MINERAL RESOURCES BRANCH

Flooding at Tank Pond, Cape Breton County, Nova Scotia: Coastal Hazard Assessment and Recommendations for Remedial Action

P. W. Finck

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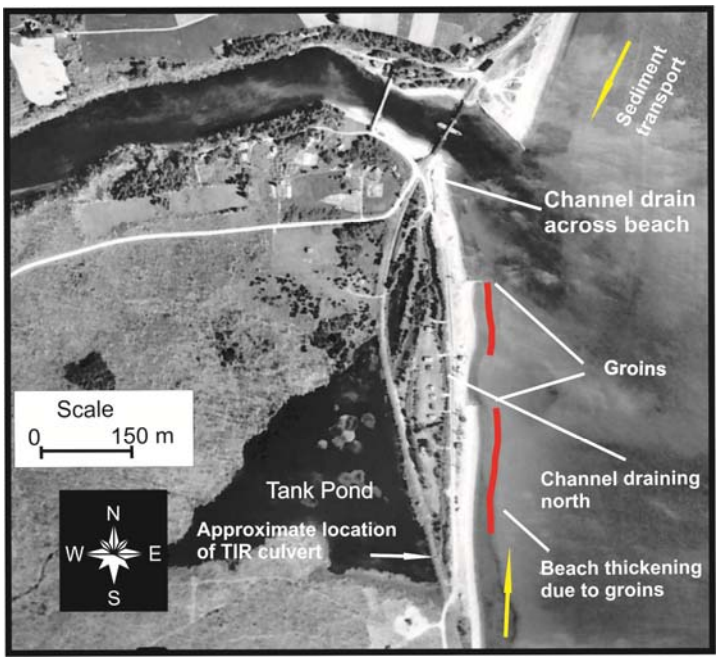

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Introduction

For several years property owners at Tank Pond, located at Mira Gut in Cape Breton County, Nova Scotia, have had drainage and flooding problems. The specific properties affected are located between Mira Bay Drive and the ordinary high-water mark of Mira Bay (Figs. 1 and 2). On September 17, 2012, a meeting was held at the residence of Ms. Diana MacKinnon–Furlong to discuss long-term flooding and drainage issues facing land owners at Tank Pond. The meeting was chaired by the Honourable Alfie MacLeod, MLA, Deputy Speaker. In attendance were various landowners, other stakeholders and several representatives of provincial government departments. On September 21, 2012, Mr. Brian MacSween (NSDNR), on behalf of Mr. MacLeod, requested that I visit the Tank Pond site and provide my opinion about the drainage issues facing the landowners.

A site visit to Tank Pond was conducted on October 1, 2012. Ms. MacKinnon–Furlong was kind enough to show me around the various properties, discuss the history of flooding in the area and brief me on the landowners' concerns. She subsequently showed me various maps, photographs and other information relating to the site and issues in question. She also brought to my attention a report by Strait Engineering Limited and W. F. Baird & Associates (2009) titled *Mira Gut Channel Sedimentation Study, January 20, 2009*, which I subsequently reviewed. The residents were then in the process of having a detailed property survey conducted, and they provided me with a copy of the plan on November 21, 2012, when it was completed (Eric Whyte, N.S.L.S., unpublished plan no. 2012-030, 2012; reproduced here as Fig. 2). I had delayed this report as I had mistakenly assumed that there would be detailed topographic information included in the survey. Unfortunately this was not the case.

Geology

Historical Overview

The properties affected by flooding and drainage problems are located on what is interpreted to be a formerly well developed spit. The spit formed by transportation of beach sediment north along the shore to where the longshore drift and entrained sediment is transported offshore by seaward water flow out the mouth of the Mira River. The spit fronts and underlies the former, now eroded, Mira Road (identified as "abandoned highway" on Figure 2). The Mira Road and structures seaward of the road no longer exist. The spit has been heavily modified by railroad, highway and residential development. Construction of the former S & L Railway along the east side of Tank Pond (Fig. 2) produced a linear topographic high. This, in effect, resulted in the properties in question being placed in an artificial topographic low between the natural storm ridge along Mira Bay and the backing topographic high of the rail line. This blocked the free westward drainage of surface water off the properties into Tank Pond, though without the presence of the rail line the water would have naturally encroached on properties built on the spit during periods of high water levels in Tank Pond. In this report when I refer to 'properties,' I am referring to those properties (including dwellings unless otherwise specified) located between the east side of Mira Bay Drive and the ordinary high water mark as shown in Figure 2.

