

# **SITE C CLEAN ENERGY PROJECT**

## **IMPERVIOUS CORE MATERIAL SOURCE**

### **DEVELOPMENT PLAN**

#### **85<sup>TH</sup> AVENUE INDUSTRIAL LANDS**

**Doc EIS-1A-005**

**[Final]**

**Prepared for BC Hydro by**

**Tetra Tech**

**November 2012**

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**TABLE OF CONTENTS**

**1.0 INTRODUCTION AND PURPOSE ..... 1**

**2.0 BACKGROUND ..... 3**

**3.0 DEVELOPMENT PLAN BASIS ..... 5**

**4.0 85<sup>TH</sup> AVENUE INDUSTRIAL LANDS – OPERATIONS..... 7**

    4.1 Production and Scheduling Estimates ..... 7

    4.2 Operations..... 8

    4.3 Access..... 9

    4.4 Safety and Environmental Management During Operation ..... 9

    4.5 Site Reclamation and Future Use ..... 10

**5.0 REFERENCES..... 12**

**LIST OF TABLES:**

**TABLE 4.1 VOLUME OF IMPERVIOUS MATERIALS PLACED AND COMPACTED FROM 85<sup>TH</sup> AVENUE INDUSTRIAL LANDS.....7**

**LIST OF FIGURES:**

**FIGURE 1.1 LOCATION OF THE PROPOSED 85<sup>TH</sup> AVENUE INDUSTRIAL LANDS IMPERVIOUS CORE SOURCE ..... 2**

**FIGURE 2.1 85<sup>TH</sup> AVENUE CURRENT LAND USE AND INFRASTRUCTURE..... 4**

**FIGURE 3.1 PREDICTED EXCAVATION EXTENTS ..... 6**

**FIGURE 4.1 PROPOSED DEVELOPMENT OF 85<sup>TH</sup> AVENUE INDUSTRIAL LANDS IMPERVIOUS CORE SOURCE .....11**

## 1.0 INTRODUCTION AND PURPOSE

If the Site C Clean Energy Project (the Project) proceeds, it would require impervious core material for the proposed earthfill dam, approach channel lining and temporary cofferdams. The preferred source for the impervious material should:

- Be close to the dam to minimize haul distance
- Be high quality material

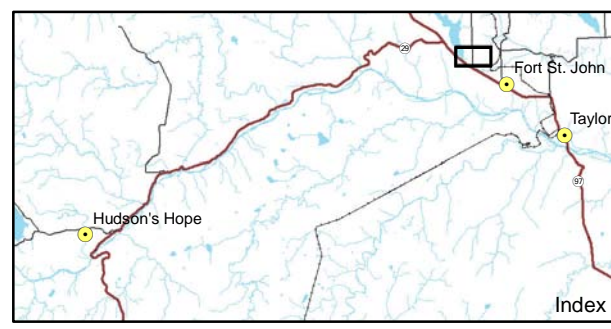
Impervious materials available locally include glacio-lacustrine silty clays and glacial tills (mixtures of gravel, sand, silt and clay laid down by glaciers). Glacial tills are preferred due to their superior engineering characteristics.

BC Hydro has identified the preferred source of impervious core material on what is referred to as the 85<sup>th</sup> Avenue Industrial Lands, located approximately 4.5 kilometres north of the proposed Site C Dam site. The lands are adjacent to the City of Fort St. John and within the boundary of the Peace River Regional District, as shown in Figure 1.1. The area of the 85<sup>th</sup> Avenue Industrial Lands is 98 hectares, bordered by 85<sup>th</sup> Avenue to the north, 100<sup>th</sup> Street to the east, Old Fort Road to the west, and extending approximately 780 metres to the south, as shown in Figure 1.1. This area contains sufficient glacial till to meet the Project's needs. Further details on the requirements of the earthfill dam are provided in Project Description (Section 4.3 of the EIS).

The objective of this plan is to: 1) facilitate environmental assessment approvals; 2) support permitting requirements; and 3) plan for guiding the use of the pit site during construction and operations.



