APPENDIX E
Coal Waste Study

Concept Study on Coal Waste Disposal Options - Donkin Mine

Concept Study on Coal Waste Disposal Options from Proposed Mining Activities at Donkin Mine - Donkin, Nova Scotia

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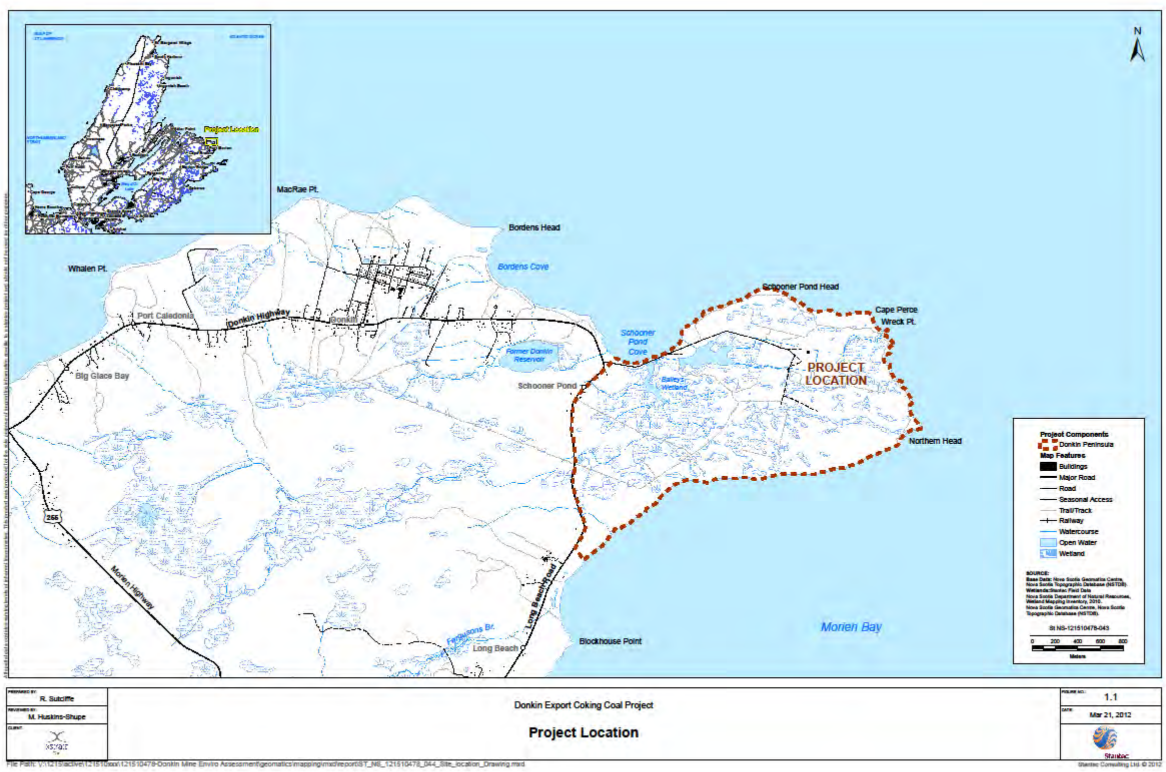
1.0 Introduction

Xstrata Coal Donkin Management Limited (XCDM) proposes to build upon the existing Donkin Mine infrastructure to construct and operate an underground coal mine facility capable of producing coal suitable for the export coal market. It is located on the Donkin Peninsula, within the Cape Breton Regional Municipality (CBRM), Nova Scotia (Figure 1.1).

Figure 1.1 Location of site



Associated with the mining of the coal resource and the production of the product for export, is the residual waste stream(s) of rejects from the coal processing streams on site. The potential manner and location for storage of this waste stream and other site waste components is the subject of this report.

1.1 MINING DESCRIPTION

The proposed Export Coking Coal Project is to be located at the existing Donkin Mine site on the Donkin Peninsula, Cape Breton, Nova Scotia. XCDM proposes a multi-continuous miner underground operation producing approximately 3.6 million tonnes per annum (Mtpa) of ROM (run of mine) coal that is subsequently washed to provide 2.75 Mtpa of product coal that is suitable for the international export coking coal markets. A material handling and processing plant system capable of processing 3.6 Mtpa of raw coal from the Donkin Mine will be constructed to produce a coking coal ready for presentation to a barge loading facility and marine transportation operation.

The life of the mine is proposed to be at least 30 years.

1.2 PROJECT COMPONENTS

The proposed Project is a potential 3.6 Mtpa ROM underground mining operation. Use of four continuous miners is currently planned with the ROM coal produced being beneficiated (*i.e.*, processed) onsite to produce an estimated 2.75 Mtpa of marketable product coal. This leaves approximately 0.85 million tonnes per annum as reject materials or waste that must be disposed of as part of the process.

A raw coal stockpile, reclaim, and sizing system will be constructed to prepare a minus 50 mm raw coal feed to the Coal Handling Preparation Plant (CHPP). The 650 tonnes/hour (t/h) processing plant features a single stage large diameter dense medium cyclone to process coal, spirals to process the mid-size material, and flotation to process the fine coal. A product sampling and reclaim system will prepare product coal ready for loading onto a barge or truck load-out facility.

Product coal is reclaimed to an overland conveyor that feeds directly to a barge loading facility proximal to the Donkin headland in Morien Bay. Coastal barges of 4,000 tonne capacity are loaded and then towed by tug to a transshipping location within Mira Bay where the coal is transshipped to bulk vessels.

The reject CHPP materials are similarly prepared for dry disposal and are loaded out by conveyor to a site stockpile from where they are available for relocation to permanent storage.

The Project includes the following fundamental components:

- an underground coal mine;
- a coal handling preparation plant (CHPP) with a product sampling and reclaim system to prepare product coal and a dry disposal reject handling system;
- ancillary services to support the underground mine and CHPP (administration building, workshop, coal weighing and sampling facilities, dust suppression systems, conveyors, stackers, reclaim units and stockpiles, water infrastructure, mobile equipment *etc*., a new 138 kV power line from Victoria Junction to the Project site); and
- a barge load-out facility proximal to the Donkin headland and barges to transport product coal to a transshipping location within Mira Bay.
- Ancillary services to support the barge load-out facility (material handling outhaul conveyor, radial, luffing telescopic stacker; fuel lines and valving for fueling of vessels; light and power and potable water supply).

The location and inter relationship of the various site components are established by others and for this review of waste disposal options, all infrastructure locations have been considered fixed (CBCL 2012).

2.0 Waste Description

2.1 INTRODUCTION

In order to facilitate the design of the various storage options under consideration for the waste coal rock generated from the coal production process, a breakdown of each phase of the coal handling process; from the raw coal retrieved in the mine to the completion of the handling process was developed. Two materials types are generated during this process; the product (yield) to be marketed and the waste (rejects) which are to be handled in a waste storage capacity. Two additional waste streams must be considered for disposal as well; one for waste rock generated by mine development for the third tunnel (Tunnel No. 1) in year 4, and dredging spoils from the development of the barge load-out facility.

The annual and total mine life tonnages and quantities that need to be addressed for the Donkin project are presented in Table 2.1, and are based on a 30 year mine life.

Table 2.1 Predicted Waste Quantities

	Material Type (Source)		
	CHHP Process reject waste (on-going)	Third Tunnel (Tunnel No. 1) Development Waste (Year 4) (one time development)	Dredge Spoils for Product Marine Structures (Year 1) (one time development)
Daily, t/h	80	--------	--------
Daily, m^3/h	61.5	--------	--------
Annual tonnage, t	850,000	200,000	--------
Annual volume, m^3	654,000	180,000	11,250
Life of mine, t	25.5 million	200,000	--------
Life of mine, m^3	19.6 million	180,000	11,250

Mining operations will occur below the ocean floor at rock depths of greater than 200 m below sea level, where existing access has already been established to the mining face. The mine design and mining operation is based on the use of standard continuous miner (CM) sections. A section consists of one CM, one roof bolter, and three shuttle cars. Depending on the roof conditions, the CM advances the entry or crosscut face on average 6 m and then moves to the next place to be cut. If the roof conditions allow, extended cuts up to 12 m could be taken. The roof bolter then moves into the recently mined place and installs the roof bolts and other secondary supports that make up the immediate roof support.

Given the depth of the reserves at Donkin, large pillars will be left during advance under the deeper cover of a significant portion of the reserve. Retreat mining and partial extraction of the pillars will be utilized later in the mining sequence.

The raw coal handling system will receive coal directly from underground, then stockpile on surface and then convey and size to minus 50 mm and convey the sized materials to the CHPP at 650 t/h. Raw coal emerging from the underground tunnel via the drift conveyor will be deposited onto a stockpile. The “as mined” coal was assumed to have a top size of 250 mm. The stockpile is necessary to disconnect the mine operations cycle from the plant operations cycle to allow for the higher mining rate and fluctuations in underground production.

2.2 COAL HANDLING PROCESS PLANT (CHPP)

Discharge from the reclaim conveyor will be directed to a two stage crushing system comprising a sizing station to produce a minus 50 mm plant feed material. The crushed raw coal will discharge onto the plant feed conveyor which in turn will discharge directly into the desliming screen feed box on the top of the CHPP building.

The coal handling process can be generalized as follows:

1. Raw coal is extracted from the mine at a maximum aggregate diameter of 250 mm and stockpiled at surface.

2. The raw coal is taken from the stockpile and fed into a 2 stage crusher to produce a 50 mm minus material.

3. The 50 mm minus material is fed into the CHPP, consisting of a three stage process.

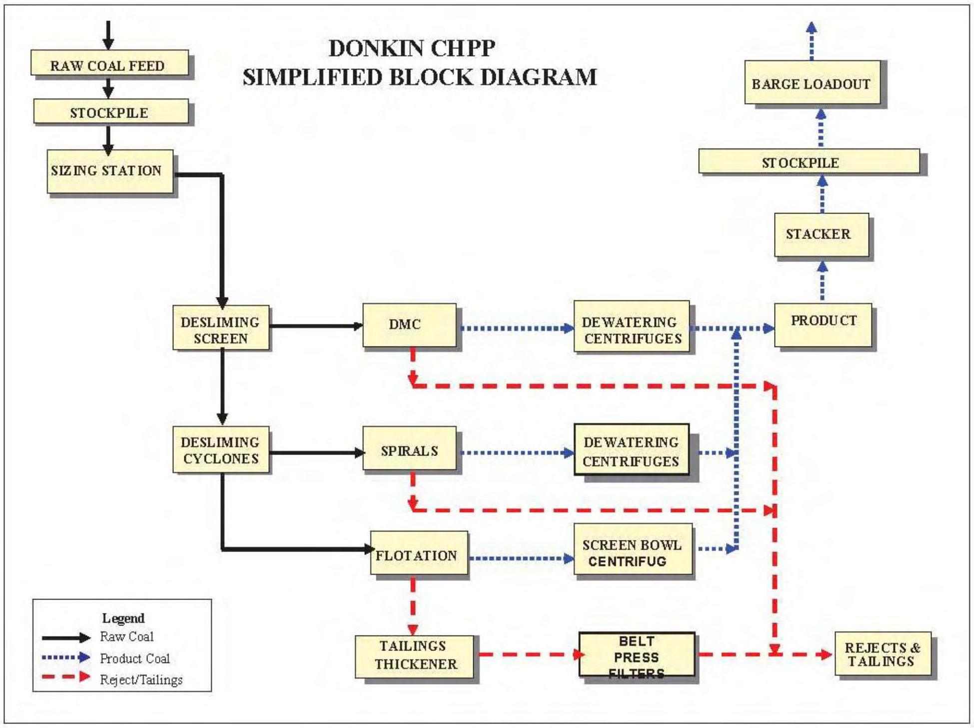
4. Each of the processes handles a specific material size and generates a product stream and a waste stream, each with a unique and varying product yield and recovery efficiency.

5. The Dense Medium Cyclone handles material sizes between 50 mm and 1.4 mm in diameter (large size). Spirals will handle 1.4 mm to 0.25 mm (mid-size) and Flotation is proposed for the 0.25 mm and below materials (fine size). Since each process has a range of efficiency (yield), the percentage of material sizes entering the CHPP will not necessarily equal the percentage of material sizes being generated in the product and waste streams.

6. Reject materials from each process will be dried and combined before being transported to the waste stockpile.

A simplified process diagram is presented in Figure 2.1, with further description of the general process presented in the following text.

Figure 2.1 A Schematic Block Flow Diagram of the CHPP



2.2.1 Desliming and Coarse Coal Circuit

Plant feed coal will be slurried in the desliming screen feed box and fed onto a multislope desliming screen. The -1.4 mm wet weight (ww) material and water will be collected in an underpan and piped to a desliming cyclone feed sump. The -50 to +1.4 mm (ww) material will discharge from the desliming screen and be flushed into a dense medium cyclone (DMC) feed sump.

Product coal will be directed to coarse coal centrifuges for dewatering prior to being discharged onto a product conveyor.

Reject coal will underflow from the dense medium cyclone into a tile lined screen feed box which will direct the reject material onto a reject conveyor.

2.2.2 Mid-Size Circuit

The desliming screen undersize (1.4 mm (ww) material will be pumped to a cluster of desliming cyclones. The cyclones will classify the feed at approximately 0.250 mm, with the underflow (+0.250 mm) gravitating to spirals and overflow (-0.250 mm) reporting to the flotation feed sump.

The thickened underflow will be dewatered by two fine coal centrifuges before discharging onto the product conveyor.

Spiral rejects will gravitate to a high frequency dewatering screen. Dewatered rejects will discharge onto the reject conveyor, and screen underflow will report to the thickener.

2.2.3 Flotation

Desliming cyclone overflow and spiral product thickening cyclone overflow will be combined in the flotation feed sump and pumped to a single Jameson Cell.

The concentrate from this cell will gravitate to a screen bowl centrifuge to dewater the flotation concentrate. The tailings from the flotation cells will report to the de-aeration tank where a portion of the flotation tailings will be recycled as sump level control and as a scavenging process. The remainder of the tailings will gravitate from the de-aeration tank to the tailings thickener.

2.2.4 Waste Handling

Due to the proximity of the proposed site to neighbouring townships, as well as concerns with the potential impacts of tailings (waste rejects) on groundwater from a conventional tailings dam, a full dry disposal system for the CHPP reject has been proposed as part of the CHPP. A dry disposal system in this sense is understood to mean disposing of the combined streams of dewatered tailings and coarse reject. In the dry disposal reject handling at this stage of project development, it has been assumed that belt press filters will be used. Coarse and mid-size reject will discharge from their respective screens onto the main reject conveyor.

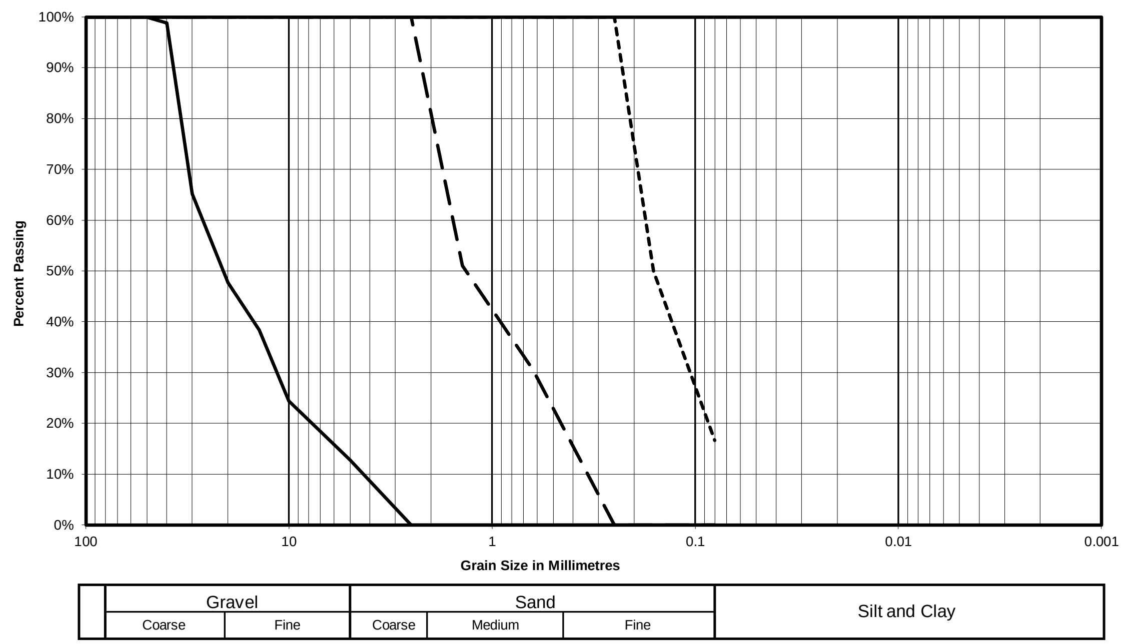
Thickener underflow will be pumped to the filter feed sump and flocculated prior to being fed to belt press filters. Dewatered tailings cake from the belt press filters will discharge via chutes onto the main reject conveyor. This conveyor will convey all reject to the waste stockpile. A weigh scale will record the instantaneous tonnage of total reject and tailings material generated by the plant. In addition, a reject sampling system will be included for sampling waste prior to stockpiling.

2.3 DISTRIBUTION OF MATERIAL SIZES IN PRODUCT STREAM VERSUS WASTE STREAM

In order to effectively manage the waste generated from the CHPP, it is necessary to determine parameters such as the total waste volume and the physical characteristics of the waste(s). An accurate grain size distribution of the combined waste stream coming from the CHPP is necessary in order to determine design parameters for the waste rock material, *i.e.,* angle of repose, compaction requirements, combined bulk density, *etc.*

From Fig 2.1, it is shown that each process within the CHPP has a product stream and a waste stream. Each process recovers product coal at varying efficiencies, therefore the relative waste volume from each process also varies. This variation in process efficiency will produce a waste stream with a grain size distribution that differs from that of the plant feed material. The grain size distribution of each waste stream from the CHPP is presented graphically in Figure 2.2.

Figure 2.2 Grain Size Distribution of WasteStreams



Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	SAMPLE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
———	Waste Stream	DMC	Rejects	87%	13%		Waste Stream DMC
— — -	Waste Stream	Spirals	Rejects		100%		Waste Stream Spirals
- - - -	Waste Stream	Flotations	Rejects		83%	17%	Waste Stream Flotations

It is therefore necessary to define the volume of feed material entering into each of the CHPP processes in order to determine the waste stream volume generated from each process.