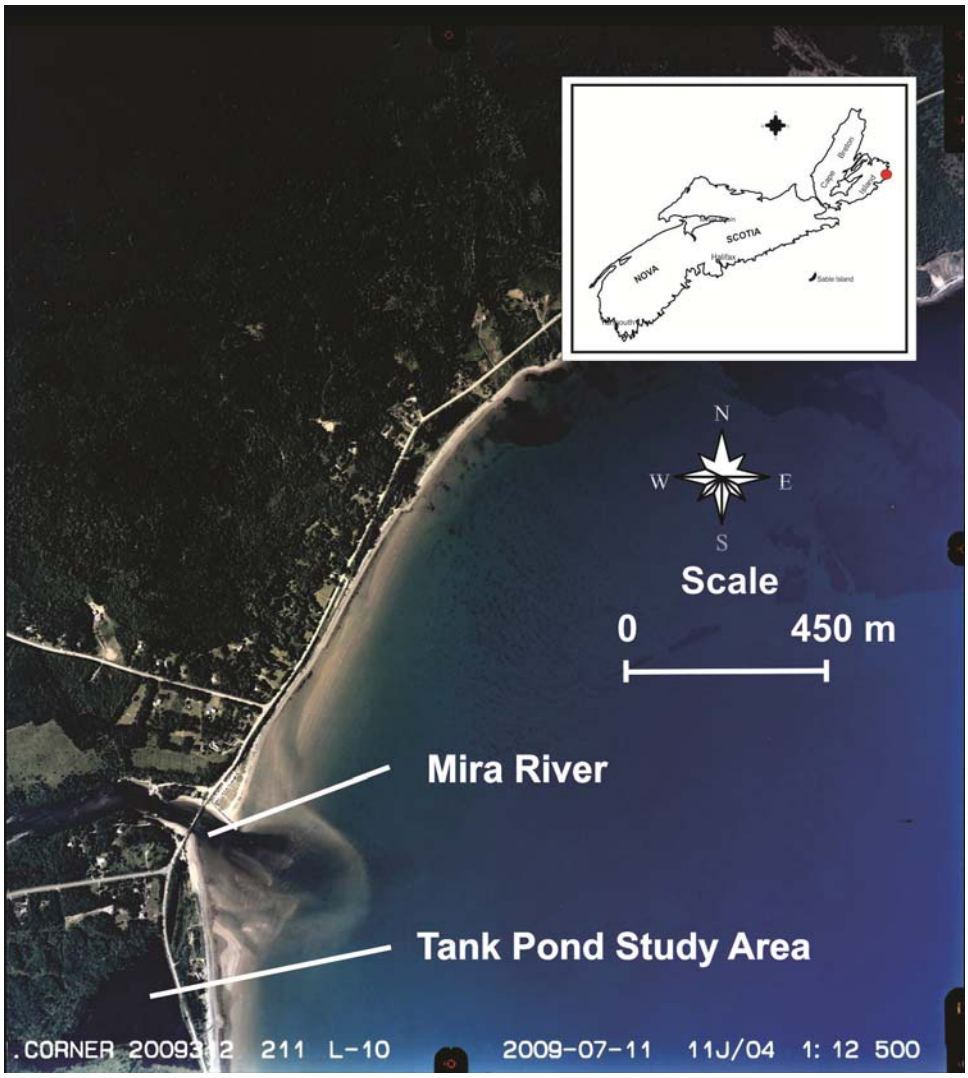

Figure 1. Aerial photograph of the Tank Pond study area.

Ms. Diana MacKinnon–Furlong provided the author with an unpublished survey tracing of the area made in December 1957. The tracing reproduces data from what the author of the map referred to as a "limp but intelligible tracing" of an 1875 survey that is identified as plan M-18 in the Sydney office of the Municipal Registry of Deeds. The author does not have a formal reference for this tracing. In my experience survey maps of the type shown for 1875 are quite accurate, and I have no reason to doubt the accuracy or completeness of the 1875 survey or the 1957 tracing of the original survey.

The tracing of the 1875 map shows the locations of several properties that still appear in similar locations. It also shows properties that have since been destroyed by coastal erosion or removed by property owners. These properties were located east of the old Mira Road, which also no longer exists. Figure 2 indicates the former locations of two buildings of these now nonexistent properties east of the present ordinary high-water mark.

