4.1.1 Modeling of a number of treatment technology options (Approval Item 5.I.b.i)

Each of the discharge Cases shown in section 2.2.4 of this report will be modelled through one of the following five (5) treatment Models:

- Model A: Current ASB System, unchanged.
- Model B: Current ASB System with Primary Treatment and Sludge Dewatering Located on the Mill Site.
- Model C: Modified ASB System with Primary Treatment and Sludge Dewatering Located on the Mill Site.
- Model D: Current ASB System with Tertiary Treatment Following Point C.
- Model E: New Activated Sludge Treatment System Located on the Mill Site.

A description of each system is provided below along with an order of magnitude capital cost estimate. In the following section 4.1.2, the predicted effluent characteristics for each Model at various locations from the mill to Point C are calculated.

Model A: Current System

A description of the basic system already exists at the beginning of Section 2.1 of this report. This model uses actual operating data from to determine performance of the various flow cases. Small modifications and changes to operating parameters could be made if required such changes in quantity and location of aerators and baffle curtains, but these will be discussed in Section 4.2 of this report.

Model B: Current ASB System with Primary Treatment and Sludge Dewatering Located on the Mill Site.

In this scenario, a primary clarifier would be added onsite to handle the TSS load coming from the mill. For the purposes of this report, a clarifier that could handle the whole mill effluent (~70,000 m^3/d) was sized and priced, which provides a kind of "worse case" scenario in terms of sizing. During a detailed study of the mill's sewer systems, segregation of the clean effluent (acid) sewer could be done to reduce the capital cost of the clarifier. However, changes to the existing sewers and TME pumping station would have to be made, which would add complexity and cost.

A new primarily clarifier represents an excellent compromise between building a new system on the mill site and continuing to use the BHTF as is. The removal of the majority of suspended solids on the mill site brings with it the following benefits:

- Reduced solids loading on the settling lagoons reducing dredging operations, but more importantly reduced carryover of inert solids into the ASB which reduces hydraulic retention time and result in carryover at Point C.
- Less "dead load" into treatment that results in an overall decrease in BOD reduction. In addition, the existing settling lagoons would continue to be used in a polishing capacity.
- Solids removed and dewatered onsite can be burned along with bark in the mill's power boiler which reduces or eliminates the problem of landfilling wet sludge (from dredging operations).
- A primary clarifier onsite would serve as an early warning system for fibre spills in the mill. A choked clarifier is difficult to ignore and process problems will be dealt with in a timelier manner.

A primary clarifier onsite is a good solution. Rather than adding a new spill basin onsite which would represent an extra capital investment that is not required, if there is an excess flow to the clarifier, it should simply be bypassed to the lift station and the remaining material would carry on to the existing settling basin(s) as it does today.

The new clarifier would be 68 meters in diameter and would be constructed near the standpipe by the old Canso chemicals plant. The TME station pumps would lift the effluent to the clarifier and the discharge would enter the standpipe and continue to the BHTF as it does currently. It is assumed that 70% of the incoming suspended solids would be removed in this step. Sludge from the clarifier would be pumped to a new dewatering system (gravity table + screw press) near the existing woodyard where dewatered sludge could be mixed with bark destined for the power boiler. The capital cost for this system was estimated at $12.8 million ($9.85 million direct & $2.95 million indirect). Details of the capital cost estimate are shown in Appendix 4.

Model C: Modified ASB System with Primary Treatment and Sludge Dewatering Located on the Mill Site

In this option the primary solids removal and sludge dewatering steps would be relocated to the mill site as in Model B with the 68m diameter primary clarifier constructed on mill property near the standpipe that is near the start of the gravity pipeline.

One of the settling basins at the BHTF would be converted to add about 1 day of hydraulic residence to the ASB system and would create a lagoon system with 5 cells rather than 4 cells in series. Ten of the 50 HP floating aerators would be relocated from Cell 1 and Cell 2 into the settling basin and two new aerators purchased. Most of the removal of soluble BOD_5 will now occur in Cell 1 (the converted basin, 40% BOD removal assumed) and Cell 2 where the mixing intensity will be relatively high, preventing much settling of suspended solids. Mixing in Cells 3, 4 and 5 will be low and will permit solids settling and digestion of the solids in the bottom sludge layer. The nutrient silo or piping from it would be relocation to inject the blended nutrient upstream of the new aeration cell.

