CBNS - Rail Infrastructure Evaluation for Service to Novaporte Intermodal Facility

Port of Sydney Development Corporation

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Rail Infrastructure Evaluation for Service

to Novaporte Intermodal Facility

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1. Executive Summary

As part of the preliminary engineering work being carried out for the transportation of double stacked containers destined to or from Novaporte in Sydney, Nova Scotia, the Port of Sydney Development Corporation has mandated Hatch to evaluate the possibility of upgrading the existing Cape Breton and Central Nova Scotia railway to provide a reliable rail connection to the mainland North American rail network. As the Hopewell subdivision is currently in operation under adequate track conditions, analysis presented here focuses on the Sydney subdivision.

Two site visits were held to inspect the Sydney subdivision, one to assess the condition of the track, track structure, and signals equipment, the other to evaluate the bridges and structures' condition. The structures team also benefitted from extensive and reasonably current engineering information to perform its analysis, however the track and signals teams had virtually no data available to them. It was not possible to inspect the Hopewell subdivision.

Two phases are considered in our work and cost estimate: Infrastructure work to attain short-term, 2-year, operating status under Class 1 running conditions was estimated; longer term, presumably 5-year, work to attain Class 3 conditions were also assessed and estimated separately. The total cost presented assumes the work performed as one phase to capture possible savings due to efficiency gains.

Following the infrastructure assessments, the operations analysis team performed summary track capacity and rail operations analysis to evaluate the ability of the CBNS rail line, under various scenarios, to support desired intermodal traffic levels.

Following are the infrastructure cost items identified throughout the study. Actual costs are summarized in the cost summary table below.

Two-year schedule to run trains over the Sydney subdivision

According to our estimations, although considerable, the work to allow the running of trains under at least Class I conditions from Truro to the Novaporte terminal should be feasible within a two-year time frame. The Grand Narrows swing span bridge work duration, which is likely to be the longest execution time item in this project, is difficult to estimate with precision, however, short term operating modes, such as opening/closing the span using a tugboat, could be used to bridge the time between the opening of rail operations on the Sydney subdivision and the bridge being fully operational.

Cost Summary Table

Total estimated investment required over 2 year and 5 year periods

Task	Phase I Immediate Work Class 1	Phase 2 Long-term Work Class 3	Total If performed as one phase to Class 3 (1)
Track	$7,850,000	$21,400,000	$27,950,000
Civil & Geotechnical	$7,080,000	--	$7,080,000
Signals & Communications	$800,000	$13,000,000	$13,400,000
Bridges	$22,732,500	$27,582,500	$50,315,000
Sidings	$4,400,000	(will depend on desired throughput)	$4,400,000
Total	**$42,862,500**	**$61,982,500**	**$103,145,000**

(1) Total costs column include identifiable savings in track and signals work due to logistical efficiencies.

Note: All cost estimates are expressed in Canadian currency.

Track work

To operate under Class 1, 10MPH, conditions, significant track work including the following items is required:

- The entire subdivision required surfacing, lining and brush-cutting
- 42 miles of track need a minimum of 800 ties per mile
- bridge approach ties at all open deck bridges need replacing

To operate under Class 3, 40MPH, conditions, the following additional track work is required:

- Rehabilitation of all public crossings.
- Major tie replacement (approx. 150,000 ties) and track resurfacing programs on the entire subdivision;
- All existing spring frogs at switches need to be replaced
- A subdivision wide ditching program is required to improve drainage and avoid any future land-slides and washouts.

Civil/Geotechnical

A number of civil/geotechnical issues were also noted. These affect track stability and safety, and all work items were identified as needing to be done in the short term timeframe. These include Bank slide, culvert collapse and washout repairs, as well as cliff stabilization work. The estimated cost below accounts for the lower cost armour stone and rip-rap solution. The higher cost sheet pile solution could also be considered, as mentioned in section 4.2. Also, only short term solutions are presented here as long term cliff stabilization could be considered an operating cost.

Signals and Communications

Considerable work is required on grade-crossing protection equipment. Generally speaking, short term work, for 10MPH train speed, can be described as merely making existing equipment operational. This includes

- Detailed inspection and testing of all signal cases , batteries, wires, insulated joints, Grade Crossing Warning Devices, etc.
- Modification of approach circuits, light fixtures and replacement of insulated joints
- Preparation of engineering plans for all crossings

In order to increase track speed to 40MPH, or Class 3, substantial work will be required at all of the crossings to ensure that both active and passive crossing warning systems meet the new Transport Canada Grade Crossings Regulations :

- Replace all signal cases / housings with new 6'X6' bungalows with Faraday cages, and;
- Back-up battery systems, chargers, equipment housings, foundations, electrical services, all necessary wire and cable, track bonds and connections,
- Upgrade all Automatic Warning Devices control equipment with Grade Crossing Predictor (GCP) replacing DC track circuits, new monitoring systems, grade crossing predictors, solid state crossing controllers and recorders;
- Replace all Warning Signal Masts and cables and replace with gates where necessary;
- Etc.

Structures

The bridges situated within the limits of interest in this study were principally built between 1910 and 1920, while a few were replaced between 1950 and 2000. On the in-service portion of the line, 10 bridges are seen as requiring work to comply with class 1 requirements. 9 more require work to reach Class 3 condition.

On the out-of-service portion, most of the Sydney subdivision, 12 require work to reach Class 1 conditions. This includes the Grand Narrows swing span bridge, which requires major work prior to being put back into service.

Following the initial capital investment in the structures to put the railroad back into operation, additional maintenance shall be required to complete the rehabilitation and upgrade bridges to Class 3 conditions. This concerns bridge approaches, decks and structures.

Train Operations and Track Capacity

Assuming a 50% rail-bound ratio for Novaporte terminal capacity, three operating scenarios were evaluated to determine the required number of trains per week. Under our assumptions, for 200,000TEU terminal capacity, 3 trains per week are required. 5 trains at 500,000TEUs and 10 trains at 1,000,000TEUs.

Train running times were calculated using a Train Performance Calculator, testing several typical train configurations and track conditions. Current Hopewell track speeds and Class 1 conditions on the Sydney subdivision result in 17-18hour transit times between Truro and Novaporte. Class 3 timetable speeds provide transit times of less than 10 hours per direction, and conceivable track improvements yield transit times as low as 7 hours.

These all play into available track capacity, but over 12hour transit time means that daily trains into Novaporte are not possible under those conditions without the construction of a siding or operating trains as fleets of two or three into and out of the terminal.

The estimated cost of one 12,000ft siding was included into the cost estimate.