Harbour seam samples were obtained in August 2006, and underwent intensive pre-treatment making them suitable for CPP design purposes. The grain size distribution, adjusted for 50 mm topsize, are reported in Sedgman (2010).

In order to define the waste streams from the CHPP, the plant feed material was selected for analysis, as this more closely resembles the material that will be entering the CHPP. The nominal grain size distribution curve was selected for the purposes of determining waste characteristics, as it is an average of the six (6) samples obtained.

Each stage of the CHPP receives the feed material based on grain size, and based on the provided grain size distributions, the percentage of plant feed material entering the CHPP has been calculated and is summarized in Table 2.2.

Table 2.2 Plant Feed Material Entering CHPP

Unit		Particle Size	Percentage of Raw Material Captured
Dense Medium Cyclone	Large Size	-50 mm to +1.4 mm	92%
Spirals	Mid-Size	-1.4 mm to +0.250 mm	5%
Flotation	Fines	-0.250 mm	3%

The majority of the plant feed material (92%) is sized between a particle diameter of -50 mm to +1.4 mm and will be processed in the coarse coal circuit in the dense medium cyclone. The remaining feed material (8%) will be handled in the spirals and flotation processes.

In order to determine the grain size distribution of the waste from the three processes (combined waste stream), the overall grain size distribution of the feed material as well as the product yields of each process are considered. These values were prepared by Sedgman (2010) and are reproduced herein in Tables 2.3 for convenience.

Table 2.3 CHPP Product Yield Efficiency

Unit	Minimum	Nominal	Maximum
Dense Medium Cyclone	75%	89%	95%
Spirals	60%	80%	90%
Flotation	40%	58%	80%

In order to determine grain size distribution of the waste stream, it is necessary to compare the percentage of feed material that is handled by each CHPP process with its corresponding product yield efficiency to determine the volume rate of each process.

As an example to determine the waste stream from the DMC, 92 percent of the feed material entering the CHPP is handled by the DMC (Table 2.2), which operates at a nominal product yield of 89 percent (Table 2.3). In a numerical example, one tonne (1000 kg) of ROM feed material into the CHPP, 920 kg would be expected to pass through the DMC. Since 89 percent (nominal) of this material will be recovered for product, a yield of 819 kg of product (81.9%), and 101 kg of reject (10.1%). The same calculation could be carried out for the other processes. Table 2.4 indicates the product and waste for the example 1 tonne (1000 kg) of material passing through the CHPP, with nominal yield as per Table 2.4.

Table 2.4 Product and Waste Distribution of 1 tonne of Feed Material

Unit	Total	Yield	Product, kg	% of Total	Waste, kg	% of Total
DMC	92%	89%	819	81.9%	101	10.1%
Spirals	5%	80%	40	4.0%	10	1.0%
Flotation	3%	58%	17.4	1.7%	12.6	1.3%

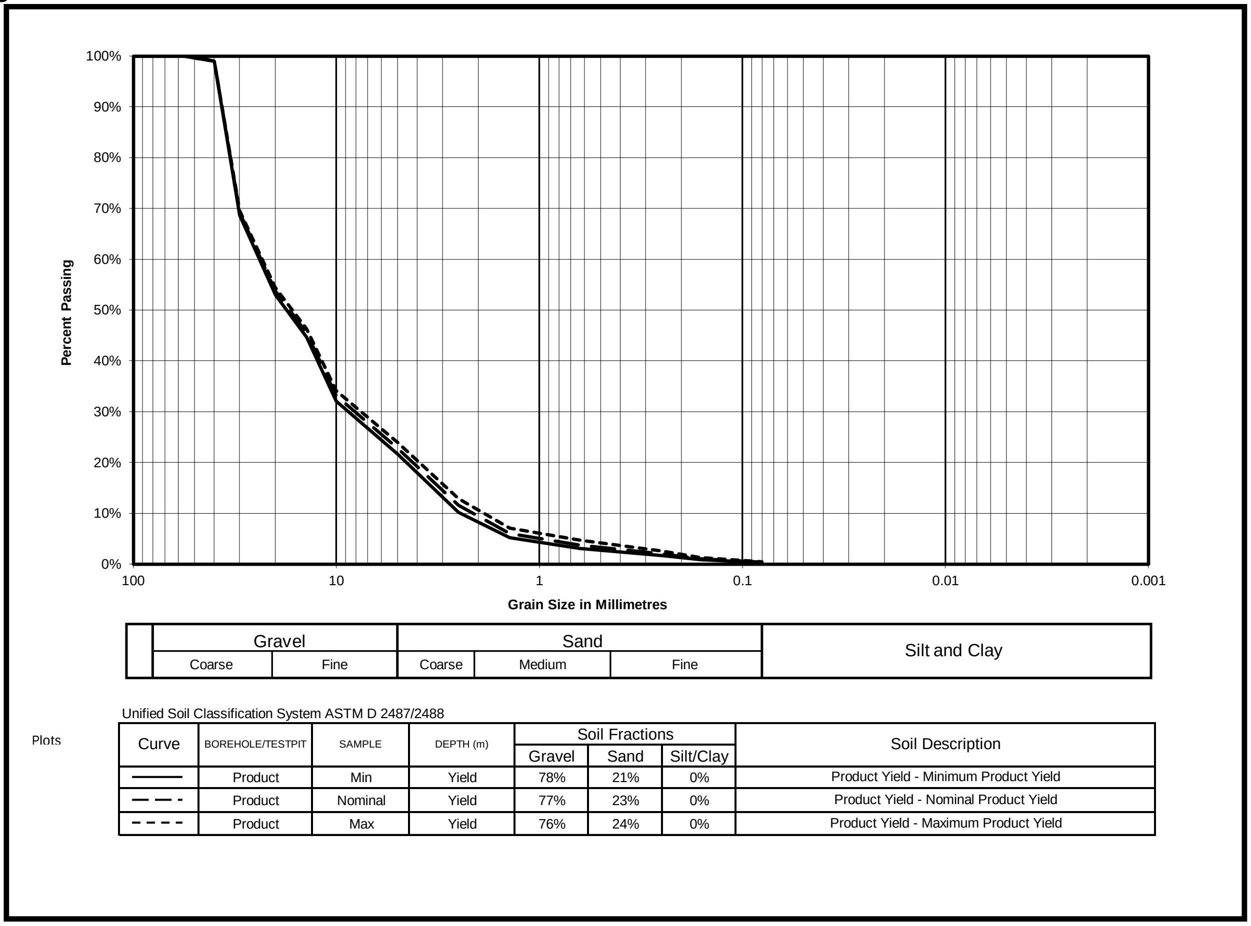
The product recovered from the CHPP is 876.4 kg, about 87.6 percent of the total material entering the CHPP, while the waste stream generated from a 1000 kg of feed material is 123.6 kg, about 12.4 percent of the total entering the CHPP. The more efficient a process, the less waste generated, thus the grain size distribution of a combined (processes with varying efficiencies) product stream and combined waste streams will differ slightly from one another. Table 2.5 shows the variance in material distribution of the product stream and of the waste stream from each process.

Table 2.5 Material Distribution of Product Stream and Waste Stream

Unit	Product, kg	% of Product Stream	Waste, kg	% of Waste Stream
DMC	819	93.5%	101	82.0%
Spirals	40	4.5%	10	8.0%
Flotation	17.4	2.0%	12.6	10.0%
Total	876.4		123.6	

In a comparison of the two combined streams, the product stream received a greater percentage of material from the DMC than the waste stream, and less from the spirals and flotations, resulting in a material with a higher percentage of gravel and sand. This is presented graphically in Figure 2.3.

Figure 2.3 Grain Size Distribution of Product Streams



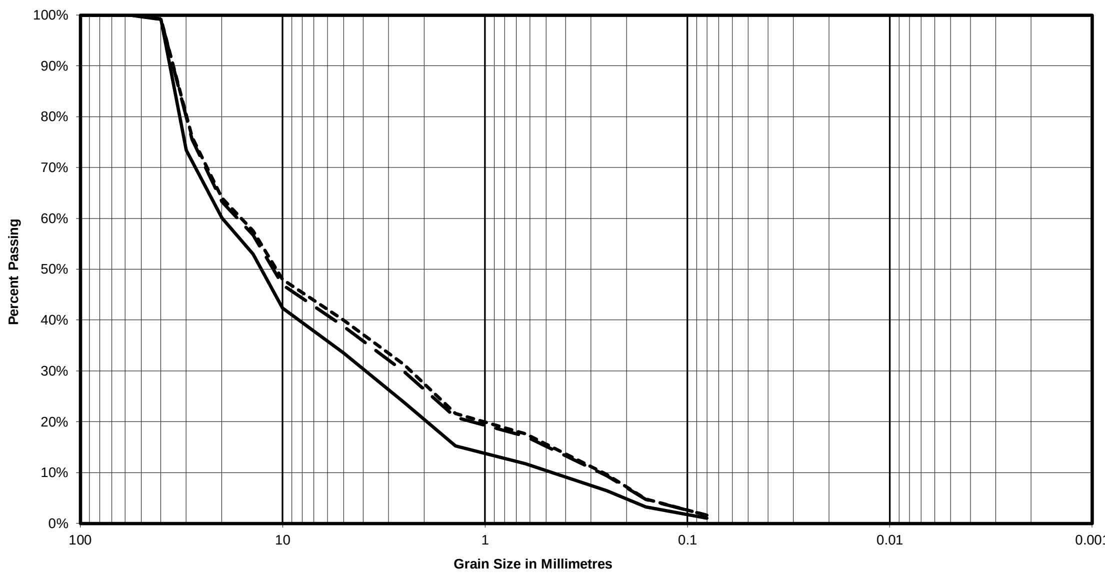
In a similar manner, grain size distributions were determined for the combined waste stream, using the maximum, nominal, and minimum waste yield from Table 2.5. A summary of the grain size distribution for the combined waste stream is shown in Table 2.6.

Table 2.6 Summary of Grain Size Distribution for Combined Waste Stream

Description	Soil Fractions		
	Gravel	Sand	Silt/Clay
Maximum Waste Yield	66%	32%	2%
Nominal Waste Yield	61%	37%	2%
Minimum Waste Yield	60%	38%	2%

The waste stream grain size distribution is presented graphically in Figure 2.4.

Figure 2.4 Grain Size Distribution of Waste Streams



	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

Unified Soil Classification System ASTM D 2487/2488

Curve	BOREHOLE/TESTPIT	SAMPLE	DEPTH (m)	Soil Fractions			Soil Description
				Gravel	Sand	Silt/Clay	
———	Waste Stream	Maximum	Rejects	66%	32%	1%	Combined Waste Stream - Maximum Rejects
— — -	Waste Stream	Nominal	Rejects	61%	37%	2%	Combined Waste Stream - Nominal Rejects
- - - -	Waste Stream	Minimum	Rejects	60%	38%	2%	Combined Waste Stream - Minimum Rejects

The combined waste stream showed a range of gravel sizes from 60 to 66 percent with an average of 62 percent, a range of sand sizes from 32 to 38 percent (average 36 percent) and a silt/clay sizes of 2 percent.

Grain size distributions were also determined for each waste stream and are shown in Table 2.7.

Table 2.7 Summary of Grain Size Distribution for each Waste Stream

Description	Soil Fractions		
	Gravel	Sand	Silt/Clay
Waste Stream DMC	87%	13%	---
Waste Stream Spirals	---	100%	---
Waste Stream Flotation	---	83%	17%

As shown in Table 2.7, the waste streams from the DMC and Spirals fall within the gravel and sand soil fractions, while the majority of the waste from the flotation are sand fractions, albeit fine sand. Given that flotation make up 10 percent of the total combined waste stream and the fraction of silt and clay from the flotation waste stream is 17 percent, the silt/clay sizes comprise only 1.7 percent of the total weight of the combined waste stream, and is interpreted as not being significant in defining the material general physical properties and behavior with respect to the design of waste pile geometry.

2.4 FEASIBILITY OF COMBINED WASTE STREAM

The feasibility of combining the waste streams, to be stored simultaneously in compacted lifts in a designated waste storage area is enhanced by the low percentage of silt/clay sizes in the total waste stream.

The void ratio of the DMC material was determined to be approximately 0.3 based on reported literature values for similar materials (Hunt 1986). With this void ratio, a calculated volume of 0.3 m^3 of void space for every 1000 kg of this material is determined. This is a sufficient volume to include the small percentage of sands and fines in a combined waste stream while not altering the overall volume or soil properties of the mass.

2.5 WASTE STORAGE PILE GEOMETRY

Sedgman (2010) in the CHPP design report presents the following soil parameters for the run of mine and reject materials:

- Bulk Density design values (Volume Calculations) → γ=1,100 kg/m^3
- Angle of Repose → ø=37°
- Surcharge angle → β=20°

In the absence of additional testing, for continuity the values provided in the CHPP design are retained and carried through this report.

In accordance with Nova Scotia provincial guidelines for surface coal mine reclamation plans, the land form must be stable and hydrologically compatible with the surrounding area. The objective for land forming to provide stability through reduced slope angles is preferred and slopes greater than 3 horizontal to 1 vertical (18 degrees) must be flattened by step berming to reduce the overall slope to less than 18 degrees. For the conceptual design stage, a factor of safety (FS) of 2.0 was chosen for the waste pile slope construction, which corresponds to a slope angle of 20 degrees which by coincidence is the same as the surcharge angle of 20° provided by Sedgman (2010). The corresponding minimum side slopes to be used in the design of the proposed waste storage piles would therefore be 2.75 horizontal: 1 vertical.

2.6 WASTE STORAGE PILE VOLUMES

The coal waste pile volumes generated are estimated based on the reported proposed waste stream of 0.85 Mt per year, with a field bulk density of 1.1 t/m^3. As noted in Section 2.4 with a combined waste stream material, the fines can be disposed of in the combined waste stream, increasing the bulk density but without affecting the overall volume of the DMC and spirals waste. The field bulk density would be increased with the inclusion of the finer materials within the existing void spaces, with a further increase realized by means of compaction during the placement of waste materials. Utilizing this method, the resulting in-place field bulk density could be increased to 1.3 t/m^3, (at field moisture content), which converts to a decrease in the total volume required for storage by approximately 18 percent.

Waste material placed in this manner would result in a proposed waste stream estimated at a volume rate of 654,000 m^3/yr.

2.7 OTHER POTENTIAL WASTE STREAMS

The most significant waste stream requiring storage or disposal is the reject coal waste from the CHPP process. However two other potential small sources of similar waste will likely be generated during the project life.

1. Development rock for Tunnel #1 construction.

2. Dredge spoils from marine works associated with barge load-out facility

2.7.1 Development Waste

The development of a third access tunnel to the coal face is planned for year 4 of the project development and would be approximately 200,000 tonnes of waste likely composed principally of mudstone and sandstone. It is likely that construction would be carried out using a tunnel boring technique and so the waste would likely be similar to a uniformly graded minus 75 mm minus crushed rock.

At present 450,000 tonnes of development waste from the past construction of tunnels 2 and 3 exists on the surface at the site. This material was the subject of an acid characterization review in 2010 (Stantec, 2010) and was found to be non-acid generating and a non-sulphate bearing material and is therefore of limited environmental concern for disposal.

For the development of the concept plan for reject coal disposal this 200,000 tonnes of material was incorporated into the waste stream from the CHPP and co-deposited with the reject coal (approximately 0.8% of the total waste volume).

2.7.2 Dredge Spoils from Marine Works

It has been predicted that up to approximately 11250 m^3 of organic silt dredge spoil could be generated during the barge load-out facility construction (CBCL, 2012). At present this material is proposed to be stored along the outhaul conveyor route in a 75 m x 75 m containment area.

It is also noted in the CBCL report that this waste could be co-deposited in the CHPP reject waste storage area and this would be acceptable to the concept presented herein, dependent on the construction timing and stage of development. The placement of this benign silt waste in the rejects pile would have little to no impact on potential storage volume (0.26% of Phase 1).

2.7.3 Acid Rock Drainage Potential

Characterization of the waste rock for acid generation potential was reviewed by Stantec (December, 2011) and it was concluded that the CHPP waste will have a strong potential to generate acid rock drainage (ARD), if stored on the surface exposed to the atmosphere and precipitation. The acid runoff would need to be contained and collected and treated from any surface storage facility.

Mitigation of acid drainage effects can be reduced and possibly minimized by progressive reclamation and a focused deposition management plan.

Storage by either sub aqueous methods or capping without exposure to direct precipitation would also limit to eliminate ARD risks and should be considered as a benefit for conceptual design.

3.0 Potential Options Reviewed

During the thirty year operation of the mine, there will be approximately 20 million cubic metres of waste generated that will require storage. Due to the proposed large volumes, several disposal options were reviewed, and are discussed in the following sections.

- Surface storage on Donkin Mine site;
- Surface storage in the local region;
- Underground storage on Donkin Mine site;
- Underground storage in the local region; and
- Ocean disposal.

3.1 SURFACE STORAGE – DONKIN SITE

The Donkin Peninsula consists of a relatively small land mass with variable topography and identified wetland areas located throughout. As noted, it is necessary to design sufficient storage for 20 million cubic metres of waste and available space for surface storage is limited. A review of the available area proved sufficient storage capacity at one location was impractical, therefore designing waste piles in separate locations was necessary.

The construction of large piles of waste coal that extend above the surrounding topography would not be aesthetically pleasing and would potentially adversely affect the air quality due the dust generated from the exposed piles.

Run-off water resulting from precipitation on the waste piles and presenting as surface runoff, or having percolated through the waste piles will be required to be collected and treated during the LOM; with a permanent treatment system in place should the waste piles remain exposed into reclamation. The waste water would be piped, pumped and/or ditched to holding ponds and a treatment plant. Treated water would pass through the existing serpentine ponds and be released to the environment. Sludge generated during the water treatment would be disposed of within the working waste piles. An innovative method for suppressing ARD is an emerging technology that uses an engineered, flow-able or pumpable foam (pHoam™) that is introduced by means of injection through boreholes. The concept basis is to treat large volumes of mine waste using low volumes of water. Although still in a development stage and additional study is required, the concept does indicate promise particularly for a progressive reclamation application where ARD could be delayed through pHoam™ application until the operations cell could be capped and reclaimed. As the project advances it would merit consideration of this method. A cost deferral or offset with water treatment costs could be realized in the long term with ARD abatement by progressive reclamation.