In 1875, drainage is shown from the south end of Tank Pond running north along the back of the former Mira Road and discharging into the mouth of the Mira River (unpublished survey tracing, 1957). This is identified on Figure 2 as "location of old channel." Additional separate drainage is shown on the 1875

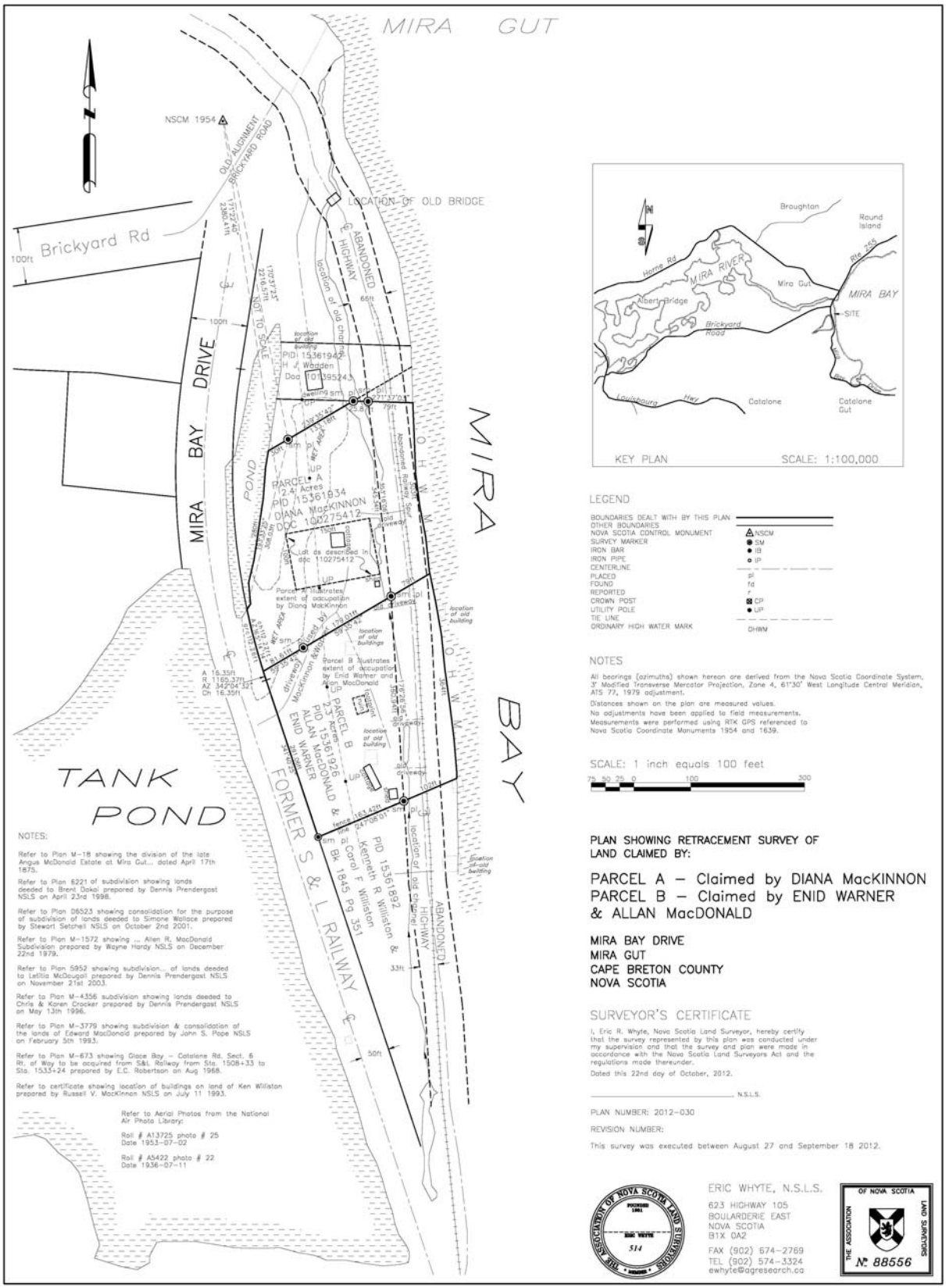

Figure 2. Survey (Plan no. 2012-030) by Eric Whyte, N.S.L.S completed October, 2012. Survey reproduced with permission from Diana MacKinnon–Furlong and Eric Whyte.

map (unpublished survey tracing, 1957) flowing from the north end of Tank Pond and discharging likewise into the mouth of the Mira River. On the 1875 map (not shown in this report) there is no indication of the pond at the north end of Tank Pond that now exists on the present survey map (Fig. 2).

On the 1957 tracing of the 1875 map, the drainage channel flowing from the south end of Tank Pond is shown as flowing along the back of what would have been at that time over-wash sediments. The storm ridge would have been seaward of the former buildings east of the old Mira Road (Fig. 2), and approximately 0.3 m or more lower than the present 2012 storm ridge.

