PETITCODIAC RIVER CAUSEWAY PROJECT
STAGE 2 FOLLOW-UP PROGRAM RESULTS

YEAR 8 EXECUTIVE SUMMARY

Submitted to:

New Brunswick Department of Transportation and Infrastructure
Fredericton, New Brunswick

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1.0 INTRODUCTION

1.1 Purpose

This document is a summary of the results of Year 8 (April 1, 2017 – March 31, 2018) of the Stage 2 Follow-up Program (S2FUP) for the Petitcodiac Causeway Project (the "Project"). Year 8 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 Stage 3. Thus, 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 8 of Stage 2 are trending as compared to the EIA predictions and conclusions specific to Stage 3 and beyond. The document presents the findings and conclusions relevant to the six Valued Ecosystem Components (VECs, see Section 1.3).

For a comprehensive description of background, methodology, references, program modifications and a more detailed presentation of the results the reader is encouraged to refer to the main report, Stage 2 Follow-up Program Results for the Petitcodiac River Causeway Project Year 8 (April 1, 2017 – March 31, 2018) which is available from the New Brunswick Department of Transportation and Infrastructure (NBDTI) 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 compared 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; and
- improve understanding of environmental cause and effect relationships.

1.3 Transitioning from Stage 2 to Stage 3 Follow-up Program

Stage 2 was originally planned for at least two full seasons before proceeding with Stage 3. Although the exact Stage 2 duration was never specified, it is implicit in the EIA that Stage 3 would be initiated after two years of Stage 2, assuming the above-mentioned objectives had been satisfied. The implementation of Stage 3 had been delayed for reasons that are not related to the environmental effects that have occurred since the opening of the gates on April 2010. Thus, the

Stage 2 Follow-up program data collection continues to complement and support the results and conclusions of the first two years intended for the duration of Stage 2.

On December 16, 2016, the provincial government announced funding for Stage 3 of the Project, which includes the construction of a new bridge. Bridge construction began in May 2017 and is scheduled to be complete in 2021. Planning for the transition between the Stage 2 and Stage 3 Follow-up Programs is currently underway.

1.4 Scope

The S2FUP focuses on six VECs:

- Physical Characteristics of the Petitcodiac River and Estuary;
- Commercial Fisheries;
- Archaeology;
- Public Health and Safety – Surface Water;
- Fish Passage; and
- Engineered Environmental Protection Works.

1.5 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 (CoA4). The S2FUP is divided into phases that correspond with the Implementation Plan, as per CoA5, 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, with 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 ("the River"), the Petitcodiac Estuary ("the Estuary"), and the Upper Bay of Fundy ("the UBoF") after gate opening to understand effects on width, depth, and other physical characteristics as compared to baseline conditions.

The data collected between 2010 and 2015 indicated that the physical changes which occurred relatively rapidly in the first years after the gates were opened are now occurring at a reduced rate. Accordingly, the program of physical measurements was modified in 2015 to a two-year schedule for the river and Shepody Bay bathymetry. This was again modified in 2017 to conduct the next river and bay surveys in 2018 to better accommodate the new bridge construction schedule.

2.2 Results

2.2.1 Cross-sections

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

2.2.1.1 Upstream of the Causeway

Cross-section surveys were carried out at a high-water level and referenced to geodetic datum. Due to the development of tidal flats and the subsequent lack of accessibility to the river by boat, LiDAR surveys have been carried out starting in 2012 to obtain elevations along the reach between the causeway and the railway bridge near Salisbury. In 2017 the LiDAR survey was extended down river to approximately one kilometre past the bend at Outhouse Point. In previous surveys, the edges of the riverbanks downstream were established by ground survey methods. Extending the 2017 LiDAR survey downstream provides this information without the necessity of ground surveying. In addition, it provides a detailed contour of the river banks through the highly populated areas of Moncton, Riverview and Dieppe for comparison with the November 2008 LiDAR surveys.

