Petitcodiac River Causeway project

Stage 2 Follow-up Program
Year 4 Results

Executive Summary

Submitted to:

New Brunswick Department of

Transportation and Infrastructure

Fredericton, New Brunswick

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Fredericton, New Brunswick

December 2014

TE8300229

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1.0 INTRODUCTION

1.1 PURPOSE

This document is a summary of the results of Year 4 of the Stage 2 Follow-up Program (S2FUP) for the Petitcodiac Causeway Project (the "Project"). Year 4 results are compared to baseline conditions established during the Stage 1 Follow-up Program with respect to predictions and conclusions contained in the Environmental Impact Assessment (EIA) and provide a measure of the effectiveness of mitigation measures undertaken in Stage 1. The predictions and conclusions contained in the EIA are generally focused on conditions that will be present following completion of Project Option 4B (the bridge); therefore it is not possible to verify these during Stage 2 of this three stage Project. This document focuses on how the environmental effects observed during Year 4 of Stage 2 are trending as compared to the EIA predictions and conclusions specific to Stage 3 and beyond. The document focuses on the findings and conclusions relevant to the seven Valued Ecosystem Components (VECs, see Section 1.3).

For a comprehensive description of background, methodology, references, and a more complete presentation of the results the reader is encouraged to refer to the main report, which is available from the New Brunswick Department of Transportation and Infrastructure by contacting the Communications Director:

1.2 FOLLOW-UP PROGRAM OBJECTIVES

The S2FUP objectives are to:

- Examine trends in environmental conditions for selected VECs to determine how environmental conditions are trending in regards to the environmental effects predictions in the EIA.
- Verify the effectiveness of mitigation measures to protect physical works installed during Stage 1.
- Provide an early indication of any unexpected change in environmental conditions.
- Improve understanding of environmental cause and effect relationships.

1.3 SCOPE

The S2FUP focuses on seven VECs:

- Physical Characteristics of the Petitcodiac River and Estuary
- Tourism
- Commercial Fisheries
- Archaeology
- Public Health and Safety
- Engineered Environmental Protection Works
- Fish Passage

1.4 REGULATORY CONTEXT

The EIA required a Follow-up Program that would satisfy the objectives presented above. The S2FUP is a key component of the Environmental Management Plan (EMP), and is required as per Condition of EIA Approval (4). The S2FUP is divided into stages that correspond with the Implementation Plan, as per Condition of EIA Approval (5), and has been and will continue to be submitted to the New Brunswick Department of Environment and Local Government (NBDELG) for review and approval when required. The S2FUP is also required under the *Canadian Environmental Assessment Act* (*CEAA)* as a condition of the *CEAA* Screening undertaken by Fisheries and Oceans Canada (DFO). A Technical Review Committee (TRC), comprised of federal and provincial agency and department representatives, presided over the EIA process. The TRC was co-chaired by NBDELG, and DFO acting as the federal lead Responsible Authority. A similar TRC, chaired solely by NBDELG with input from DFO, was assembled to preside over the implementation of the Project.

2.0 PHYSICAL CHARACTERISTICS

2.1 OBJECTIVES

The objective of this component is to monitor and measure changes to the Petitcodiac River (hereinafter River), the Petitcodiac Estuary (Estuary), and the Upper Bay of Fundy after gate opening in order to understand effects on width, depth, and other physical characteristics as compared to baseline conditions.

2.2 RESULTS

2.2.1 Aerial Photography

Aerial photographs were obtained in Year 4 of Stage 2, using similar methods as in Stage 1, and in the preceding years of Stage 2. Except where noted, the flights extended from Salisbury to Hopewell Cape Rocks, a linear distance of about 65 km. Details of the timing and conditions under which air photos were obtained are presented in the main report. Generally, images were taken near low tide so that the mudflats were exposed. The results are summarized as follows:

Immediate vicinity of the control structure: The main channel is well developed and the mudflats were well established with local drainage channels being formed on the mudflats and adjacent to the causeway.

Immediately downstream of the Gunningsville Bridge: The planform of the estuary at this location in 2013 was similar to that in 2011. The overall channel geometry is tending to smooth out the former abrupt bend in this area.