Spontaneous combustion (sponcom), a process whereby certain materials can ignite through internal reactions, is also an observed phenomenon in exposed coal stockpiles. Although studied for over 200 years, the exact cause is not well understood. There are several indicators such as heat, smell, sweating, haze, smoke and unusual coloring that are used to detect sponcom. Affected areas are dealt with as early as possible and it would be required to be controlled through a spontaneous combustion management system.

Limitation and ultimately the elimination of these issues could be possible through progressive reclamation and final capping of the waste piles with an impermeable layer, with the intent of limiting the exposed surface area of waste coal as much as possible during construction. Progressive reclamation would consist of capping completed portions of the waste pile. Capping in this case could consist of placing a double non-woven geosynthetic clay liner (GCL) over a graded and compacted coal waste surface, with reclaimed grubbings then placed over the GCL. Hydroseeding or other means of introducing grasses could be employed to create a rootmat to limit erosion of the topsoil layer.

Impact on the existing wetland areas of the Donkin Peninsula is unavoidable with surface storage on site. Limited available surface area may dictate there is not sufficient area available for the creation of new wetland areas or avoidance of existing wetland areas. Wetland compensation to ensure a no-net-loss of wetland function (as required by provincial and federal policy) will be extensive over the life of the mine and on site compensation opportunities are limited.

The following sections address various waste storage options that attempt to mitigate these issues, and the design and construction of the proposed waste pile cells.

No further development of an estimate of wetland impact has been carried forward in this waste option concept. The issue of land use and wetlands is the subject of work by others and this report provides the expected (anticipated) land area use for waste storage as an input parameter to this work.

3.1.1 Waste Storage Options

Four disposal options have been reviewed as viable site storage options and are as follows:

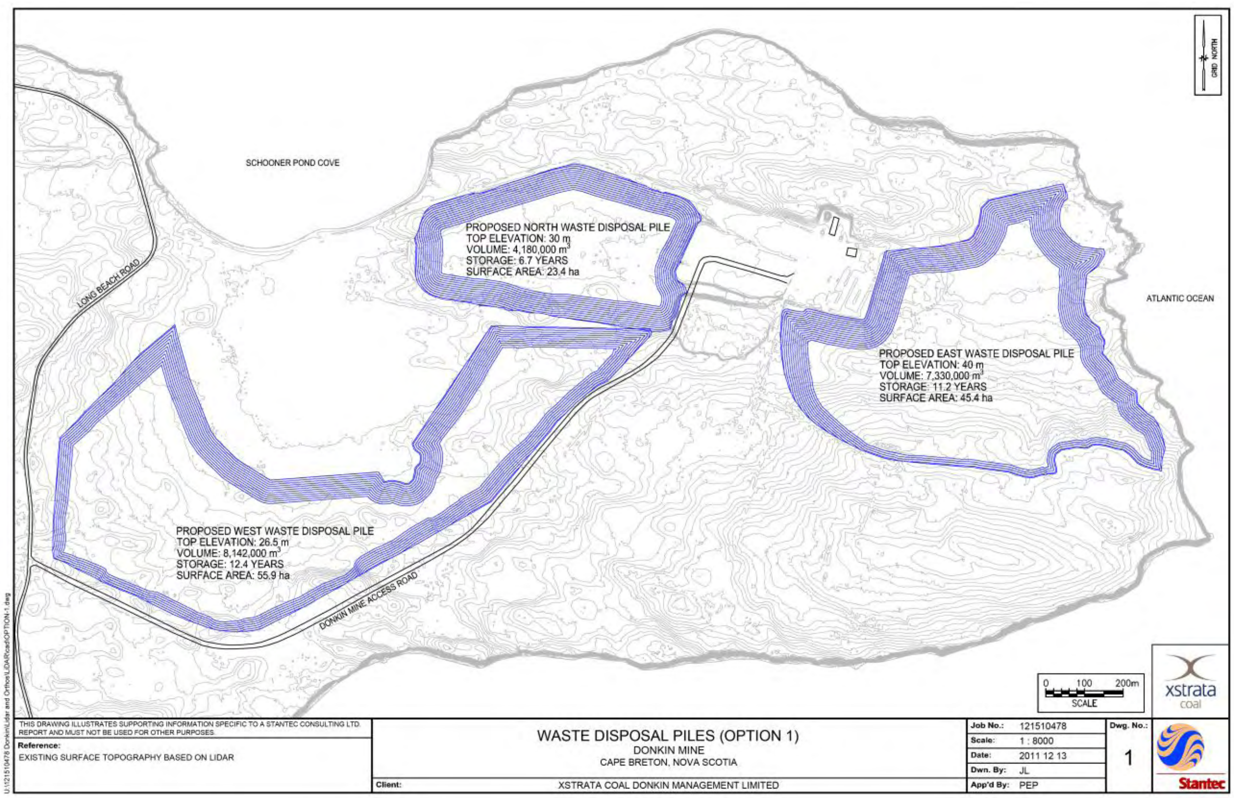
1. Minimize Height Exposure;
2. Optimize Height and Spatial Exposure;
3. Minimize Spatial Exposure; and
4. Minimize Spatial Exposure, with Stage Storage Construction.

The fourth option (Option 4) was developed to the concept level with regards to constructability and ancillary waste piles as it is the preferred combination of storage and phase construction.

3.1.1.1 Disposal Option 1

In consideration of the visual aspect of waste storage, *i.e.,* minimizing the height exposure of the waste piles, site topography and features were reviewed with the intent of infilling lower areas and designing the top elevation of the piles so as to blend in with the existing topography as much as possible. Limiting the top elevation of the waste piles meant more surface area was required. Three areas were selected for waste disposal, as shown on Drawing 3.1 below (also included in larger format in Appendix I), and it was determined that a total land mass of approximately 125 ha would be occupied by the waste coal, over the proposed 30 year mine life. The top of pile elevations included the proposed east waste pile at 40 m, the west waste pile at 26.5 m and the north pile at 30 m, which was in the order of 25 m above existing topography but not exceeding the high point of land on the peninsula.

Drawing 3.1 Disposal Option 1

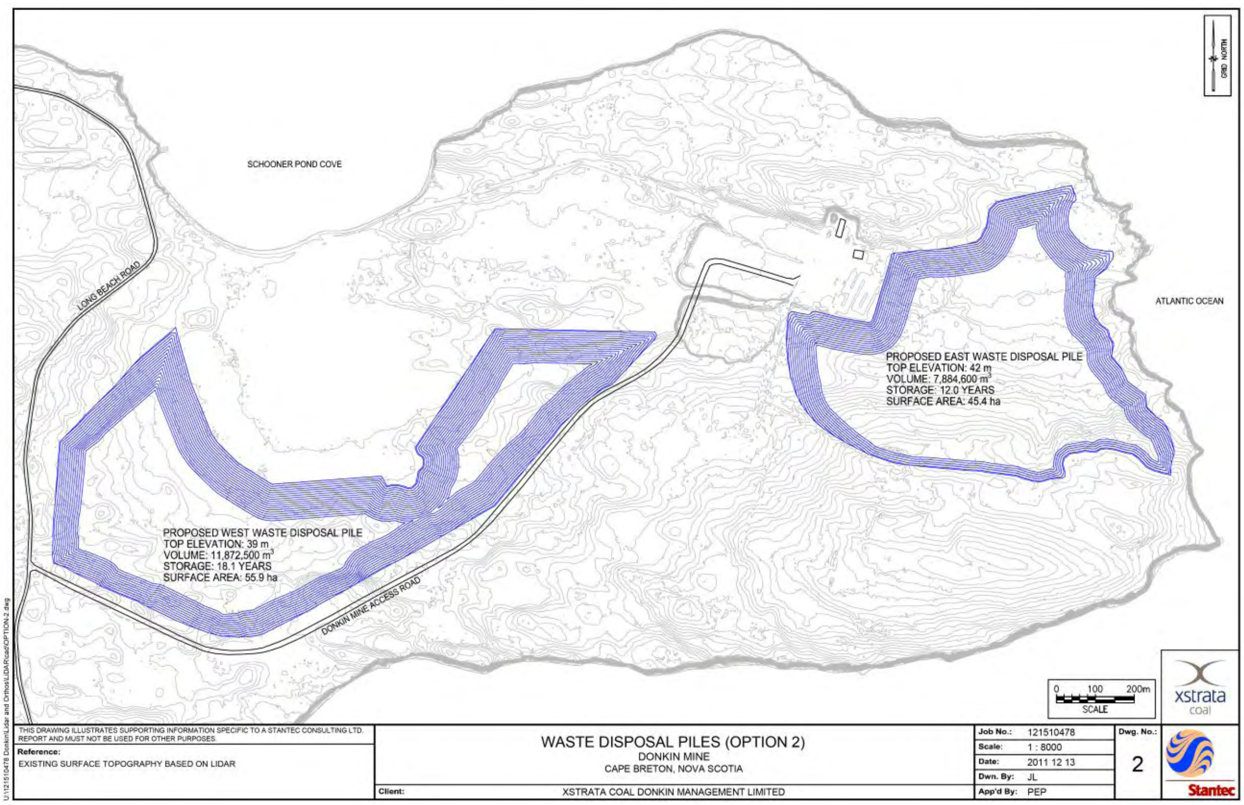


In conclusion, there would not be sufficient land mass available on the peninsula to store the waste rock in a manner that would not be generally conspicuous from the surrounding area. The piles would be prominent and not aesthetically pleasing even at minimum design elevations. Utilizing the maximum surface area available would entail the elimination of significant wetland area, thereby increasing the costs associated with wetland compensation. Construction costs related to site preparation of the containment cells would likely be the worst case scenario.

3.1.1.2 Disposal Option 2

Next, consideration was given to optimizing the height and spatial exposure of the waste piles. The north waste pile was not considered for waste storage. The footprint of the proposed east waste pile would remain unchanged, with a top elevation of 42 m (5% increase from Option 1). The footprint of the proposed west waste pile also would remain unchanged, with a top elevation of 39 m (almost 50% increase from Option 1). The total land mass area would be reduced to approximately 100 ha (decreased by 25% from Option 1), and is shown on Drawing 3.2 below (also included in large format in Appendix I).

Drawing 3.2 Disposal Option 2



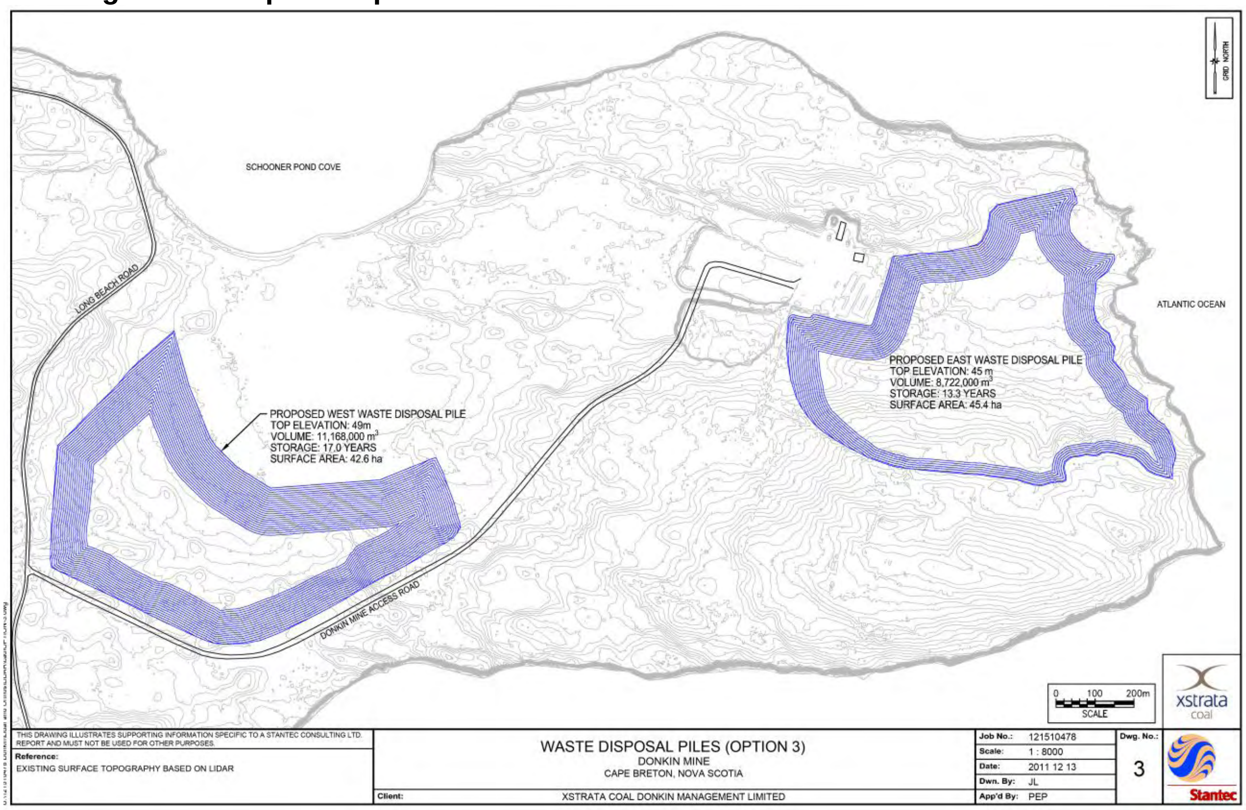
In conclusion, the piles would be constructed at increased design elevations, therefore will be a more prominent landscape feature. A decrease in surface area required would subsequently decrease the costs associated with wetland compensation and site preparation.

3.1.1.3 Disposal Option 3

In consideration of causing minimal impact on existing site conditions, *i.e.*, minimizing the spatial exposure; site topography, and features were reviewed with the intent of storing waste in such a way that would seek to minimize the costs associated with wetland compensation and site preparation. The footprint of the east waste pile would remain unchanged, with a top of pile elevation of 45 m (an increase of 12% from option 1). The footprint of the west waste pile would be decreased to 42.6 ha (a decrease of 25% from Option 1), with a top of pile elevation of 49 m (an increase of 85% from Option 1).

This option would create piles that would be in some cases almost 40 m above existing grade, making them more susceptible to wind erosion, thereby being the least attractive option for air quality management. The total land mass area required for this option would be approximately 88 ha (a decrease of 30% from Option 1). The configuration of the waste storage piles is shown on Drawing 3.3 below (also included in larger format in Appendix I).

Drawing 3.3 Disposal Option 3

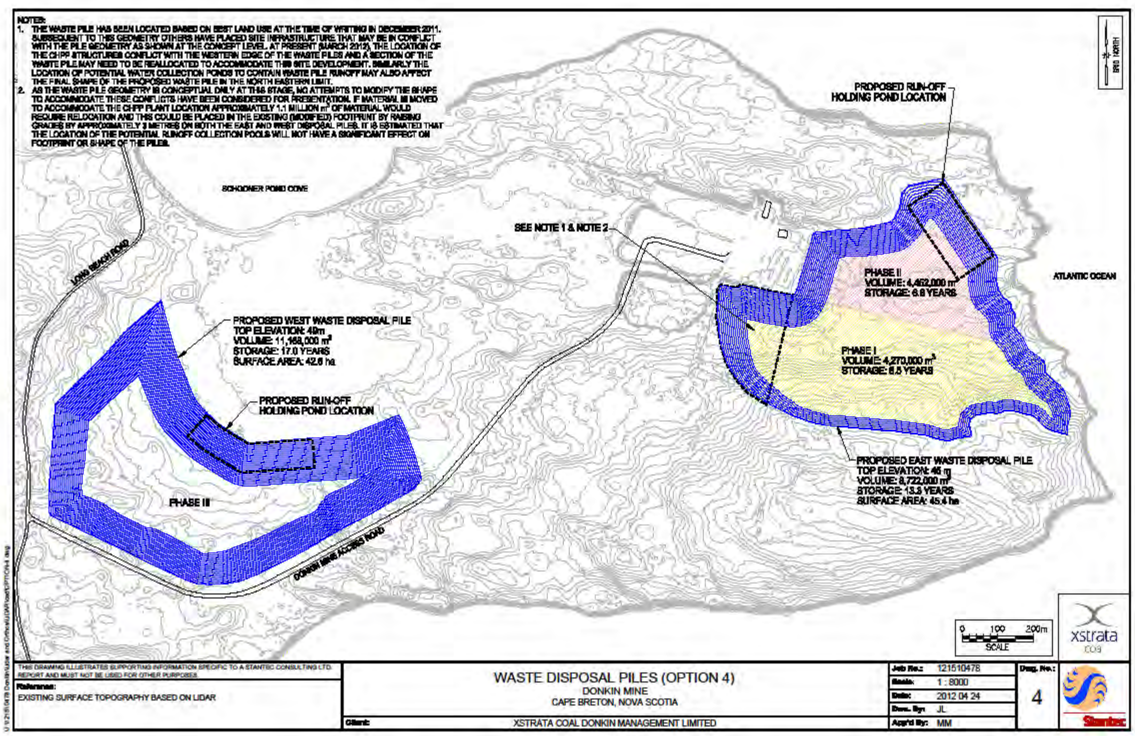


3.1.1.4 Disposal Option 4

The area of the proposed east waste pile consists of existing topography that ranges from a forested hillside in the southwest portion of the area to a lightly treed wetland area in the northeast. Subsurface conditions are likely to vary significantly between these two areas. It is anticipated the subsurface conditions within the forested area to the southwest would generally consist of a thin rootmat and topsoil layer over glacial till. Conversely, it is anticipated the subsurface conditions in the wetland area will consist of soft silt and clay materials and peat at a thickness of up to 1.0 m.

Consequently, the area of the east waste pile was reviewed with consideration for developing the area in two stages or phases, as shown on Drawing 3.4 below (also included in larger format in Appendix I). The first phase would develop the forested hillside area and infill and compact the coal waste up to a top of pile elevation of 45 m. At the completion of Phase I, at approximately 6.5 years, the wetland area would then be developed for storage. The estimated storage capacity of Phase II would be approximately 7 years.

Drawing 3.4 Disposal Option 4



Given the variability anticipated for foundation conditions of the waste pile areas a concept level site construction drawing was developed to assist in defining the extent of these foundation conditions. This concept construction information is presented in Drawing 5 located in large format in Appendix I.