The 1953 air photograph of the study area (Fig. 3) shows a large breakwater on the north side of the mouth of the Mira River, which produced channelization on the south side of the breakwater and deposition of a large fillet beach on the north side. It appears that there is a current flowing from north to south on the north side of the Mira River mouth; this observation is consistent with results from Strait Engineering Limited and W. F. Baird & Associates (2009). The northern fillet beach would not have existed without the presence of the breakwater. However, of far more relevance is the existence

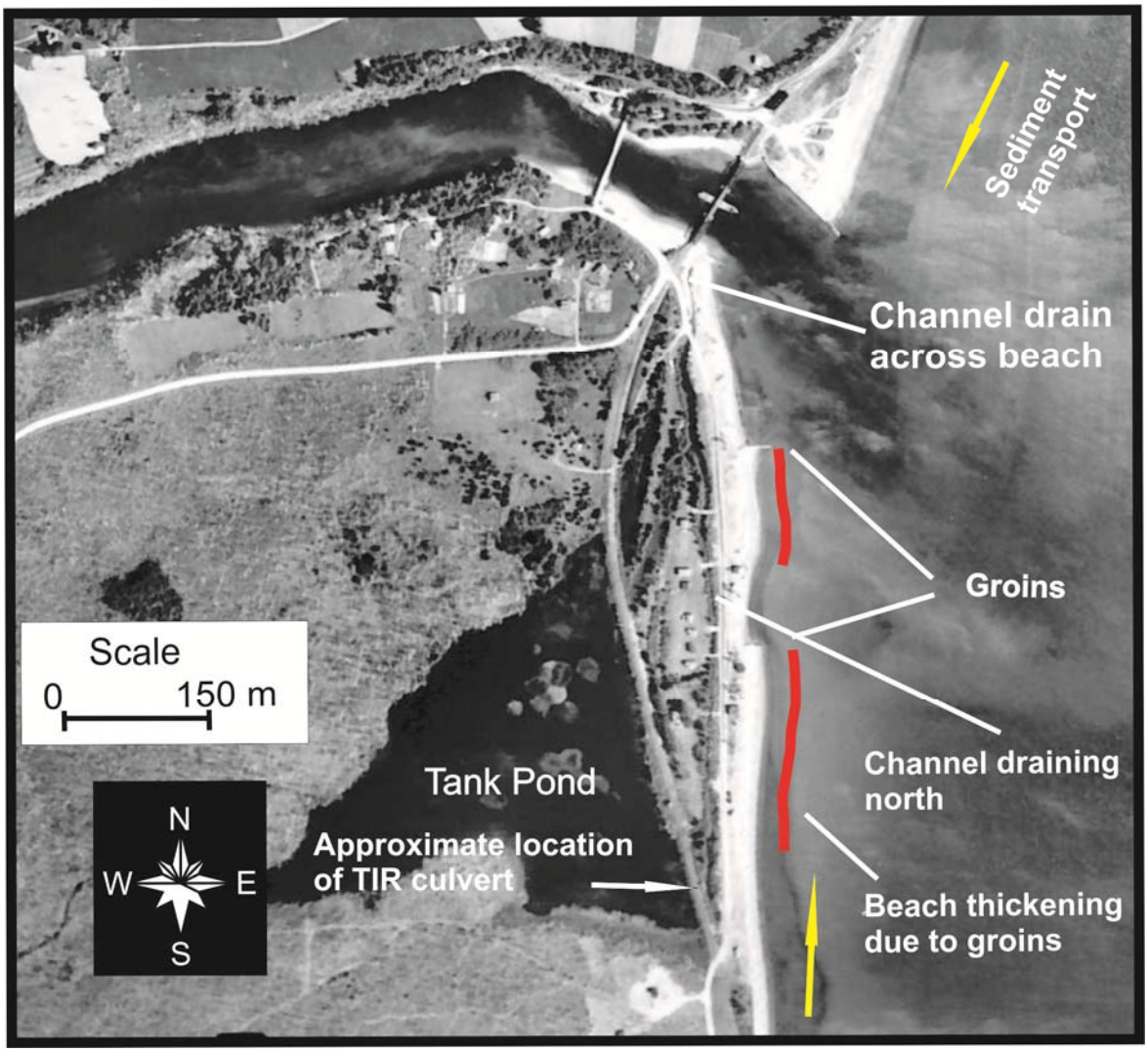

Figure 3. Air photograph of the Tank Pond study area taken in 1953 showing presence of groins.

of two clearly defined groins on the shoreline of the properties under study. It can be seen that the two groins trapped large amounts of sediment on their southern sides, preventing coastal erosion in front of associated buildings on the shoreline. In 1969 imagery (not shown), the groins are no longer visible, and the shore line appears to have eroded substantially. By 2009 the spit was eroded and narrowed such that all of the structures seaward of the old Mira Road and the road itself were gone
(Fig. 1).