Near the GMSC outfall: The mudflats on the upper east side of the channel have grown appreciably between September 2011 and November 2013. The mid-channel bar to the north evident in 2009 has been greatly reduced and an ebb flood channel developed. In the most recent image of November 2013 small drainage channels have become established on the surface of the developing mudflat.

10.5 km downstream of the causeway: This area now has a well-developed ebb channel (west) and flood channel (east) whereas in 2009 there was only a single channel. The ebb and flood channels are separated by a low water mid-channel bar. The flood channel is both enlarging and migrating upriver. .

2.2.2 Cross-sections

All references to "right" or "left" are taken as looking upstream.

2.2.2.1 Upstream of the Causeway

- **At km 1.1:** As of November 2013 extensive mudflats have developed on both sides of the channel to elevation +6.4 to 6.6 m±, a rise of 3.9 to 5.2 m since May 21, 2009. The channel width at elevation 4.0 m has narrowed from about 440 m on May 21, 2009 to about 175 m in November 2013. The LiDAR survey in November 2013 did not provide the bottom elevation below water level.

- **At km 6.1:** (just downstream of Turtle Creek) The channel bottom has varied between elevation 1.0 m and -1.0 m± depending on the season. Mudflats have formed on the left to an elevation of 6.4 m± increasing in height by about 3 m since May 2009. The river channel width at elevation 4.0 m has narrowed from greater than 230 m in May 2009 to 117 m in November 2013.

- **At km 15.2:** LiDAR surveys in 2012 and 2013 show that narrow mudflats have formed on the left bank to elevation 6.4 m± with a depth of deposition of about 2.5 to 3.0 m since the gates were opened. The main channel width at elevation 6.0 m has reduced from 138 m in 2008 to 96 m in 2013.

2.2.2.2 Downstream of the Causeway

- **At km 0.9:** the channel width, at an elevation of 2.0 m, has increased by about 23 m on the right up to November 5, 2013, an increase of about 5.0 m since the same time last year.

- **At km 5.1:** The seasonal accumulation of silt in the bed has been greatly reduced after the gate opening. The section has widened on the left (Riverview side) by about 27 m since 2009 at an elevation of 2.0 m with an increase of about 1.0 m since 2012.

- **At km 7.3:** (Chartersville area) This cross-section exhibits some of the most substantial changes along the reach from the causeway to Hopewell Cape. The channel bed has slightly increased in elevation in 2012. The left bank has widened by about 80 m at elevation of 2.0 m since 2009, but actually narrowed about 4.0 m since 2012.

- **At km 19.5:** (about 4 km upstream of Stoney Creek) Most of the changes are restricted to the riverbed which has deepened by about 2.5 m on average. The left bank at an elevation of 2.0 m has widened by about 35 m since 2009 with a change of 3.0 m since 2012, whereas the right bank has not changed to any significant degree.

- **At km 35.9:** (Hopewell Cape) The section on November 30, 2013 is very similar to that of November 2009, except that the thalweg is now down to the level of 1991, indicating that there has been little net change in this section since the gates were opened.

2.2.2.3 Upper Bay of Fundy

- **At km 39.2:** (Calhoun Flats) There has only been a marginal increase in silt accumulation since 2012.
- **At km 42.8:** (Grand Anse) The bed level in the central portion of the section (Middle Ground area) has risen about 0.5 to 2 m over a width of about 2500 m since 2010 with the peak in November 2013 being about 0.4 m higher than in November 2012. This rise in the bed level is attributed to the net erosion of sediment from the estuary upstream of Hopewell Cape, which is being transported downstream and is now depositing in the upper part of Shepody Bay.
- **At km 48.8:** (Daniels Flats) A deposition of about 3 m over a width of 1000 m has occurred in the deepest part of the Bay since 2010, with additional deposition of about 0.4 m since 2012.

2.2.3 Channel Profiles along the Estuary

2.2.3.1 Thalweg Profiles

The thalweg profile represents the lowest elevations along the length of the Estuary and provides a means of assessing areas where water may pond during periods of low tide and low flow from the land.

Estuary: The thalweg elevation is to some extent a function of the antecedent river flow conditions; if the survey falls in a period following a long sequence of low fresh water flows then the riverbed will be elevated due to the seasonal silt depositions.