In conclusion, this option is identical to Option 3, in regards to the geometry of the waste piles. The use of stage construction could provide some advantages financially and with constructability of the waste cells. Stage construction is discussed in more detail in Section 3.1.7.

The Option 4 is the preferred Donkin surface storage option with the use of staged construction. The following sections regarding the various components necessary to construct the surface storage facilities are tied to Option 4 but are also applicable with the other three options (1 to 3), however the sequencing and detail would vary. Only Option 4 sequences are detailed further in the following sections.

The waste pile has been located based on best land use at the time of writing in December 2011. Subsequent to this geometry others have placed site infrastructure that may be in conflict with the pile geometry as shown at the concept level. At present (March 2012), the location of the CHPP structures conflict with the western edge of the waste piles and a section of the waste may need to be reallocated to accommodate this site development. Similarly the location of potential water collection ponds to contain waste pile runoff may also affect the final shape of the proposed waste pile in the north eastern limit.

As the waste pile geometry is conceptual only at this stage, no attempts to modify the shape to accommodate these conflicts have been considered for presentation. If material is moved to accommodate the CHPP plant location approximately 1.1 million m^3 of material would require relocation and this could be placed in the existing (modified) footprint by raising grades by approximately 3 metres on both the East and West Disposal Piles. It is estimated that the location of the potential runoff collection ponds will not have a significant effect on footprint or shape of the piles.

3.1.2 Borrow Site

Site preparation for the liner installation would require tree cutting, grubbing of stumps and topsoil, and the shaping and grading of glacial till subgrade. In many cases, shaping and grading of the glacial till subgrade would be feasible utilizing the existing soil available. In wetland areas such as Phase II, additional fill would be required to bring the prepared subgrade elevation above the existing water table elevation. For conceptual design purposes, a fill thickness in the order of 1000 mm is assumed, although a geotechnical investigation would be necessary to confirm the thickness of fill required. Consequently, a borrow area would be required for any significant quantities of additional fill. It is assumed that the insitu glacial till would be suitable for use as an infill material, *i.e.,* material is near optimum moisture content and is able to be placed and compacted in lifts (reference Drawing 5, Appendix I).

The area of Phase I may be considered as a potential borrow source, depending on the amount and quality of glacial till that is available within the area. It is conceivable that glacial till material could be removed from within the proposed waste cell area and stockpiled nearby until Phase II is ready to be constructed. Removing material from within the footprint of Phase I would increase its volume capacity, while simultaneously decreasing the cost associated with infilling the wetland areas of Phase II, as this would cut the truck haul distances significantly.

Site preparation of Phase III would also require fill material to infill some wet, low-lying areas. Similar to the cut and fill method proposed for Phase I and II, and contingent on the amount and quality of the glacial till, insitu material from the hillside area may be removed and used to infill the lower areas.

Phase III could be prepared similarly to the East Pile. Consideration could be given to dividing the proposed storage area into smaller, manageable sections to be prepared ahead of the constructed waste pile.

3.1.3 Grubbing Materials Stockpile

A sufficient area will be required for the storage of grubbing materials removed from within the proposed waste pile areas. The grubbing materials would consist of stumps and rootmat material. Based on an assumed grubbing materials thickness of approximately 300 mm in the area of Phase I, about 74,250 m^3 will be generated. The grubbings may be stockpiled along the perimeter of the proposed waste pile. As Phase I is being infilled with coal waste, progressive reclamation would include the grubbing materials being removed and placed on completed areas of the waste pile, *i.e.,* side slopes. Considering site preparation would commence on Phase II prior to completion of Phase I, an additional 175,000 m^3 of grubbing materials would also be generated and stored along the perimeter of the Phase II area. Similarly, the grubbing materials would be removed from the storage area and placed over completed areas of the coal waste pile during progressive reclamation. Phase III covers an area of approximately 43 ha. Assuming an average grubbing materials thickness of 500 mm, 220,000 m^3 of grubbing materials would be generated and require storage. For conceptual design, an increase of 30 percent would result in a proposed volume of grubbing materials of approximately 260,000 m^3.

It is not expected that grubbing materials would be placed in lifts and compacted but would be dumped by off-road haul truck and pushed by a dozer. Due to the organic matter and higher moisture content of the grubbing materials, soft soil conditions, rutting and likely unstable side slopes could be expected. Therefore, a maximum height of about 6 m would be proposed for the grubbing materials.

It should be noted that after sitting and drying for a period of time, the stumps could be removed, chipped and blended back in with the pile. This method would decrease the bulk of the pile and aid in the decomposition of organic matter. This material would be available for reclamation purposes in the future.

3.1.4 Concept Design Section

Site preparation would consist of the shaping and grading of existing glacial till and/or borrow material to prepare a competent subgrade for liner installation. At the perimeter of the waste piles, a berm would be constructed as per detail 2, Typical Waste Coal Containment Berm Detail on Dwg. No. 5 (Appendix I). It would be necessary to construct the perimeter berm so as to facilitate the installation and anchorage of the HDPE liner and cushion sand. Upon completion of the liner and sand cushion anchorage, the remainder of the perimeter berm could be constructed.

Typically, the liner would consist of a 60 mil HDPE with a sand cushion and a running course to prevent point loads from individual rocks and truck movement that could puncture the liner. A sand cushion layer, 300 mm thick, would be placed over the subgrade area and lightly consolidated. The HDPE liner would be placed over the sand cushion, and fused together over the area being prepared. An additional sand cushion layer, 300 mm thick, would be placed over the HDPE liner and lightly consolidated. A running course, consisting of a well-graded gravel with maximum size of 25 mm, would be placed and compacted in three equal lifts. The running course would blend into the perimeter berms. Upon completion of the liner and running course, the area would be prepared sufficiently to manage the waste coal. A minimum distance of 2000 mm should be left between the toe of the inside of the perimeter berm and the toe of the coal waste slope for runoff collection and drainage.

Design of the waste cell subgrade would be such as to direct any rainfall runoff to a holding pond. Run-off water coming from contact with the waste piles will be required to be collected and treated during the construction; with a permanent treatment system in place during operations should the waste piles remain exposed. The waste water would be collected by toe ditches and then pumped and/or gravity feed to holding ponds and a treatment plant. The resulting treated water would pass through the existing serpentine ponds and be released to the environment. Sludge generated as part of the water treatment process would be disposed of within the working waste piles.

The conceptual design of a runoff control and ARD treatment system is being carried out under a separate cover.

An innovative method for suppressing ARD is an emerging technology that uses an engineered, flow-able or pumpable foam (pHoam™) that is introduced by means of injection through boreholes in the stockpile. The intent is to treat large volumes of mine waste using low volumes of water. The active ingredients of pHoam™ work is to suppress the ARD reactions in the pile and thus mitigate the production of acidic water. Although much study remains to advance this emerging technology, with the developers currently seeking demonstration sites to develop the product, the potential of this technology could be beneficial in a mine waste application such as the waste piles (Gusek, James, Masloff, Brian and Fodor, John, (2012)).

3.1.5 Slopes and Stability

Section 2.5 describes the rationale of the design side slope selection for conceptual design. Past experience at similar sites in Industrial Cape Breton have shown that the waste coal may have a greater amount of fines than what has been shown in the grain size curves given. This could be due to the coal breaking down with handling, *i.e.*, dumping, spreading, and compaction. Freeze and thaw cycles may also contribute to the breakdown of the coal.

Consideration could be given to lowering the side slopes to that previously considered for other local reclaimed waste piles, which are in the order of 5H: 1V. Lowering the side slopes will decrease the holding capacity of the waste piles and would necessitate increasing the height of the piles and/or increasing the footprint of the piles.

3.1.6 Spontaneous Combustion

Spontaneous combustion (sponcom), a process whereby certain materials can ignite through internal reactions, is also an observed phenomenon in exposed coal stockpiles. Although studied for over 200 years, the exact cause is not well understood. There are several indicators such as heat, smell, sweating, haze, smoke and unusual coloring that are used to detect sponcom, and affected areas are dealt with as early as possible. It would be required to be controlled through a spontaneous combustion management system.

3.1.7 Progressive Reclamation and Final Capping

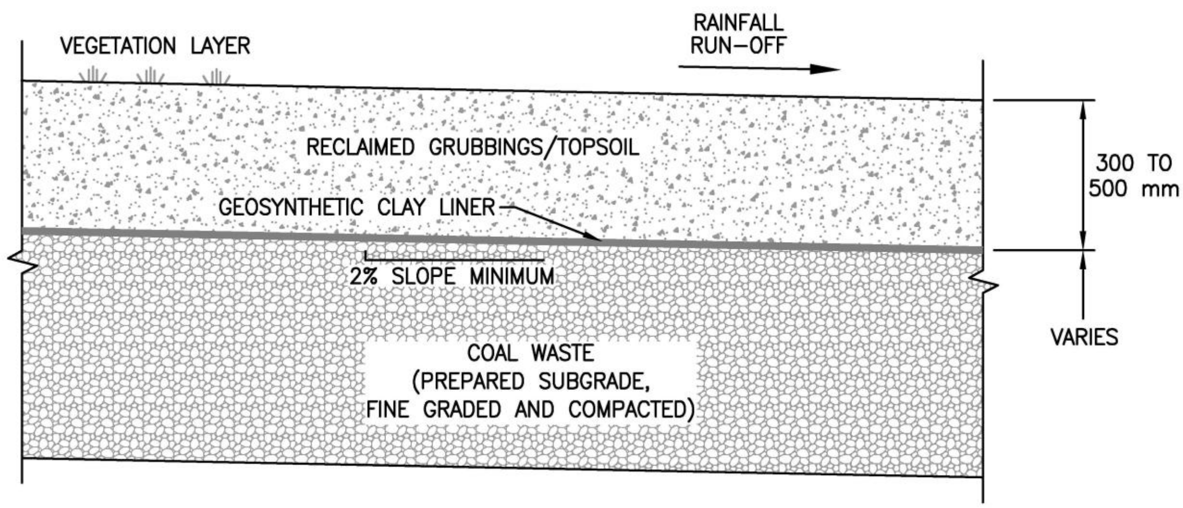
As side slopes are completed, progressive reclamation with the development of an impermeable cap to limit oxygen and precipitation infiltration would thereby limit erosion of the side slopes, aid air quality by limiting the exposure of coal waste to wind action, reduce the potential for sponcom, and reduce the volume of run-off water generated through the waste pile. Therefore reclamation planning should be integral to the waste development plan in final design.

Limitation of potential site ARD issues could be possible through progressive reclamation and final capping of the waste piles with an impermeable layer, with the intent of limiting the exposed surface area of waste coal as much as possible during construction. Progressive reclamation would consist of capping portions of the waste pile once they are completed.

The application of pHoam technology could also be considered as a progressive mitigation step during operations to limit the amount of ARD requiring treatment. If the generation of ARD can be limited within the stored waste then the cost of operating the water treatment plant could be offset by the cost of the progressive reclamation method selected.

Final capping for surface storage waste piles, could consist of placing a double non-woven geosynthetic clay liner (GCL) over a graded and compacted coal waste surface, with vegetated reclaimed grubbings acting as the stabilizing cover placed over the GCL. Hydroseeding or other means of introducing grasses could be employed to create a rootmat to limit erosion of the topsoil layer. Figure 3.1 indicates the conceptual capping detail of a completed pile.

Figure 3.1 Capping Detail



3.1.8 Haul Truck Movement

During initial operations, the waste coal generated will be taken from the CHPP by conveyor to the waste rock stockpile. Conceptual plans have the location of the waste stockpile along the perimeter of the proposed location of the east waste pile. It is conceivable that the waste rock could be carried by conveyor to the east waste cell, where it would then be spread and placed in lifts with a bulldozer. After a period of time, it may become feasible to utilize off-road trucks to haul the waste rock to all points within the east waste pile. Haul truck movement would be limited to the area of the east waste pile.

At the completion of the east waste pile at year 13.3, waste rock would be hauled to the west waste pile. This would necessitate a change in the haul truck route as the waste rock will be required to move from the east side of the site to the west side. A potential change in CHPP waste conveyance could also be considered to the west pile (Phase III) so that a similar sequence of load and haul could be employed.

3.1.9 Phase Construction

Phase construction could be carried out for the cell construction and could be beneficial for the following reasons:

1. Distribute cash flow requirements for the construction of waste facilities over a longer period of the project life.
2. Site exposure as needed (limit exploitation of land until required)
3. Reserve construction in consideration of future potential additional storage options.

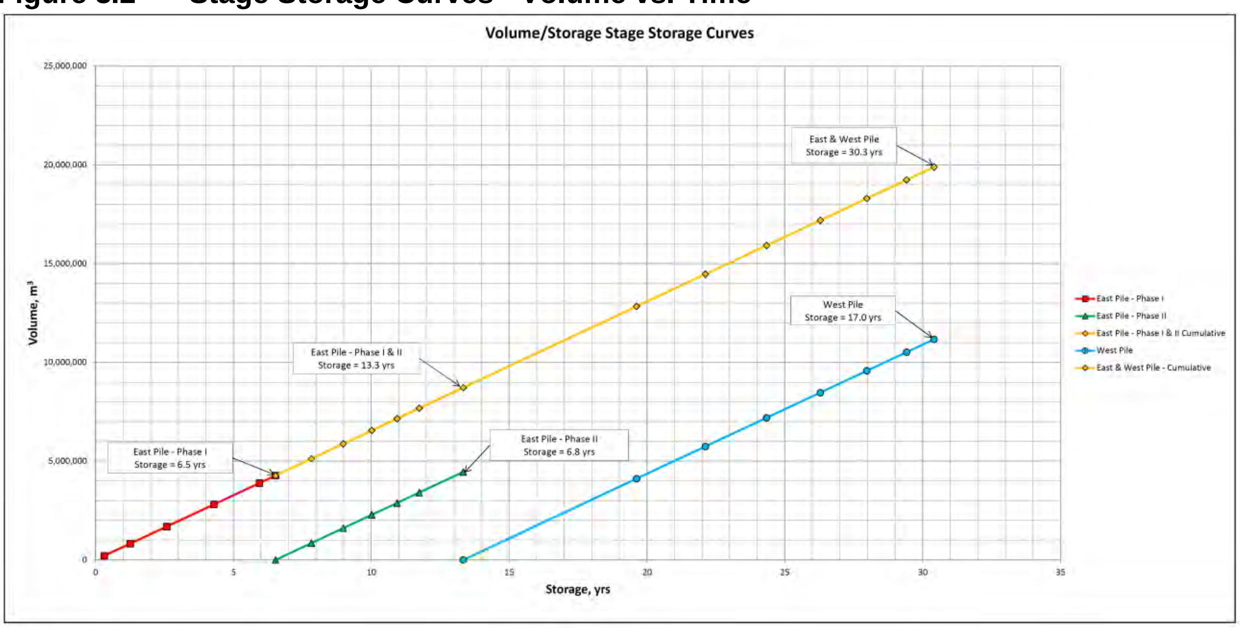
Phase construction could be beneficial financially to the project as construction would be carried out on an as-needed basis, thereby minimizing cash flow to when it is required. Capital that would normally be spent in the first year of operation to prepare a large waste storage area instead could be spent over a span of several years, and within a more manageable budget.

At the commencement of the project, Phase I could be prepared with a storage capacity of about 6.5 years. Prior to Phase I storage area reaching capacity, an additional contract could be carried out to prepare Phase II for storage capacity for another 6.8 years. The stage storage curves for Phase I, II and II are shown graphically on Figure 3.1.

Phase construction would only expose a portion of the site necessary for a couple of years of storage. The limited area exposed would lessen the effects on air quality as opposed to a large open area. The water collection system would only require handling the runoff from a limited area, as opposed to a large catchment area. Reclaimed grubbing materials could be placed on portions of the waste pile that have been shaped to design grade. As the site is exposed, completed portions of the waste pile could be capped and seeded so as to limit the runoff that has to be collected and treated.

During the operational life of the mine, there may be scenarios which arise that could provide for commercial use of the waste coal, thereby negating the requirement for the large land areas which are currently required. One such scenario is the potential for technology to develop and emerge that will utilize the coal waste and render it marketable. Another is that mining operations may develop in such a way that underground storage becomes feasible, or a market may develop for the waste coal and an outside party may purchase the waste coal.

Figure 3.2 Stage Storage Curves - Volume vs. Time



In the event that such a scenario may arise, it would be prudent to be constructing the waste piles and exposing the site in such a way that it requires minimal cost and effort to complete the reclamation of the waste pile area.

3.2 SURFACE STORAGE - LOCAL REGION

As part of the potential identification of potential sites for the surface storage of waste the local region was reviewed for abandoned surface open pits, large valley structures that could be converted into a waste facility with limited construction for basin closure, or other large tracts of land which would have less potential long term environmental impact than the Donkin Peninsula area. The search was limited to within 75 to 100 km distance from the site for transportation cost consideration. The search was also limited to existing transportation routes. There have been no areas identified that are sufficient to handle the proposed volume of waste that will be generated.

3.3 UNDERGROUND DISPOSAL - ON SITE

It is reasonable to consider the use of the mine workings to dispose of the waste stream from the mining operation in so much as the waste stream is only approximately 12 percent of the total volume mined. Even with very conservative bulking factors, the volume of the mined cavity should always be much greater than the volume required for waste disposal.

In the case of the Donkin Mine, this potential method of waste disposal was discussed in the preliminary assessment of options with Xstrata staff and it was determined that exploitation of the underground areas for waste disposal is not compatible with the potential long term exploitation of additional coal resources found at depth below the level presently planned for production.

Based on this limitation, this option was not investigated further but should remain as a potential waste disposal site should the mine and resource development plans change in the future. This method (site) for waste disposal could be combined with the onsite surface disposal options in later years and thus limit the amount of waste stored on surface as defined in this report.

3.4 UNDERGROUND DISPOSAL - LOCAL REGION

Due to the large volume of coal mined in the region during the last century, consideration has been given to disposing of the coal waste back into these numerous abandoned underground workings. The following sections address the practice of disposal in abandoned underground workings throughout the world and the feasibility of this method for this particular project.

3.4.1 Brief Overview of Mine Waste Disposal in Abandoned Underground Workings

Alternatives to the surface disposal or sub-aqueous disposal of mine wastes have been evaluated at mining operations worldwide. The practice of returning some or all of the waste produced into worked-out underground voids, which is generally referred to as "backfilling" has been adopted at many mine sites. Generally, the two primary advantages to this practice compared to other more conventional surface based disposal options and sub-aqueous disposal are that potential for subsidence of historic mine workings can be reduced and this option is generally considered to cause less of an environmental impact compared to more conventional practices.