The other settling basin would be converted to an operable spill basin and would remain unchanged in this option. Any spills collected in the basin would be bled gradually into the ASB, but downstream of the converted settling cell. The modifications proposed in the above option would improve the BOD_5 removal and possibly lower the final effluent TSS, but only marginally.

The capital cost for this system is estimated at $15 million ($11 million direct & $4 million indirect).

Model D: Current ASB System with Tertiary Treatment Following Point C

The concentration of TSS in the ASB effluent at Point C has averaged 38 mg/L between January 2011 and July 2012. About a third of this should be removed as a long term average to comfortably achieve the new effluent limits. TSS polishing after ASB treatment is not a conventional practise except for systems with polishing lagoons that accomplish some uncontrolled TSS reductions (which is what Boat Harbour is doing currently). Gravity filters (i.e. sand or multi-media), Dissolved Air Flotation (DAF), microscreens and high-rate carrier assisted gravity clarifiers (ActiFlo) are four processes that could be considered in this case. The installation of a mechanical system for solids polishing may be an inefficient use of capital. The treatment plant records from 2010 through 2012 suggest that such a system would be needed to operate as little as 20 to 30 percent of the time to achieve the new target. DAF's are used successfully for final effluent polishing at Domtar Papers in Windsor, Quebec and by the Ortvikens Mill in Sundsvall, Sweden.

It is premature to select a specific solids removal process to replace the solids polishing ability of the stabilization basin at NPNS. However, some assumption was necessary in order to develop an order-of-magnitude estimate of capital cost for post ASB solids removal. For this purpose it was assumed that a DAF polishing system would be reasonably representative in cost to other mechanical systems identified above. A DAF process was used to develop the cost model in this option. It contains a system comprising three DAF's installed in a building on the north shore of the ASB. This requires another lift station to pump to the DAF's and a 6-hour effluent impoundment between the DAF's and the final pump station. Finding an acceptable location for the 6-hour impoundment may be a significant challenge owing to the very limited land available to NPNS at the site.

Dewatering of the approximately 1,000 kg/d of sludge solids from this process would need to be dewatered somehow and mixed with sludge removed from the settling basins. This is only done on a bi-annual basis however. Alternately, the old belt press in the effluent treatment building could be modified, repaired or replaced to treat this tertiary sludge which would then be landfilled or sent by truck for combustion at the mill. The capital cost for this system was estimated at $13 million ($10 million direct & $3 million indirect).

Model E: New Activated Sludge Treatment System Located on the Mill Site

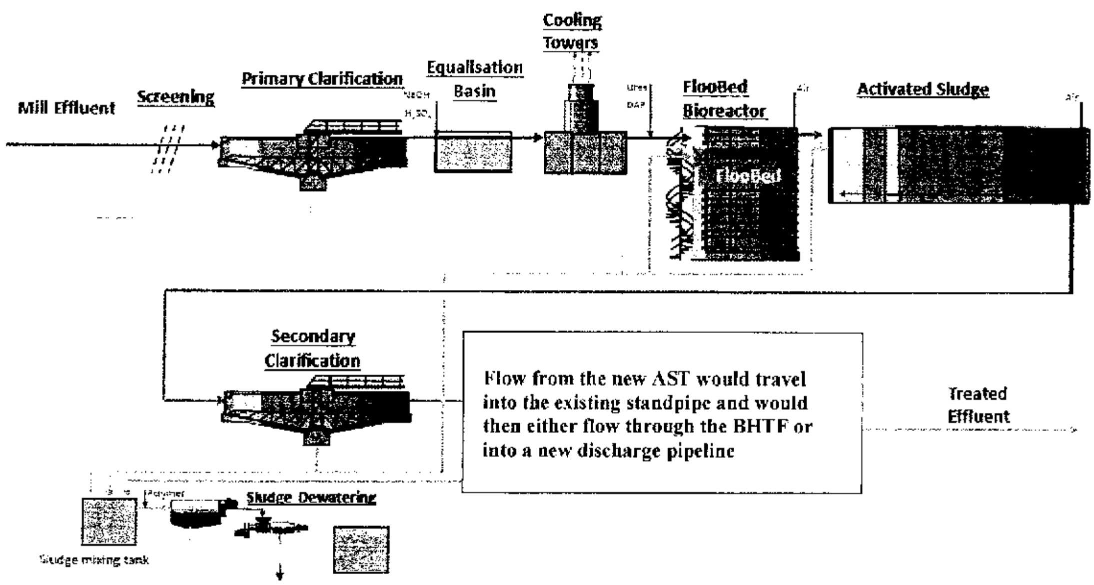
A potential site for an AST system on NPNS owned land was identified as a 20 hectare area starting south of the old Canso Chemicals and running about 600 m south close to the east fence of the mill's present landfill. This site is relatively remote from immediate neighbours and visually screened from view. Terrain elevation in this area will permit the civil works to be designed efficiently. This is convenient for gravity flow into the existing pipeline standpipe to either flow through the BHTF or through a new pipeline to a new discharge location.