Location of Proposed Site C Dam



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Base Data: Province of B.C.  
 4. Orthophotos created from 1:15,000 photos taken Aug 26th 2011; TRIM.

- Legend**
- 85<sup>th</sup> Avenue Industrial Lands Boundary
  - Highway
  - Road

1:35,000 0 1.25 km

<b>Figure 1.1: Location of the Proposed 85<sup>th</sup> Avenue Industrial Lands Impervious Core Source</b>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6126-1 R 0

## 2.0 BACKGROUND

BC Hydro selected the 85<sup>th</sup> Avenue Industrial Lands as the preferred location for the impervious core material for the following reasons:

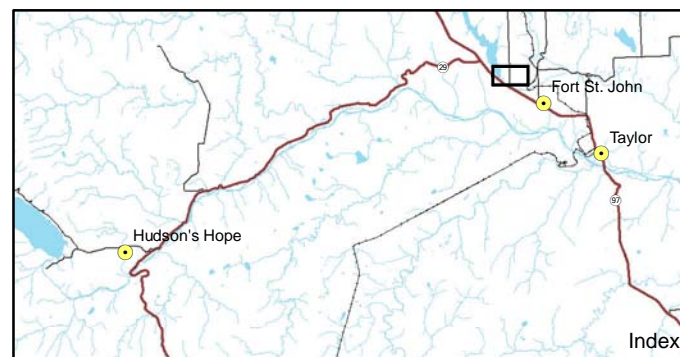
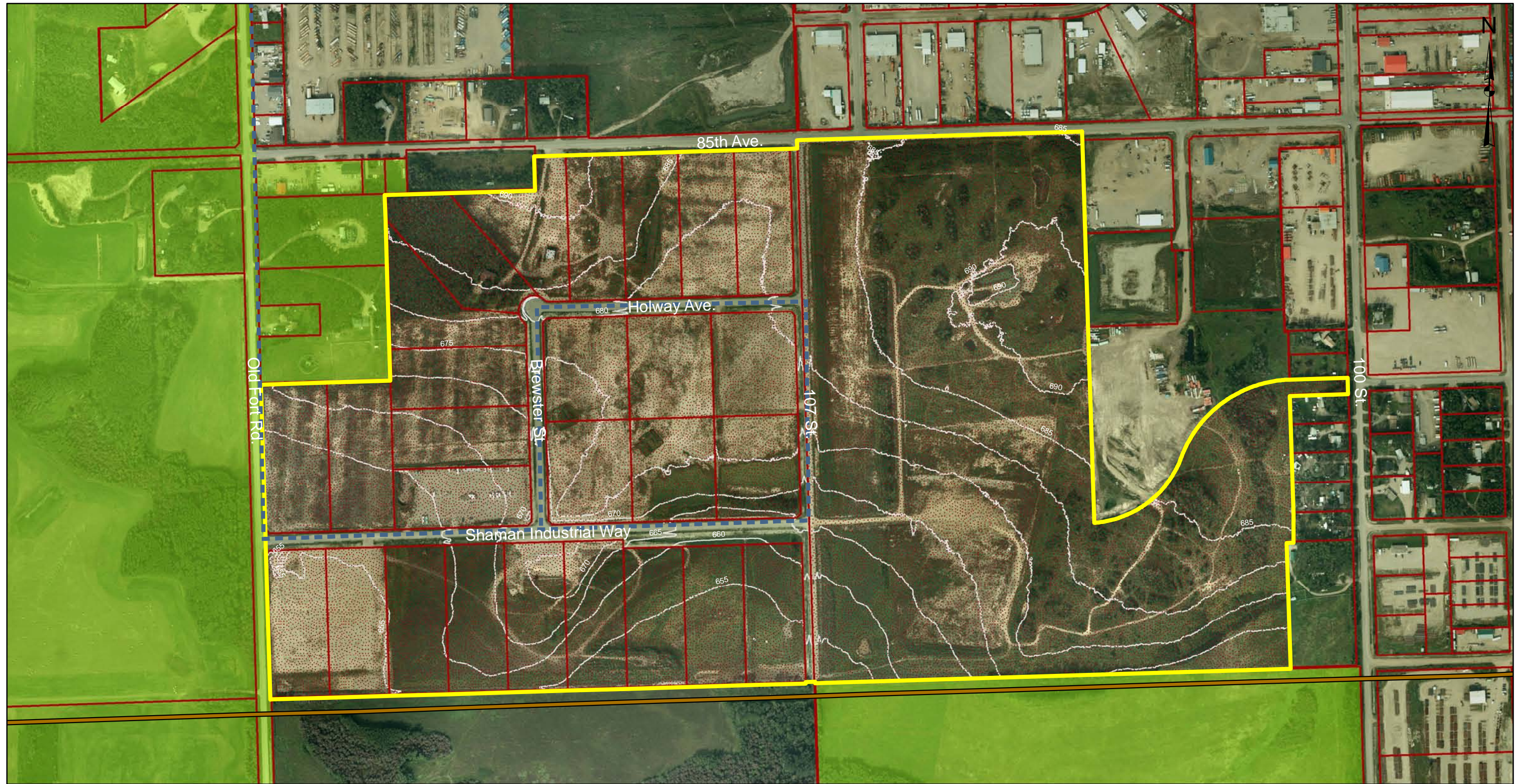
- The material met the quantity, quality and suitability requirements for impervious material
- The site includes materials that would be suitable for constructing other parts of the dam, such as the approach channel lining and temporary cofferdams
- The site is close to the proposed Site C Dam (approximately 4.5 kilometres)