"Mud Plug": There is a mound of material over the old water main followed by a secondary scour hole about 1.5 m deep with a secondary mound about 50 m further upstream. The former waterline located approximately 160 m upstream of the control structure is now a hydraulic control point in the channel and has caused an additional scour hole and mound further upstream in response to flows during the flood tide.

The obstruction caused by the old watermain limits the outflow from the lower several kilometres of the upstream reach and is directing flow towards the Riverview bank with subsequent erosion on the bank so that the old watermain is now exposed. In winter, during low tides large blocks of ice have grounded on this area.

Scour Hole (at control structure):

Upstream: Conditions have stabilized and any additional scour in the future at this site should be relatively small. The peak tidal inflows are not likely to increase over time. The deepest part of the scour hole is located about 36 m upstream of the upstream extent of the concrete slab associated with the bridge crossing at the control structure. The slope of the hole is in the order of 1V:6H and should not negatively impact the control structure. However, the monitoring should continue at least twice a year near the time of the peak flow from the land in the spring and fall.

Downstream: It is expected that the peak tidal outflows will decrease over time. As a consequence, it is predicted that the depth of the scour hole downstream of the control structure should not increase to any significant degree over time.

2.2.3.2 Tidal Flats

The amount of suspended sediment that is transported from the land is extremely low compared to the suspended sediment transported by tidal action in the estuary. Some of the sediment that is transported upstream of the control structure in the causeway is deposited on the channel bed and when the tidal elevation exceeds the top of the developing tidal flat some of the sediment is deposited on the tidal flat. The suspended sediment that deposits on the tidal flats is more or less locked in place and is not entrained in the flow during the ebb tide. When the tidal flat is below mean high tide elevation, a deposit of about 3 mm occurs during each tidal cycle. The estimate of 3 mm is based on observations made in deposits on the tidal flats that formed downstream of the causeway after the gates were placed in operation in 1968. With 706 tidal cycles per year, the maximum annual deposition is expected to be roughly 2 metres until the tidal flat exceeds the mean high tide level at which time the rate of annual deposition will decline. Once the tidal flat is formed, the only sediment that is eroded from the surface is that associated with local drainage channels on the surface of the tidal flat.

Most of the tidal flat development is taking place between the control structure and the confluence of the Petitcodiac estuary with Turtle Creek.

Based on historic observations, it is anticipated that the tidal flats upstream of the causeway will start to become colonized by vegetation by about 2018. Some vegetation has started to appear in 2013.

In the long term, the planform of the channel could change in the area between the causeway and Turtle Creek if ebb flow and flood flow channels should begin to diverge. The enlarged ebb flow-flood flow channel could move laterally into the newly deposited sediments that form the tidal flats upstream of the causeway. This process, if it occurred, would increase the tidal storage upstream of the control structure.

2.2.3.3 Channel Width Relationships

In order to assess the changes in the channel both upstream and downstream of the causeway, width at elevations 2.0 m and 4.0 m were measured.

Upstream of the Control Structure: The channel width has contracted significantly in the lower portion of this stretch and has reached a relatively stable position within a year or less of the gate opening. There has been some narrowing of the channel up to the railway bridge at Salisbury. It is likely that some of the narrowing identified in 2013 is associated with seasonal silt which built up during low flows from the land in late summer and fall of 2013. The 2013 LiDAR survey shows that in November there was still over 2 m of seasonal silt in the riverbed at the Gunningsville Bridge and the months of August to October had low fresh water flows.

Downstream of the Control Structure: This section has not shown much change since 2012 and the rate of widening has slowed significantly.

2.2.4 Bottom Sediment Samples

2.2.5 Ground-level Observations

Ground-level observations were carried out on both the left and right bank of the Petitcodiac River from Salisbury to Hopewell Cape seasonally from May 2010 to December 2013. In addition to the shoreline surveys, site visits were also made to the Hopewell Cape Park (The Rocks) to determine if changes in the river flows related to the opening of the causeway gates have resulted in noticeable silt build up on the beach areas.

As a general observation, no discernable changes in the shoreline at the lower portions of the estuary were noted. Furthermore, flow from the land in the small creeks flowing into the Petitcodiac appear unaffected by the opening of the gates, and the silt build up in the mouth of Halls Creek and Jonathan Creek immediately downstream from the causeway was less than was observed seasonally prior to opening of the gates, due to the deepening of the river bottom in these areas. No appreciable silt build up was observed on the Hopewell Cape beach.