While backfilling of abandoned mine workings might seem to be an obvious solution to mine waste management, it is a relatively complex endeavor and operations require detailed multidiscipline engineering to develop site specific processes and methods, compared to more common practices of disposal of mine wastes into exhausted open pits, which is comparatively a more straightforward backfilling operation.

The economic and practical feasibility of the use of backfilling techniques for underground mine workings is largely site specific. Most commonly the process of backfilling for mine waste management has been employed at metalifferous mines, with more limited application in coal mines. More frequently, backfilling techniques are employed at the same mine site from where the mine wastes originated, and little information is available on relocation of mine wastes to off-site historic abandoned mine workings.

In effect, implementing a backfilling operation for disposal of mine wastes at an abandoned underground mine site would require “re-opening” the mine for the purpose of backfilling rather than extraction of ore. The associated infrastructure and methods of backfilling operations for abandoned mines can be expected to vary, largely dependent on the physical/chemical make up of the waste material and the condition of the receiving mine (*e.g*. storage capacity available, mining methods used, condition of workings and supports, and many other factors). In general terms, a conceptual operational system for disposal of mine wastes by backfilling of abandoned historic mine workings would include the following main elements:

- Mine Waste Transport System: A system for transporting the mine wastes from the source mine to the proposed underground abandoned mine. This could entail utilizing existing transportation infrastructure, but depending on physiographical and socio-economic factors, could require development of new transportation infrastructure. Detailed assessment and engineering and regulatory approvals may be required to assess the most feasible transportation options.
- Process Plant (*e.g*. Paste plant): Intended to process and provide additives to the mine waste to achieve the desired physical properties for backfilling. The nature and complexity of a paste plant would be highly influenced by the design intent(s) for backfilling (*e.g*. Subsidence control, environmental control, *etc*.) and the physical characteristics of the mine waste material
- Conveyance System (*e.g*. Conveyor belt, pipeline): The system implemented to transport the modified wastes to the underground workings for permanent storage.

The feasibility of backfilling of abandoned underground mines would also be highly influenced by physiographical and socio-economic factors associated with the proposed receiving mine site. For example, areas at and adjacent to historic mine sites may have become developed, or current environmental regulations may identify features at historic mine sites that would complicate permitting and approval processes associated with re-opening a mine to undertake a backfilling operation.

3.4.2 Brief History of Coal Mining for the Sydney Coalfield

The Sydney Coalfield contains the largest coal reserves in eastern Canada, and extends Northwesterly from Cape Morien to Cape Dauphin, over a distance of about 36 miles. There are twelve (12) major seams in the Sydney Coalfield, varying in thickness from three (3) to seven (7) feet (with localized areas of around 10 ft). The legacy of coal mining in the Cape Breton Regional municipality is considerable, and has been concentrated primarily in areas of Glace Bay, Morien, New Waterford, and Sydney Mines

The Sydney Coalfield lies close to the Atlantic Ocean coastline and a large percentage of the fields extend under the ocean. As a result, a considerable portion of the historic underground mining was sub-marine. Generally speaking, there have been two main methods of extracting coal employed in historic mining operations. The first, and most generally used in the earlier years of coal mining, was the "room/bord and pillar" method. The second primary method of extraction was the "long wall" method, which was used in the more recent mining endeavors in the Sydney Coalfield.

3.4.3 Summary of Coal Mine Productions for Sydney Coalfield

For the period between 1863 to 1976, Nova Scotia Department of Natural Resources (formerly Nova Scotia Department of Mines) reported coal production totals for the Sydney Coalfield as being 258,506,325 tons, which included nearly 100 individual coal mines throughout five (5) main districts. These districts and associated reported coal production totals between this period are summarized in Table 3.1, below.

Table 3.1 Sydney Coalfield Coal Production Volumes (1863-1976)

Coal Mining District	Number Reported Organized Mines(1)	Production Range of Individual Mines In District (tons)	Coal Production Total for District (tons)
Port Morien District	16	555 to 2,341,056	4,037,486
Glace Bay District	25	2,380 to 86,364,095	141,133,564
Sydney Mines District	41	293 to 42,868,466	44,994,987
New Waterford District	12	137 to 30,951,424	68,165,311
New Campbellton District	2	551 to 174,426	174,977
		Total Reported Production Tons (1863-1976) =	***258,506,325***

Notes:
(1) The number of reported mine sites does not include illicit "bootleg" mines, which was a common occurrence in the Sydney Coalfield, and reportedly included substantial additional coal production over that noted above.

3.4.4 Option Evaluation Framework

For the purpose of this assignment, a high level evaluation has been undertaken to assess a disposal option of backfilling of abandoned mine workings in the Sydney Coalfield for the management of coal wastes generated from the future Donkin Mine. A comprehensive assessment of specific receiving abandoned mines for feasibility of underground disposal is beyond the scope of this assignment, and the intent is to identify the general viability of this mine waste management practice for management of the generally 23 million tonnes of coal waste estimated to be generated over the forecasted operating period for the Donkin Mine.

In this context, only a small number of abandoned mine sites have been considered as part of this option evaluation. Further, mine sites considered have been limited to known abandoned mine sites that are closest geographical relation to Donkin Mine site and with reported largest coal production tonnages, as these two characteristics are considered to be two of the primary features of a potential receiving mine site so as to be considered feasible and economical for a backfilling option. Mine sites considered for this evaluation are summarized in Table 3.3, and have been grouped into three main categories based on geographical location of the former mine in relation to Donkin. General locations of these Groupings and associated abandoned mine sites are depicted on Figure 3.2. Figure 3.3 provides a depiction of the same general study area, but identifies general areas and extents where historic underground mine workings are known to be present. It should be noted that for Groups 1 and 3, there has been considerable sub-marine coal mining activity, and the extent of workings shown in Figure 3.3 extends a considerable distance northward below the Atlantic Ocean.

It should be noted that there are several other abandoned mines in the same general area of those identified herein, however as previously stated, this evaluation has been limited to historic mine sites noted as having larger and significant historic productions.

Table 3.2 Summary of Mine Sites Considered

Grouping No.	Mine District	Township	Abandoned Mine Sites Considered	NSDNR Reported Production Volume (tons)
1	Glace Bay	Donkin	Dominion 6 Colliery	3,162,876
		Donkin	Schooner Pond/Acadia Mine	18,541
		Port Caledonia	Clyde Mine	238,310
			Combined Production for Group 1 =	***3,419,727***
2	Morien	Port Morien	Blockhouse Mine	1,168,986
		Morien	Gowrie Mine	1,930,837
		Birch Grove	Dominion 21/22 Colliers	3,626,956
		Broughton	4 Star / Broughton Mine	1,599,990
			Combined Production for Group 2 =	***8,326,769***

Table 3.2 Summary of Mine Sites Considered

Grouping No.	Mine District	Township	Abandoned Mine Sites Considered	NSDNR Reported Production Volume (tons)
3	Glace Bay	Caledonia	Dominion 24 Colliery	5,790,101
		Steeles Hill	Dominion 11 Colliery	7,241,587
		Caledonia	Dominion 4 Colliery	19,918,811
		Sterling	Dominion 2 and 20 Collieries	37,738,322
		New Aberdeen	Dominion 1B and 26 Colliers	36,858,781
		Reserve Mines	Dominion 5 and 10 Collieries	8,386,940
			Combined Production for Group 3 =	***115,934,542***

Figure 3.3 General Location of Abandoned Mine Sites Relative to Donkin Mine (Source: Google Maps)

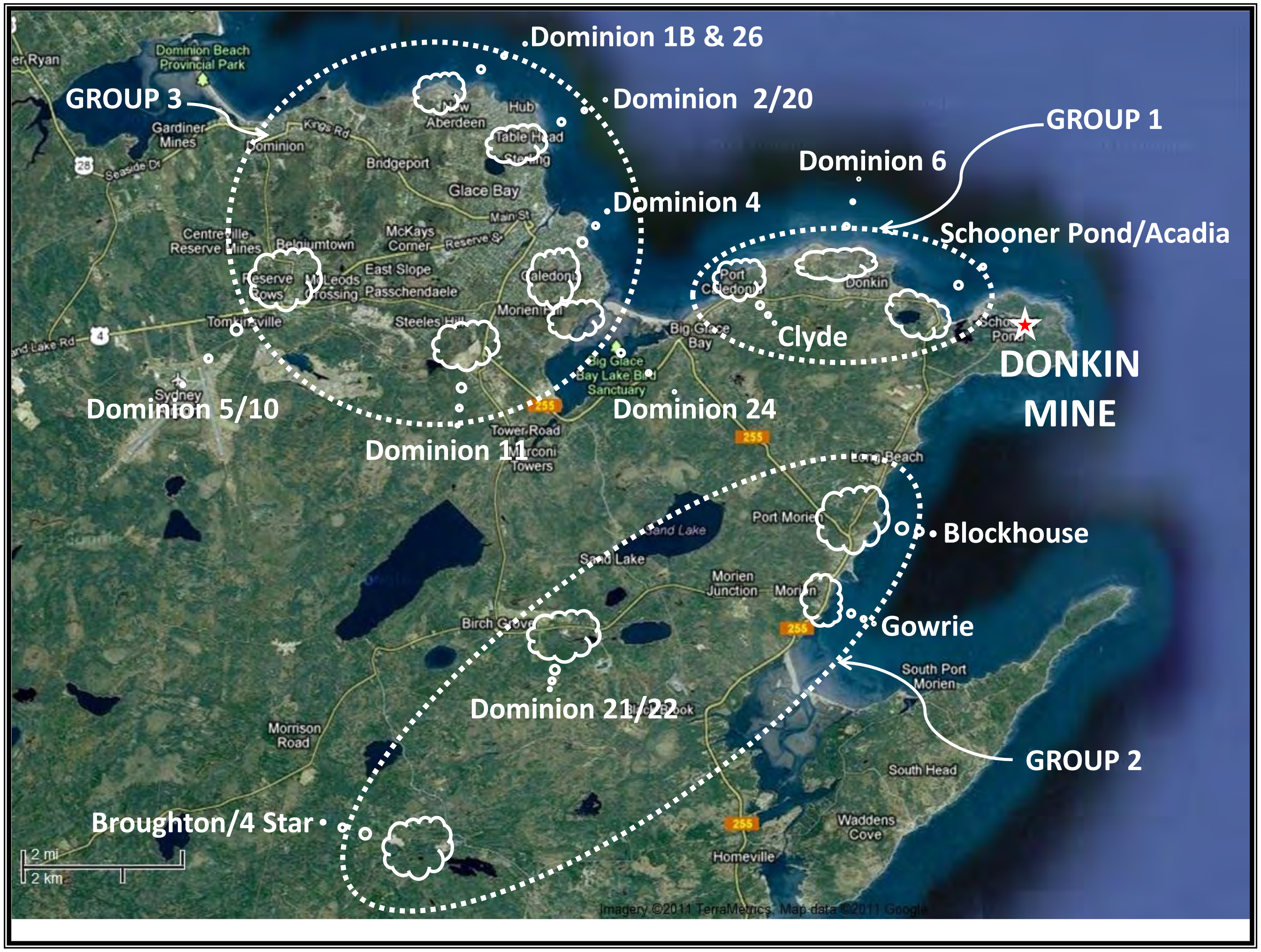
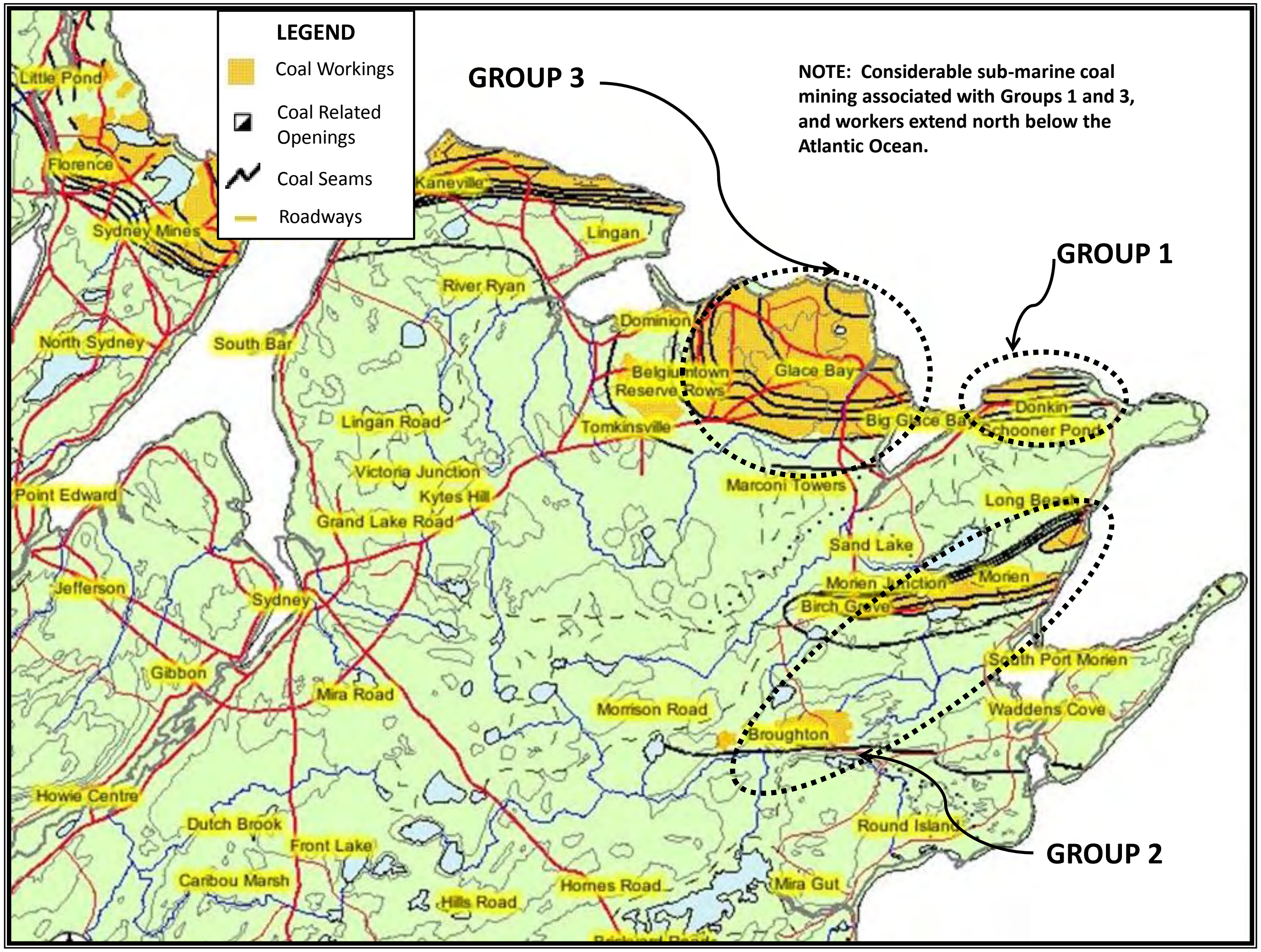


Figure 3.4 General Areas of Historic Mine Workings (Source: NSDNR GIS)



3.4.5 Discussion of Findings

For assessing the suitability and feasibility of backfilling abandoned mine sites as a mine waste management option, there are numerous physical, physiographical, social, environmental, economic, and other considerations that would have to be evaluated. Considering the purpose and scope of this evaluation, the option evaluation will be limited to what are considered to be Primary Site Considerations, as listed below:

- Potential storage capacity of the receiving mine;
- Transportation of mine waste from Donkin to receiving mine;
- Condition of receiving mine workings; and
- Potential constraints/sensitivities related to physiographic and/or existing land development/usage at receiving mine.

While economic considerations are fundamentally important to the evaluation of any option, they have not been specifically included as a Primary Considerations at this level of evaluation. The Primary Considerations identified above may exclude the feasibility of developing a site for backfilling, regardless of the associated costs. Further, from an order of magnitude costing level, the infrastructure and development at any site would generally be expected to include the same types of infrastructure and methods, with similar cost implications per site. The most significant factors expected to influence variations in site specific costs between abandoned mine sites are associated with the transporting the reject material from the Donkin site to the receiving site and the existing conditions of the mine workings at the receiving site, which are included in the Primary Considerations identified above.

Using readily available public reference sources, cut-sheets have been developed for the mine sites considered as part of this evaluation. Cut-sheets are included in Appendix II, along with Figures depicting the general locations of sites within each grouping.

Table 3.4 provides a brief summary of mine features/characteristics identified for the historic mine sites considered, as it pertains to the primary considerations identified above. It should be noted that these characteristics have been evaluated on a high level and based on limited site specific information that was attainable from readily available public sources. More detailed assessments on a site specific basis would be required to properly identify existing conditions and to thoroughly characterize feasibility of a specific mine site for backfilling with mine wastes.

Considering the findings for each of the abandoned mine sites, the following sections discuss the potential receiving sites as evaluated against the Primary Considerations identified above. Table 3.5 provides a comparison of identified significant pros/cons and strengths/limitations identified from this evaluation of Primary Considerations.