Specifically, the Activated Sludge System (see Figure 4-1) selected for this estimate was again, one that would treat the whole mill effluent, without reductions in mill to account for flow and other savings. Flow would be the first item to tackle in terms of reducing the cost of the new plant since an effluent cooling tower is included in the estimate which could handle an increase raw effluent temperature due to reduced flow from the mill. Modifications could also be made to the collection systems in mill in order to segregate the acid (low solids) from the alkaline sewer. The head works before the lift pumps at the TME station would have to be either reworked to pump separate streams up to the new AST location. There, the alkaline sewer would flow though the same primary clarifier (or smaller if flow reduced) as in Model B. The clarified effluent would then flow to a neutralization tank where it would be mixed with the acid sewer. The combined mixture would be adjusted for pH control and then sent for cooling through a new cooling tower to adjust the effluent feed temperature to ~32-36°C.

The combined effluent would then be treated biologically in a series (two trains) of concrete aeration basins. The first stage of aeration would be done in a carrier-assisted basin which contains plastic rings to enhance biological growth by supplying a substrate for the biology to attach to. This method was selected for its ability to remove large amounts of BOD in a small volume while also providing protection to the microbiology from temperature and pH shocks which can happen from time to time in a mill of this age. The effluent then flows through a standard aerated basin and then on to two secondary clarifiers which remove and recycle the biosolids back to the beginning of aeration.

Sludge generated from the primary clarifier and wastes from the secondary clarifiers would be combined and pumped to a holding tank located near the existing wood handling areas. There two trains of gravity tables followed by screw presses would work to dewater the sludge prior to mixing it with bark and other woodwaste for combustion in the mill's power boiler.

Figure 4-1
Activated Sludge Treatment Concept



The capital cost for this system was estimated at $45.9 million ($35.3 million direct & $10.9 million indirect). Details of the capital cost estimate are shown in Appendix 4.

4.1.2 Wastewater quality at strategic locations (Approval Item 5.I.b.ii)

From the above 5 Models discussed above, the following discharge qualities at various locations along the effluent treatment train can be calculated. The tables below are set up to show the effluent characteristics for key parameters starting from the mill sewer and going right to the mill's final effluent. Flow, BOD, COD, and TSS are modelled on a kg/d basis and that for each of the discharge Cases from Section 2.2.4.

Tables 4-2 to 4-6 below contain the results for the three discharge cases.

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Table 4-2

Model A: Current System

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
TME Station					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Standpipe Entrance					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Point A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Point B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	16,500	16,500	13,200	10,313
COD	kg/d	82,000	82,000	65,600	51,250
TSS	kg/d	3,000	3,000	2,727	2,727
Point C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	2,020	1,818	1,616	1,023
COD	kg/d	51,000	45,900	40,800	25,819
TSS	kg/d	2,660	2,063	2,432	2,025
Final Discharge					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	2,020	1,818	1,616	1,023
COD	kg/d	51,000	45,900	40,800	25,819
TSS	kg/d	2,660	2,063	2,432	2,025

Table 4-3
Model B: Current System with Primary Onsite

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
TME Station					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Standpipe Entrance					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	14,000	14,000	11,200	8,750
COD	kg/d	58,100	58,100	46,480	36,313
TSS	kg/d	1,650	1,650	1,500	1,500
Point A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	14,000	14,000	11,200	8,750
COD	kg/d	58,100	58,100	46,480	36,313
TSS	kg/d	1,650	1,650	1,500	1,500
Point B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	11,550	11,550	9,240	7,219
COD	kg/d	57,400	57,400	45,920	35,875
TSS	kg/d	900	900	818	818
Point C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,414	1,145	1,131	644
COD	kg/d	35,700	28,917	28,560	16,266
TSS	kg/d	2,660	1,857	2,432	1,823
Final Discharge					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,414	1,145	1,131	644
COD	kg/d	35,700	28,917	28,560	16,266
TSS	kg/d	2,660	1,857	2,432	1,823