During the winter and spring months particular attention was paid to the build-up of both shorefast ice and sheet ice in the estuary since ice being transported by the flow has the potential to damage the causeway gates or jam the opening in the control structure or the approach channel. While shorefast ice did build up to comparable levels of past years in both the river and its tributaries, we did not observe the typical number of large ice cakes either on the adjacent marshes or more importantly in the river during the winters of 2011, 2012 and 2013, and as a result no concerns with respect to the safe passage of ice through the gates were reported. The winter of 2011 and 2012 were particularly mild while the winter of 2013 appears to be more typical in terms of colder temperatures. The formation and melting of the ice cover and the shorefast ice and that ice may become more significant in future years.

Conditions of the river and tributaries downstream of the control structure during the winters of 2012 and 2013 appeared to be similar to that of past winters with respect to the build-up and passage of ice. Tributaries such as Halls Creek, Jonathan Creek, Mill Creek, Weldon Creek, and Stoney Creek experienced a significant build-up of shorefast ice, resulting in a narrowing of the channel. Likewise, the upper portions of the Petitcodiac River downstream of the control structure narrowed as in past winters due to the formation of shorefast ice. Above the control structure significant narrowing of the river occurred as a result of both the build-up of shorefast ice and the presence of stranded ice deposited by incoming tides. For much of the winter of 2012 and 2013 the river upstream of Turtle Creek was frozen over.

Ice passage did not cause any significant problems for the control structure, although NBDTI does monitor the situation and carried out periodic de-icing of the gates during the winter months as a precautionary measure.

2.2.6 Sediment Deposition, Erosion and Net Accumulation

For Year 4 the hydrographic data were supplemented by a LiDAR survey upstream to capture the elevation of the mudflats upstream of the causeway which are no longer accessible by boat.

The following estimates are provided for changes in volume during the monitoring period:

- **Upstream of the Causeway -** Between April 2010 and November 2013 approximately 6.6 million m^3 of silt accumulated in the former reservoir mainly in the form of mudflats which have now reached an elevation of 6.4 - 6.6 m±. In addition to the permanent infilling, about 2.0 to 2.5 million m^3 of sediment moves into the upstream area in the summer and is eroded out in the subsequent fall or spring.

- **Causeway to Hopewell Cape -** Between April 2010 and November 2013 a net erosion of approximately 45.8 million m^3 has occurred in this reach. The most active widening of the river seems to be between Dieppe and Upper Dover. This is an increase of 3.0 million m^3 since last year.

- **Shepody Bay (Post-Gate Opening) -** The volume changes in Shepody Bay over the period April 2010 to November 2013, indicate that the net difference between the total estimated erosion downstream, from the causeway to Hopewell Cape, and deposition upstream at the causeway should approximate the deposition in Shepody Bay.

  The general limits of deposition in Shepody Bay over the period 2009-2013 indicate that the major portion of the deposition is occurring in an area shown as the “Middle Ground” on the hydrographic charts, an area which was dry at low water in 1965 but which subsequently disappeared and is now rebuilding

2.2.7 Estuary Volume and Tidal Prism

Upstream of the causeway the estuary volume was measured from the November 2013 LiDAR survey accounting for the mudflats which have now reached +6.4 to +6.6 m. The rates of erosion and deposition are occurring more rapidly than predicted by the numerical modelling, but are in general agreement with initial volumetric projections. As well, the area of most change is located 5 to 15 km downstream of the causeway and is in line with the EIA projections.

When the gates were initially opened the tidal prism (or volume of water coinciding with the elevation of the upstream high tide level and the low tide elevation) was increased immediately by about 19.0 x 10^6 m^3 or about an 8% increase from the April-May 2002 value due to the increased tidal volume in the former headpond. This has decreased by November 2013 to about 14.0 x 10^6 m^3 due to channel narrowing and mudflat build-up upstream of the causeway. Note that this is a decrease of 5 x 10^6 m^3 instead of the 6.6 measured. This is because initially a tide level of 7.75 downstream only filled the headpond to elevation 6.55 m whereas in 2013 it filled it to elevation 7.25 m. Therefore the tidal prism volume did not decrease as much as the total volume.