The data from these surveys enabled cross sections to be generated above the water level which in 2017 was about elevation 1.2 m at slightly upstream from the causeway and 6.1 ± m at about 500 m downstream from the Salisbury road bridge. Cross sections were generated to include the channel banks, tidal flats, valley bottom and hill slopes. No data could be obtained with this technology to define the bathymetry of the channel below the water surface.

2.2.1.2 Downstream of the Causeway to Hopewell Cape

No hydrographic surveys were carried out downstream of the causeway in 2017. The next scheduled hydrographic survey is in the fall of 2018.

2.2.1.3 Upper Bay of Fundy (downstream of the causeway)

No hydrographic surveys were carried out downstream of the causeway in 2017. The next scheduled hydrographic survey is in the fall of 2018.

2.2.1.4 Development of the Scour Hole

Upstream of the control structure: The control structure was designed for flow in the downstream direction only; no extended apron was placed on the upstream side. A short concrete slab extends 8.7 m upstream of the location of the bridge deck. The peak flows, both upstream and downstream, associated with each tidal cycle with the gates open is exceed the 100-year flood flow.

Before the gates were opened, rough estimates of the maximum depth of the upstream scour hole ranged from 5.4 m to 11.5 m with an average of 8.7 m, the lower estimate being for scour in weak rock. These estimates suggested that detailed surveys be carried out in the approach channel leading up to the control structure.

Most of the scour has taken place within the first two weeks after the gate opening. The maximum depth of the scour hole, with reference to the initial bed level, was about minus 6.03 m in June 17, 2015. The deepest part of the scour hole is located about 36 m upstream of the upstream extent of the concrete slab. The rate of scour over time is expected to decrease 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.

Downstream of the control structure: A concrete apron extends 18.0 m past the ends of the piers. The original design recognized that the structure had to pass high flows in the order of 1000 m^3/sec. Once the gates were opened, the tidal outflows were in the order of 1000 to 1500 m^3/sec twice a day. These high flows could result in the development of a scour hole downstream of the structure. This process became evident when a mound of material was noticed in 2011 at a location about 100 m downstream of the end sill on the downstream apron.

Detailed hydrographic surveys indicate the deepest portion of the scour hole is about midway across the central gate opening between Pier 2 and Pier 3. The deepest elevation of the scour hole has stabilized since the spring of 2012. The deepest elevation was minus 8.79 m on June 17, 2015. It is expected that the peak tidal outflows will decrease over time and therefore the depth of the downstream scour hole should not increase to any significant degree.

2.2.1.5 Tidal Flats Upstream of the Causeway

The data for the elevation of the tidal flats at different times after the gates were opened indicate that the rate of increase in the surface elevation of the developing tidal flats is decreasing with time. In general, the tidal flats are still rising at a rate of approximately 100 mm/yr. It is estimated that the tidal flats immediately upstream of the causeway will continue to increase in elevation from 6.9 m±, observed in October/November 2017, to about 7.5 m within the next decade.

2.2.1.6 Channel Width Relationships

Upstream of the Control Structure: The channel width has contracted significantly in the lower portion of this reach. There was some channel narrowing in 2017, probably due to accumulation of seasonal silt on the banks, which had not been eroded because of the low river flows. There has been some narrowing of the channel up to the Salisbury railway bridge. The 2017 survey shows continuous narrowing since 2015. It is likely that the narrowing is associated with seasonal silt built up during low overland flows in late summer and fall of 2017.

Downstream of the Control Structure: No hydrographic surveys were carried out in this section in 2017. However, the 2017 LiDAR survey indicates the rate of widening has generally stabilized, and, in some areas, has decreased slightly.

2.2.2 Ground-level Observations

Ground-level observations have been conducted on both banks of the River from Salisbury to Hopewell Cape seasonally from 2010 to 2017.

Winter conditions (2016-17) resulted in narrowing of the river along the City of Moncton and Town of Riverview shorelines, and even more prevalent upriver of the causeway. No problems with ice jamming were observed at the control structure, and the shorefast ice built up downriver of the control structure continued to protect the shoreline and any infrastructure adjacent to the river, such as trails and viewing platforms, during the winter months.