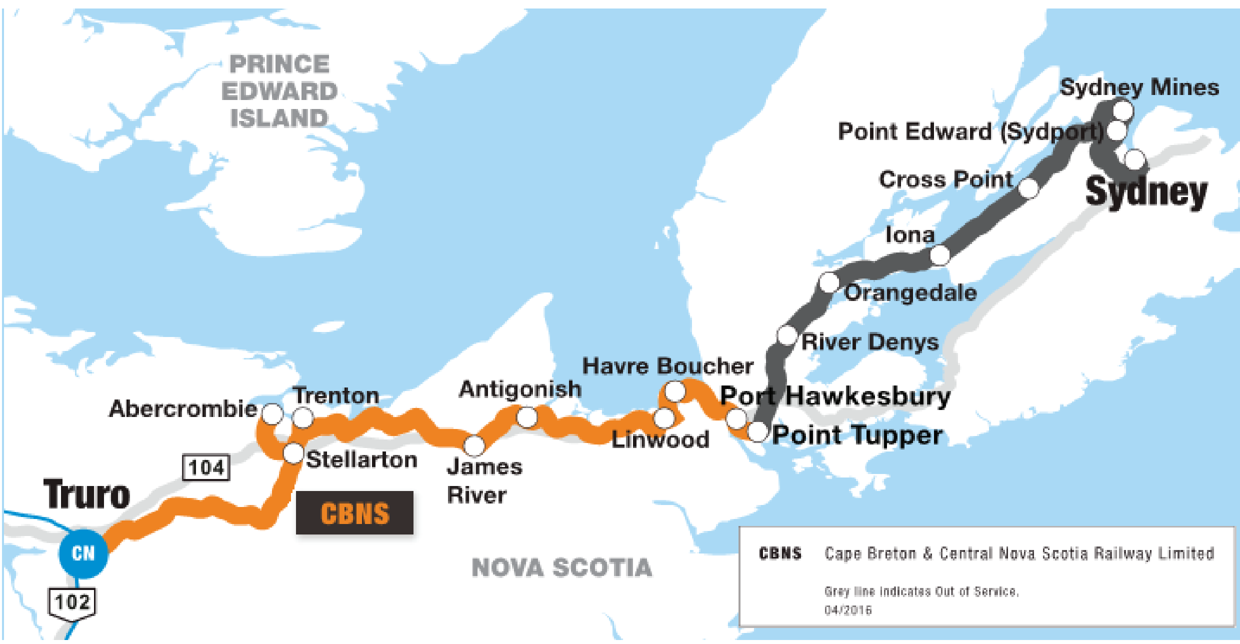
2. Introduction

2.1 Scope

As part of the preliminary engineering work being carried out for the construction of a Ultra Large Container Vessel (ULCV) deep port in Sydney, Nova Scotia, Port of Sydney Development Corporation has mandated Hatch to evaluate the possibility of upgrading the existing Cape Breton and Central Nova Scotia railway to provide a reliable rail connection to the mainland North American rail network.

The objective of this report is to evaluate the feasibility of upgrading the existing railway infrastructure to meet minimal requirements for a Class 1, 10mph, railway and to support double-stack, 286kip railcars from Sydney to Truro, Nova Scotia, the connexion point with Canadian National Railway, within a two year timeframe. This evaluation is accompanied by an executive estimate (+-50%) for the work required on track, signal and structural elements of the railroad.

Figure 1: Map of CBNS Railway[1]



In addition, this report provides a second executive estimate for the infrastructure work required to improve travel time over the line on both the Hopewell and Sydney subdivisions, in order to meet Class 3 railway requirements with a maximum operating speed of 40mph.

[1] https://www.gwrr.com/railroads/north_america/cape_breton_central_nova_scotia_railway#m_tab-one-panel

2.2 Background

The Cape Breton and Nova Scotia Central Railway runs from Truro to Sydney, Nova Scotia and is composed of two principal subdivisions, Hopewell and Sydney, as well as several small spurs. Based on existing infrastructure drawings, the original railway was built between 1887 and 1929 by the Intercolonial Railway, later becoming the Canadian National railway in 1918. The two subdivisions were then sold to the holding company RailTex in 1993, followed by Rail America in 2000 and finally Genesee Wyoming Rail Roads (GWRR) in 2012, who has since owned and operated the track. According to GWRR, the Sydney subdivision has been out of service between approximately mile 15 to 115 since 2014. It should also be noted that GWRR has applied to the provincial government to abandon this section of track, but was refused. There is currently an agreement in place between the Nova Scotia government and GWRR to not abandon the track and it is renewed on an annual basis.

Passenger trains have not operated on the CBNS for some time, however freight traffic continues to use the entire Hopewell subdivision and from mile 0 to 15 of the Sydney subdivision.

Table 1: Infrastructure Inventory

	Hopewell	Sydney
Miles of mainline track	115	114
Sidings	5 (+ 1 yard)	9
Rail Bridges	55	41
Overhead Bridges	7	6
Level Crossings	200	219
Culverts	600	610

Note: Quantities do not include spurs. Culvert numbers are approximate.

3. Methodology

A review of all available material regarding the original and current state of the railway was performed in order to identify existing deficiencies in the railway track, signals and structures as well as any overhead clearance conflicts with double-stack cars. The limits of this study include the track infrastructure between mile 0.00 Hopewell to approximately mile 108 Sydney, where the spur connecting to the future Novaporte installation will be located.

Site visits were performed by two teams in order to evaluate the existing infrastructure on the out-of-service portion of the Sydney subdivision from mile 15.0 to mile 113.00. The site visits took place between Oct. 22 to Oct.27, 2017 and Oct. 31 to Nov.2, 2017. Hatch inspectors were accompanied by a CBNS track supervisor, and who acted as the flagman. In addition, several visual inspection measurements were taken using a gauge meter, a tape measure and a rail wear measure.

It was not possible to visually inspect the Hopewell subdivisions and only a desktop review of these areas was performed.

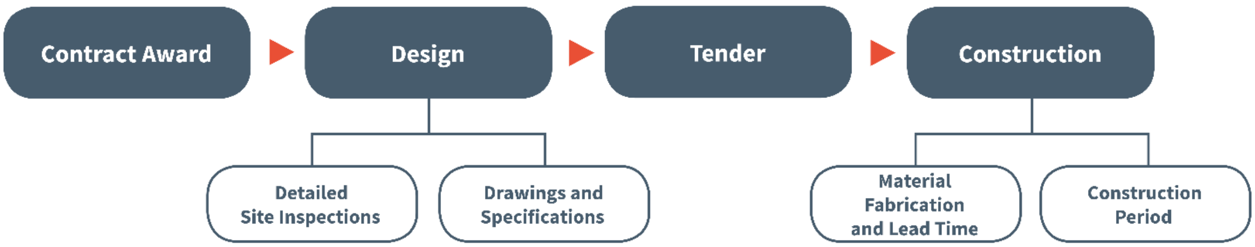
Following the on-site evaluation of the railway, a comprehensive list of immediate work required to put the track in service as a Class 1 railway (minimum operational speed of 10MPH) was compiled. This scope of work required to put the track in service represents the minimum requirements to operate the railway in the short term (1 to 2 years). In addition to summarizing the immediate work required, a list of additional work required over the next 5 years to improve the track to Class 3 and increase operating speed to “Track speed” as indicated in the current CBNS Timetable No.9, - Effective 0001 – Atlantic Standard Time – February 19, 2012 was compiled. This additional work will enable the railway to operate safely over a longer period of time, however it is important to note that ongoing capital and maintenance investments shall be required to ensure the long term operation of the railway.

As described in previous reports, the track is currently classified as Transport Canada – Class 3, but the current time table speeds and other restrictions put in place by CBNS limit speeds to 25MPH on the in-service portion (Class 2) and to 10MPH, stop-and-proceed, on the out-of-service portion (Class 1).

Cost estimates for immediate work required on the bridge structures has been included in the present document. These estimates are based on the existing condition of the structures as assessed by Hatch inspectors and the information provided in the 2014, 2015 and 2017 Parsons bridge inspection reports.

In order to evaluate the feasibility of putting the track in service within a two (2) year time frame, all aspects of the track rehabilitation design and construction were taken into account. In addition to the construction time, lead times on material fabrication were taken into account as well as the time required to carry out the field investigation, engineering and tendering process as outlined in Figure 2.

Figure 2: Work Flow Chart



After establishing the scope of work and cost estimate a high-level schedule was evaluated and recommendations provided regarding the optimal methods with which to proceed with the engineering, tender and procurement required for the upgrade of the railway. A comprehensive description of the work required to upgrade the track is provided in the following sections.

Train operations and track capacity were assessed under scenarios matching the state of repair outlined in the infrastructure sections of the reports.

4. Findings

4.1 Track

Currently the in-service section of track on the Sydney subdivision is operating as a Class 2 railway at 25MPH. Therefore it is reasonable to assume that no additional capital work is required for the purposes of this report. In contrast, the remaining portion of the Sydney subdivision has not been in regular service for several years and requires maintenance prior to running trains on a regular basis. The following sections summarize the state of the rail infrastructure.

4.1.1 Ballast and Surface

The track surface was found to be in poor condition over the entire section inspected between mile 15 and 113. Many locations lack adequately sized ballast between ties and on the track shoulders, especially in the curves. The ballast is contaminated by fines, vegetation and has been undermined by passing all-terrain vehicles. The entire subdivision requires ballast and resurfacing prior to operating as a class 3 track.