At the same time the tidal prism downstream of the causeway has increased by an estimated 25 x 10^6 m^3 and the total volume by 46 x 10^6 m^3.

Thus the increase on the total tidal prism in the estuary since 2002 is now about 37 x 10^6 m^3 or 14% greater than in 2002 or about 18% greater than the tidal prism was projected to be when the gates were opened. The rate of erosion is at least double than predicted in the EIA but the total increase in the tidal prism is still well below that predicted to eventually occur.

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3.0 COMMERCIAL FISHERIES

3.1 OBJECTIVES

The objective of this component is to determine how the Project affects commercial fisheries landings; specifically lobster and scallop in the Upper Bay of Fundy. The eel fishery in the Estuary was compensated for loss of fishing opportunity.

3.2 RESULTS

3.2.1 Sediment

In Years 1 to 4, the Physical Characteristics of the River program has demonstrated that almost all of the redistributed sediment can be accounted for in the area of the Middle Ground and upstream of the causeway. There is no evidence of large amounts of sediment entering the Bay of Fundy from the Petitcodiac River. The program also shows that the rate of redistribution is slowing. Taking this into consideration, and that the channel opening at the causeway is static for the duration of Stage 2, there is no reason to suspect that sediment will be redistributed into areas causing adverse environmental effects on lobster landings for the duration of Stage 2. As such, site specific measuring of hydrological and suspended sediment conditions in the estuary, including ADCP events and the collection of vertically integrated suspended sediment samples at the Gunningsville Bridge and during Bay cross-section surveys have been discontinued in Stage 2 Year 4.

In Year 4 and beyond, the continued cross-sectional surveys throughout the estuary and the Bay will be used to monitor for any changes in conditions as a result of sediment flux.

3.2.2 Lobster

At-sea sampling was only carried out during the spring of Year 4. No out-of-season or fall data were collected. To replace these data, logbook catch data were analyzed.

Overall the catch per unit effort of legal lobsters in commercial traps during Stage 2 (2010 through 2012) in both the Control and Exposure areas has increased or has remained similar to the CPUE of legal lobsters in Stage 1 (2008 and 2009). Since CPUE is being used as a surrogate for "landings" in evaluating the potential effects on the fishery from the removal of the causeway, the results indicate no discernible negative effects.

The change in CPUE of sub-legal lobster is not as clear. A lower catch rate of sub-legal lobsters was observed in traps hauled from the Exposure area than from the Control area during the spring and out-of-season 2011 and 2012 sampling programs from the commercial traps in 2011 and from the FSRS juvenile traps in each of the years. The juvenile catch rates in the fall, out-of-season and spring declined in the Control area in 2012 when compared with 2011, and increased in the spring and remained virtually stable in the out-of-season and spring periods when compared with the year before. It should be noted that the Upper Bay was historically not a nursery area for lobsters.

3.2.3 Logbook Catch Data Comparisons

The decision to go to a log book program was made because the program was mandatory and it therefore draws on many more trap hauls than the at-sea sampling program. What is lost in the precision, reliability and detail of the data gathered during the dedicated at-sea monitoring program is hopefully gained through the increased statistical power of many more records.

Data quality for commercial logbooks appears to be consistent as of fall 2007 for the Petitcodiac Project Area and LFA 35, based on reporting levels in terms of fishermen respondents, effort and location data. Additionally, CPUE outliers were infrequent throughout the entire time-series, indicating that there were no particularly problematic years for reporting. During spring, CPUE of legal catch (kilograms per trap haul) from commercial logbooks exhibited similar trends in the Control and Exposure areas from 2008-2010. However, differences between areas were observed in 2011-2013. In contrast, trends in the CPUE of legal catch during fall 2007-2012 were comparable in the Control and Exposure areas in all years except 2012. Although commercial logbooks and at-sea sampling generated similar trends in the CPUE of legal catch during spring 2009-2013, differences between datasets were observed during fall 2008-2012. The agreement for the Spring sampling is encouraging. The reasons for such differences in the fall comparisons are unclear and may reflect different seasonal limitations of the two approaches.

3.2.4 Scallop

In Years 2010 to 2013 there was no statistical difference in meat weight at shell height between the control zone and the exposure zone. This suggests that scallop meat weight at shell height was similar in the control and exposure areas before the opening of the gates, as well as after the opening. The Year 4 results indicate that environmental conditions for scallop growth were better in the Control Zone than in the exposure area.