The old wharf section of the boardwalk in the City of Moncton deteriorated more in 2017. During the December 2017 high tides, the river overtopped the old timber wharf and flowed under the boardwalk in the Chateau Moncton area.

As a general observation, supported by photographic records, no discernible changes in the shoreline at the lower portions of the Estuary have been noted. Furthermore, the small creeks flowing into the River appear unaffected by the 2010 opening of the gates, and the silt build up in the mouths of Halls Creek and Jonathan Creek immediately downstream of the causeway was less than observed seasonally prior to opening of the gates, due to the deepening of the River bottom in these areas. No appreciable silt build-up has been observed on the Hopewell Cape beach.

2.2.3 Water Level Observations

2.2.3.1 Effect on Tide Levels

Measured high tides at Saint John and Gunningsville for the typical month of December over the period 2010-2017 indicates that for each year the tides at Moncton show an increase when compared to Saint John. This means that the total initial decrease in tide levels at Moncton, after opening the gates, is likely not permanent. However, the tide heights appear to be stabilizing about midway between the 2010 levels and those with the gates closed. The slope of the 2017 data is slightly steeper than past years in that the lower tides are slightly lower, and the high tides are slightly higher.

When the gates were opened in April 2010 the high tide levels at Turtle Creek varied from about 0.5 - 0.9 m below that at Gunningsville, with the former value at lower tides and the latter at higher tides. This differential was the result of the hydraulic capacity of the control structure being too small to allow the full upstream volume to fill during the tidal cycle. As sediment became permanently deposited in the tidal flats upstream of the causeway the volume available for storing tidal water decreased during each tidal cycle. This difference in high-tide elevations is decreasing at a decreasing rate at the Gunningsville Bridge. The recent changes are much smaller, but still measurable at higher tide levels. In 2017 the differential was almost the same as 2015 and 2016 indicating the volume of the upstream basin is becoming stabilized. The implication is that substantial sedimentation in the new tidal flats has taken place to reduce the total storage available in the upstream area during a tide. Cross sections have indicated that the initial volume upstream has been reduced by about 40 percent since the gates were opened due to the formation of the new tidal flats.

2.2.4 Sediment Deposition, Erosion and Net Accumulation

No downstream and Bay of Fundy cross sections were taken in 2017.

Upstream of the causeway, the 2017 fall LiDAR survey indicates that the tidal flats increased in elevation about 0.2 m and the river narrowed significantly. The permanent accumulation of sediment on the tidal flats since 2015 is estimated at 350,000 m^3. The narrowing of the channel is estimated at 300,000-500,000 m^3, but most of this is likely to be seasonal and will be eroded during the next flood season.

2.2.5 Estuary Volume and Tidal Prism

The three cross sections obtained downstream from 2017 fall LiDAR indicate that the rate of bank widening is similar, or perhaps less than, that occurring before 2015. The downstream erosion since 2015 is estimated at 4-8 million m^3 most of which has been deposited on the middle ground area of Shepody Bay. The erosion/deposition is now occurring at a relatively constant rate similar to the rate of deposition of 2.3 million m^3/year in the estuary between 1991 and 2001, when the gates were closed.

Based on the surveys to 2015, the tidal prism is estimated to be increasing at the rate of about 2 million m^3/year.

3.0 COMMERCIAL FISHERIES

3.1 Objectives

The objective of this component is to determine how the Project affects commercial fisheries landings; lobster and scallop in the UBoF.

3.2 Results

In March 2015, due to the prolongation of Stage 2 and in recognition of the extensive information collected to date, a temporary suspension of the Lobster and Scallop monitoring program was approved in May 2015. This monitoring program will be resumed in Stage 3.

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 due to changes in flow patterns and erosion after the causeway gates were opened.

4.2 Results

A field survey was not scheduled for 2017 and based on the results of the 2016 Follow-up Program archaeological field survey, Archaeological Services (ASNB) accepted the recommendation that field surveys be removed from the Stage 2 program. However, should additional excavations be conducted on the historic marshlands associated with the Project, these activities should be monitored by a permitted archaeologist. In addition, in the event that erosion has negatively affected an archaeological site or cultural feature, the provincial regulator should be notified, and mitigation measures should be considered.