Table 3.3 General Characterization Summary of Abandoned Mine Sites

Mine Site				Mine History								Site Location Relative to Donkin		General Area Characterization Of Existing Land Usage	
Options Evaluation Grouping	Former Mine	District	Township	Years of Operation	Coal Seam Mined	Reported Coal Production (tons)	Predominately Submarine or Below Land Mine Workings	Mining Method	Associated Mine Openings	Flooding Status	Possible Connections to Other Mines	Primary Existing Transportation Route(s)	Approx Distance From Donkin (km)	General Site Setting / Land Usage	Possible Sensitive Areas/Development Constraints
Group 1	Schooner Pond/Acadia (Cut Sheet 1)	Glace Bay	Donkin	1863-1874	Emery	20,000	Below Land	Unknown	2 slopes 2 shafts 1 water level	Unknown (Likely Flooded)	Unlikely	Public Roads: Donkin Highway	1 km along public road	Vacant/Undeveloped Land with Sparse Residential Development	Municipal Reservoir Atlantic Ocean Small Unnamed Stream
	Dominion 6 (Cut Sheet 2)	Glace Bay	Donkin	1910-1930	Phalen	3,321,575	Sub-Marine (Some shallower workings below land)	Room and Pillar	4 slopes 3 shafts	Unknown (Likely Flooded)	Yes (Clyde and Possibly Dominion 4)	Public Roads: Donkin Highway	3 km along public road	Residential/Recreational/School	Atlantic Ocean Considerable Residential Development Near Mine Site. School Near Mine Site
	Clyde (Cut Sheet 3)	Glace Bay	Port Caledonia	1863-1892	Phalen	238,310	Below Land	Room and Pillar	3 slopes 3 shafts 1 water level	Unknown (Likely Flooded)	Yes (Dominion 6)	Public Roads: Donkin Highway	4 km along public road	Undeveloped land near residential development.	Atlantic Ocean Stream to South Considerable Residential Development Near Mine Site.
Group 2	Blockhouse (Cut Sheet 4)	Morien	Port Morien	1868-1888	Blockhouse	1,168,986	Below Land	Room and Pillar	2 slopes 3 shafts 1 drainage level	Unknown (Likely Flooded)	Unlikely	Public Roads: Long Beach Road	2 km along public road	Vacant/undeveloped land. Some sparse residential development within 1 km.	Atlantic Ocean
	Gowrie (Cut Sheet 5)	Morien	Morien	1863-1892	Gowrie / McAulay	1,930,837	Below Land	Room and Pillar	2 slopes 3 shafts	Unknown (Likely Flooded)	Unlikely	Public Roads: Long Beach Road	4 km along public road	Vacant/undeveloped land. Some sparse residential development within 1 km.	Atlantic Ocean/Morien Bay Reservoir to south
	Dominion 21/22 (Cut Sheet 6)	Morien	Birch Grove	1911-1930	Gowrie / McAulay	3,626,956	Below Land	Room and Pillar with Pillar Extraction	6 slopes 3 shafts	Unknown (Likely Flooded)	Unlikely	Public Roads: Birch Grove Road and Long Beach Road	9 km along public roads	Undeveloped Land with considerable residential development in close proximity.	Morrison Lake Reservoir at John Allen Lake Considerable Residential Development Near Mine Site.
	Broughton/Four Star (Cut Sheet 7)	Morien	Broughton	1914-1969	Tracy	1,599,990	Below Land	Room and Pillar. Mechanized & Hydraulic Longwall.	4 slopes 1 shaft	Unknown (Likely Flooded)	Unlikely	Public Rods: Birch Grove Road, Long Beach Road and Broughton Road	18 km along public roads	Vacant / Undeveloped Land	Loon Lake Black Brook and Tributaries
Group 3	Dominion 11 (Cut Sheet 8)	Glace Bay	Steeles Hill	1913-1949	Emery	7,241,587	Below Land	Room and Pillar with section of Long wall	2 slopes 3 shafts	Unknown (Likely Flooded)	Possible (Dominion 24)	Public Roads: Donkin Highway and Brookside Street .	11 km along public roads	Undeveloped/Recreational Land with considerable residential development in close proximity.	Renwick Brook Considerable Residential Development Near Mine Site.
	Dominion 24 (Cut Sheet 9)	Glace Bay	Caledonia	1920-1953	Emery	5,790,101	Sub-Marine (Some shallower workings below land)	Room and Pillar	2 slopes 3 shafts	Unknown (Likely Flooded)	Possible (Dominion 11)	Public Roads: Donkin Highway, Brookside Street and Lake Road.	15 km along public roads	Vacant/undeveloped land. Some sparse residential development within 1 km.	Big Glace Bay Lake Bird Sanctuary
	Dominion 4 (Cut Sheet 10)	Glace Bay	Caledonia	1910-1961	Phalen	19,918,811	Unknown	Room and Pillar with Pillar Extraction. Long wall in 1950.	1 slope 2 shafts 1 water level	Unknown (Likely Flooded)	Possible (Dominion 6)	Public Roads: Donkin Highway, Brookside Street, South Street and Douglas Avenue.	18 km along public roads	Undeveloped/Recreational Land with considerable residential development in close proximity.	Big Glace Bay Lake Bird Sanctuary Considerable Residential Development Near Mine Site.
	Dominion 2/20 (Cut Sheet 11)	Glace Bay	Sterling	1911-1971	Phalen	37,738,322	Sub-Marine (Some shallower workings below land)	Room and Pillar with Pillar Extract and Long wall	1 slope 3 shafts	Unknown (Likely Flooded)	Yes (Dominion 1B/26 and Dominion 5/10)	Public Roads: Donkin Highway, Brookside Street and Sterling Road.	18 km along public roads	Undeveloped/Recreational Land with considerable residential development in close proximity.	Considerable Residential Development Near Mine Site. Reservoir to South
	Dominion 1B/26 (Cut Sheet 12)	Glace Bay	New Aberdeen	1924-1976	Phalen / Harbour	36,858,781	Sub-Marine	Room and Pillar Long wall	1 slope 2 fan shafts 1 water level	Unknown (Likely Flooded)	Yes (Dominion 2/20 and Dominion 5/10)	Public Roads: Donkin Highway, Brookside Street, Sterling Road Beacon Street, Wallace Street, Connaught Avenue and One B Road.	19 km along public roads	Ocean front vacant land with some existing structures (possibly a lighthouse), with some residential development in close proximity.	Atlantic Ocean / Wallace's Cove
	Dominion 5/10 (Cut Sheet 13)	Glace Bay	Reserve Mines	1905-1942	Phalen / Emery	8,386,940	Below Land	Room and Pillar with Pillar Extract & Long wall	3 slopes 2 shafts 1 water level	Unknown (Likely Flooded)	Yes (Dominion 2/20 and Dominion 1B/26)	Public Roads: Donkin Highway, Brookside Street, Reserve Street and Main Street.	17 km along public roads	Undeveloped Land with considerable residential/commercial development in close proximity.	Considerable Residential/Commercial Development Near Mine Site.

Table 3.4 Evaluation of Mine Site Characteristics Against Primary Considerations for Redevelopment

Primary Consideration	Mine Group	Primary Cons/Limitations	Primary Pros/Strengths	Sites With Potential Favorable Characteristics
Potential Storage Capacity	1	• Collectively, this group of mines would not provide the required storage capacity to be considered backfilling as a primary option for management of coal wastes from the Donkin Mine Site. • The mine sites in this group are not likely connected underground based on production volumes and coal seams mined. • The actual capacity of any mine is largely uncertain, as it is primarily dependent on the existing condition of the underground workings.	• The Dominion 6 mine is the only site within this group expected to have any significant storage capacity to accept coal mine wastes. It is possible that the Dominion 6 Mine may be connected underground to the Group 3 mines (Possibly Dominion 4 Mine), which in turn may be connected to other large mines in the Glace Bay District. Conceivably, if underground connections to other mines are available/usable, the required storage capacity may be attained with re-opening a single mine at Dominion 6.	Dominion 6 Mine
	2	• Mines in this group individually or collectively would not be considered to provide sufficient capacity for backfilling to make this group an option to consider backfilling as a primary waste management option for Donkin, and would require development of mine sites in other areas/districts. • The actual capacity of any mine is largely uncertain, as it is primarily dependent on the existing condition of the underground workings.	• None Identified.	None Identified

Table 3.4 Evaluation of Mine Site Characteristics Against Primary Considerations for Redevelopment

Primary Consideration	Mine Group	Primary Cons/Limitations	Primary Pros/Strengths	Sites With Potential Favorable Characteristics
	3	• The actual capacity of any mine is largely uncertain, as it is primarily depend on the existing condition of the underground workings	• This Group offers the greatest storage capacity. • On an individual mine basis, it is unlikely that any one mine could accommodate the forecasted mine waste volume from Donkin. However, considering that mines in this group are likely interconnected underground, this group would provide the greatest potential for available capacity. • There are several other mine sites in the area of this Group that have not been considered herein, and that could potentially provided additional storage capacity.	All Sites Considered in this Group
Transportation of Mine Wastes	1	• Existing transportation route is through developed parts of Donkin township. • Damage/deterioration to existing roadways and associated maintenance/repair costs.	• In closest proximity to Donkin, and would be expected to have lowest associated transportation costs. • Offers some opportunity for construction of alternate transportation infrastructure.	All Sites Considered in this Group
	2	• Transportation costs expected to be much higher in comparison to Group 1 sites, given increased distance from the Donkin Site. • Some residential developments along existing route. • Damage/deterioration to existing roadways and associated maintenance/repair costs.	• Existing transportation route is less developed, and comparatively expected to generate the least public adversity. • Would seem to have least constraints for option of developing new transportation infrastructure. • Former rail line ROWs existing at some locations, which possibly could be utilized to minimize transportation impacts along public roadways.	All Sites Considered in this Group

Table 3.4 Evaluation of Mine Site Characteristics Against Primary Considerations for Redevelopment

Primary Consideration	Mine Group	Primary Cons/Limitations	Primary Pros/Strengths	Sites With Potential Favorable Characteristics
	3	• Transportation costs expected to be much higher in comparison to Group 1 and Group 3 sites, given increased distance from the Donkin Site. • Significant commercial and residential development along existing transportation infrastructure. • Existing developments expected to provide constraints to considering options for development of new transportation infrastructure.	• None identified.	None Identified
Condition of Mine Workings	1, 2, and 3	• Existing condition of workings unknown. • Based on age of mines, potential significant constraints with condition of mine supports and possible cave-ins. • Dewatering is expected to be required for all sites.	• Considering the mining methods employed, considerable coal resources would still be *in-situ* between existing workings. Depending on the condition of the mine workings and if technologically feasible, it may be possible to recover additional coal for commercial value to off-set the costs of backfilling as a site management option. However, consideration of this as a strength is superseded by the uncertainty of the actual conditions of mine workings.	None Identified
Existing Land Development/Usage Constraints	1	• Considerable residential development at and around areas of former mine plant sites, expected to pose constraints for re-opening mines. • An existing school is located in close proximity to the former Dominion 6 mine.	• For the Schooner Pond/Acadia mine, areas are largely undeveloped with some minor residential development in adjacent areas.	Schooner Pond/Acadia Mine
	2	• Dominion 21/22 Colliers situated adjacent to the south of the community of Birch Grove and considerable residential development in this area.	• Blockhouse, Gowrie and Broughton/4 Star mines are in largely undeveloped areas, with relatively minor residential development in surrounding areas.	Blockhouse Mine Gowrie Mine Broughton 4/Star Mines

Table 3.4 Evaluation of Mine Site Characteristics Against Primary Considerations for Redevelopment

Primary Consideration	Mine Group	Primary Cons/Limitations	Primary Pros/Strengths	Sites With Potential Favorable Characteristics
	3	• Extensive residential, commercial, residential development in Glace Bay township, which is in close proximity to most mine sites in this Group.	• Former Dominion 1B/26 Mines and Dominion 4 Mine are located near Atlantic Ocean Shoreline, with less development constraints in immediate area.	Dominion 1B/26 Dominion 4
Potential Environmental Constraints/Sensitivities	1, 2, and 3	• Detailed assessment would be required to evaluate and identify potential environmental receptors. • Mine water dewatering expected to be associated with all sites, which could provide significant environmental permitting constraints. • Multiple mine sites would likely have to be developed for backfilling option. Unique environmental assessments and approvals would be associated with each site considered.	• The option of backfilling of mine wastes is considered to have less potential environmental impact than more conventional surface management options.	Further Assessment Would be Required to Identify Sites.

3.4.6 Potential Storage Capacity

Based solely on reported coal production volumes, collective reported production volumes for historic mine sites would certainly suggest that sufficient capacity is available within the mined areas of the Sydney Coalfield to accommodate the forecasted volumes of coal waste expected to be generated over the operating life of the Donkin Mine. However, on an individual mine site basis, there are no individual mines sites within the groups considered that would be expected to solely accommodate the expected volume of mine waste. There is potential that some of the mine sites are connected, and it may be possible to utilize underground connections to access multiple mine sites, with a single historic mine site developed with mine waste processing and conveyance systems. However, considering the uncertainty of conditions of workings for historic mines, it is considered most likely that multiple former mine sites would have to be utilized to make a backfilling option feasible.

3.4.7 Transportation of Mine Wastes

The only existing transportation infrastructure identified that could be utilized for transport of mine wastes from the Donkin Site to the potential receiving abandoned mine sites is via public roadways, which are under provincial and municipal jurisdictions. While existing transportation infrastructure is in place for a road based transportation option, there are considerable potential limitations with respect to community impacts (public concerns of noise and increased traffic, safety risks of increased haulage traffic, deterioration of primary roadways, *etc.*) and environmental impacts. Group 3 sites are expected to have the most limitations given the considerable land development around the mine sites. Construction of new and less disruptive transportation infrastructure may have to be considered, which may be physically or cost prohibitive depending on the distance from the Donkin Site, physiographical constrains, and/or existing developments along available routes.

3.4.8 Expected Condition of Mine Workings

For all the abandoned mine sites considered, information is not available to characterize the existing condition of the mine workings. However, some general statements regarding potential conditions of historic mine workings based largely on the age of the mines and mining methods identified are provided below:

- Based on the age of the mines, it is likely that all sites are currently flooded to equilibrium, or approaching equilibrium. It is considered likely that redevelopment of any abandoned mine site will require substantial dewatering efforts, posing potential constraints associated with regulatory approvals and environmental controls.
- As previously mentioned, it is likely that multiple mine sites may be connected underground. This is especially true of the Group 3 mine sites.
- Considering the age of the mines, the condition of the mine supports are expected to be deteriorated and considerable sections of caved workings may have occurred.

- Considering the mining methods employed, considerable volumes of coal seams left *in-situ* would remain. This may offer a positive consideration for backfilling, as conceivably it may be possible to recover coal as part of backfilling operations.

3.4.9 Potential Constraints Related to Existing Land Development/Usage and/or Sensitivities

To undertake a backfilling option for management of mine wastes, effectively this would entail re-opening former mines. Since cessation of the historic mining operations, in some cases considerable development has occurred at and adjacent to the former mine sites. Associated current land usage could provide significant constraints with respect to considerations of re-opening a mine for the purpose of backfilling. Such re-development constraints are considered most prominent for Group 3, and to a lesser extent for Group 1. The Group 2 mines sites are situated in areas of least development and expected to have least constraints associated with current land development.

The sites by the defined grouping are illustrated in Figures 3.4, 3.5, and 3.6.

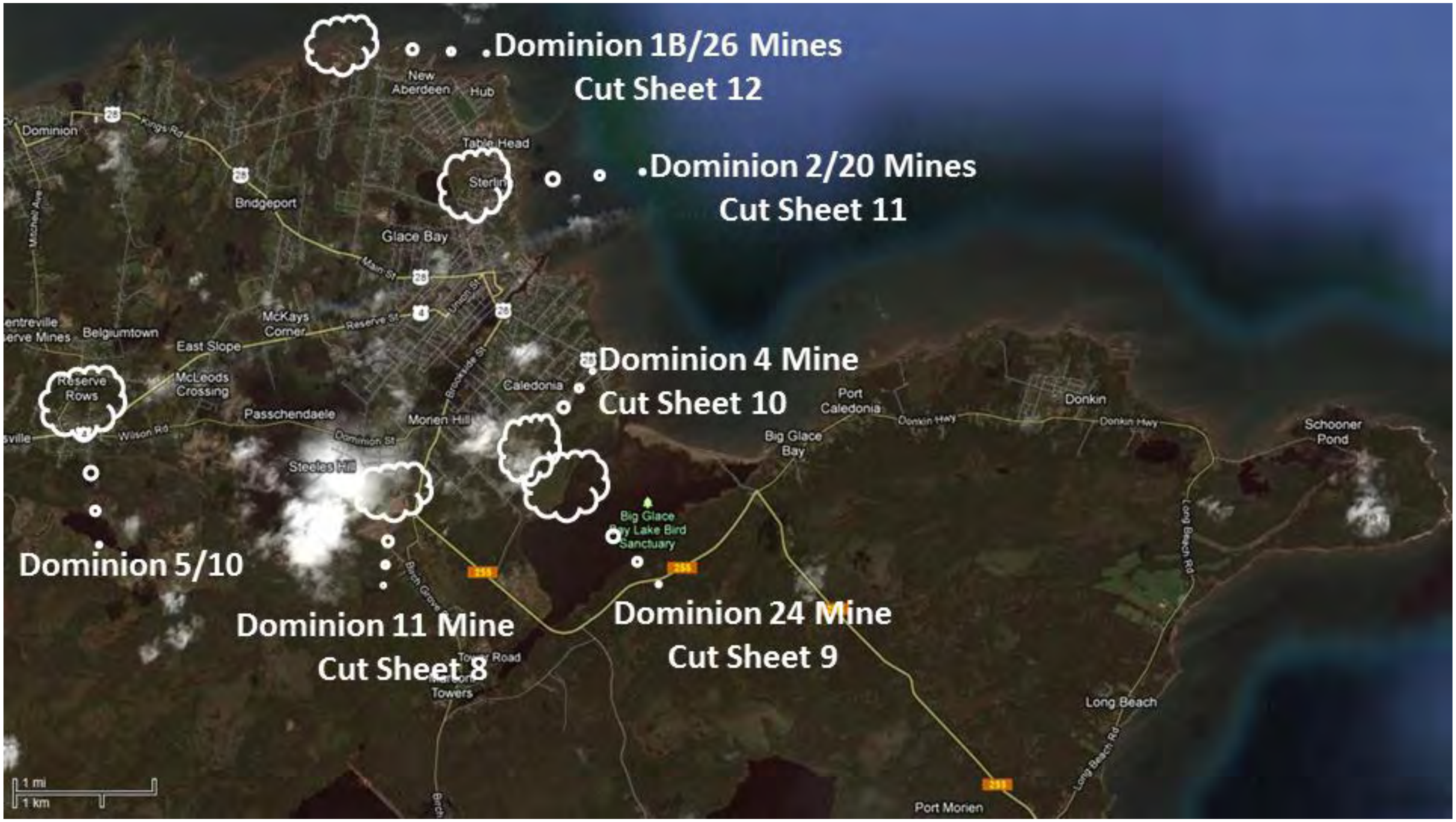
Potential environmental or regulatory constraints are difficult to define at this level of assessment, and would require more detailed investigation and assessment. However, some general comments are provided below with respect to environmental approvals and considerations:

- Backfilling of mine wastes underground is generally considered of lower risk than more conventional surface management options.
- It is expected that multiple abandoned mine sites would have to be considered for backfilling to be feasible, it is expected that unique environmental assessments and approvals would be required for each abandoned mine site.
- As previously discussed, re-opening abandoned mine sites for backfilling would be expected to require dewatering of mine workings. Mine water management, control, and possibly treatment would have to be considered which would be expected to have significant cost and environmental regulatory implications. Further, if multiple sites are required to be developed for backfilling, dewatering may have to be employed at multiple sites (excepting possible interconnected mines, which potentially may be dewatered from a single location).