4.1.2 Sightlines and Vegetation

The entire subdivision has a tremendous amount of grass and small trees growing in the track between rails. Additionally, fallen branches, trees and overgrowth on both sides of the right-of-way are encroaching on the track, posing a risk of derailment and reducing sightlines substantially. Before running any rail traffic a heavy brush cutting program must be carried out to clear fouled track and restore sightlines to ensure the safety of train operations and the public.

4.1.3 Rail

All of the mainline track on the Sydney subdivision is composed of 115lbs rails produced in Sydney between 1957 and 1974. It is estimated that the track is 85/15 continuous welded rail (CWR) / bolted rail. Measurements taken indicate a low level of wear, between 0mm to 6mm depending on the location. However, since the closure of the subdivision, a moderate layer of rust has coated the rail and must be grinded off before opening the track to traffic to ensure the proper functioning of railway signals. Grinding would also permit a more accurate evaluation of the level crossings. The scope of the current investigation did not include a detailed review of track alignment and this should be completed by passing a “Sperry” car across the subdivision to identify track alignment issues.

4.1.4 Ties

Tie counts were performed at different intervals in order to determine the percentage of defective ties. A total number of one hundred (100) ties were counted at each interval. A list detailing tie counts performed in 2013, in bad ties per mile, was provided by the CBNS track supervisor and revised based on spot counts performed by Hatch inspectors. Based on a review of the 2013 tie-count and the inspection carried out as part of this report Hatch has increased the bad tie counts by 15%.

Based on this evaluation **42** miles of track have more than 1490 defective ties per mile and, therefore, do not meet the requirements for Class 1 track as shown in Table 3. Consequently, approximately 800 new ties per mile must be installed before trains can go by at 10 mph on Class1 Track. Additionally, another **28** miles have more than 1244 deficient ties per mile meaning new ties must be installed before trains can go by at 40 mph on Class 3 Track. These requirements for Class 1 or Class 3 are based on industry standards as shown in the following tables.

With regards to hand thrown switches, it is estimated that approximately 30% of the ties at these locations require replacement.

Table 2: Minimum number of non-defective ties evenly distributed per 39 feet of track[2].

Track Class	Tangent and Curves 2°	Turnouts, and Curves ≥ 2°
4 & 5	12	14
3	10	10
2	8	9
1	5	6

Table 3: Allowable defective tie counts by railway Class.[2]

Track Class	Percentage of Defective Ties	Defective Tie Count
4 & 5	25 – 30%	777 – 933
2 & 3	35 – 40%	1088 – 1244
1	45 – 50%	1341 - 1490

4.1.5 Turnouts

The out-of-service Sydney subdivision has **23** - #10 hand thrown switches for the 115lb rail in place that include spring frogs. Spring frog type switches are acceptable for Class 1 railways, however they would pose a serious derailment risk to Class 3 track and would have to be replaced by rail bound manganese steel (RBM) type frogs. Two hand thrown switch spring frogs have been removed completely, therefor a total of 25 RBM frogs would need to be installed in order to upgrade the track to class 3, while maintaining all existing sidings and back tracks. However, these estimations could change depending on how many sidings and back tracks are required for future operations.

4.1.6 Road Crossings – Public & Private

The Sydney subdivision between miles 6 to 114.00 includes **40** active public crossings, **4** passive public crossings and **156** passive private crossings. The crossings within these limits were audited for both signals and track compliance with industry standard guidelines. Local municipalities have paved over the mud rails of several crossings and substantial vegetation and gravel has accumulated on others. All level crossings require cleaning

[2] Canadian National Railways Track Standard, Sept. 2016

and removal of any material from mud rails prior to operating at class 1, 10 MPH. The majority of the crossings require rehabilitation in order to meet class 3 requirements.

There are approximately 160 private crossings with mud rails that will have to be cleaned before traffic will be able to start as Class 1. New crossing planks and rehabilitation will be required at all private crossings before trains can run as Class 3 Track (40 MPH). Additionally, **200** insulated joints will need to be tested, and changed if required, prior to operating the railway as a Class 1 track.

4.1.7 Wayside Inspection Systems

Hot box and dragging equipment detectors are installed at three locations along the Sydney subdivision, however the technology used appears dated and non-functional based on visual inspection. Previous reports indicate that the equipment was functional up until recently, but they were not tested as part of this study. In either case, it will be important to upgrade the equipment before running trains at 10MPH.

4.1.8 Summary of work require to operate at Class 1

Based on the information currently available, the in-service section of the Sydney and Hopewell subdivisions already operate as a Class 2 railway at 25MPH, therefore no work or additional funding should be required on these sections of track beyond the normal operational maintenance. However, the out-of-service portion of the Sydney subdivision will require the following work to operate trains at 10 MPH (Class 1)

- The entire subdivision required surfacing and lining;
- The entire subdivision requires a brush-cutting program to remove trees, grass, etc. and to restore sightlines.
- All the private and public level crossing mud rails need to be cleaned;
- 42 miles of track need a minimum of 800 ties per mile for an approximate total of 35,000 ties and at the same time rehab the private crossings that are in the tie program limits;
- Track geometry must be validated via Sperry car and rail flaw detector testing prior to regular train operations
- The top of the rails must be cleaned and rust ground off to permit track geometry tests and to ensure proper functioning of signals at level crossings. This could be achieved with a switch and crossing grinder;
- Replace bridge approach ties at all open deck bridges.

The total cost for the scope of work listed above is estimated to be **$7,850,000.**

4.1.9 Summary of work required to operate at Class 3

Once the track is operational at 10MPH, additional track work will be required to further increase track speeds to original values (Class 3). The work detailed below will be required on the Sydney subdivision to achieve 40MPH, or track design speeds:

- Rehabilitation of all public crossings. This can be performed in conjunction with the tie replacement program;
- Major tie replacement (approx. 150,000 ties) and track resurfacing programs on the entire subdivision;
- All existing spring frogs at switches will need to be replaced with safer RBM frogs and switch tie sets. Switches will require ongoing maintenance even once they are replaced with modern technology.
- A subdivision wide ditching program will be required to improve drainage and avoid any future land-slides and washouts.

The total cost for the scope of work listed above is estimated to be **$21,367,000.**

4.2 Track Stability and Drainage

4.2.1 In-Service Track

As noted previously, the Hopewell subdivision and mile 0.00 to 15.0 of the Sydney was not inspected by Hatch personnel and there is little information available regarding the current state of track substructure and drainage. However, given that CBNS has recently invested in bringing the track speed up to 25MPH for 286kip trains, it is reasonable to assume that the track stability is acceptable and that localised areas of instability are dealt with as part of regular track maintenance.

4.2.2 Out-of-Service Track

In addition to reviewing the state of track materials, the condition of track substructure, embankments and drainage was evaluated during the site visits and a review of available aerial photos. As recorded by CBNS, several track washouts and bank slides occurred in 2016 and appear to be an ongoing issue with the railway given its proximity to major waterways.

During the track inspection several important sources of track instability were noted:

- Bank Slides: loss of ballast shoulder and ballast under ties due to erosion or excessive slopes;
- Culvert Collapse: localised areas of ballast loss at track level indicating the collapse at mid-point or at end of culvert;
- Washouts: complete loss of ballast, sub-ballast and culvert (if present) under track;
- Cliff instability: undermining and erosion of rock face underneath track;

Figure 3: Wash-out and destroyed culvert at mile 110.1.

Based on aerial photos taken of the subdivision in 2017, it is apparent that many small bank slides have undermined the track in the past. Many of these areas have since been reinforced by placing armour stone and rip-rap, however many have not and the entire Sydney subdivision will require constant maintenance in this respect. Similarly, it is likely that certain culverts will need to be replaced. Frequently track washouts are caused by culverts that are hydraulically deficient. In these cases, the culvert is unable to handle the flow from large rainfall events and water ponds on one side of the track until the hydraulic pressure blows out the track structure. A culvert inspection and replacement program will likely be required in order to address damaged, blocked or hydraulically deficient culverts, however this is typically covered in the operational costs of a railway. Additionally, 7 beaver dams locations affecting drainage were identified and pose the risk of destabilizing the track.