In October 2017, it was observed that a portion of a stone pier foundation from the former Gunningsville Bridge became exposed on the north shore of the Petitcodiac River, as a result of shoreline erosion. The exposure of this historic cultural feature was under the purview of the Project archaeological and heritage resources program. The original Gunningsville Bridge, constructed between 1864 and 1867, was severely damaged by the Saxby Gale in 1869. The bridge was rebuilt and reopened in 1873, to be damaged again by a storm in 1891. The bridge was closed in 1915, and a fourth bridge completed in 1917. Based on historical documentation and photographs, the first three Gunningsville Bridges (1864-1915) had pier foundations constructed of rock and wooden crib structures, enclosed by wooden planking. However, the forth incarnation of the bridge used quarried stone for the pier foundations. In 2006 the “Old Bridge” was demolished, including the removal of a few piers within the present channel. The cut stone bridge pier exposed by the erosion of the present-day shoreline is part of the historic Gunningsville Bridge and likely dated to 1917. This historic feature is considered an archaeological site, as defined by the province (100 years old). ASNB was notified of the exposed cultural feature and the archaeological site has been registered with the province (Site CaDe-17). In addition, it is recommended that should the demolition of this feature be considered, further archaeological investigations and documentation of the site should be conducted prior to demolition. It is also recommended that this feature be included in any possible future archaeological field survey program completed as part of the Stage 3 Follow-up Program.

5.0 PUBLIC HEALTH AND SAFETY: SURFACE WATER QUALITY

5.1 Objectives

The objective of sampling during Stage 2 (including Year 8) is to continue to obtain interim surface water quality data following the opening of the causeway gates in order to provide an indication of how the environment is trending toward the predictions and conclusions contained in the EIA.

5.2 Conclusions

The results of the surface water quality sampling events indicate that there are many factors that contribute to water quality, including faecal indicator bacteria concentrations, in the Petitcodiac River estuary. As a result of the 12-hour sampling events conducted at the Gunningsville Bridge and Salisbury Railway Bridge, it can be seen that E. coli concentrations 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 the precise sampling time in the tide cycle (i.e., slack low and slack high tide times). Further, the nature of the Project is such that the environmental conditions significantly changed between Stage 1 and Stage 2, particularly upstream of the causeway. Attempting to determine which factors are responsible for water quality conditions is problematic given the complexity of the system, limitations of the available data, and knowledge of how bacteria behave in suspended sediment-rich systems.

There is evidence to support some water quality trends. Most importantly, the overall magnitude and variability in E. coli concentrations appears to be decreasing in Stage 2 at Gunningsville Bridge. The reducing trend in E. coli concentrations continues to hold for Stage 2 Year 8 for Gunningsville Bridge. With the inclusion of the Year 8 results at Gunningsville, a statistically significant trend was observed during the summer events between Stage 1 and Stage 2. This trend indicates E. coli concentrations are decreasing at a rate of approximately one percent per year.

Salisbury Railway Bridge data indicate increasing E. coli concentrations in Stage 2. A statistically significant trend was observed during the summer events between Stage 1 and Stage 2, indicating a greater presence of E. coli on the incoming tide. The trend between Stage 1 and Stage 2 represents a one percent increase in E. coli concentrations per year.

It is expected that increased concentrations of nutrients from the TransAqua Waste Water Treatment Facility (WWTF) would be present at greater concentrations on the flooding tide. At the Salisbury Railway Bridge there was a statistically significant difference in orthophosphate and total dissolved phosphorous (TDP) between the high and low tide samples during the summer sampling events. The sewage lagoon that operates in Salisbury may be an additional factor that could be influencing the concentration of bacteria in the Petitcodiac River. The effluent discharge volumes and timing of this lagoon is not known and therefore has not been accounted for when interpreting the bacteria data at this location.