Present Hydrology

Approximately 50% of area mapped as land and spit in 1875 no longer exists. Properties located east (seaward) of the former Mira Road no longer exist. The current properties, including structures, are now fronted on the east by a cobble, gravel and sand storm ridge that is greater than 2 m in height. Between the structures and the storm ridge are remnants of a drainage channel, which is shown on the 1875 map (unpublished survey tracing, 1957) and marked as “location of old channel” on the current survey map (Fig. 2). To the west the properties are backed by the elevated Mira Bay Drive constructed on the former S & L Railway bed. The topography appears to be lowest immediately east of the road, as shown by the presence of swamp and otherwise boggy or standing water conditions.

There is a small body of water at the extreme south end of the properties (Fig. 2). At present it drains very poorly southwards to the channel into which the culvert from the south end of Tank Pond empties. In the past, however, this body of water drained northwards into the old channel along the back of the spit, as indicated in Figure 2. The old channel is no longer an effective drainage channel for this small body of water. It is in-filled along much of its length by what appears to be a combination of landward movement of the storm ridge due to centuries of slow progressive sea-level rise, re-vegetation and infill by some residents. In 1875 the old channel drained not only the small body of water, but also water from the south end of Tank Pond (unpublished survey tracing, 1957).

Examination of the site shows that there is no effective drainage system between the former S&L Rail line (the present location of Mira Bay Drive) and the property immediately to the east. Driveways accessing Mira Bay Drive also block any natural drainage. Thus, there is no possibility for southward drainage of water across driveways to the channel through the storm ridge at the end of the culvert that drains Tank Pond. Likewise, there is little opportunity for drainage northward.

At present, water drains from the south end of Tank Pond into Mira Bay via a culvert that empties into a channel cut through the storm ridge (Figs. 3 and 4). At the north end of Tank Pond, culverts or some other form of sub-road drainage apparently drain water from Tank Pond into the smaller pond just north of Tank Pond and across Mira Bay Drive (Fig. 2). This is indicated by reports by local citizens of a current that prevents freezing of parts of the pond; this was not observed by the author. There is no effective drainage from this small pond.

The channel through the storm ridge at the south end of Tank Pond is not sustainable during periods of reduced water flow; longshore drift blocks the channel, causing water to back up onto the properties in question. During storm conditions heavy wave and current action re-establish the storm ridge, which blocks the channel; coupled with heavy precipitation, this blockage floods the properties. Blocking of the channel also prevents what limited southward drainage that might occur from the gutter zone of Mira Bay Drive from draining seaward.

It was suggested by local residents that drainage under Mira Bay Drive at the south end of Tank Pond has contributed to the loss of the old channel along the back of the storm ridge. It is my opinion that loss of the channel is predominantly a natural process due to rising sea level and transgression (landward

