions over time. As per the protocol, the team recorded information related to the condition of the riparian and riverine zones at each of the reaches. They noted areas of erosion and slope failure, areas that had been channelized or stabilized with manmade structures, areas with debris and garbage present, and the size and vegetative composition of the riparian zone. Each reach was assigned a score to nine assessment factors: channel condition; bank stability; riparian zone condition; water appearance; nutrient enrichment; barriers to fish movement; instream fish cover; pools;

and canopy cover. An overall summary score for each reach was derived by taking the average of scores assigned to the nine assessment factors; this overall score then corresponded with an overall ranking of poor, fair, good or excellent.

The team also inspected the riparian zone for twelve non-native plant species deemed invasive and intrusive by the Memorial University Botanical Garden Unwanted Invasive Alien Plants project. The non-native species identified were as follows: black knapweed; Canada thistle; cattail; coltsfoot; common reed; goutweed; Japanese knotweed; purple loosestrife, sea buckthorn; St. John's wort; wild chervil; and yellow iris. Additionally, instream details were observed such as instream cover, the appearance of the water, the presence of algae as an indicator of high nutrient levels, and any structures or debris that might be a barrier to fish passage. The location of inflows to the main river were also recorded, and classified based on whether or not they had water flowing in them during the visit as a means of inventorying potential sources of inputs to water quality. Photos were taken while walking along each reach to supplement the details recorded and provide a visual representation each reach.

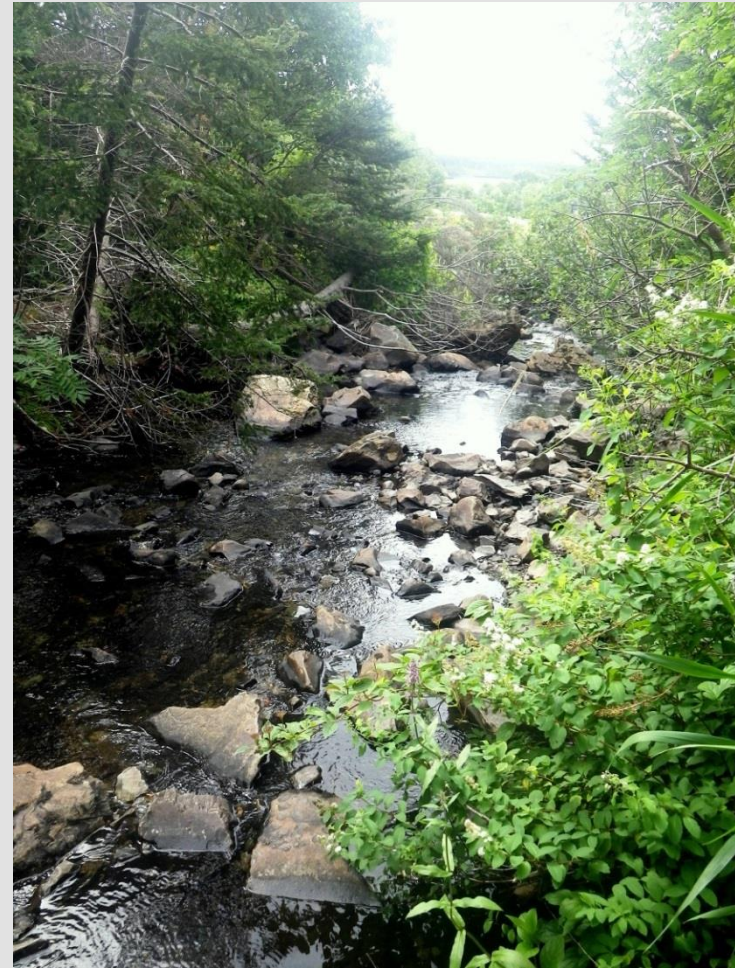
In order to map the reaches assessed, the GPS coordinates of the start and end points of each reach were uploaded into GIS and then the straight lines between the two were edited to follow the shape of the streams shapefile downloaded from the National Hydro Network. The summary ranking for each reach and the ranking for each of the nine assessment factors was also included in the GIS file, allowing queries and color coding of different rankings for visual representation on maps.

RESULTS AND DISCUSSION

Appendix B contains the results of the Visual Assessment Protocol, including the scores for the nine assessment factors and the overall summary score (the average of the scores from the nine assessment factors) and associated overall ranking for each reach. Although assessed, scoring and ranking were not completed for Reach 7 and Reach 8 (along Long Pond) as the methodology is specific to a river and not best suited to a pond environment. Therefore, results will be discussed for the remaining 25 reaches.

None of the 25 river reaches visited and ranked received an overall ranking of excellent. The number of reaches ranked as either poor, fair or good were similar, with good being the most frequent ranking (Table 1). The average of the scores for the 25 reaches was 6.76 ± 1.56 , which corresponds to an overall ranking of poor, fair or good. The variability of rankings for this watershed makes it difficult to suggest a consistent ranking for the entire watershed.

Overall, the assessment criteria most commonly identified as problematic throughout the study area were lack of pools, lack of canopy cover, channel condition and bank stability (Appendix C). Although not specified as separate assessment criteria for the ranking, there were also frequent findings of garbage and debris throughout the watershed and non-native invasive plants were regularly identified. These criteria are discussed in further detail in the sections below.



Ranking	Poor (average overall score less than 6)	Fair (average overall score of 6.1-7.4)	Good (average overall score of 7.5-8.9)	Excellent (average overall score greater than 9)
Number of Reaches with Ranking	8	7	10	0
Percentage with Ranking	32	28	40	0

Table 1. Overall summary of the number of reaches ranked as each of the four classifications.