The results of the nutrient sampling and analysis indicate fluctuations between seasons and sampling stations, with nutrient concentrations generally higher at Gunningsville Bridge. The assessment of effluent signal parameters indicates that neither orthophosphate, TDP, or ammonia concentrations during the flooding tide are significantly higher than during the ebbing tide at the Gunningsville Bridge. This indicates the TransAqua effluent is likely diluted prior to reaching the Gunningsville Bridge during the flooding tide. or concentrations of the effluent signal parameters are consistently elevated at the Gunningsville Bridge and do not change significantly between high and low tides.

6.0 FISH PASSAGE

6.1 Objectives

The objective of this component is to measure the passage of the nine fish species that require access to the Estuary for life cycle purposes. Fish passage monitoring that was originally proposed for Stage 3 was moved forward to Stage 2 due to the delay in implementing Stage 3.

6.2 Results

Based on a review of the data collected during the first eight years of monitoring, most species are successfully passing uninhibited through the open gates of the control structure. The "hold-out" species are American shad and Atlantic salmon. A few spawning recruits of each of these species have been observed, and fish passage does not appear to be the problem.

6.2.1 Presence of an open channel

The operation of a fish trap was used to verify the presence of diadromous fish species that were prevented from entering the river when the causeway gates were closed. A physical search was conducted for rainbow smelt, the upstream migration of which was also impaired. The capture of many individuals from a host of anadromous fish species at the trap, principally tomcod and American shad, verifies that the river channel is sufficiently open for fish to pass from the estuary and into the headwaters.

6.2.2 Presence of fish species

The S2Y8 results of the Fish Passage monitoring program may be summarized as follows:

- **Gaspereau:** In contrast to historic trends, the number of gaspereau caught in 2017 was 61% of the total catch at the trap. The 2017 catch of gaspereau remains well below observations during the years immediately after the causeway gates were opened. The capture numbers were significantly lower in the past three years in comparison with the first three years of trap operation.

- **American shad:** During the 2017 season, seven shad were captured at the trap site, a comparable number to the six shad caught in 2016. In 2017, there were three adult shad caught in mid-to-late June (shortly after the spawning season), and four juveniles were captured, two in June, and two in August. Shad spawn in May, and river conditions in May 2017 prevented fishing the trap at that time. The adults encountered in June were likely exiting the river, after having spawned upstream of the trap.

  Capturing adult shad during the immediate post-spawning season for the third time in five years, as well as juvenile shad for the second straight year provides mounting evidence of a gradual recolonization by shad to the Petitcodiac by means of individuals straying into the river and successfully spawning. Until definitive confirmation is available, occasional captures of shad, such as occurred in 2017, do not contradict the conclusion that shad remain effectively extirpated from the Petitcodiac River system. Shad show a high fidelity to their natal streams, so it is expected that a river lacking a resident population would require an extended period of time to be recolonized by strays.

Striped bass: Striped bass capture numbers fell in 2017 to 491 individuals, the lowest catch since 2013. This was a statistically significant decline from 2016, when the largest number (4,288) of striped bass were captured. Though numbers of striped bass caught have varied during the years of monitoring at the trap site, they have trended upwards. The low 2017 capture numbers may be related to two recent spawning year-class failures on the Stewiacke River in NS, that produces the juveniles that occupy the upper Petitcodiac River Estuary's nursery habitat.

- **American eel:** American eels were caught in greater numbers in 2017 than in 2016, continuing the upward trend in eel capture numbers since the causeway gates were opened. In 2017 1,522 eels were captured at the trap between June and early November, the second greatest total for eels during the eight years of monitoring. For the second year in a row a new record was set for the largest eel (97 cm).

- **White sucker:** In 2017 sucker capture numbers (345) were noticeably lower than in 2016 (1,196), but, this difference was not statistically significant.

- **White perch:** Capture numbers (231) were essentially unchanged in 2017 compared to 2016 (172) or 2015 (167). These continuously low capture numbers may indicate that by 2017 a new plateau in white perch population density had been established that is somewhat lower than that indicated by the record high of 600 captures in 2013. The white perch tolerates estuarine-level salinities and moved through the fishway prior to the gates on the causeway being opened in 2010.