This conclusion is highly dependent on the results of three tows: 274, 279, and 280. The other exposure area tows were near-normal or better. These tow results may be sampling outliers, perhaps related to water temperature. The temperature data tend to support the theoretical notion that the Exposure Zone is warmer in the summer than the Control Zone, and that that water in the northern zone in 2012 and 2013 may have reached temperature levels that were greater than those preferred by scallops. Therefore, warmer water may be the reason for the relatively lower meat weights among the scallops of the northern zone when compared to those of the southern zone.

4.0 ARCHAEOLOGICAL AND HERITAGE RESOURCES

4.1 OBJECTIVES

The objectives of this component are to ensure all areas of potential archaeological interest are identified, and, where necessary to mitigate risk to archaeological and heritage resources.

4.2 RESULTS

The Year 4 Follow-up Program included a visual survey of 37 areas by a permitted archaeologist and the limited mitigation of one registered archaeological site. The survey included 10 EAs along the upriver headpond identified as having potential for considerable erosional activity, 25 registered archaeological sites identified since 2009, the boardwalk area at Halls Creek, and a wooden cultural feature identified by the public in 2012. As a result of the visual survey, one previously unrecorded archaeological site was documented in the Halls Creek area and nine previously registered sites were observed to be partially exposed and/or negatively impacted over the past year. Of these nine negatively impacted sites, eight were assessed to not require mitigative action in 2013. Thus, only one archaeological site was assessed as requiring mitigation measures (partial excavation and reburial).

The previously unrecorded site identified in the Halls Creek area is presently interpreted as an historic wharf feature; very likely the remnants of Dunlap (Central) Wharf, which would have been constructed in the late 1800s. This feature is located in a known high erosion area and will likely be negatively impacted by erosional forces in the immediate future. Another site that was partially excavated in 2013, was interpreted as a previous shoreline with the remnants of a mid-1900s scuttled wooden rowboat. A site identified in 2012 at the mouth of Michaels Creek, was visually inspected in 2013 and interpreted to be a dyke and wooden “facing” feature, rather than a dock/wharf feature. A specific date for this feature has not been determined, but is believed to likely be either Acadian or Planter (approx. 1700-1800). Dendrochronological analysis was conducted in 2013 on a wooden artifact (a watercraft “knee”), which was collected in 2010 from Site CaDf-29. This analysis provided a cut date of 1795. The present interpretation of this site is that this artifact possibly represents a piece of flotsam from a mid-1800s shipyard, which may have resulted from the refurbishment of a seagoing vessel built in the late 1700s at another location. Finally, a potential historic site on Marsh 42, which was identified by the public in 2012, was surveyed in 2013. No physical evidence was observed to remain at the location reported by the public. It is not clear whether this was an *in situ* feature removed by the excavations or whether it was historical flotsam. Due to the lack of observed evidence, a MARI form (site registration) was not completed for this publically reported feature.

5.0 SURFACE WATER QUALITY

5.1 OBJECTIVES

The objective of the Year 4 Follow-up Program was to continue to obtain interim surface water quality data following the opening of the causeway gates, to give further indication of how the environment is trending towards the predictions and conclusions contained in the EIA. A fulsome understanding of environmental and physical conditions in the Petitcodiac River Estuary as well as anthropogenic influences are necessary to properly interpret water quality data. A complete description of the many parameters is provided in the main report.

5.2 CONCLUSIONS

The results of the Surface Water Quality sampling events indicate that there are many factors that contribute to water quality, including bacteria counts, in the Petitcodiac River Estuary. The 12-hr sampling events conducted at the Gunningsville Bridge and Salisbury Railway Bridge indicate that bacteria counts vary greatly throughout a tidal cycle and that the multi-station sampling methodology used in Stage 1 and Stage 2 Years 1 to 3 was not able to fully control for hydraulic conditions. Further, the nature of the Project is such that the environmental conditions were significantly changed between Stages, particularly upstream of the Causeway. Attempting to determine which factors are responsible for water quality conditions is problematic given the complexity of the system and the limitations of the available data, and knowledge of how bacteria behave in suspended sediment-rich systems.