Figure 3.5 Group 1 Historical Coal Mine Sites

Figure 3.6 Group 2 Historical Coal Mine Sites

Figure 3.7 Group 3 Historical Coal Mine Sites



3.4.10 Summary of Findings and Conclusions

Considering the comparison of historic mine sites considered as part of this option evaluation to the Primary Considerations discussed above, the following general conclusions are provided:

- The available information would indicate that abandoned mine sites in the Sydney Coalfield could accommodate the expected volumes of mine wastes expected to be generated from the Donkin Mine. However, it is realistically expected that multiple sites would have to be re-developed to support a backfilling option.

- In consideration of all the primary considerations for re-opening, there is no individual Group or mine site that would not be expected to provide significant constraint(s) with respect to re-development for the purpose of backfilling. For example, if considering all the primary considerations evaluated, former mine sites in Group 2 and the Schooner Pond/Acadia Mine in Group 1 would appear to be best suited to minimize public concerns and associated regulatory approvals, however, these sites have the least available capacity for storage and would require more sites to be considered.

- The uncertainty of the condition of existing mine workings is a paramount consideration, as it could negate all the potential positive attributes of a particular mine site as far as feasibility for re-development. Considerable assessment and investigation in this capacity alone is expected to be complex and likely cost prohibitive.

In conclusion, consideration of backfilling of abandoned mine workings as a management practice for mine wastes generated from the Donkin site is considered theoretically possible, but highly impractical and improbable considering known constraints, uncertainties regarding the condition of historic mine workings, and the level of effort required to evaluate for further consideration.

3.5 OCEAN DISPOSAL

Ocean disposal of coal waste would require specific engineering considerations and would increase the regulatory burden for the Project and uncertainty of approval. Adverse ecological and socio-economic effects would require special consideration and would require specific consultation efforts and likely result in additional compensation requirements. This review of ocean disposal of the defined CHPP waste stream(s) relies on the previous work compiled by XCDM and presented in their February 2011 report - Coal Waste Ocean Disposal Investigation (A Concept Study).

As indicated on page 65 of the Concept Study, under the heading Deep Sea Tailings Placement …, the coal waste material will likely need to be altered for transport and deposition and therefore would be best characterized as a slurry.

Engineering considerations to be factored into Project design, should ocean disposal of this waste be selected as a preferred alternative, include:

- **Removal of air bubbles from the slurry to prevent formation of a surface plume:** This may require de-aeration and/or thickening of tailings.

- **Mixing of tailings with seawater:** Seawater can be used to coagulate the slurry and provide a dilution factor prior to marine discharge.

- **Discharge pipe engineering:** Special consideration must be taken to select an appropriate pipe entry point for discharge (*e.g.*, shoreline/shallow water, deep sea tailings disposal). The pipe must also be designed using adequate material to withstand waves and currents and avoid pipe blockage or breakage. Slope of the pipe and rate of discharge can affect blockage.

- **Receiving environment:** The receiving marine environment will affect the flow and dispersion of the slurry. Water currents and sediment grain size will influence the deposition and migration of the slurry. Modeling would be required to predict the extent of slurry deposition. This information would be required to predict ecological and socio-economic effects for permitting, consultation, and compensation.

Designation of an appropriate disposal site would be required in consultation with Environment Canada, Fisheries and Oceans Canada (DFO) as well as fishers and representatives of the Mi'kmaq Community. Depending on the distance to an acceptable candidate site, this may have engineering, logistical, and financial implications for the Project, particularly if the site is far removed from the Project and would require barging of waste material.

Marine disposal of coal tailings would be considered "disposal at sea" and would require authorization under Section 127 of the Canadian Environmental Protection Act (CEPA). Under this authorization process, only certain materials are eligible for authorized disposal, including: dredged waste; fish waste; uncontaminated organic matter of natural origin; inert, inorganic geological matter; bulky substances; and vessels. In this case, the pipeline tailings would need to be demonstrated to be inert geological matter.

As part of the permitting process, the Proponent would be required to demonstrate there is no viable alternative to the ocean disposal of waste and that the material will not pose a risk to the marine environment. This requirement would prove difficult as a feasible alternative (*i.e.*, land disposal) exists as demonstrated elsewhere in this report.

Testing and characterization of the material to be disposed at sea, as well as characterization of the proposed disposal site would be required. Guidance can be obtained from Environment

Canada on requirements for selection and characterization of a disposal site, but generally this includes, at a minimum, a description of bathymetry, currents, water depth, and benthic habitat at the proposed site. This information is gathered through a dedicated marine survey. The permit process requires public notification and consultation with users/managers of marine resource area. The length of time to obtain this permit would likely be in the range of two to four months.

There is also a fee associated with the permit which, based on the estimated quantity of coal waste for disposal, could be approximately $10.9 million for the LOM based on 23,200,000 m^3 for disposal (based on values from ACDM, 2011). This does not include any operational costs that may be associated with installing a discharge system and/or hauling waste by barge to the disposal site, nor does it include compensation or monitoring costs.

Disposal at sea would also require an authorization for fish habitat alteration, disruption, and destruction (HADD) under the Fisheries Act. This authorization requires quantification of the extent of habitat effects and habitat compensation to ensure no net loss of fish habitat. Ocean disposal of coal waste (particularly given the low specific gravity of the material) would inundate the seafloor near the discharge point resulting in localized mortality of marine benthic species and substantially affecting the productivity of the benthic environment in the area of deposition.

Other effects would include turbidity and sedimentation as well as changes to substrate type and chemistry. Mitigation of these effects will require extensive habitat compensation programs to ensure no net loss of the productive capacity of fish habitat as required by DFO Policy. Other adverse environmental and operational effects could also be expected from the barging of coal waste such as increased air emissions from marine transportation as well as down time associated with inclement weather.

There is also a possibility that authorization may be required under the Navigable Waters Protection Act (NWPA), depending on the discharge location and infrastructure that may be required (*e.g.*, discharge pipe).

Disposal at Sea, HADD, and NWPA authorizations would trigger environmental assessment under the Canadian Environmental Assessment Act (CEAA). The Donkin Mine Coking Coal Export Project is currently under a CEAA process, although disposal at sea would increase the permitting burden.

The marine environment around the peninsula has been characterized as productive lobster habitat and active fishing grounds for commercial and Mi’kmaq fisheries. Effects on fish habitat could result in reduced resource availability (*e.g*. fish mortality and/or dispersion of stocks), decreased access to fishing area, and interference with fishing gear and/or navigation, depending on the location of the disposal site. These effects could result in reduced net income for commercial fishermen and affect Mi’kmaq fisheries. These effects would add to the other predicted effects on marine habitats and the fishery associated with the construction of a marine load-out facility, and transshipment mooring. Disposal at sea will raise serious concerns among fishers in the Project/disposal area and could require financial compensation to address these effects.

In summary, disposal at sea will require considerable planning and consultation and, in order to get regulatory approval, the application would require demonstration that no other viable alternative exists for disposal. Given there is a technically and economically feasible alternative to ocean disposal where environmental effects can be managed (*i.e*., land disposal) there is a substantial risk that large scale ocean disposal of Donkin coal waste would not be approved.

4.0 Conclusions

Several options were reviewed for the disposal of the potential 20 million cubic metres of coal process rejects involved with the Donkin Project. This large volume of rejects, and the site location, requires the use of multiple sites when considering conventional methods, which unavoidably adds complications, cost, and additional land use. It follows that the direct comparison to other case histories must be carefully reviewed to ensure that local limitations are properly considered.

In the case of ocean dumping, the total volume and the nature of the rejects make it highly unlikely that a successful application and dump site could be obtained.

Underground disposal on site is limited by current XCDM mining and long term development plans, but remains an available option if such plans for development change in the future.

Regional underground storage in abandoned workings required development of several sites and was found to be technically possible but not practical.

Surface storage on the XCDM property on the Donkin Peninsula is a viable option for surface storage of production waste (CHPP) materials.

Four options for surface storage were reviewed and the preferred option (# 4) involved the stage construction of the storage facilities on site. This process of stage (or phased) construction has several advantages that are outlined in the document.

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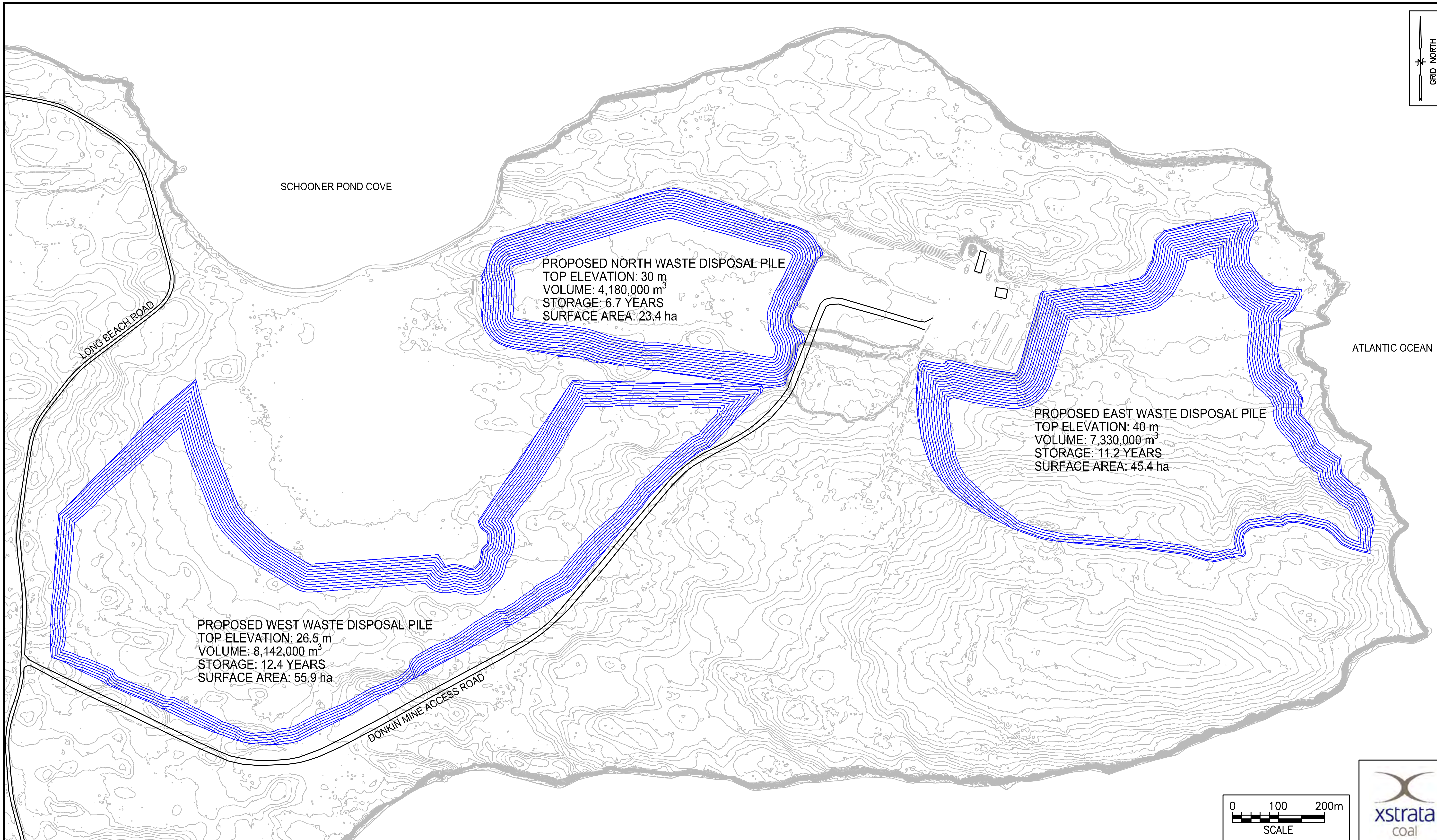
APPENDIX I

Donkin Peninsula Surface Deposition Options



xstrata coal

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Reference:

EXISTING SURFACE TOPOGRAPHY BASED ON LIDAR

WASTE DISPOSAL PILES (OPTION 1)

DONKIN MINE

CAPE BRETON, NOVA SCOTIA

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App'd By:	PEP

Dwg. No.: 1

Stantec

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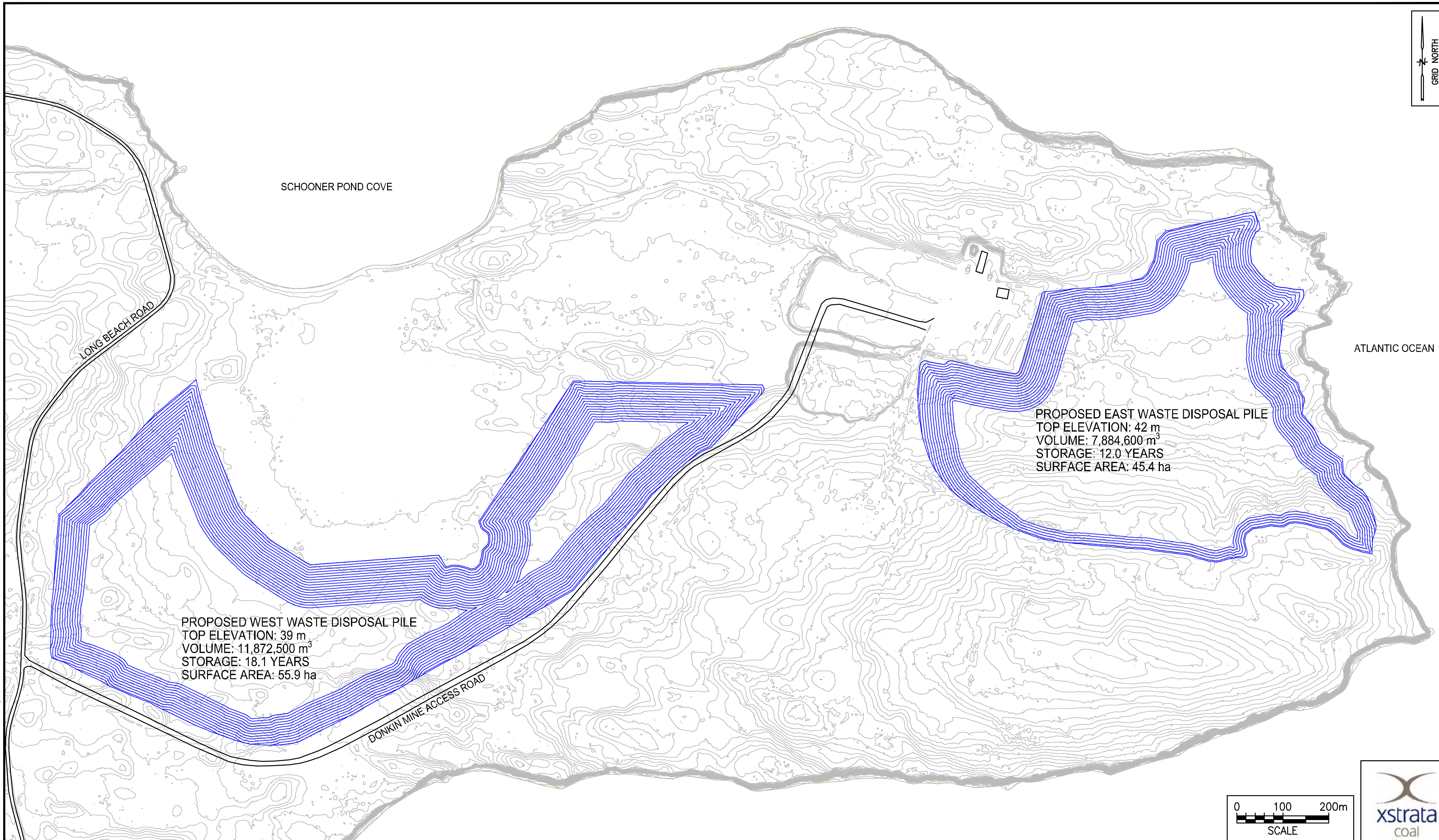

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WASTE DISPOSAL PILES (OPTION 2)