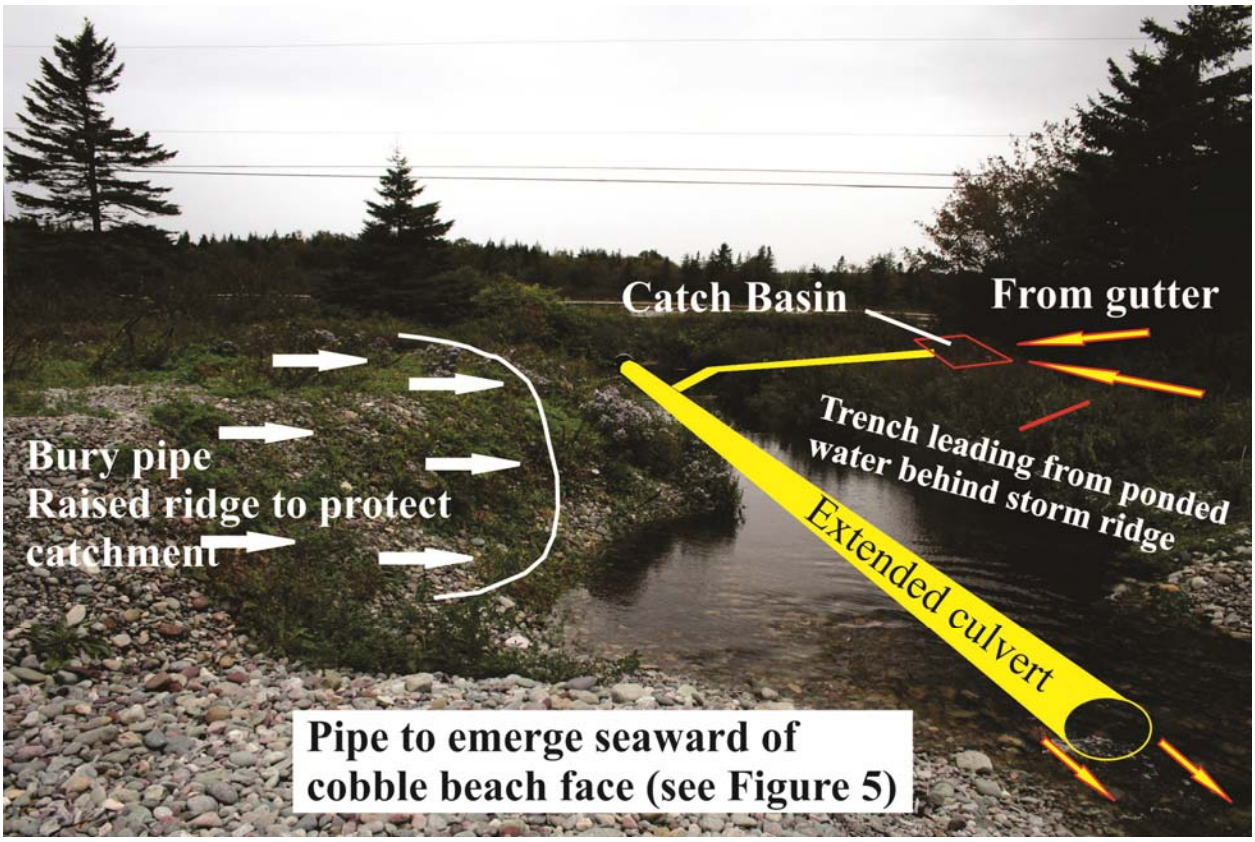

Figure 4. Illustration of extension of existing Tank Pond culvert and associated drainage modifications.

movement) of the shoreline storm ridge, and is exacerbated by infill by some land owners as described above.

Drainage Issues and Remedial Measures

Drainage Issues

There are four main problems at this location that lead to repeated property flooding:

1) Lack of drainage from a pond at the north end of Tank Pond; this is exacerbated by significant water inflow from Tank Pond;

2) Lack of drainage of standing water and flood water that accumulates at the back of the properties along Mira Bay Drive;

3) Lack of drainage of standing water and flood water from the eastern edge of the properties along the back of the storm ridge;

4) Periodic blockage of the channel leading from Tank Pond to Mira Bay at the south end of Tank Pond; when the drainage channel is blocked, the residents' properties flood.

All of these issues are exacerbated by the low, flat nature of the properties in question, a water table that is at or very near the surface, long-term sea-level rise on a century scale, and by subsurface and sub-road drainage from Tank Pond. Water levels in Tank Pond contribute to maintaining the high water table on the opposite (east) side of the road.