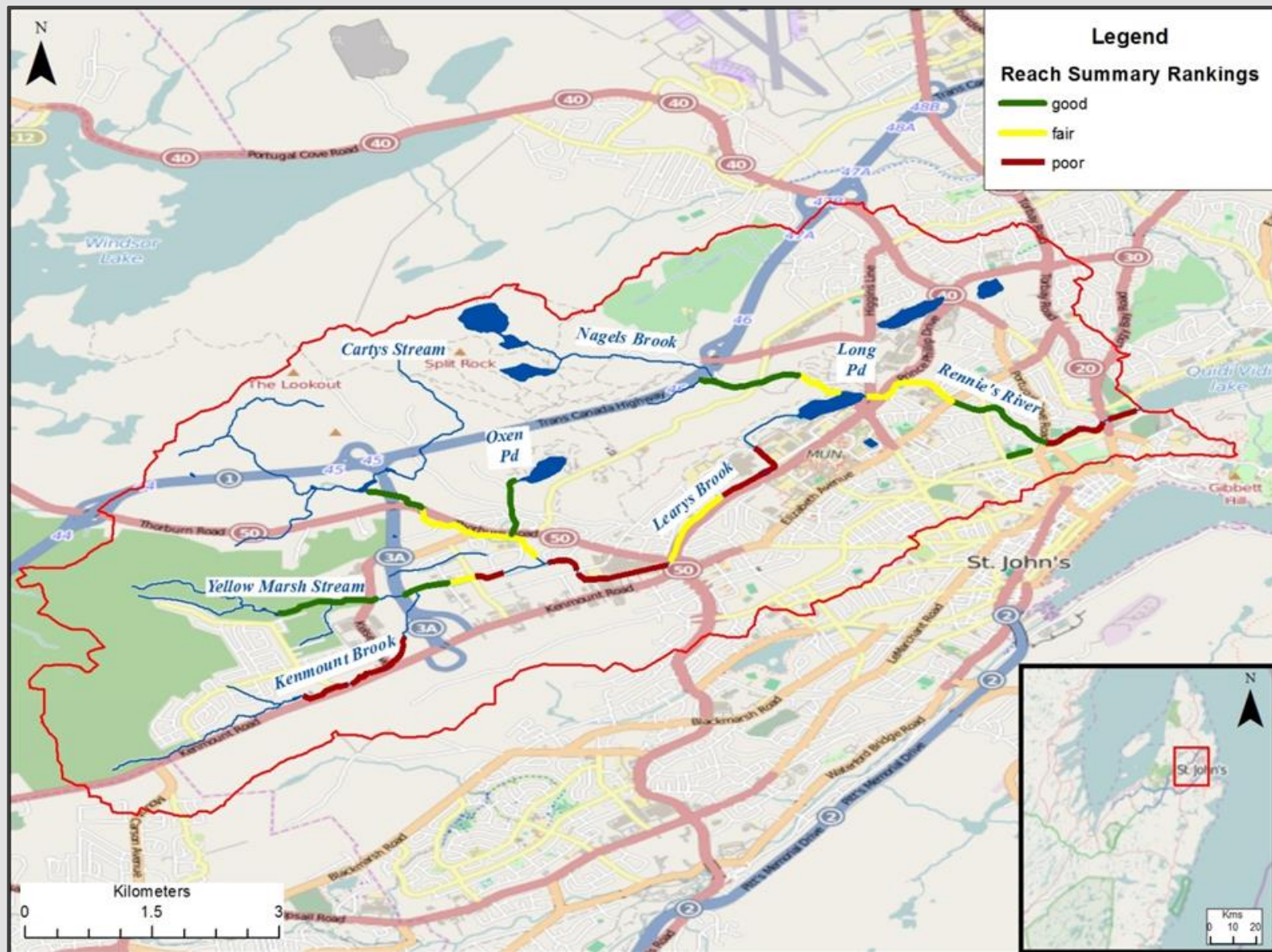


Figure 2. Color coded reach rankings for the Rennie's River / Learys Brook watershed, based on applying Visual Assessment Protocol methodology during Summer 2014.

Geographically, the reaches ranked as good were found towards the headwaters sections, where there was generally a lesser degree of

human influence (Figure 2). The exceptions to this were the reaches along Rennie's River between Portugal Cove Road and Elizabeth





Avenue (Reach 3 and Reach 4), including the daylighted section of Kelly's Brook (Reach 2A). Although surrounded by residential areas, Reaches 3 and 4 appeared to have healthy riparian vegetation, buffer zones between development intact and minimal amounts of channelization. The overall score of Reach 3 was negatively impacted mainly by a lack of canopy cover, while the overall score of Reach 4 was negatively impacted by a lack of pooling, as defined in the methodology. Although only a small section of an otherwise buried stream, Reach 2A scored as good as there was abundant riparian vegetation and the channel appeared to be in good condition.

This assessment reflects conditions at the time of the assessment. Since the assessment, changes within the watershed may alter the scoring that reaches received. One known case is in Reach 11, between O'Leary Avenue and where Leary's Brook is culverted under the Avalon Mall parking lot. The Salmonid Association of Eastern Newfoundland (SAEN) conducted instream and bank habitat improvement activities in that area after the assessment for this project, which would likely mean that scores would improve for the reach. Also, the assessment was conducted during the summer, meaning that water levels were generally at annual lows, which would impact scoring of some assessment factors, including pools.

Some reaches, particularly the lower ones, had access facilitated by a walking trail, while access to other reaches was more difficult and required treading through vegetation or even walking the stream bed. This variation in access resulted in varying vantage points to collect assessment information. Some areas between reaches and headwater portions were not assessed due to access or safety concerns, but it is believed that the watershed received adequate coverage for assessment as a large distance was covered.



Non-Native Invasive Plants

One issue that repeatedly appeared throughout the watershed was the presence of non-native invasive plants species. Eight of 12 non-native invasive species that were targeted were found during the assessments. The plants found were: Japanese knotweed (Figure 3a & 3b); black knapweed (Figure 5); Canada thistle; coltsfoot; goutweed (Figure 4); purple loosestrife; St. John's wort; and wild chervil. Data on the quantity of each species was not collected, but location information was noted during reach assessments, so that they could be located for future remediation efforts.

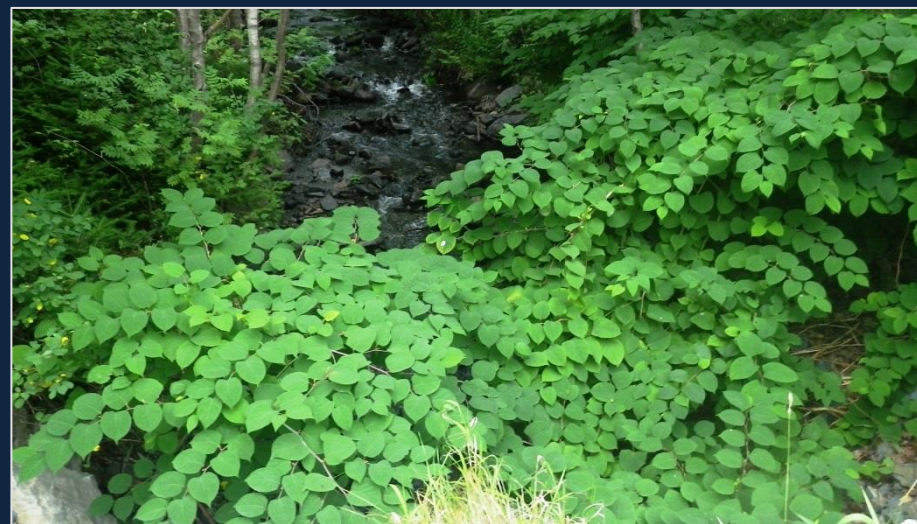


Figure 3a. Japanese knotweed, in the foreground, has covered the entire stream channel at Nagels Brook



Figure 4. Goutweed was found throughout the watershed.