DONKIN MINE
CAPE BRETON, NOVA SCOTIA

Client: XSTRATA COAL DONKIN MANAGEMENT LIMITED

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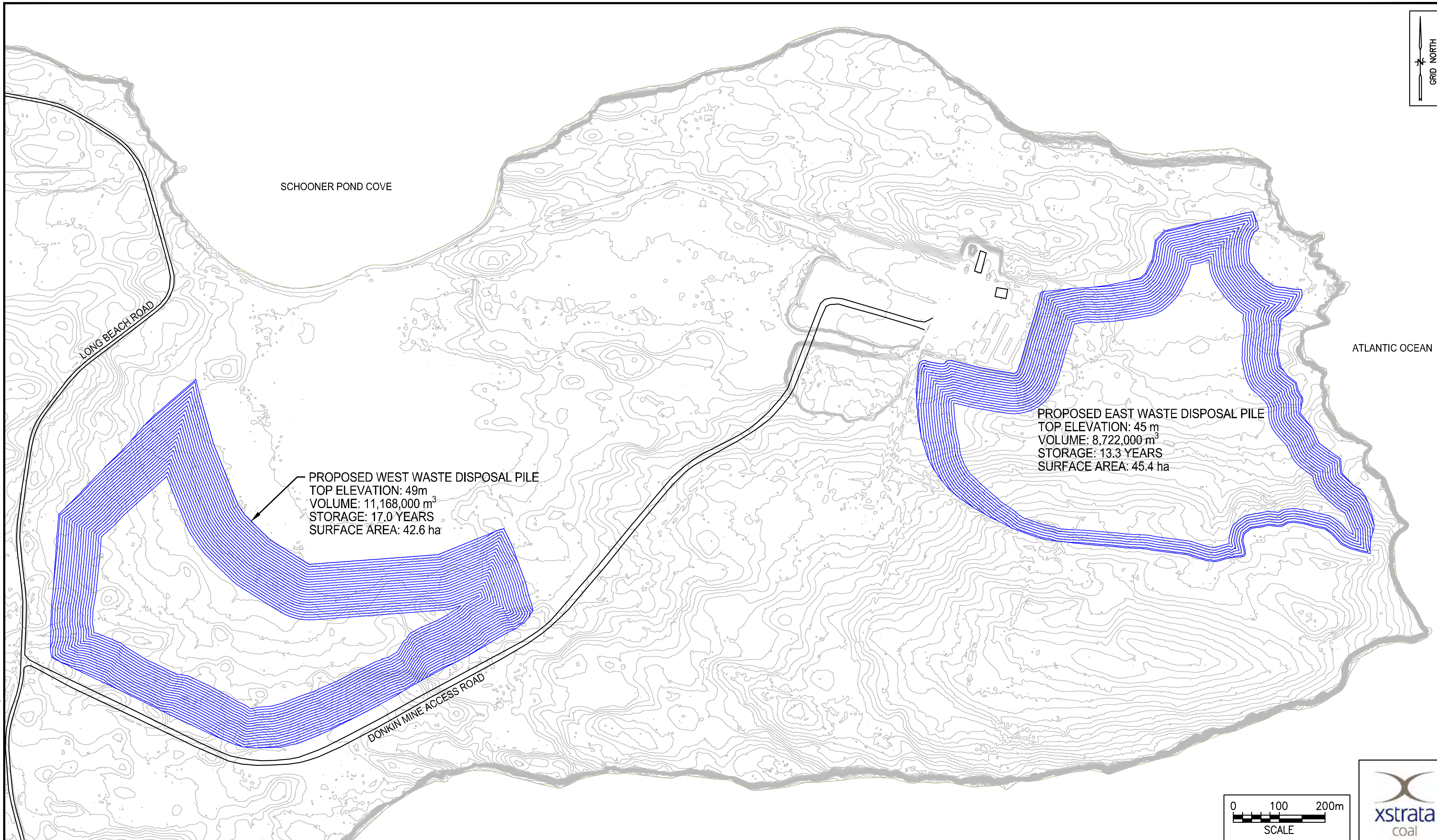

xstrata coal

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WASTE DISPOSAL PILES (OPTION 3)

DONKIN MINE

CAPE BRETON, NOVA SCOTIA

Client: XSTRATA COAL DONKIN MANAGEMENT LIMITED

Job No.:	121510478
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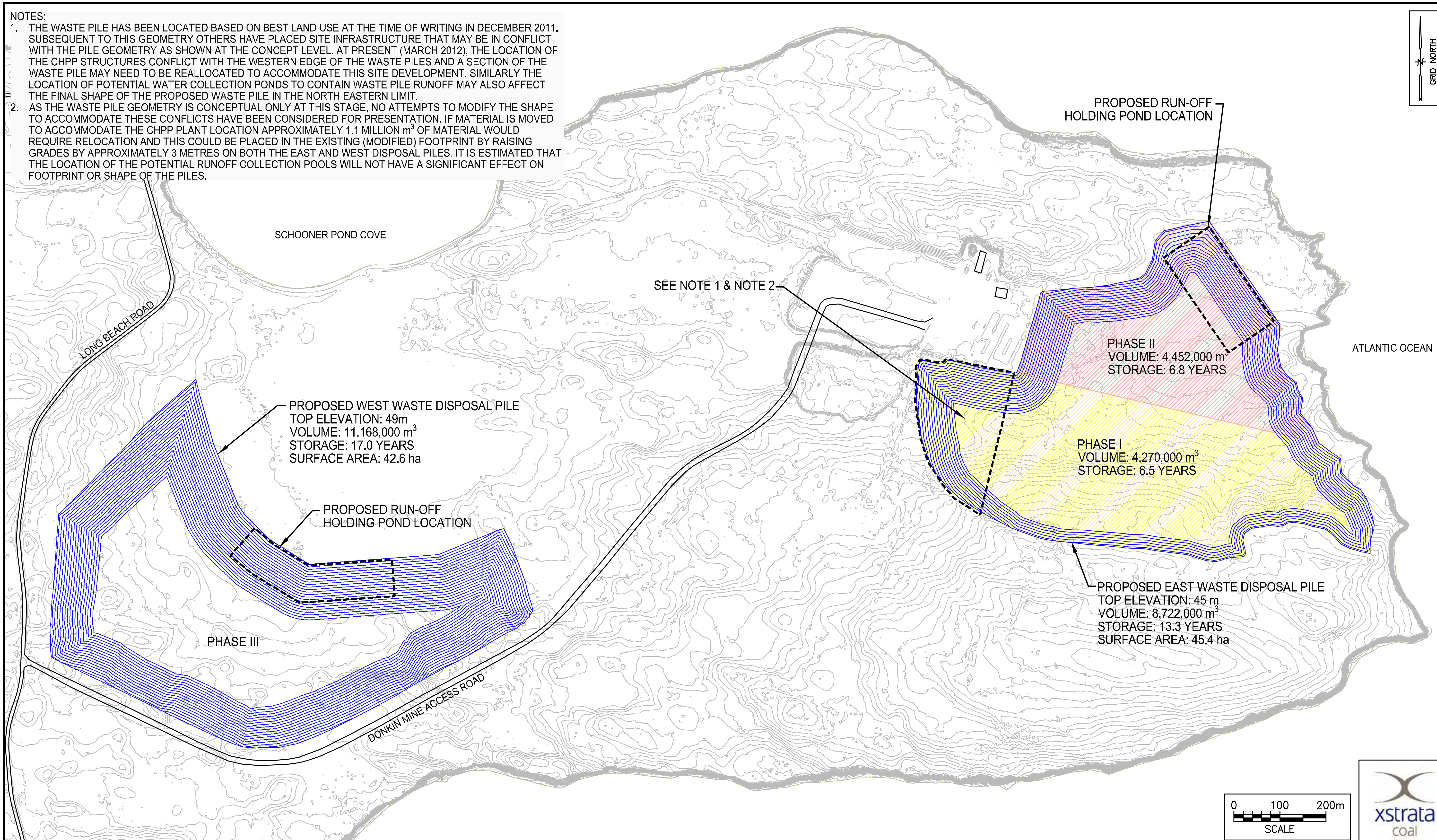
NOTES:
1. THE WASTE PILE HAS BEEN LOCATED BASED ON BEST LAND USE AT THE TIME OF WRITING IN DECEMBER 2011. SUBSEQUENT TO THIS GEOMETRY OTHERS HAVE PLACED SITE INFRASTRUCTURE THAT MAY BE IN CONFLICT WITH THE PILE GEOMETRY AS SHOWN AT THE CONCEPT LEVEL. AT PRESENT (MARCH 2012), THE LOCATION OF THE CHPP STRUCTURES CONFLICT WITH THE WESTERN EDGE OF THE WASTE PILES AND A SECTION OF THE WASTE PILE MAY NEED TO BE REALLOCATED TO ACCOMMODATE THIS SITE DEVELOPMENT. SIMILARLY THE LOCATION OF POTENTIAL WATER COLLECTION PONDS TO CONTAIN WASTE PILE RUNOFF MAY ALSO AFFECT THE FINAL SHAPE OF THE PROPOSED WASTE PILE IN THE NORTH EASTERN LIMIT.
2. AS THE WASTE PILE GEOMETRY IS CONCEPTUAL ONLY AT THIS STAGE, NO ATTEMPTS TO MODIFY THE SHAPE TO ACCOMMODATE THESE CONFLICTS HAVE BEEN CONSIDERED FOR PRESENTATION. IF MATERIAL IS MOVED TO ACCOMMODATE THE CHPP PLANT LOCATION APPROXIMATELY 1.1 MILLION m^3 OF MATERIAL WOULD REQUIRE RELOCATION AND THIS COULD BE PLACED IN THE EXISTING (MODIFIED) FOOTPRINT BY RAISING GRADES BY APPROXIMATELY 3 METRES ON BOTH THE EAST AND WEST DISPOSAL PILES. IT IS ESTIMATED THAT THE LOCATION OF THE POTENTIAL RUNOFF COLLECTION POOLS WILL NOT HAVE A SIGNIFICANT EFFECT ON FOOTPRINT OR SHAPE OF THE PILES.



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THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
EXISTING SURFACE TOPOGRAPHY BASED ON LIDAR

WASTE DISPOSAL PILES (OPTION 4)
DONKIN MINE
CAPE BRETON, NOVA SCOTIA

Client: XSTRATA COAL DONKIN MANAGEMENT LIMITED

Job No.:	121510478
Scale:	1 : 8000
Date:	2012 04 24
Dwn. By:	JL
App'd By:	MM
Dwg. No.:	4

xstrata coal

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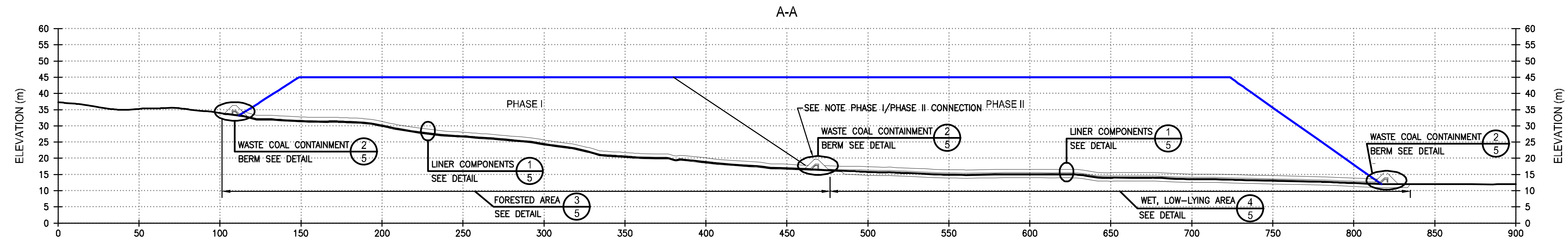
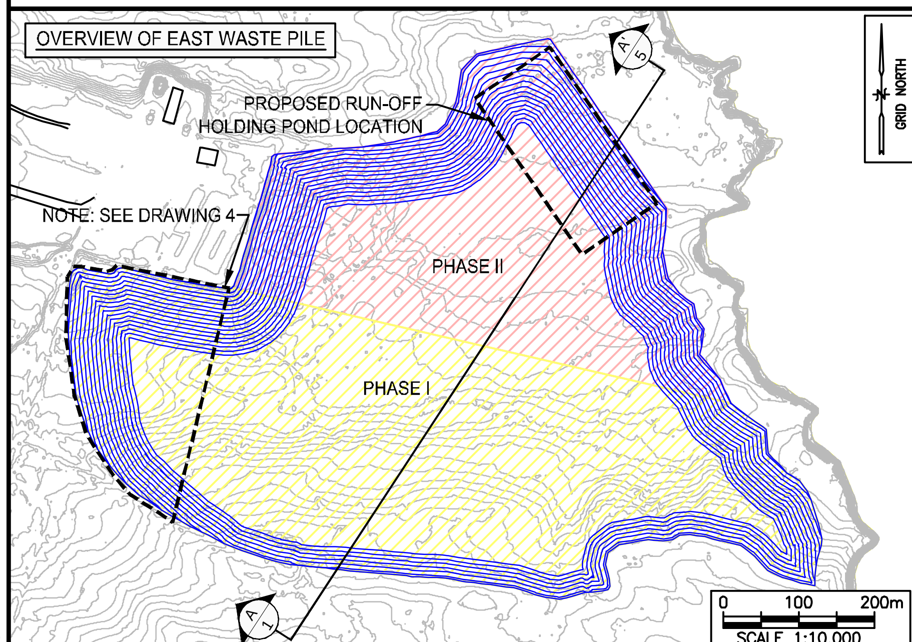
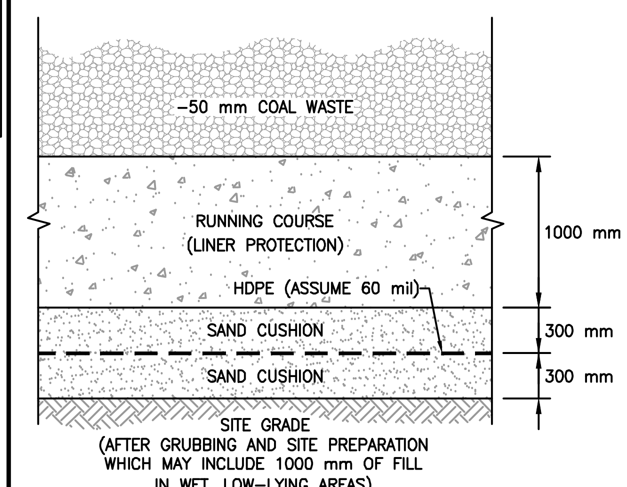


SECTION A-A' / 5
HORZ. SCALE: 1 : 1250
VERT. SCALE: 1 : 625

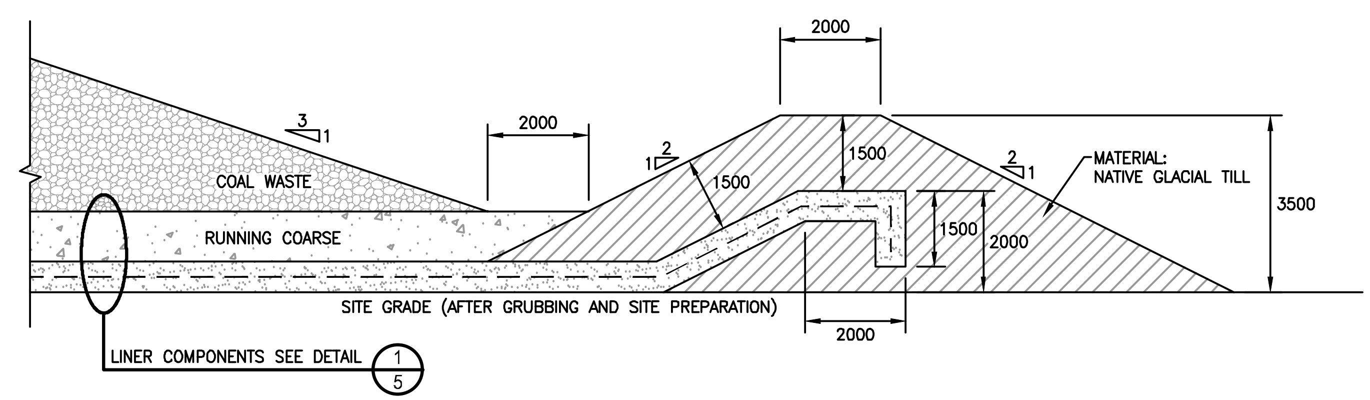
GENERAL WASTE PILE CONSTRUCTION





DETAIL 1/5
SCALE 1 : 50

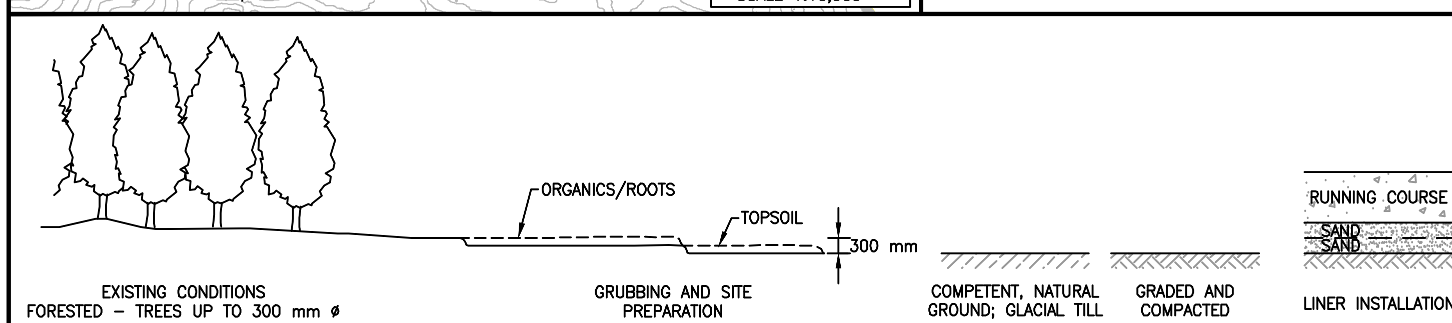
TYPICAL LINER COMPONENTS DETAIL



DETAIL 2/5
SCALE 1 : 150

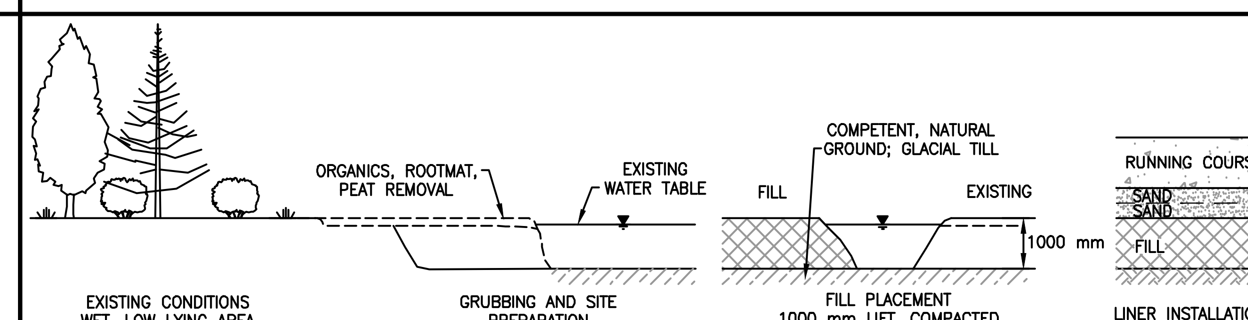
TYPICAL WASTE COAL CONTAINMENT BERM DETAIL

(NORTH BERM ILLUSTRATED)



DETAIL 3/5
N.T.S.

WASTE PILE CONCEPT - FORESTED AREA (PHASE I)



DETAIL 4/5
N.T.S.

WASTE PILE CONCEPT - WET, LOW-LYING AREA (PHASE II)

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Reference:
EXISTING SURFACE TOPOGRAPHY BASED ON LIDAR

EAST WASTE PILE CONSTRUCTION DETAILS
DONKIN MINE
CAPE BRETON, NOVA SCOTIA

Client: XSTRATA COAL DONKIN MANAGEMENT LIMITED

Job No.:	121510478
Scale:	AS SHOWN
Date:	2012 04 24
Dwn. By:	JL
App'd By:	MM

Dwg. No.: 5

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