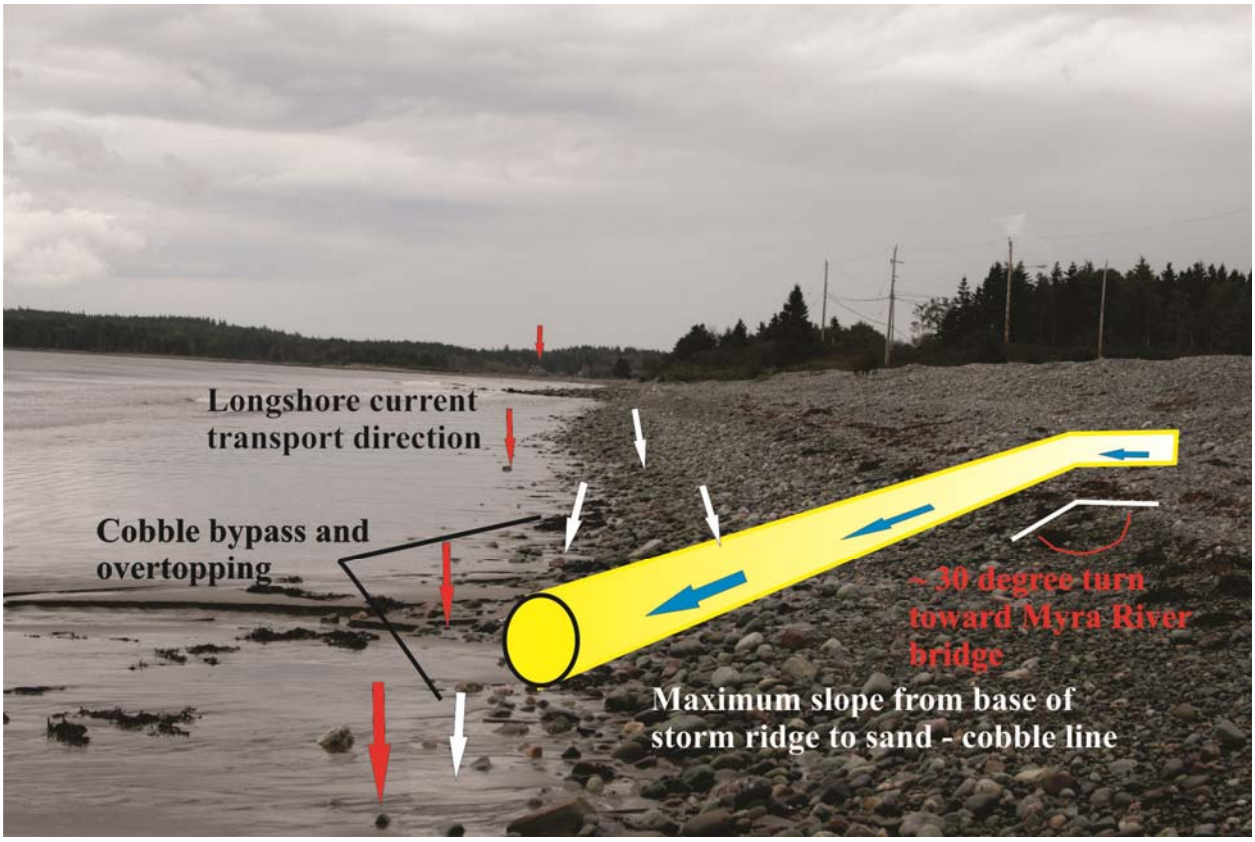

Figure 5. Placement of the extended culvert across the intertidal zone under the storm ridge.

Remediation

It is important for readers of this report (both local residents and other parties with vested interests or responsibilities) to clearly understand the assumptions I have made and the applicability of the following recommendations to the various parties. As a registered Professional Geologist I make no assumption about whether any level of government will or will not fund any of the remedial measures. I am only reporting my observations and offering my professional opinion, and I do not imply any liability for damages due to drainage and flooding on individual properties.

Offering suggestions for remedial action is hampered by the lack of slope measurements in the gutter zone along the east side of Mira Bay Drive. Such a survey is outside the author's area of expertise. If that information becomes available the recommendations in this report can be easily adjusted.

The following are my recommendations.

1) Conduct a detailed slope survey along the east side of Mira Bay Drive and determine in what direction(s) water would flow (i.e. north, south or both). If the slope is in both directions, determine the point of high ground.

2) Construct a proper drainage system based on the results of the slope survey.

3) Placement of material from construction of a drainage system along Mira Bay Drive should only be placed onto private property if care is taken to ensure that it would not inhibit drainage of water off the private properties to the drainage system.