Figure 5. Black knapweed (above) was found throughout the watershed



Figure 3b. Japanese knotweed growing adjacent to Leary's Brook, with a Green Team member adjacent to it for scale



Potential Barriers to Fish Passage

There were some areas encountered that contained possible barriers to fish passage. This is a concern for this watershed as it is habitat for salmon, brook and brown trout. While these fish species have varying habitat requirements and the exact conditions needed for each one to effectively pass an obstacle was not assessed, potential barriers were identified at a preliminary level. Further in depth assessment would be needed to determine if these potential barriers interfere with movement of a particular species.



Figure 6. Along Kenmount Brook, the cement casing for the culvert and a section of chain link fence has fallen into the river and has accumulated debris, and could be a barrier to fish passage.

Garbage and debris buildup were repeatedly noted as a potential source of barrier to fish passage. Grates that cover culverts and fallen trees collect garbage which has the potential to block passage. The condition or installation of stream crossing infrastructure was also often viewed as a potential source of barriers to fish passage. The drop height on the downstream end of culverts is commonly a barrier to fish passage, and was noted at numerous locations throughout the watershed. However, as no detailed measurements of the extent of the drop were collected, it is not possible at this time to conclude if they were barriers to specific fish species or life stages. Deteriorating stream crossings were also found throughout the watershed that could act as possible barriers to fish passage. There were some private driveway crossings that were found to be in disrepair and falling into the river channel. One such case was along Kenmount Brook, at the downstream end of the crossing for the business located at 350 Kenmount Road, where the cement casing surrounding the culvert and a section of chain linked fence have collapsed into the river. These structures are not only themselves blocking the flow, but are allowing garbage and debris to build there as well (Figure 6), enhancing the potential for blockage.



Garbage and Debris

Although not included in the nine assessment factors used for assessment, there were a number of locations that contained garbage or debris. This varied from areas of urban litter such as take-out garbage to larger debris including car parts. The locations of some notable occurrences of large debris were recorded for future clean ups (Figure 11 and Table 2). While effort was made to document the coordinates of large debris found during assessment, this is not necessarily a complete inventory of all large debris found along the studied waterways.

Shopping carts were a type of debris commonly found throughout the watershed, notably in areas near commercial development including the Avalon Mall and Kelsey Drive (Figure 7), but also further downstream towards the Health Sciences Centre. Car parts and various

metal pieces were also found (Figure 8), with excessive amounts in the upper portions of Leary's Brook, upstream and downstream of Thorburn Road. Figure 11 illustrates that large debris was only documented upstream of Long Pond, while no such debris was found downstream along Rennie's River. This is likely because there is a walking trail that borders the river. It is possible that in the past large debris that existed there was removed to improve aesthetics of the walking trail. It is also less likely that residential areas would act as a source for large debris and metal scrap such as shopping carts and car parts; these types of debris are more likely entering the river from commercial and industrial areas.

Although not documented in Figure 9 and Table 3, litter was found throughout the watershed. There were some areas where litter and garbage accumulated, such as in vegetation. Grates across culverts also often accumulated garbage (Figure 8 and Figure 9).



Figure 7. Large debris, including numerous shopping carts, found along the riverbank of Kenmount Brook behind Marks Work Wearhouse and Canadian Tire on Kelsey Drive (Reach 17).



Figure 8. Garbage accumulated on a grate covering the culvert at the Thorburn Road crossing of the Oxen Pond tributary (Reach 22).



Figure 9. Garbage accumulated on a grate covering a culverted inflow to Rennie's River found in Reach 1, downstream of Kings Bridge Road.





Figure 10. Large debris, metal car parts and tires, found in Reach 20, downstream of Thorburn Road. Debris of this nature was common between Critchs Path and Thorburn Road.