In addition to the track work defined in the previous section, it is critical that sources of track instability be addressed prior to operating this section of track at even Class 1 speeds. A summary of the data collected during the inspections and the respective costs to rehabilitate these items is provided in Table 4. The total cost estimates for this work are based on the estimated quantity of ballast and rip-rap material required to stabilize the track, as well as the replacement of defective culverts and the re-alignment of track where the supporting rock cliffs have been undermined by erosion.

Table 4: Summary of track stability work required on Sydney subdivision to operate as Class 1.

Issue	No. Locations	Quantity	Unit Cost	Totals
Bank Slides	31	9,700 m^3	$200	$1,940,000
Culvert Collapses	10	10	$40,000	$400,000
Washouts	3	12,000 m^3	$200	$2,400,000
Cliff Instability	2	300m	$7,800	$2,340,000 (1)
TOTAL				**$7,080,000**

Note: All cost estimates are expressed in Canadian currency.

(1) This estimate is based on the Armour stone and rip-rap solution described below.

A large portion of the Sydney subdivision runs along the Bras d'Or lakes on cliffs that are composed of very friable rock such as gypsum. In many locations, totalling roughly 1,100 meters, these cliffs have eroded substantially and will eventually undermine the track. 300 meters of this length appear severely deteriorated and would require stabilization prior to trains running at any speed. According to CBNS personnel, the track at these locations has already been moved away from the water as much as possible without requiring major excavation work. Figure 4 shows one of these locations where the track has been shifted and a segment of collapsed cliff was reinforced with armour stone and rip-rap.

Estimating the cost of stabilizing these cliff is difficult, largely due to the lack of adequate geotechnical information which would require a full geotechnical investigation, including borehole and sample analysis. Our approach was the following: Two solutions to the instability issue appear reasonable: The armour stone and rip-rap solution, at least short term, has been used successfully in other locations on the Sydney subdivision. This solution may not provide long-term stability, but likely addresses concerns over the short term. A longer term solution consists of a sheet pile wall, protected on the water side with armour stone. This more expensive solution would be expected to provide a longer term protection against erosion. Given the unknowns surrounding the cliff stability issue, a 50% contingency was used in the estimation of both solutions. Table 4 shows the cost associated with the Armour stone and rip-rap solution. The sheet pile solution is tentatively estimated at $7,200,000.

Figure 4: Erosion of gypsum cliff supporting track, approx. mile 53.

As time goes on, erosion of the cliffs will continue to progress. Without more in-depth information, it is not possible to estimate the rate or the extent of the erosion. From the observation of areal photographs, we tentatively project another 800m of cliff in need of stabilization in the foreseeable future. This stabilization could be addressed using either the armour stone or sheet pile solutions. We estimate the cost of the additional work at $6,240,000 to $19,200,000, depending on the chosen solution. These costs are not included in our capital cost estimate for this project, as they can be considered operating costs to maintain the railway in operating order. Table 5 presents a summary of estimated costs per option associated with the stabilization of cliffs in this area.

Table 5 Cliff stability options and costs

Solution	Short Term (300m)	Long Term (800m)	Total (1100m)
Rip-rap and Armour Stone	$2,340,000	$6,240,000	$8,580,000
Sheet pile	$7,200,000	$19,200,000	$26,400,000

4.3 Signals and Communications Equipment

In this context, ***Signals Equipment*** refers to all track side electric or electronic equipment, which traditionally is the responsibility of the railroad Signals & Communications group. These include grade-crossing protection equipment, way-side detectors, radio towers, if present, or any communications infrastructure used to operate the railway.

As with the track and structures inspections, only the Sydney subdivision was visually inspected. The in-service portion of the Hopewell and Sydney subdivisions are maintained by CBNS signals maintainers and is currently operating as a Class 2 track.

There are a total of 40 active public road crossings between Macintyre Lake and Sydney (MP 20.0 – MP 113.8). By definition active crossings are equipped with automated crossing warming systems and passive crossings are equipped with signs only. In addition to the 40 active crossing there are 4 passive public crossings and 156 private crossings, typically providing access to lakefront cottages. Each of these crossings was visually inspected by Hatch personnel and the condition of all elements, including bungalows, lights, power sources, logbooks and plans were inspected.

The general state of the crossings indicate that they have been effectively abandoned. The majority of the crossing signals do not have log books to indicate any recent testing or electrical drawings that would permit an adequate evaluation of the system, as is required by industry standards. In addition, many signal bungalows are missing batteries or signals posts and many "Power off lights" have been disconnected or covered over. Isolated track joints required for the proper functioning of the crossing alarms are largely deteriorated and in several locations the mud rails have been paved over by local municipalities. As noted in the previous sections, there is a layer of rust covering the rails that currently impedes rail axles from closing the signals circuits as they approach the level crossings.

Beyond the electrical defects noted at each of the level crossings, the quality and state of repair of the light fixtures and barriers does not meet current Transport Canada requirements. It was noted that 26 crossings had flashing light units with incandescent lights, which are no longer acceptable. Existing approach circuits are located according to original track speeds, typically 35MPH or 45MPH. If the track is opened at 10MPH Class 1, and these circuits are not relocated, approaching trains will set off signals long before actually arriving at crossing causing significant nuisance noise to residents. This also increases risk of public crossing the tracks due to impatience.

4.3.1 Summary of work require to operate at Class 1

Based on the available information and the site inspections carried out, the out-of-service portion of the Sydney subdivision will require the following signals work to bring the 40 crossing up to a fully functional state to operate trains at 10 MPH (Class 1)

- Detailed inspection and testing of all signal cases and bungalows;
- Preparation of engineering plans for all crossings (to be kept on site for installation and testing);
- Grade Crossing Warning Devices shall be tested as per General Instructions and AREMA. Among other things, battery & ground tests, wire & cable resistance testing;
- Batteries must be cleaned, and free of corrosion. Load tests shall be measured as per instructions;
- A portion of the signal cases / housings must be repaired. One housing is so damaged that it will need to be replaced. In this case, all the crossing warning lights should be new and in accordance with the new Grade Crossings Standards;
- One location is missing a signal mast (knocked-down). Mast and existing equipment, must be replaced;
- All the approach circuits shall be relocated according to the train speed limit to provide consistent warning times and reduce nuisance noise;
- Replace **26** incandescent light fixtures with Light Emitting Diodes (LED);
- Repair all Power-Off lights at bungalows;
- Test approximately 100 insulated joints and replace if found defective. The joints should be electrically tested with an S&C Short Finder;
- **1-800 #** and Location ID # should be complete, visible and legible at all crossings;
- Clear vegetation to ensure that all railway and vehicular traffic sight lines are clear.

The total cost for the scope of work listed above is estimated to be **<u>$800,000.</u>**

4.3.2 Summary of work require to operate at Class 3

In order to increase track speed to 40MPH, or Class 3, substantial work will be required at all of the crossings to ensure that both active and passive crossing warning systems meet the new Transport Canada Grade Crossings Regulations that will become mandatory in November 2021. These requirements apply to both public crossings and private crossings.

- Replace all signal cases / housings with new 6’X6’ bungalows with Faraday cages, and;
- Back-up battery systems, chargers, equipment housings, foundations, electrical services, all necessary wire and cable, track bonds and connections,
- Upgrade all Automatic Warning Devices control equipment with Grade Crossing Predictor (GCP) replacing DC track circuits, new monitoring systems, grade crossing predictors, solid state crossing controllers and recorders;
- Replace all Warning Signal Masts and replace with gates where necessary;

- Install new cable to crossing masts and track circuits;
- Upgrade the existing power service to 120/240VAC 100 Amp
- Remove all approach cases and pole lines.

The total cost for the scope of work listed above is estimated to be **$13,000,000.**

4.4 Structures

The bridges situated within the limits of interest in this study were principally built between 1910 and 1920, with several exceptions on the Hopewell subdivision where several structures were replaced between 1950 and 2000.