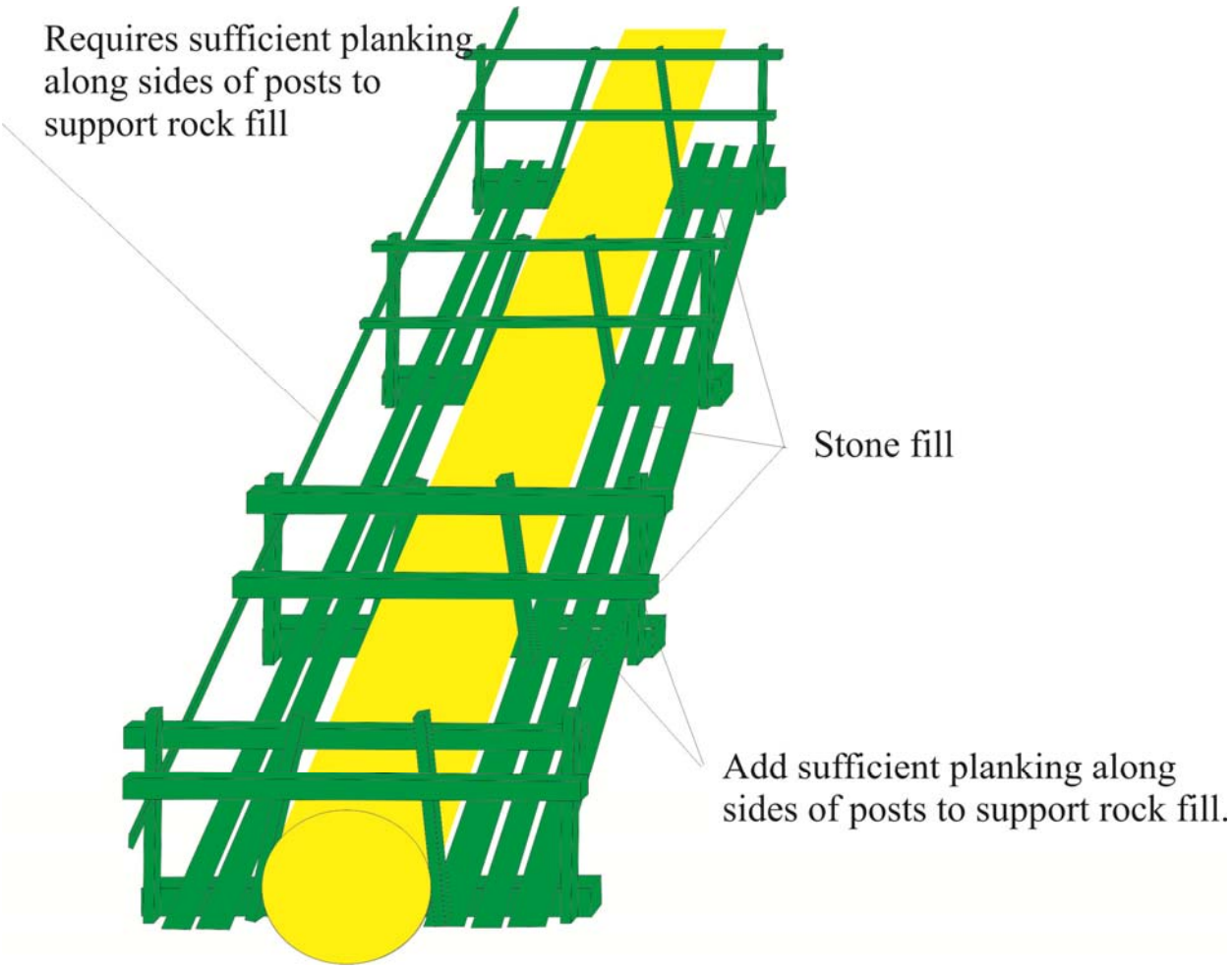

Figure 6. Illustration of a stone-filled crib anchoring the culvert in the intertidal zone on the beach.

4) Construct a drain from the north end of the small pond (at the north end of Tank Pond) to allow water to drain north and discharge on to the small sand beach near the Mira River Bridge. This could be a combination of gutter and covered culvert to reduce cost. This is a critical recommendation.

5) Water flowing under Mira Bay Drive at the south end of Tank Pond floods the residents' properties when the channel across the storm ridge is blocked. It is necessary to create a sustainable drainage system across the beach ridge to prevent or alleviate such flooding.

   Figure 4 shows a proposed extension of the culvert from Tank Pond. The culvert would be covered and pass underneath the storm ridge, which would no longer have to be repeatedly excavated to keep the drainage channel open. The figure also shows a proposed catchment that would collect water from a gutter that drains water ponded behind the south end of the storm ridge. It would also collect water from a drainage system along Mira Bay Drive as previously described. The catchment would be connected to the extended culvert from Tank Pond.

   Figure 5 shows the extension and orientation of the culvert with its termination at the base of the cobble beach. Figure 6 shows one method of anchoring and protecting the culvert. The culvert could alternatively be buried by armour stone, though crushing of the culvert would need to be avoided. The author has also observed similar systems where the culvert was made from concrete with a

rectangular cross-section. It would be advisable that a section of the top of the culvert, nearest the beach, be removable in case the need to clean out the culvert arose.

6) The storm ridge protects the properties from damage and flooding during severe storms. The storm ridge has been degraded and in at least one place removed. In the case of a severe storm or hurricane at high tide, this may cause severe flooding behind the storm ridge. It will allow wave action to penetrate behind the ridge and cause surging. Water flowing seaward through gaps could further erode the storm ridge. I strongly advise that residents close and stabilize gaps in the storm ridge.

It is important to note that even if all of the recommendations above were implemented, during periods of heavy precipitation, large storms, or spring snow melt, there is a high probability that there would still be periods of significant flooding.

Acknowledgments

Thanks are given to Diana MacKinnon–Furlong for her input and for providing materials for the study. Eric Whyte is thanked for providing a digital copy of the survey reproduced in Figure 2.

Reference

Strait Engineering Limited and W. F. Baird & Associates 2009: Mira Gut Channel Sedimentation Study; Report no. 11375.000.