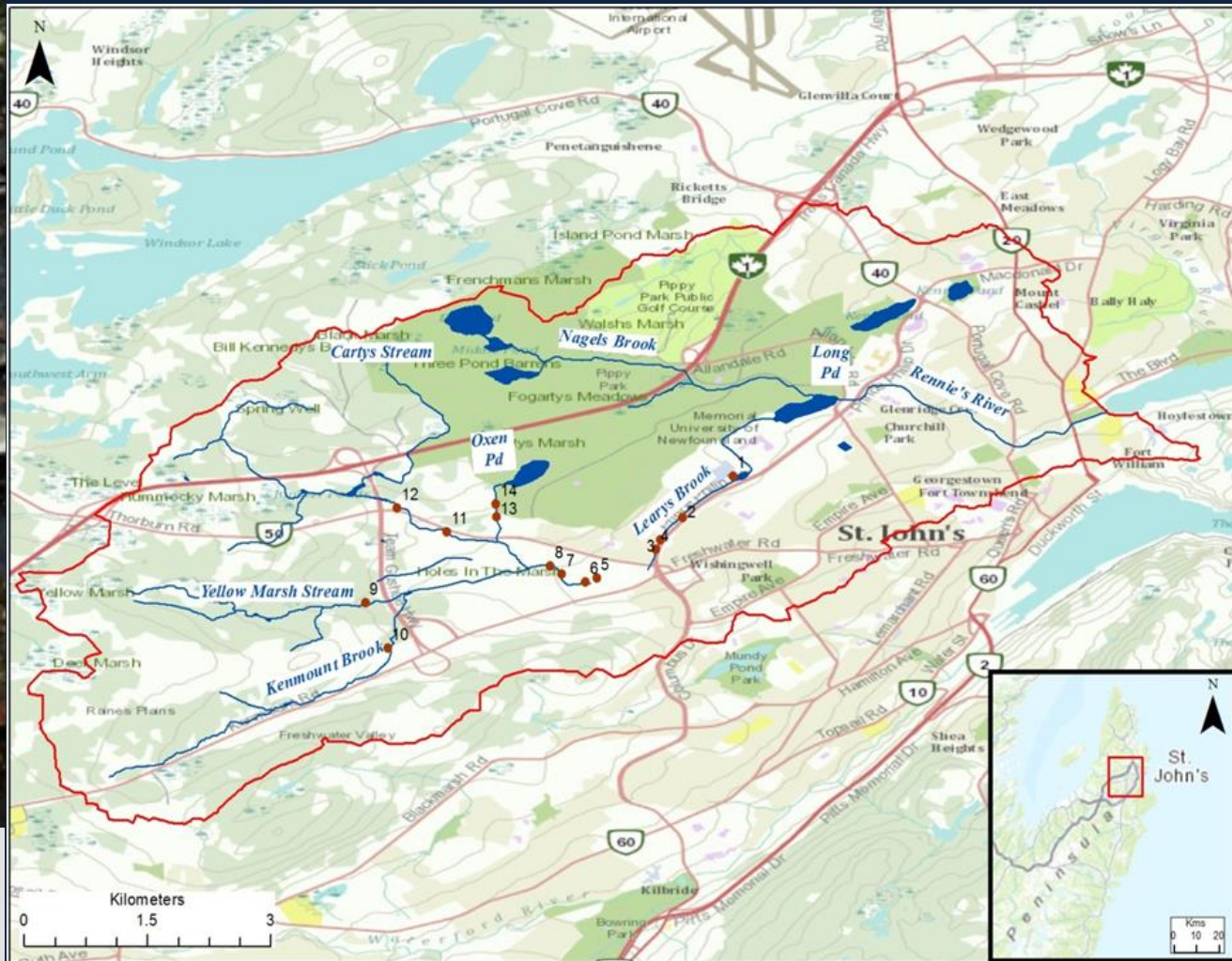


Figure 11. Map showing locations of large debris noted during assessment in 2014. Descriptions of each sighting are found in Table 3.

Number Assigned for mapping	Description
1	Shopping carts within pond next to Health Sciences Centre
2	Shopping carts and accumulating debris of a variety of types
3	Tire, street sign, other debris build up by Provincial real time monitoring station
4	Shopping cart in river
5	Shopping cart in fish ladder by mall parking lot, pallet in pooling area, accumulation of a variety of debris
6	Shopping cart in river by mall parking lot
7	Shopping cart well buried by substrate deposition
8	Metal debris scattered throughout this area of river
9	Large amount of fallen trees, catches other debris and garbage Just downstream of Kelsey Drive stream crossing
10	Shopping carts/large amounts of garbage found on hill behind Mark's Work Warehouse and Canadian Tire.
11	Rusted out car and parts littered around river, located on left bank touching the river flow
12	Private driveway has fallen into the river on the upstream side, causing rocks and debris to fall into opening of the culvert
13	Large piece of metal, about 10ft long located at the mouth of the culvert downstream of Seaborn Street
14	Old rusted cars and parts up a hill about 15ft away from the river

Table 2. Descriptions of debris found at locations throughout the Rennie's River / Leary's Brook watershed, as illustrated in Figure 11.



Bank Erosion and Stability

Erosion is a natural process, but can often be increased in urban settings due to the removal of riparian vegetation and increased volume and velocity of surface runoff from hard surfaces. In many cases during this assessment, steep slopes were experiencing erosion, likely exasperated by overland runoff from developed areas. In some cases bank erosion was decreasing the distance between the river channel and anthropogenic areas. One such case was along Yellow Marsh Stream downstream of Pippy Place, where the bank has eroded and exposed garbage that was buried in the past (Figure 12). Near this area, the opposite bank also showed instability; large rocks that were likely placed to stabilize the riverbank had fallen into the river.

Another issue found throughout the watershed is channelization. This is linked to bank erosion and stability as bank stability measures often have the disadvantage of channelizing, not only altering the shape of the channel and the flow dynamic, but also removing riparian vegetation. While stabilizing one area, stabilizing structures can sometimes create an erosional problem downstream, when accelerated flow velocities as a result of the hardening of the riverbanks erode areas downstream. In some areas channelization consisted of stream straightening, but with riparian vegetation present (Figure 13) while in others natural vegetation was mainly replaced by a hard surface (Figure 14).



Figure 14 (right).

The section of Yellow Marsh Stream downstream of Pippy Place has been straightened and channelized, and is now subject to stream hardening.

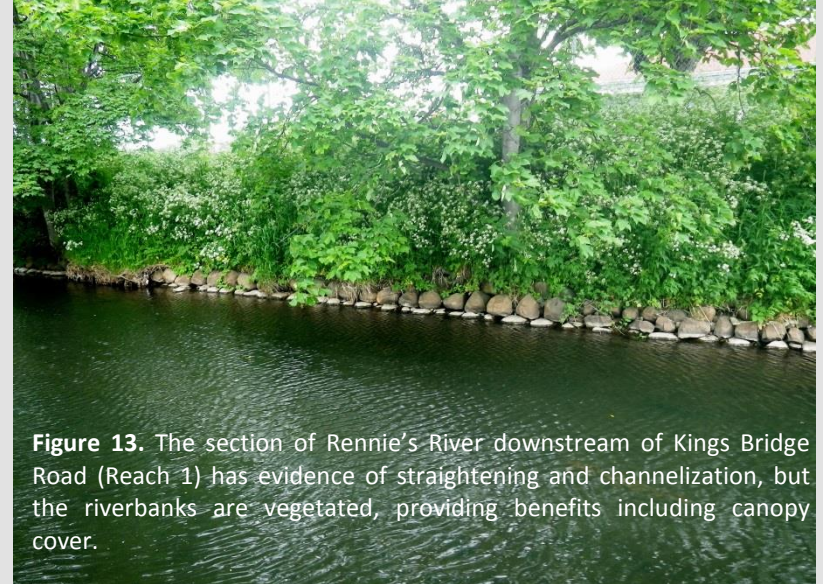


Figure 13. The section of Rennie's River downstream of Kings Bridge Road (Reach 1) has evidence of straightening and channelization, but the riverbanks are vegetated, providing benefits including canopy cover.