Regardless, there is sufficient evidence to support some trends. Most importantly, the overall levels of *E. coli* have noticeably decreased in the system as the extremely high levels observed during Stage 1 between the Causeway and Dover have been significantly reduced, which is consistent with predictions contained in the EIA. The trend of reduced *E. coli* levels continues to hold for Year 4 for Gunningsville Bridge.

As supported by the results of the 12-hr sampling program at Gunningsville Bridge in 2013, bacteria counts are strongly correlated to the presence of TSS caused by the re-suspension of sediments in the water column. This may well explain the results of past sampling programs where a correlation existed between turbidity and bacteria, while a weak relationship existed between salinity and bacteria levels. Although somewhat supported by some of the 2013 results at the Salisbury Railway Bridge, additional 12-hr sampling events would need to be undertaken at this location to validate and confirm any observed trends that may exist among water velocity, water level, TSS, salinity and the concentration of bacteria.

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6.0 ENGINEERED ENVIRONMENTAL PROTECTION WORKS

6.1 OBJECTIVES

The objective of this component was to ensure that erosion protection installed at the former Moncton landfill, the Greater Moncton Sewage Commission (GMSC) outfall, along the Riverview riverfront, along the Moncton riverfront near Westmorland Street, and along the Chateau Moncton shoreline performed as required.

6.2 RESULTS

6.2.1 Armoured Areas

Inspections of all erosion protection measures were completed throughout Years 1 to 4 of Stage 2. In Year 4 no significant changes to existing erosion protection were noted at any locations.

6.2.2 Dykes and Aboiteaux

As in previous years, the dykes and aboiteaux generally appeared to be functioning properly in Year 4, preventing estuarine water from impacting the protected areas and allowing surface water to drain as planned. During the November 2013 aerial survey, some siltation was observed upstream and downstream of the aboiteaux. A ground survey in June 2013 was also completed as part of the on-going monitoring to assess the physical condition of the dykes and aboiteaux.

- Aboiteaux 42-4 did not appear to be functioning, and both the inlet and outlet channels were submerged at the time of the survey. It was recommended that the structure be resurveyed at low tide. Aboiteaux 33-3 and 4-2 were also identified as not functioning at full capacity due to siltation.

Maintenance activities on the dykes, aboiteaux and marshes are conducted by the NB Department of Agriculture, Aquaculture and Fisheries (NBDAAF). Information on areas identified during the Engineered Protection Works Program requiring maintenance was provided to NBDAAF in July 2013. Throughout 2013 NBDAAF conducted various maintenance and site improvement activities such as; clearing inlet and outlets of aboiteaux, ditching and land forming, and access road upgrades and fencing. All of these aspects of dyke and aboiteaux maintenance continue to be monitored and works undertaken as required.

6.2.3 Traffic Circle Drainage Improvement and Starter Dyke

During Year 4 inspections, water within the drainage channel was found to continue to flow correctly and no new issues were identified. The flap gate, which was repaired in October 2012, continues to show signs of leakage during visual inspections in June 2013 and replacement in 2014 is recommended. General drainage and function of the drainage improvements and associated works will continue to be monitored on a quarterly basis as part of the on-going visual inspections.

6.2.4 Watermain

No issues were noted during Year 4 inspections. Overall, the watermain and associated infrastructure has functioned as planned and no issues are anticipated.

6.2.5 Additional Erosional Areas

The following erosional areas adjacent to existing infrastructure were identified during Year 1. These areas were inspected bi-weekly or monthly as part of the on-going Year 4 inspections:

- downstream from existing rip-rap at the GMSC;
- southern shoreline immediately upstream of the causeway;
- between Chateau Moncton and Roger's Building; and
- upstream of Chateau Moncton adjacent to, and underneath boardwalk.

6.2.5.1 Erosion at the GMSC Outfall

An area of slight erosion was identified near the GMSC outfall in Year 4, but overall no significant change was observed. As such, no additional erosion protection has been installed and no additional erosion protection is deemed necessary at the current time. It is recommended that this section of shoreline continue to be monitored as part of the on-going visual inspections so that additional erosion protection can be installed if erosion advances.

6.2.5.2 Causeway Intake Channel

Monitoring of this area has continued in Year 4. Monitoring and assessment activities completed at this site include monthly visual inspection and bathymetric cross section surveys along the upstream channel that included the base of this section of shoreline. Surveys were completed in May and November of 2013.