- **Atlantic salmon:** The Petitcodiac River Atlantic salmon population was extirpated, probably due to construction of the causeway with an absence of effective fish passage, as well as due to the general downturn on the related populations of adjacent Inner Bay of Fundy (IBoF) Rivers. The IBoF Atlantic salmon populations were listed as endangered under the *Species at Risk Act* in 2003 (DFO 2010a).

  Since the opening of the gates, a re-introduction program using gene-banked pre-spawning adult salmon or unfed young-of-the-year salmon (fry) has been undertaken on the Petitcodiac River drainage. In October 2017, one Atlantic salmon, a pre-spawning female from the Conservation Sea Cage site, was captured in the fyke nets. In 2017 hundreds of salmon were released to the Pollett and Little rivers, far upstream of the trap site, however, a great majority of these fish were stocked in late October, shortly before the salmon spawning window, and immediately before the trap was shut down for the season. A second adult, another Conservation Sea Cage female fish that was also released in October, was captured in the near-by Auxiliary net.

No salmon smolts were caught at the picket trap in the spring of 2017. Previously, smolts have been caught every other year at the trap except in 2011. Smolts are typically deposited in the trap when river flows reverse because of an incoming tide. The late start of fishing combined with the timing of the tides, and the timing of the smolt run provide some explanation for the lack of smolts detected in 2017.

- **Atlantic tomcod:** Captures fell to 1,609 in 2017, from 3,544 in 2016. Tomcod were not present in the upland Petitcodiac River for much of the 42 years that the causeway gates were closed, and only 1 tomcod was captured at the trap in 2010 when the gates were first opened.

- **Brook trout:** In 2017, it was conjectured that most upstream movement of trout at the trap site occurs prior to the installation of the trap in the spring. This hypothesis was strengthened by the capture of only one trout in 2017. This is not significant however, as the annual capture rate has broken into double digits only once before (19 in 2014). The sea trout migration in eastern Canadian rivers is not a spawning run. Rather, it is a feeding run. Trout in the Petitcodiac River system apparently run very early, probably coincident with the upstream spawning migration of their rainbow smelt forage base.

- **Chain pickerel:** This species was captured for the first time in 2015, when there were 10 caught, but none were not encountered at the trap site in 2017. It is unclear why they were not caught previously, since they were present in the headpond, and are reportedly encountered with some frequency by anglers further upstream near the mouth of the Pollett River. One possible explanation for the 2015 captures is that an individual is rumored to be transporting and releasing the species to the Petitcodiac system from the Mactaquac (St. John River) headpond. An increase in pickerel numbers due to such activity could explain their abrupt appearance and the large size of the pickerel.

  Chain pickerel are adept ambush predators and have been recognized as a threat to smolt-sized salmon in deadwater areas of Atlantic salmon rivers and are the most potentially harmful exotic species detected during monitoring to date. Allowances to remove chain pickerel when they are encountered are warranted considering the threat they pose to a *Species At Risk Act* listed species, the Inner Bay of Fundy Atlantic salmon.

- **Smallmouth Bass:** This invasive species was present in the head pond. In 2017, 5 were captured. Failure to catch them does not mean that smallmouth bass were no longer in the system. Habitat such as the Turtle Creek Reservoir and the lower warm-water reaches of the Petitcodiac (such as in Little River) are refugia that remain sources for recolonization. The saline-intolerant bass now probably find the trap site to be less than ideal because of the brackish water that frequently floods the area with the high tides.

7.0 ENGINEERED ENVIRONMENTAL PROTECTION WORKS

7.1 Objectives

The objective of this component is to ensure that the physical works completed during Stage 1, prior to gate opening, are working as intended, and to identify potential maintenance requirements. These works include:

- Armoured areas for tidal surge and erosion protection at the former Moncton landfill, the TransAqua outfall, along the Riverview riverfront, along the Moncton riverfront near Westmorland Street, and along the Chateau Moncton shoreline.
- Agricultural dykes and aboiteaux upstream of the causeway.
- Drainage improvements at the traffic circle and starter dyke.
- Re-alignment of the underground 750 mm watermain crossing the Petitcodiac River.