Figure 12 (above). Extensive bank erosion along Yellow Marsh Stream, upstream of where it meets with Learys Brook (Reach 13).

Inflows to Main Streams

Although not one of the nine assessment criteria for the assessment, information was also collected on the location of inflows to the main stream paths. These locations could be useful for future assessments, specifically to track pollution sources. Figure 15 shows inflows with

either water flowing from them or no water flowing from them at the time of assessment. As shown in Figure 15, there appears to be more inflows without flow than with flow. As assessment was conducted during summer, which is generally dry, it is likely that many of the inflows are storm sewer outlets.

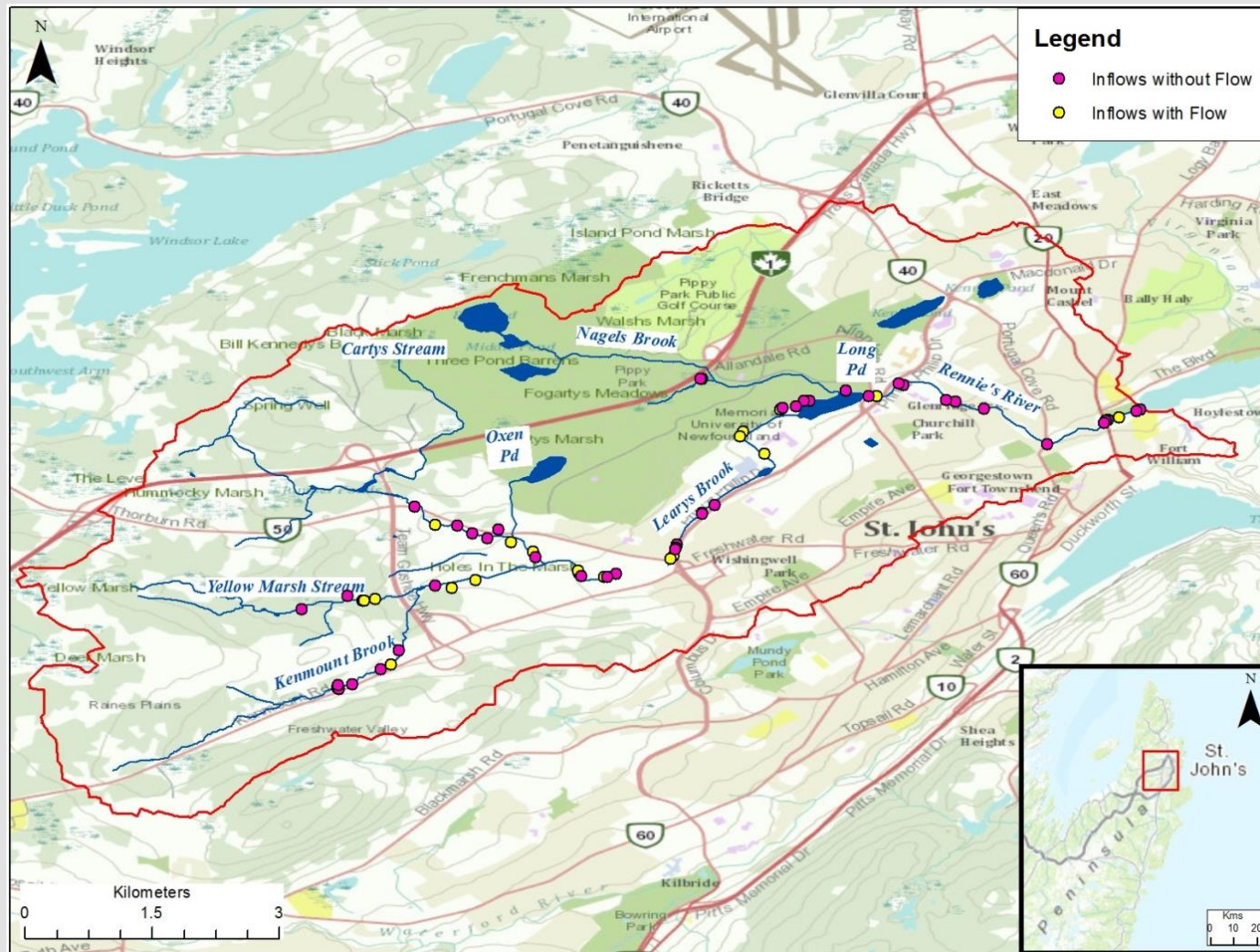


Figure 15. Recorded locations of inflows to the main streams, both with water flow and without water flow at the time of assessment.

RECOMMENDATIONS

The results of this project have identified a number of issues and problem areas throughout the Rennie's River / Learys Brook watershed. The scale of remediation needed for these varies based on their location and the nature of the problem. A summary of the following recommendations for improvement are contained in Appendix D.

Removal of invasive plants. One aspect of the riparian zone that could benefit from future attention is the vegetation assemblage. Non-native invasive plants were found throughout the watershed, with a heavier presence in some areas than others. Remediation is possible with further research on proper techniques for their removal. Native species could then be planted in place of the non-native species.

Planting of native trees and shrubs. Planting of native plant species could also be a priority in areas where bank stability or canopy cover is an issue. Further research is needed to determine the most appropriate species for these roles. Generally, areas in the vicinity of road crossings were sparsely vegetated and were often home to invasive plants. It should be noted that Rennie's River is slated for flood control measures as per the *Rennies River Catchment Stormwater Management Plan* and it would probably be best to undertake any planting initiatives along that river after any flood control measures are in place so that the plants are not impacted during the installation of the flood control measures. Native plants could also be incorporated into the design of these measures.

Develop and implement engineering solutions for erosion. Some areas experiencing bank erosion or instability are unsuited for planting as the sole remediation strategy. Steep slopes and those that showed extensive erosion will need further observation and engineering solutions. These solutions may involve the use of heavy equipment in some cases. It is important to be mindful of impacts on surroundings while installing bank stability structures, such as sediment control during installation; any changes to water flow velocity that may then increase erosion downstream; and incorporating vegetation into the design to recreate a natural riparian zone with adequate canopy cover. Ideally, options with minimum effects of stream hardening are preferred, such that streamflow velocity is not increased and ultimately increase erosion in downstream areas. The permeability of the material used in the stability control structure may be one factor that can help ensure this. One area requiring future bank stability measures is Yellow Marsh Stream downstream of Pippy Place, where one bank has eroded into the river (Figure 12), while on the opposite bank large rocks that were placed for stability have fallen into the water. Another area of extreme bank erosion is along Nagels Brook, in the vicinity of the white building which once housed Easter Seals. The section of Learys Brook between the Avalon Mall and Toys R Us is also experiencing bank erosion, with a narrow buffer remaining between the water and the parking lots.