Based on the existing 2015 and 2017 bridge inspection reports and the bridge capacity ratings completed by Parsons, the structures along the CBNS were evaluated with respect to the following criteria:

- **Immediate Work:** required to put track into service within 2 years for 286kip traffic at 10MPH, under a “Normal” rating. This is equivalent to a Class 1 railway.
- **5 Year Work:** required to upgrade service to “Track Speed” under “Normal” bridge ratings. This is roughly equivalent to a Class 3 railway.

It is important to note that allowing the track to operate under a “Maximum Rating” is not recommended and should only be considered as a temporary condition. Maximum ratings permit 20% over-stress of main structural members and may lead to fatigue cracking of structures if traffic loads larger than those supported by “Normal” ratings are permitted to run on a regular basis.

4.4.1 In-Service Structures (0.00 Hopewell to 13.1 Sydney)

The section of track running from Truro to Port Hawkesbury is currently operational and has been subject to more regular maintenance than the remaining track continuing to Sydney. It is understood that CBNS is currently working on upgrades to the bridge structures in order to run 286kip loads over the next 20 years along the entire Hopewell subdivision and up to mile 13.1 of the Sydney subdivision. The work planned by CBNS will permit trains to pass regularly under a “Normal” structure rating at 25MPH, with several restrictions (i.e. no stopping or accelerating) at certain locations. Therefore, the structures located within this section of track will meet the operation criteria defined above for operation of the railway within 2 years. CBNS plans to carry out this work within the next year and therefore will be complete prior to the beginning of Novaporte construction.

In order to establish a long term work plan, a detailed review of the available bridge rating capacity information was carried out and summarized below in Table 5. Of the 34 bridges situated on the active section of track, ten of these require work to support 286kip vehicles at 10MPH. As previously stated, this work is currently being done by CBNS. In order to run traffic at the time table track speeds, nine additional structures, detailed in Table 6 below, require rehabilitation work.

Table 6: List of Structures Requiring Work for 10MPH and Track Speed on Active Section of Track.

Bridges Requiring Work for 10 mph (Class 1)	Bridges Requiring Work for Track Speed (Class 3)
42.2 Hopewell	35.1 Hopewell
51.9 Hopewell	42.9 Hopewell
64.4 Hopewell	43 Hopewell
65.9 Hopewell	67.7 Hopewell
66.1 Hopewell	78.6 Hopewell
82.2 Hopewell	105.7 Hopewell
84.4 Hopewell	106.4 Hopewell
95 Hopewell	0.3 New Page
95.2 Hopewell	9.6 Sydney
0.5 Sydney	

4.4.2 *Out-of-Service Structures (13.1 to 110 Sydney)*

The section of track running from Port Hawkesbury to Sydney has been out of service since 2014 and no detailed bridge capacity rating information is available. The structures located on this section of track are all around 100 years old and do not appear to have received substantial maintenance in the last 30 years.

Without any capacity rating information, certain assumptions have been made to determine the approximate capacity of the existing structures. Based on the existing bridge drawings, the structures were designed to the *Dominion Government Specification 1908 – Class Especial Heavy*. This design standard pre-dates the E-Cooper values, however a simplified analysis of the load shows it to be equivalent to approximately E-52, or 60kip per axle. Using the information available from the Hopewell subdivision, it is assumed that a 286kip console is equivalent to between E50 and E60, depending on the exact geometry of a given structure. These values all relate to the “Track Speed”, or approximately 35 to 45 MPH, at any given structure. A reduction in speed reduces the impact loads on the structure and it is therefore reasonable to assume that all structures should support 286kip (E60) loads if track speed is reduced to 10MPH.

However, inspections from 2015 indicate substantial corrosion of principal structural members in a number of steel bridges and general deterioration of concrete on all of the structures. In order to establish exactly what work is required for each structure, it would first be necessary to carry out detailed bridge inspections followed by corroded ratings of all bridges. This is beyond the scope of the current report.

A detailed evaluation of the 2015 inspection reports and photos available was carried out and a list of structures likely to require immediate work in order to be put back into operation was compiled. Given that the design standard of the bridges in question is more-or-less equivalent with 286kip loads used as criteria for this study, it is reasonable to assume that any serious corrosion (i.e. beyond approx. 20%) will likely reduce the structural capacity below what is required. In addition to reviewing the structural capacity, a review of the drawings indicated that there were structures that also require work to permit the passage of double-stack wagons.

After performing a cursory inspection of all of the structures on the Sydney subdivision and reviewing all available material, a scope of work was prepared for both the immediate work required and that over a following 4-year period. The following sections summarize these findings.

4.4.3 Immediate Work Required – Class 1

As previously noted, the bridges on the Hopewell subdivision are currently undergoing a basic maintenance plan and, therefore, no immediate work is required. However, the Sydney subdivision is in disrepair and requires work on at least 12 structures before opening the subdivision to regular freight traffic with a reasonable level of confidence.

4.4.3.1 Vertical clearance

Within the twelve (12) bridges requiring work, there are two (2) that are in conflict with the clearance diagram for double-stack container wagons. They will require the following work:

- 57.8 Sydney – Grand Narrows 7 Span Through Truss
  - Modification of portal brace frames on all 7 spans
- 103.3 Sydney – Fairmont St. Overhead Bridge
  - Out of service road bridge to be demolished.

4.4.3.2 Bridge Approaches

Substantial vegetation has begun to grow in the ballast on bridge decks, approaches and under the spans. A long term brush cutting and removals plan must be established, however some brush cutting must be planned within the immediate work at certain locations to ensure the safe operations of the train traffic.

Prior to running any freight traffic on a regular basis the condition of the track at the approaches to the bridge needs to be addressed. It is very common to find low track conditions at bridge approaches since bridge foundation wing walls may limit track maintenance equipment from accessing these areas. In addition, raises in track level over time frequently surpass the intended limits of bridge wing walls and curbs. All the bridges on the Sydney subdivision suffer from a lack of ballast and low approaches varying in severity from minor track shoulder erosion to loss of ballast material beneath track ties. In addition to the common issues noted above, many of bridges are subject to tidal erosion and waves. Similar to track washouts and bank slides, these areas can cause serious risk to the track stability and cause derailments if not addressed.

Figure 5: Typical erosion and undermining of track support at mile 46.9 Sydney.

A summary of the most severe cases is listed below. These areas must be corrected before running regular freight traffic on this section of track.

Table 7: List of bridge approaches requiring work.

Location	Crossing	Cost
46.9 Sydney	Little Narrows	$20,000
49.4 Sydney	Ottawa Brook	$75,000
73.3 Sydney	Stream	$50,000
76.0 Sydney	Stream	$20,000
99.5 Sydney	Regent St.	$50,000
104.4 Sydney	Balls Creek	$50,000
Total		**$295,000**

The bridge approaches noted above will likely require additional support in the form of gabion walls, pre-cast concrete gravity retaining walls, or steel sheet piles, combined with rip rap in order to stabilize the approaches.

4.4.3.3 Bridge Decks

In general most of the bridges spanning a distance greater than 40 feet on the Sydney subdivision are steel structures with open decks, meaning that the bridge ties are principal structural members of the bridges. As such, the condition of the bridge ties has a direct impact on the structure's capacity to support rail traffic. Typically a bridge tie has a lifespan of approximately 30 years when subjected to normal axle loads, however this can vary substantially according to traffic frequency and load. Many of the larger bridges on the Sydney subdivision have substantially deteriorated decks showing advanced signs of rot, splitting and loss of creosote treatment. Deterioration has reached a point that notable vegetation growth was noted in bridge ties at several locations.

The table below summarizes the bridge deck replacements required as part of the immediate work.

Table 8: List of bridge decks requiring replacement.