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Table 4-4
Model C: Modified ASB with Primary Onsite

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
TME Station					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Standpipe Entrance					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	17,000	17,000	13,600	10,625
COD	kg/d	70,550	70,550	56,440	44,094
TSS	kg/d	825	825	750	750
Point A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	17,000	17,000	13,600	10,625
COD	kg/d	70,550	70,550	56,440	44,094
TSS	kg/d	825	825	750	750
Point B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	10,200	10,200	8,160	6,375
COD	kg/d	42,330	42,330	33,864	26,456
TSS	kg/d	1,000	1,000	1,000	1,000
Point C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,249	1,011	999	569
COD	kg/d	26,327	21,325	21,062	11,995
TSS	kg/d	2,660	1,857	2,432	1,823
Final Discharge					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,249	1,011	999	569
COD	kg/d	26,327	21,325	21,062	11,995
TSS	kg/d	2,660	1,857	2,432	1,823

Table 4-5
Model D: Current System with Tertiary Treatment

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
TME Station					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Standpipe Entrance					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Point A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Point B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	16,500	16,500	13,200	10,313
COD	kg/d	82,000	82,000	65,600	51,250
TSS	kg/d	3,000	3,000	2,727	2,727
Point C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	2,020	1,818	1,616	1,023
COD	kg/d	51,000	45,900	40,800	25,819
TSS	kg/d	2,660	1,857	2,432	1,823
Final Discharge					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,515	1,364	1,212	767
COD	kg/d	43,350	39,015	34,680	21,946
TSS	kg/d	665	464	608	456

Table 4-6
Model E: New Activated Sludge Treatment Onsite

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
TME Station					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Standpipe Entrance					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,000	1,000	800	625
COD	kg/d	34,030	34,030	27,224	21,269
TSS	kg/d	935	935	850	850
Point A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,000	1,000	800	625
COD	kg/d	34,030	34,030	27,224	21,269
TSS	kg/d	935	935	850	850
Point B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	950	950	760	594
COD	kg/d	32,329	32,329	25,863	20,205
TSS	kg/d	748	748	680	680
Point C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	808	808	646	505
COD	kg/d	30,712	30,712	24,570	19,195
TSS	kg/d	598	598	544	544
Final Discharge					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	808	808	646	505
COD	kg/d	30,712	30,712	24,570	19,195
TSS	kg/d	598	598	544	544

Table 4-7 provides a summary of the final discharge values for each technology given the input cases.

Table 4-7
Summary of Treatment Models

Case	Units	0 - Base	1 - Low Flow	2 - Minor Organic	3 - Major Organic and Flow
Raw Mill Effluent					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	20,000	20,000	16,000	12,500
COD	kg/d	83,000	83,000	66,400	51,875
TSS	kg/d	5,500	5,500	5,000	5,000
Final Model A					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	2,020	1,818	1,616	1,023
COD	kg/d	51,000	45,900	40,800	25,819
TSS	kg/d	2,660	2,063	2,432	2,025
Final Model B					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,414	1,145	1,131	644
COD	kg/d	35,700	28,917	28,560	16,266
TSS	kg/d	2,660	1,857	2,432	1,823
Final Model C					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,249	1,011	999	569
COD	kg/d	26,327	21,325	21,062	11,995
TSS	kg/d	2,660	1,857	2,432	1,823
Final Model D					
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,515	1,364	1,212	767
COD	kg/d	43,350	39,015	34,680	21,946
TSS	kg/d	665	464	608	456
Final Model E	(At the new AST discharge / *At final effluent after passing through BHTF)*				
Flow	m^3/d	70,000	54,300	64,000	53,300
BOD	kg/d	1,000/*808*	1,000 / *808*	800 / *646*	625 / *505*
COD	t/d	34 / *30.7*	34.0 / *30.1*	27.2 / *24.6*	21.2 / *19.2*
TSS	kg/d	935 / *598*	935 / *598*	850 / *544*	850 / *544*

All of the proposed treatment systems offer improved BOD removal for a variety of reasons including increased concentrations and removal rates due to less hydraulic flow, less solids going to aeration or increased solids removal. The TSS at Point C are more a function of flow and a typical final basin TSS concentration of ~30 mg/l rather than the quantity of solids removed (i.e. new primary clarifier). The new AST (Model E) offers the best BOD reduction, but not extremely higher than simply modifying the basins or reducing load from the mill.