Community cleanups. The extensive problem of garbage and debris is one that is identified without difficulty, but can be remediated easily in only some of the areas. Community cleanups allow for increased manpower to remove the garbage and are ideal for residential areas as residents can be involved. One area that would be a good location for a community cleanup is along the tributary from Oxen Pond, in the vicinity of Seaborn Street.

Source control for garbage. This same area, and many others, could benefit from covered public garbage cans, as garbage was noted in the vicinity of the garbage cans along the small trail between Seaborn Street and Thorburn Road, suggesting that it blew out of the cans. Leary's Brook along Prince Philip Drive could also benefit from a community cleanup, as it was found to contain both garbage and larger debris. Additionally, in commercial areas, the businesses should be encouraged to take ownership of their nearby stream reach, and to clean up surrounding their properties and ensure their waste is properly contained. Another source control action against garbage is the proper usage of commercial sized dumpsters to ensure garbage from them does not end up in the surrounding environment, as areas with garbage often corresponded to areas where dumpsters were present. This included the area surrounding Kelsey Drive, and the area between Mews Place and the Team Gushue Highway. Measures such as ensuring that a dumpster cannot blow open and not overfilling the dumpster are easily instated, while measures to ensure that garbage does not escape while emptying them may be more difficult as it may require an alteration to garbage trucks. It was noted that culverts with grates across them often caught garbage; regular cleaning of grates should be a priority to reduce the buildup. This would also assist with maintaining flowrates, as the garbage build up can block flow.

Removal of large debris. The removal of larger debris can be slightly more difficult than the removal of garbage, because of the size of the debris, and because it was often located in the water, requiring greater attention to safety during the removal. One area with a large number of shopping carts was behind Marks Work Wearhouse, where the carts were found mainly along the side of the river, but over a steep bank from the parking lot, making access more difficult. The area behind the Avalon Mall where shopping carts were also found has steep banks and will have to be accessed with caution.

Businesses taking ownership of their nearby stream. The reach between Thorburn Road and Critchs Path where various car parts and metal were found should be cleaned up. However, this area is also difficult to access. Ideally, the cooperation of some property owners in the area would facilitate the cleanup. Upstream of this reach there were numerous old car frames found along the river bank which appeared to be on private land and would also require the property owner's cooperation for removal.





Regular debris removal at grated culverts and maintenance, and regular monitoring of stream crossing infrastructure.

The condition of various stream-crossing infrastructure throughout the watershed is something that can also be improved. This is not only important from the perspective of fish passage, but is also important for ensuring that proper flow is maintained. Private stream crossings should be monitored to ensure that they are not in disrepair. The *Rennies River Catchment Stormwater Management Plan* has stream crossing evaluations contained in an Appendix, and could be a valuable start point for identifying infrastructure needing repair. The fallen culvert casing and chain link fence at 350 Kenmount Road should be cleaned up as it is an obvious problem which was identified in the *Rennies River Catchment Stormwater Management Plan* and during this project. Further fish passage studies on stream crossings are necessary to determine if they are barriers to the species specifically found in the watershed.

Increase public access by building trail systems along rivers and streams. Overall, increasing public access to the riverbanks via a walking trail seems to be effective at preserving the natural integrity of the river system and is an opportunity to utilize it for human benefit without solely relying on it for drainage purposes. This allows the river to be utilized for recreational purposes and instils a sense of ownership in residents which will in turn encourage people to care for the river system. Designing of trails should aim to maintain the natural setting of the area so as to not negatively impact the health of the watershed or contribute to the problems identified in this report.





CONCLUSION

In many aspects, the Rennie's River / Learys Brook watershed is functioning as an urban stream. It is able to support aquatic life, and has many areas that support a healthy riparian zone. Also, it has many sections that are providing aesthetic and recreational amenities for the community. However, as with all urban streams, it has problems that arise from coexistence with humans. With the efforts of local community groups, commercial and industrial operators, the City of St. John's and the public the condition of the Rennie's River / Leary's Brook watershed has seen improvements and can continue to improve. One existing success story from within the watershed is Kelly's Brook, which had its entire length culverted underground. A small section of Kelly's Brook has been day-lighted and now supports a lush riparian zone and fish life. If a piped river can transform to such a viable stream there is hope for future improvements for the sections that have not been subjected to burial.

With simple actions such as cleaning out debris, planting vegetation and reporting to the City areas with instability and large blockages, the stream condition in Rennie's River / Learys Brook would be greatly improved. Although these actions would not necessarily aid with issues that occur at the watershed level (such as high storm flows and pollution) these simple steps are a necessary component to improve stream ecosystems at small scales and symbolize our commitment to care and stewardship.





APPENDICES

Appendix A – Reach Assessment Ranking Scheme

Channel condition

Natural channel; no structures, dikes. No evidence of down-cutting or excessive lateral cutting.	Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levees are set back to provide access to an adequate flood plain.	Altered channel; <50% of the reach with riprap and/or channelization. Excess aggradation; braided channel. Dikes or levees restrict flood plain width.	Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the flood plain.
10	7	3	1

Bank stability

Banks are stable; banks are low (at elevation of active flood plain); 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation.	Moderately stable; banks are low (at elevation of active flood plain); less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the baseflow elevation.	Moderately unstable; banks may be low, but typically are high (flooding occurs 1 year out of 5 or less frequently); outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream annually, some slope failures apparent).	Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent).
10	7	3	1



Riparian zone

Natural vegetation extends at least two active channel widths on each side.	Natural vegetation extends one active channel width on each side. or If less than one width, covers entire flood plain.	Natural vegetation extends half of the active channel width on each side.	Natural vegetation extends a third of the active channel width on each side. or Filtering function moderately compromised.	Natural vegetation less than a third of the active channel width on each side. or Lack of regeneration. or Filtering function severely compromised.
10	8	5	3	1

Water appearance

Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks.	Occasionally cloudy, especially after storm event, but clears rapidly; objects visible at depth 1.5 to 3 ft; may have slightly green color; no oil sheen on water surface.	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film. or Moderate odor of ammonia or rotten eggs.	Very turbid or muddy appearance most of the time; objects visible to depth < 0.5 ft; slow moving water may be bright-green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface. or Strong odor of chemicals, oil, sewage, other pollutants.
10	7	3	1



Nutrient enrichment

Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present.	Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrates.	Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months.	Pea green, gray, or brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream.
10	7	3	1

Barriers to fish movement

No barriers	Seasonal water withdrawals inhibit movement within the reach	Drop structures, culverts, dams, or diversions (< 1 foot drop) within the reach	Drop structures, culverts, dams, or diversions (> 1 foot drop) within 3 miles of the reach	Drop structures, culverts, dams, or diversions (> 1 foot drop) within the reach
10	8	5	3	1

Instream fish cover

>7 cover types available	6 to 7 cover types available	4 to 5 cover types available	2 to 3 cover types available	None to 1 cover type available
10	8	5	3	1

Cover types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophyte beds, isolated/backwater pools, other: _____.