The channel has remained relatively stable and no significant changes to the shoreline were identified in this area during Year 4. Some exposed bedrock was broken off at the shoreline in May and June, 2013 but appears to have stabilized in subsequent inspections. At this time, there appears to be no risk to infrastructure from erosion in this area, and therefore no mitigation has been recommended. Monitoring of this area through visual inspections and bathymetric cross section surveys will continue.

6.2.5.3 Shoreline between Chateau Moncton and the Rogers Building

Erosion protection installed along the section of shoreline between Chateau Moncton and the Rogers Building in Year 2 is performing as expected in Year 4. It is recommended that this section of shoreline continue to be monitored as part of the Engineered Protection Works Follow-up Program.

Increased erosion was also observed as part of the on-going visual inspections downstream of the protected area described above, although no infrastructure was identified as being at risk. The installation of additional erosion protection was recommended along this 310 m long stretch of shoreline in Year 3 but was not completed at the request of the City of Moncton. The City of Moncton has elected to continue monitoring this section of shoreline and installation of erosion protection in this area may be completed at a later date by the City.

6.2.5.4 Exposed Cribwork under Moncton Riverfront Boardwalk

Monitoring undertaken in Year 4 reveals that the erosion protection in this location continues to function as expected.

7.0 FISH PASSAGE

7.1 Results

The summary of the 2010, 2011, 2012, and 2013 electrofishing results for Atlantic salmon and brook trout indicates that the observed densities of young-of-the-year salmon (fry) are dependent on the unfed fry or adult pre-spawner stocking programs for each year. In 2013, because the last unfed fry introduction occurred in the spring of 2012, salmon fry disappeared from the Pollett River sites. This indicates that there was little wild salmon spawning in the Pollett River in 2012. The parr densities in the Pollett River declined from 2012 at two of the Pollett River sites at (Church's Corner and River Glade), although their density was much higher at the Old Dam site. There was probably a decrease in parr density in the Pollett River because the stocking rate in 2012 was much lower than in 2011.

2013 was the first year that juvenile salmon appeared in the Little River electrofishing results; in small numbers at all four sites that were fished. Their presence undoubtedly resulted from the 2012 introduction from the Mactaquac Live Gene Bank of adult pre-spawning salmon to the river.

The widely-applied optimal densities for juvenile salmon abundance were determined by Elson (1975) on the Pollett River in the 1940s and '50s. These so-called "Elson norms" or "Elson optimums" have been interpreted differently by different salmon biologists, but referring to the summary text by the author (Elson 1975) the optimums are: 12 under-yearlings (fry, young-of-the-year, or fall fingerlings) and 10 large parr (parr) per 100 square yards (yd^2) in the late summer, early autumn. This translates to 14.4 fry and 12 parr per 100 m^2. None of the fry or parr densities observed at any of the sites in 2013 approached the Elson optimal values.

Hooper (1997) considered brook trout standing crops of <0.5 g/m^2 to be very low by New Brunswick standards. Very low brook trout densities were observed at four of the eight sites in both drainages that were fished, and no brook trout were captured at the other four sites. Assuming that the Hooper (1997) scale applies to overall salmonid standing crops (with <0.5 g/m^2 being "low", <0.5 to 2.99 g/m^2 being moderate and >3 g/m^2 being high), only two sites achieved moderate rankings in 2013, Pollett Church's Corner and Pollett Old Dam.

The habitat quality at the eight sites that were electrofished is generally good. However, most of the sites are situated in the middle or lower reaches of the two drainages. As such, they are probably thermally more suited to juvenile salmon than brook trout production. Without a continuing juvenile salmon augmentation program, either through direct introduction or pre-spawning adult stocking, and/or a suddenly renewed wild Inner Bay of Fundy salmon spawning run, salmonid standing crops will probably again fall to very low levels at all sites.

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8.0 OVERALL CONCLUSION

The results of Year 4 of the S2 FUP indicate that the mitigation measures put in place in Stage 1 are functioning as designed. The findings and conclusions relevant to the seven Valued Ecosystem Components indicate trending, from an environmental and socio-economic perspective, in a direction consistent with the predictions and conclusions contained in the EIA. However, it will not be possible to make a definitive statement in this regard until the completion of Project Option 4B.