Location	Crossing	Cost
49.4 Sydney	Ottawa Brook	$515,000
50.7 Sydney	Walker Gulch	$439,000
57.8 Sydney	Grand Narrows	$1,715,000
103.3 Sydney	Leitches Creek	$106,000
104.4 Sydney	Balls Creek	$105,000
Total		$2,880,000

It should be noted that existing rails, rail anchors, spikes, guard rails and other track materials are generally in good condition and may be kept in most cases with only partial replacement required. One notable exception to this statement is the Grand Narrows bridge at mile 57.8 where rail spikes and tie plates have corroded substantially and will require replacement.

Figure 6: Rotten and split ties with significant vegetation at 57.8 Sydney.

4.4.3.4 Bridge Structural Work

The following summary of work has been established based on bridge reference drawings and visual inspection reports prepared by Parsons in 2015 as well as a cursory site visit carried out by Hatch personnel. Consequently the proposed scope and estimate is approximate and should not be used for detailed planning. The exact scope of repair work needed prior to running regular rail traffic on the Sydney subdivision must be established by first carrying out detailed bridge inspections and bridge capacity ratings. This information is essential to establishing a prioritized list of structural bridge work needed to run rail traffic at 10MPH and at track speed.

Based on the available information the following scope of immediate work has been established.

Table 9: List of bridge work required to operate at Class 1.

Location	Structure	Immediate Structural Work Required	Cost
21.9 Sydney	2 TPG	Replace all 20 TPG span 2 stringers Replace all 11 TPG span 2 floorbeams	$575,000
35.2 Sydney	2 TPG	Replace all span 1 floorbeams and stringers Replace span floorbeam top flanges Replace all span 2 stringers	$760,000
49.4 Sydney	11 DPG Viaduct	Replace top flange angles of 60' spans Replace interior shelf angles of all 60' spans	$1,100,000
50.7 Sydney	10 DPG Viaduct	Replace holed lateral bracing system on all spans Replace interior shelf angles on all 60' spans	$400,000
57.8 Sydney	7 TT + Swing span	Resurface East and West abutments and Pier 7 Modify portal bracing to permit double stack trains Replace stringer bottom flanges throughout Rehabilitate swing span mechanical components Conduct underwater inspection	$12,400,000
80.5 Sydney	TPG	Repair bottom flanges and floorbeam webs Geotechnical study to determine cause for abutment or span movement.	$160,000 $40,000
87.4 Sydney	DPG	Replace span	$200,000
87.5 Sydney	4 TPG	Replace floorbeams throughout bridge Resurface abutments and piers Replace deficient roller bearings	$1,000,000
103.1 Sydney	O/H	Demolish out-of-service overhead structure	$50,000
103.3 Sydney	TPG	Replace stringers and floorbeams	$525,000
104.4 Sydney	TPG	Patch main girder webs Replace main girder bottom flanges	$250,000
Total			**$17,460,000**

The structures on the Sydney subdivision are generally composed of short concrete spans and moderate sized steel spans, however there are three substantial bridges; the two viaducts at miles 49.4 and 50.7 as well as the through truss swing span at 57.8. The timber decks and main girders on the steel viaducts are substantially deteriorated and will require further analysis and rehabilitation. The swing span at the Grand Narrows bridge (57.8) has not functioned since 2015 and will likely require an electrical and mechanical retrofit if it is to operate on a regular basis. It is possible to pull the swing span open and closed using tug boats, however this is not advisable for regular use given the higher risk of damage. In addition, the locking mechanisms must all be engaged manually and appear to be damaged beyond repair in many cases. Consequently, a complete retrofit of the swing span mechanics is required to operate the bridge under regular rail traffic.

Figure 7: Aerial photo of Grand Narrows Bridge[3], mile 57.8.

[3] Photo from Genesee Wyoming RailRoad aerial survey of Sidney subdivision.

Figure 8: Photo of Walkers Gulch bridge, mile 50.7

4.4.3.5 Summary of Immediate Bridge Work & Cost

Based on the scope of work established in the previous section, there is approximately $23 million dollars in immediate repair work and engineering fees required to rehabilitate the bridges. The previous report prepared by Canarail in 2015 has estimated this amount between $8 million and $9 million, however Hatch believes that several important items related to the viaduct and swing span structures were not adequately represented.

Table 10: Summary of Immediate Bridge Work Cost and Duration

Task	Cost	Duration (months)
Inspection	$200,000	2
Rating & Planning	$72,500	2
Detailed Design	$560,000	5
Approach Work	$295,000	1
Construction – Bridge Decks	$2,880,000	2
Construction – Structural Work	$17,460,000	12
Supervision	$1,245,000	
Total	**$22,732,500**	**24**

As indicated in summary shown in Table 5, the sum of all the durations estimated for the proposed work falls within the 24-month criteria. However, the engineering, fabrication and construction works must be carried out simultaneously with adequate resources assigned to each task. The critical path for the structural rehabilitation is the engineering, fabrication and construction time related to the swing span at the Grand Narrows crossing. This is due to the complexity of the engineering and the substantial lead time on the custom mechanical pieces required for repairs. Lead times for these materials can reach 12 months in some cases and the construction may take as long as a year, therefore temporary measures may need to be put in place to operate the swing span before the work is complete.

4.4.4 *5-Year Work Required to operate at Class 3*

4.4.4.1 *Bridge approaches*

Following the initial capital investment in the structures to put the railroad back into operation, additional maintenance shall be required to complete the rehabilitation. In conjunction with the brush-cutting and vegetation removal program required for the track, the substantial growth on the bridge decks, approaches and beneath the spans must be removed within 5 years.

The majority of the structures will require additional slope stabilization and protection over the following 5 years in order to rehabilitate the moderately deteriorated slopes not addressed in the immediate work plan. This shall largely be achieved through the addition of rip-rap and ballast and applies to approximately 50% of the remaining structures. A rip-rap, ballast and armour stone installation program planned over the 5 year period to address the low approaches of the remaining structures is estimated at $500,000.

4.4.4.2 *Bridge Decks*

In addition to the immediate work planned, it is estimated that approximately 5 of the 22 open bridge decks shall require replacement on the Hopewell subdivision and 5 of the 22 on the Sydney subdivision. This work may be planned over the 5 year period. The total cost for this number of structures over a 5 year period will be approximately $1,000,000.

4.4.4.3 *Bridge Structural Work*

Although the immediate work will have addressed the more serious structural issues with 11 bridges, several of these structures will require a second phase of rehabilitation largely to deal with poor foundation conditions and deteriorated secondary members. These structures are listed in the table below with specific costs related to their rehabilitation.

Table 11: Summary of Bridge Work over 5 Year period to upgrade to Class 3 track.

Location	Structure	5 Year Plan - Structural Work Required	Cost
21.9 Sydney	2 TPG	Rehabilitate bearing seats and Pier 1 Replace knee braces	$357,500
43.7 Sydney	Beamspan	Replace	$390,000
49.4 Sydney	11 DPG Viaduct	Replace perforated tower bracing & repair concrete pedestals Repair main girder bottom flanges	$730,000
50.7 Sydney	10 DPG Viaduct	Replace top lateral braces Repair Tower legs Repair main girder bottom flanges	$250,000
57.8 Sydney	7 TT + Swing span	Replace holed diaphragms and sway bracing	$255,000
72.1 Sydney	RCS	Replace concrete bridge with culvert or new span	$1,300,000
73.3 Sydney	RCS	Replace concrete bridge with culvert or new span	$1,300,000
87.5 Sydney	4 TPG	Rehabilitate abutment and piers Replace roller bearings	$1,300,000
Sum of specific bridge work on Sydney subdivision			$5,882,500
Total for remaining Sydney Subdivision bridges			$10,700,000
Total for Hopewell Subdivision bridges			$9,500,000
TOTAL			**$26,082,500**

In addition to repairing these specific bridges identified on the Sydney subdivision, additional work shall be required on both the Hopewell and Sydney subdivisions over the 5 year period. The estimated construction costs detailed in previous reports was reviewed, however it was found that these costs, which total approximately $6.5 million over a 3 year period were largely insufficient to adequately rehabilitate and maintain the structures not repaired in the immediate work plan.