Pools

Deep and shallow pools abundant; greater than 30% of the pool bottom is obscure due to depth, or the pools are at least 5 feet deep.	Pools present, but not abundant; from 10 to 30% of the pool bottom is obscure due to depth, or the pools are at least 3 feet deep.	Pools present, but shallow; from 5 to 10% of the pool bottom is obscure due to depth, or the pools are less than 3 feet deep.	Pools absent, or the entire bottom is discernible.
10	7	3	1

Canopy cover (if applicable)

Coldwater fishery

> 75% of water surface shaded and upstream 2 to 3 miles generally well shaded.	>50% shaded in reach. or >75% in reach, but upstream 2 to 3 miles poorly shaded.	20 to 50% shaded.	< 20% of water surface in reach shaded.
10	7	3	1

Overall score (Total divided by number scored)	<6.0	Poor
	6.1-7.4	Fair
	7.5-8.9	Good
	>9.0	Excellent



Appendix B - Visual Assessment Protocol Results

Table B1. Scoring for each reach assessed in the Rennie's River / Learys Brook watershed, including scores for each of the nine assessment factors, the overall (average) score and its associated ranking

Reach Number and extent:	River	Overall Score	Overall ranking	Assessment Factor Scores								
				channel condition	bank stability	riparian zone	water appearance	nutrient enrichment	barriers to fish movement	instream fish cover	pools	canopy cover
1 – Quidi Vidi to Kings Bridge Rd.	Rennie's River	5.89	poor	5	4	8	7	8	10	8	2	1
2 - Kings Bridge to Portugal Cove Rd.		5.78	poor	3	1	4	7	7	10	8	2	10
2A- Kelly's Brook behind St. Pat's Field	Kelly's Brook	8.7	good	8	10	10	8	7	9	8	7	10
3- Rennie's Mill Park (Portugal Cove Rd) to Carpasian Rd.	Rennie's River	7.83	good	9	8	9	8.5	8	10	8	7	3
4-Carpasian Rd.to Elizabeth Av.		7.61	good	8	9	9	7	8.5	10	8	1	8
5- Elizabeth Av to Prince Philip Dr.		7.3	fair	7	6	8	7	8	10	10	7	3
6- Prince Philip Dr. to Allandale Rd.		6.56	fair	8	7	8	8	9	10	5	3	1



Reach Number and extent:	River	Overall Score	Overall ranking	Assessment Factor Scores								
				channel condition	bank stability	riparian zone	water appearance	nutrient enrichment	barriers to fish movement	instream fish cover	pools	canopy cover
7-Allandale Rd, along Long Pond to Autism Society (north shore)	Long Pond	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8- Long Pond from Autism Society to Allandale (south bank)		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9- Leary's Brook Bridge (on Long Pond trail) to Western Clinch Cres.	Leary's Brook	5.2	poor	8	9	7	6	5	10	8	1	3
10- Clinch Cres. to Thorburn Rd.		6.9	fair	7	8	9	6	8	10	8	3	3
11- Avalon Mall to O'Leary Av.		3.6	poor	1	1	3	6	7	5	5	3	1
12- O'Leary Av. to junction of Leary's Brook and Yellow Marsh Stream		4.4	poor	2	1	3	7	7	10	5	3	2



Reach Number and extent:	River	Overall Score	Overall ranking	Assessment Factor Scores								
				channel condition	bank stability	riparian zone	water appearance	nutrient enrichment	barriers to fish movement	instream fish cover	pools	canopy cover
13- Junction of Leary's Brook and Yellow Marsh Stream (behind Creative Brick and Tile) to Pippy Pl.	Yellow Marsh Stream	5.7	poor	6	4	6	7	5	9	8	3	4
14- Pippy Pl. to Mews Pl.		6.4	fair	5	7	9	7	6	10	8	3	3
15- Mews Pl. to Team Gushue Hwy.		8.7	good	9	10	10	7	7	8	10	7	10
16- Downstream of Kelsey Dr. to Ariel Place		8.3	good	8	8	8	8	7	9	10	7	10
17- Team Gushue to Kenmount Court (Wing'n It)	Kenmount Brook	3.8	poor	2	6	3	3	5	5	5	2	3
18-Kenmount Court (Wing'n It) to Roberts Lane (behind Esso, Kenmount Rd)	Kenmount Brook	4.2	poor	3	4	2	3	5	5	8	5	3
19- Keyin College parking lot to Goldstone St.	Leary's Brook	7.3	fair	5	5	8	8	10	10	10	3	7



Reach Number and extent:	River	Overall Score	Overall ranking	Assessment Factor Scores								
				channel condition	bank stability	riparian zone	water appearance	nutrient enrichment	barriers to fish movement	instream fish cover	pools	canopy cover
20- Goldstone St. to Thorburn Rd.		7	fair	8	3	9	6	7	5	8	7	10
21- Thorburn Rd to Juniper Pond		7.5	good	6	6	9	8	6	5	8	10	10
22- Thorburn Rd. to Groves Rd.	Oxen Pond Tributary	8	good	7	8	8	10	8	5	8	10	8
23- Groves Road to Oxen Pond		7.9	good	8	8	9	10	10	10	5	1	10
24- Fluvarium to Former Easter Seals Bldg/ 'old laundry'	Nagels Brook	7.4	fair	4	7	8	10	10	1	8	9	10
25- Easter Seals/ 'old laundry' to Mount Scio Rd.		8.7	good	9	8	10	10	10	10	8	3	10
26 Mount Scio Rd. to Outer ring Road		8.3	good	10	10	9	10	8	10	5	3	10

Appendix C - Overall summary of the number of reaches ranked as each of the four classifications.