7.2 Results

7.2.1 Armoured Areas

Generally, the erosion protection has been observed to function as was anticipated, providing adequate protection to areas of concern. In Year 8, no significant changes to existing erosion protection was required at any of the locations.

7.2.2 Dykes and Aboiteaux

On-going inspection and monitoring of the rehabilitated dykes and new aboiteaux was completed in Year 8 to assess drainage patterns inland of the dykes, verify that the aboiteaux are functioning properly, and assess the general condition of the dykes and aboiteaux. A field survey and an aerial survey were completed in Year 8. The objective of these surveys is to assess drainage patterns and verify that water is flowing properly through the dykes at the aboiteaux. These structures are intended to prevent estuarine water from flowing into the adjacent farmland, while allowing surface water accumulating behind the dykes to drain into the Estuary.

The dykes and aboiteaux are functioning properly. During both the August and December surveys, some siltation was observed upstream and downstream of the aboiteaux. In the August survey, the dyke at Marsh 33A appeared to be fully intact, though settlement and erosion was noted upstream on the western end, and ponding was present at the eastern portion of the dyke and sediment berm. Sloughing of the slope at the dyke at Marsh 28 was noted in 2017. In the December survey, siltation was noted at several locations along the dykes and aboiteaux. Significant siltation was again observed at aboiteau 4-2, however the aboiteau was functioning. Ponding was also noted at aboiteau 41-1 and the dyke at Marsh 33, but both structures are functioning and in good condition.

Maintenance activities on the dykes, aboiteaux and marshes are conducted by NBDTI Marshland Maintenance. Throughout Year 8, NBDTI conducted various maintenance and site improvement activities such as: clearing inlets and outlets of aboiteaux; ditching and land forming; and access road upgrades and fencing.

7.2.3 Traffic Circle Drainage Improvement and Starter Dyke

During Year 8 inspections, water within the drainage channel was found to continue to flow correctly, despite some silt build-up in the channel immediately downstream of the traffic circle flap gate. Visual inspections in 2017 indicated that the flap gate on the drainage outfall to the former headpond was intermittently not operational due to silt and mud deposits. No immediate action is required; however, monitoring will continue in this area and repairs will be recommended if required.

The starter dyke flap gate structure at the drainage channel continues to show signs of leakage despite its replacement. No immediate action is required; however, this gate may need to be replaced in the near future should conditions worsen.

7.2.4 Watermain

No issues were noted during Year 8 inspections. Overall, the watermain and associated infrastructure is functioning as planned and no issues are anticipated.

7.2.5 Additional Observed Erosional Areas

The following areas of shoreline were inspected bi-weekly or monthly as part of the on-going Year 8 inspections:

- downstream from existing riprap at the TransAqua outfall;
- southern shoreline immediately upstream of the causeway;
- between Chateau Moncton and Rogers Building; and
- upstream of Chateau Moncton adjacent to and underneath the boardwalk.

TransAqua outfall: Overall, no significant change was observed in Year 8. As such, no additional erosion protection has been installed and no additional erosion protection is necessary.

Southern shoreline: No significant changes to the shoreline were identified in this area during Year 8. Some of the bedrock ledge at the area of riprap on the causeway had broken off, though it did not appear significant. There is limited risk to infrastructure from erosion in this area, and therefore no mitigation has been recommended.

Between Chateau Moncton and the Rogers building: In Year 8, as in previous years, it was revealed that an old wharf structure is becoming increasingly visible. Although no infrastructure has been identified as being at risk, the installation of additional erosion protection was recommended along this 310 m stretch of shoreline in Year 3 but has not been implemented at the request of the City of Moncton.

Upstream of Chateau Moncton: Monitoring undertaken in Year 8 indicates that the erosion protection in this location continues to function as expected.