For the purposes of this report and based on cursory evaluation of the structures it was estimated that approximately 30% of the structures not specifically listed in the repair work in tables 8 or 10 would require partial rehabilitation. Using this approach and current pricing for concrete, steel and bearing repairs the total repair costs for the remaining Sydney and Hopewell subdivision bridges were established. Excluding the $5.9 million associated with the specific bridges identified, additional funding of approximately $10.7 million for the Sydney subdivision and $9.5 million will be required, for a total of almost $26 million over a 5 year period for the structural work.

4.4.4.4 Summary of Bridge Work and Cost

Including the costs associated with a bridge approach rehabilitation program, bridge tie replacement program and the required work for the structural rehabilitation of the remaining structure it is estimated that a total of almost $28 million over a 5 year period will be required. It is important to note that these funds are not sufficient for a complete rehabilitation of all structures; rather it represents the minimum funding required to increase the operational speed of the track and ensure the ongoing safety of rail operations. Continued investment in bridge maintenance will be required beyond the 5 year period to ensure the continued safe operations of the railway.

Table 12: Summary of Bridge Costs over 5 Year period for Class 3 track.

Task	Cost
Approach Work	$500,000
Decks	$1,000,000
Structural Work	$26,082,500
Total	**$27,582,500**

4.5 Train Operations and Track Capacity

This section assesses train operations and track capacity on the CBNS rail system once track, structure and signals work has been performed and train traffic has resumed. Three operating scenarios are evaluated: 1) an initial service sufficient to accommodate a 200,000 TEU throughput at the port at lower speeds, 50% of which is on rail; 2) an *improved* service, representing approximately 500,000 TEUs total, also 50% on rail, achieved after a traffic ramp-up period and additional infrastructure upgrade work to bring track speed to its former speed class. The second scenario was chosen to represent a reasonable upper limit to the current single track line capacity, assuming 5day/week train and terminal operations. The third scenario assumes a siding of sufficient length has been built near the mid-point of the CBNS line, allowing for train meets and doubling the line capacity.

The following subsections describe the analysis performed to ascertain if the current track layout provides sufficient capacity to accommodate both scenarios, and what enhancements will be required for higher traffic levels. Other track configuration related findings are also presented.

4.5.1 Rail service at terminal

To estimate the required capacity on the rail line, total required train numbers and frequencies need to be established based on an assumed train service at the terminal. This was done following the assumptions below:

- Approximately 3-day Intermodal Yard service time: rail-bound import containers unloaded from a vessel are assumed to be processed and available for train departure from the terminal within three days of their arrival, and the corresponding export containers are loaded on the vessel within roughly the same time frame.
- In the initial scenario, a yearly throughput of 200,000TEUs (Twenty-foot Equivalent Unit) is assumed for the Novaporte terminal. For the purposes of capacity evaluation, 50% of this traffic is assumed to be rail bound; vessels are assumed to be weekly, with 50 arrivals per year. In the 500,000TEU scenario, vessel arrivals are assumed to be twice a week, and processing of their shipments are assumed to be continuous, 25% of the container traffic being rail bound.
- In ideal conditions, a loaded double-stack railcar visit to a terminal is considered to account for a throughput of 8 TEUs: one 40-foot container being equivalent to 2 TEUs, a double stacked railcar equates to 4 TEUs inbound, and 4 TEUs outbound, for a total of 8 TEUs.
- An actual TEU count per railcar visit under realistic circumstances at medium-sized ports on the East-coast is closer to 7, to account for an unbalance in import and export volumes and for the fact that, even under assumed full double-stack service, occasionally rail cars are single- loaded for various reasons. For the purposes of capacity calculations in this study, given the unknowns in the required service, a TEU per railcar visit of 6 is used.
- Train processing time, and terminal track capacity, are not considered in this analysis. It is assumed that terminal designers have accounted for sufficient track lengths for all rail operations within the yard to occur in an efficient manner.

Operating assumptions are summarized in Table 13 below:

Table 13 Operating characteristics assumptions

Operations characteristic	Assumed value		
TEU/year	200,000	500,000	1,000,000
Rail ratio (vs rail+road+ship) (Average Import / Export)	50%	50%	50%
Rail TEU/yr	100,000	250,000	500,000
TEUs/railcar visit	6.00	6.00	6.00
Required railcars / year	16,700	41,700	83,400
Average railcars / day	111*	166	332
Railcar length (ft)	65	65	65
Assumed train length for train speed calculations	120	180	180
Train length (ft)	8,000	12,000	12,000
Nb trains in each direction / week	3	5	10

(*) 3 day service assumes for each weekly vessel arrival on day “d”, export trains arrive to terminal on days d-1, d and d+1, import trains depart terminal on days d, d+1 and d+2.

Train lengths assumed for each scenario are within typical CN intermodal train lengths, and the number of railcars per train used in the capacity assessment represents a buffer of roughly 10% over what is actually required to attain the cited yearly throughput.

4.5.2 Train Travel Time

Table 14 below illustrates allowable speeds for freight and passenger trains in Canada. Current timetables show both the Hopewell and Sydney subdivisions as Class 3, with a maximum freight train speed of 40MPH, and numerous localized speed restrictions to lower speeds due to tight radius curves and structure constraints.

Table 14 Track Class - Maximum allowable speed

Track Class	Freight Train Maximum Speed (MPH)	Passenger Train Maximum Speed (MPH)
1	10	15
2	25	30
3	40	60
4	60	80
5	80	95

Four track speed scenarios were considered in the preparation of the report: The first scenario assumes the Hopewell subdivision running at the current timetable speed and the entire Sydney subdivision running under Class 1 track speeds, 10MPH. The second scenario assumes 70 miles of the Sydney subdivision are upgraded to their class 3 timetable speeds. The third scenario assumes both subdivisions running under current timetable, class 3, speeds, and the fourth subdivision considers the impact of increasing any speed limit below 25MPH to 25MPH.all locations where current speeds are below 25MPH raised to 25MPH.

Train Performance Simulations were conducted using standard CN locomotives and average double stack rail cars totalling. These simulations calculate train accelerations, speeds and travel times given train configuration, track alignment and speed limit profiles, as provided by the time tables. Four realistic train configurations, 100, 120 and 180 double stack-average load railcars with 2 and 3 locomotives were simulated, including an empty container condition for Eastbound train runs. The results presented in Table 15 show the range in travel times obtained:

Table 15 Simulated run time results

		Cumulative Time (hh:mm)	
Option	Condition	Eastward	Westward
1	**Timetable Speed Hopewell Sub (Class 2)** **10mph Speed Limit for Sydney Sub**	16:35-18:00	16:55-17:45
2	**Timetable Speed Hopewell Sub (Class 3)** **Sydney Sub 10MPH + 70 miles upgraded to Timetable speed (Class 3)**	10:00-11:35	10:20-11:20
3	**Timetable Speeds** **for Sydney and Hopewell Subs**	7:25 - 9:15	7:55-9:05
4	**Timetable Speeds** **for Sydney and Hopewell Subs** **Speeds under 25mph raised to 25mph**	7:00-8:40	7:30-8:35

Canadian regulation dictates that a single train crew may not remain on-duty more than 12 consecutive hours. Duty time includes time at both origin and destination location for various duties. Given terminal duty times, and possible variability in running times due to weather, interaction with other trains or other incidents, 10-11 hours is considered a more comfortable average run-time for a single crew to operate a train across a given territory.

4.5.3 Rail line capacity considerations

Travel time results, Table 15, illustrate that option 1, where the Sydney subdivision is operated as class 1 – maximum 10MPH, and Hopewell subdivision as Class 2, would require 2 crews between Sydney and Truro. Moreover, this scenario would not allow daily trains operating in each direction without usable sidings to allow meets between opposing direction trains, as total required track time would exceed 24hours/day. It would however allow fleeting of trains into the terminal area, and currently planned tracks in terminal would allow such an operation. Option 2 illustrates that a minimum of 70 miles, or roughly 65% of the Sydney subdivision, would need to be upgraded to current timetable speeds, as well as the Hopewell subdivision operating under Class 3 conditions, for travel times to be appropriate for daily trains in each direction with a single crew. Full current timetable speeds, with or without improvements for lower speed areas, options 3 and 4, allow a single crew operation from Sydney to Truro.