Reach Number	Description	Overall Ranking	Summary of Issues Found
1	Quidi Vidi to Kings Bridge Rd.	Poor	Channelization, incidents of slope failure, low amount of canopy cover, lack of pools, abundance of garbage (especially along grate covering inflow)
2	Kings Bridge to Portugal Cove Rd.	Poor	Channelization, narrow buffer zone, unstable banks, lack of pools
3	Rennie's Mill Park (Portugal Cove Rd) to Carpasian Rd.	Good	Low amount of canopy cover
4	Carpasian Rd.to Elizabeth Av.	Good	Lack of pools
5	Elizabeth Av to Prince Philip Dr.	Fair	Areas of erosion, low amount of canopy cover
6	Prince Philip Dr. to Allandale Rd.	Fair	Low amount of canopy cover, low amount of instream cover, one side of Prince Philip Dr. bridge blocked with concrete, lack of pools, some bank erosion
9	Leary's Brook Bridge (on Long Pond trail) to Western Clinch Cres.	Poor	Low amount of canopy cover, lack of pools, algae present, presence of garbage/ debris



Reach Number	Description	Overall Ranking	Summary of Issues Found
10	Clinch Cres. to Thorburn Rd.	Fair	Low amount of canopy cover, lack of pools, presence of garbage/ debris
11	Avalon Mall to O`Leary Av.	Poor	Portion of reach is culverted underground, heavy concrete presence along banks, bank erosion, narrow buffer zone, lack of pools, low amount of canopy cover, presence of garbage/debris, heavy presence of non-native plants
12	O`Leary Av. to junction of Leary`s Brook and Yellow Marsh Stream	Poor	Channelization, bank erosion, sparse vegetation, lack of pools, low amount of canopy cover
13	Junction of Leary`s Brook and Yellow Marsh Stream (behind Creative Brick and Tile) to Pippy Pl.	Poor	Channelization, bank erosion, low amount of canopy cover, lack of pools, heavy presence of non-native plants
14	Pippy Pl. to Mews Pl.	Fair	Channelization, lack of pools, low amount of canopy cover, heavy presence of non-native plants
15	Mews Pl. to Team Gushue Hwy.	Good	Presence of garbage/debris, heavy presence of non-native plants
16	Downstream of Kelsey Dr. to Ariel Place	Good	Channelization, heavy presence of non-native plants
17	Team Gushue to Kenmount Court (Wing`n It)	Poor	Channelization, heavy presence of non-native plants, water discolored, barriers to fish passage, lack of pools, low amount of canopy cover, presence of garbage/debris, failed silt fencing



Reach Number	Description	Overall Ranking	Summary of Issues Found
18	Kenmount Court (Wing'n It) to Roberts Lane (behind Esso, Kenmount Rd)	Poor	Channelization, sparse vegetation, water discolored, algae present, some barriers to fish passage, low amount of canopy cover , heavy presence of non-native plants
19	Keyin College parking lot to Goldstone St.	Fair	Channelization. bank erosion, lack of pools, heavy presence of non-native plants
20	Goldstone St. to Thorburn Rd.	Fair	Bank erosion and slope failure, barriers to fish passage, presence of garbage/debris, heavy presence of non-native plants
21	Thorburn Rd to Juniper Pond	Good	Barriers to fish passage, heavy presence of non-native plants
22	Thorburn Rd. to Groves Rd.	Good	Barriers to fish passage, presence of garbage/ debris, heavy presence of non-native plants
23	Groves Road to Oxen Pond	Good	Lack of pools, presence of garbage/debris, heavy presence of non-native plants
24	Fluvarium to Former Easter Seals Bldg/ 'old laundry'	Fair	Channelization, heavy presence of non-native plants
25	Easter Seals/ 'old laundry' to Mount Scio Rd.	Good	Lack of pools, heavy presence of non-native plants
26	Mount Scio Rd. to Outer Ring Road	Good	Lack of pools, heavy presence of non-native plants



Appendix D - Recommendations for improvements to the riparian and riverine areas of the Rennie's River / Leary's Brook watershed.

Problem	Recommendation for Remediation Action	Locations
Invasive plants found throughout, with varying intensity	Removal of invasive plants	<ul style="list-style-type: none"> – Throughout the watershed – Areas near road crossings
Riparian zone sparsely vegetated	Planting of native trees and shrubs	<ul style="list-style-type: none"> – Areas near road crossings – Areas where invasive plants are removed – Areas lacking canopy cover and areas with surface erosion – Incorporated into the design of flood control measures slated for Rennie's River
Bank erosion	Develop and implement engineering solutions for erosion	<ul style="list-style-type: none"> – Yellow Marsh Stream downstream of Pippy Place (Reach 13), where both banks are experiencing erosion. – Nagels Brook, at the site of the old laundry building, more recently used to house the Easter Seals office (Reach 24) – Leary's Brook, section between the Avalon Mall and Toys R Us (Reach 11)
Litter	Community cleanups	<ul style="list-style-type: none"> – Seaborn Street area (Reach 22) – Leary's Brook along Prince Philip Drive (Reach 9 and 10)



Problem	Recommendation for Remediation Action	Locations
Ongoing litter spread	<p>Source control for garbage</p> <ul style="list-style-type: none"> – keeping garbage placed in garbage cans and dumpsters. – covered garbage cans in public areas and along trails – keeping commercial dumpster continuously covered and ensuring that they are not overfilled – adjusting collection trucks to reduce the amount of garbage escape during the transfer from the dumpster to the truck 	<ul style="list-style-type: none"> – Garbage cans and commercial dumpsters along river
Flow blockages	<ul style="list-style-type: none"> – Regular debris removal at grated culverts – Maintenance and regular monitoring of stream crossing infrastructure 	<ul style="list-style-type: none"> – Grated culverts that were observed to retain debris and garbage – The crossing located at 350 Kenmount Road (Reach 17)
Industrial and commercial waste	Businesses taking ownership of their nearby stream	<ul style="list-style-type: none"> – Industrial and commercial areas
Lack of public oversight of stream conditions	Increase public access by building trail systems along rivers and streams	<ul style="list-style-type: none"> – Areas upstream of Long Pond to headwaters





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