4.5.4 Other operating considerations

Train Priority

This assessment was done assuming that the Novaporte train service will be either the only train traffic on the CBNS line between Novaporte and Truro, or that Novaporte train priority is such that any other traffic will not impede the Novaporte traffic. This would be consistent with typical intermodal train priority schemes across North America. This implies that additional capacity for other CBNS customers will need to be investigated separately.

Siding location near Novaporte terminal

Building a departing freight train requires a track length, clear of interference such as grade crossings, of at least the length of the train to allow train building and pre-departure inspections and tests to take place. Current Novaporte track design does not seem to allow for such a track. A staging track should be investigated in close proximity to Novaporte terminal.

Staging track near CN junction at Truro

Depending on service agreements with CN, staging tracks on the Hopewell subdivision near Truro may be desirable to allow for efficient and timely handoffs of trains between carriers.

Sidings

In every case considered here, train lengths exceed available siding lengths on the CBNS line. Any siding identified as required will need to be lengthened to the projected train length when detailed engineering is performed.

Siding construction cost estimate

Reasons for needing at least one train length siding are numerous, and it would be prudent to include the cost in this estimate to insure operational flexibility. A reasonable estimate for siding building is 1M$ per km, and 200K$ for each manual switch. For a 12,000 foot siding, this means approximately 4,4M$.

Findings summary

- To allow single crew running and daily train arrivals at Novaporte, 65% of the subdivision needs to be brought to its former Class 3 condition.
- This track condition would allow a throughput of up to 250,000TEUs on rail
- Additional speed improvements to the track could increase track capacity by 50% without additional passing sidings, other than those possibly required at the ends of the line
- A siding near the midpoint of the CBNS line would nearly double track capacity on the line
- A staging track near Truro and a train building track near Novaporte need to be considered for the smooth operation of daily intermodal trains

5. Conclusions

Although there is a substantial amount of maintenance to perform in both the short term and long term in order to bring the Cape Breton & Nova Scotia Railway up Class 1 operating speeds, it should be possible to do so within a 2 year timeframe. This is largely due to the fact that over half of the railway is currently operational and is undergoing a structural maintenance program. In addition, the Sydney subdivision is out-of-service and rehabilitation works will not be impeded by train traffic, which normally dramatically affects the speed at which rail maintenance can be performed.

Several significant challenges will still present themselves. First, the Cape Breton & Nova Scotia Railway has limited resources and is not equipped internally to manage, oversee and provide track protection for large scale repair works occurring simultaneously over several locations. Second, local structural contractors and steel manufacturers may not have the capacity to carry out the scope of work defined above within the 24 month time period. Similarly, track and signals maintenance will likely be beyond the capacity of local contractors and will consequently have to be carried out by companies from Quebec and Ontario. The rehabilitation of the swing span bridge at the Grand Narrows crossing (MP 57.8 Sydney) will likely represent the critical path in opening the track to regular service. The engineering, procurement and construction of the rehabilitation work required to permit the safe regular operation of the span is complex and long lead times for parts risks surpassing the 2 year timeframe. However, temporary alternative methods, such as using tugboats to move the swing span, may be developed to operate the swing span until rehabilitation works are complete.

In addition, there will be track rehabilitation contracts overlapping with both bridge work and signals work, which may lead to complications in awarding individual contracts to contractors. This may be overcome by engaging a single experienced rail consortium, or general contract administrator, capable of planning, coordinating and overseeing construction work of this scale spread out over a substantial distance. Such a firm could prepare the engineering and tender documents in such a way that many of the logistical issues may be avoided. Common practice of short line railways, such as CBNS, is to engage a firm to prepare engineering documents and to then use internal resources to award, manage, oversee technical aspects of individual rehabilitation projects. While this is cost efficient for individual small scale projects, it would inefficient and time consuming to do so for repairs of this scope.

The possibility of completing the rehabilitation work required within the 2-year timeframe depends partially of the timing of the 4 principal phases of work: Detailed investigation, Design, Tender & Permitting and Construction. Ideally the project would begin in the fall allowing engineering staff to perform all detailed inspections required, after which the detailed design and planning of work would take place in the winter, permitting the beginning of construction in the following spring.

Unlike many railroads, the CBNS lines fall under provincial jurisdiction and therefore is subject to provincial environmental permitting. Ensuring the efficient and rapid award of environmental permits for all slope stabilizing and structural work over waterway will be a critical issue in completing work within 2 years.

On the train operations side, although likely using two crews to traverse the CBNS line, it will be possible to run trains following the 2-year timeframe. The benefit of the Class 3 status, in terms of travel time and line throughput, might make a compelling argument to have the infrastructure work done as quickly as possible.

6. Total Estimated Costs

Table 16: Total estimated investment required in 2 and 1 Phase scenarios

Task	Phase I Immediate Work Class 1	Phase 2 Long-term Work Class 3	Total If performed as one phase to Class 3 (1)
Track	$7,850,000	$21,400,000	$27,950,000
Civil & Geotechnical	$7,080,000	--	$7,080,000
Signals & Communications	$800,000	$13,000,000	$13,400,000
Bridges	$22,732,500	$27,582,500	$50,315,000
Sidings	$4,400,000	(will depend on desired throughput)	$4,400,000
Total	**$42,862,500**	**$61,982,500**	**$103,145,000**

(1) Total costs column include identifiable savings in track and signals work due to logistical efficiencies.

Note: All cost estimates are expressed in Canadian currency.

The Civil and Geotechnical estimate accounts for the armour stone and rip-rap solution. A higher estimate for a sheet pile solution is presented in section 4.2.

It is important to note that this summarizes capital investments required to bring the railway to the indicated track class level of repair. This does not include operating costs, which are recurring and should be treated separately.

7. Recommendations

Based on the findings and conclusions summarized within this report the following recommendations have been established for the work required to re-establish rail service on the CBNS railway from Sydney to Truro:

7.1 Track

- Perform extensive brush-cutting program to clear sight lines for both rail and road traffic (Class 1);
- Engage consultant to perform geotechnical study on track stability at key locations (Class 1);

- Re-align track and stabilize cliff erosion at key areas along Bras d'Or lakes (Class 1);
- Perform major track stabilizing program through placement of rip-rap, gabion walls and ballast;
- Replace minimum number of ties required to meet Class 1 railway requirements
- Perform large tie replacement and resurfacing program and replace all switch frogs to meet Class 3 requirements.

7.2 Signals

- Perform minimum work required to render existing technology operational temporarily for 10MPH Class 1 railway operations.
- Perform complete rehabilitation and upgrade of signals to modern predictive technology and lighting prior to 2021 implementation of Transport Canada requirements to meet Class 3 requirements.

7.3 Structures

- Perform detailed bridge inspections and bridge capacity rating studies for all structures on the out-of-service portion of the Sydney subdivision in order to establish more accurate scope of work.
- Swing span mechanical inspection and engineering represent a critical path. Priority should be given to this to ensure custom mechanical system can be designed, fabricated and installed within 2 years. Specialized work will be performed by specialized engineering firm and steel fabricator likely based in the USA.
- All remaining work is achievable within 2 year period, however it must be planned carefully to remain cost efficient.
- Local steel fabricators in Halifax have capacity to carry out work, however it is recommended that any future tender processes be opened up to fabricators out-of-province in Quebec and Ontario to ensure competitive bids from multiple steel contractors with the resources to complete all of the work in the specified time period.
- The significant structural contracts should be combined together where practical to reduce mobilisation and start-up costs as well to achieve material discounts.

7.4 Sidings

- The estimated costs presented above include a provision for the construction of one 12,000 ft siding. Although it seems likely that at least one train length siding will be required to operate daily trains to the terminal, actual siding length and location will be determined as the operating mode is determined with more precision.