Testing of the material from the 85<sup>th</sup> Avenue Industrial Lands has confirmed the following soil characteristics:

- Maximum particle size of 150 millimetres
- The material consists of 31.5 per cent gravel sizes, 39 per cent fines and the remainder sand
- Compacted density is 2,050 kilograms per cubic metre
- The optimum moisture content for the material is approximately 11 per cent
- The water table is variable, ranging from 11 metres to 32 metres below existing grade

Most of the site is cleared with the northwest corner forested (Figure 2.1). The site is zoned for light industrial use. The eastern half of the site is undeveloped. The western half of the site has a combined 1,500 metres of paved road developed to BC Ministry of Transportation and Infrastructure standards (107th Street, Shaman Industrial Way, Brewster Street and Holway Avenue) with natural gas and overhead electrical services. Figure 2.1 illustrates the current land use and infrastructure.







Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011.  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of Sept 24th, 2012.

**Legend**

- 85<sup>th</sup> Avenue Industrial Lands
- Agricultural Land Reserve
- Natural Gas Line
- Transmission Line
- BC Hydro Owned (Leased)
- BC Hydro Owned
- Crown Land
- Private Land
- Contour - Major 5m

1:5,500 0 250 m

			
<p><b>Figure 2.1: 85<sup>th</sup> Avenue Current Land Use and Infrastructure</b></p>			
Date	Nov. 23, 2012	DWG NO	1016-C14-B6126-2 R 0

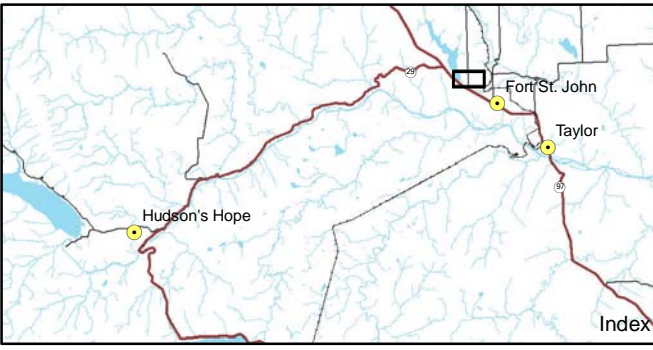
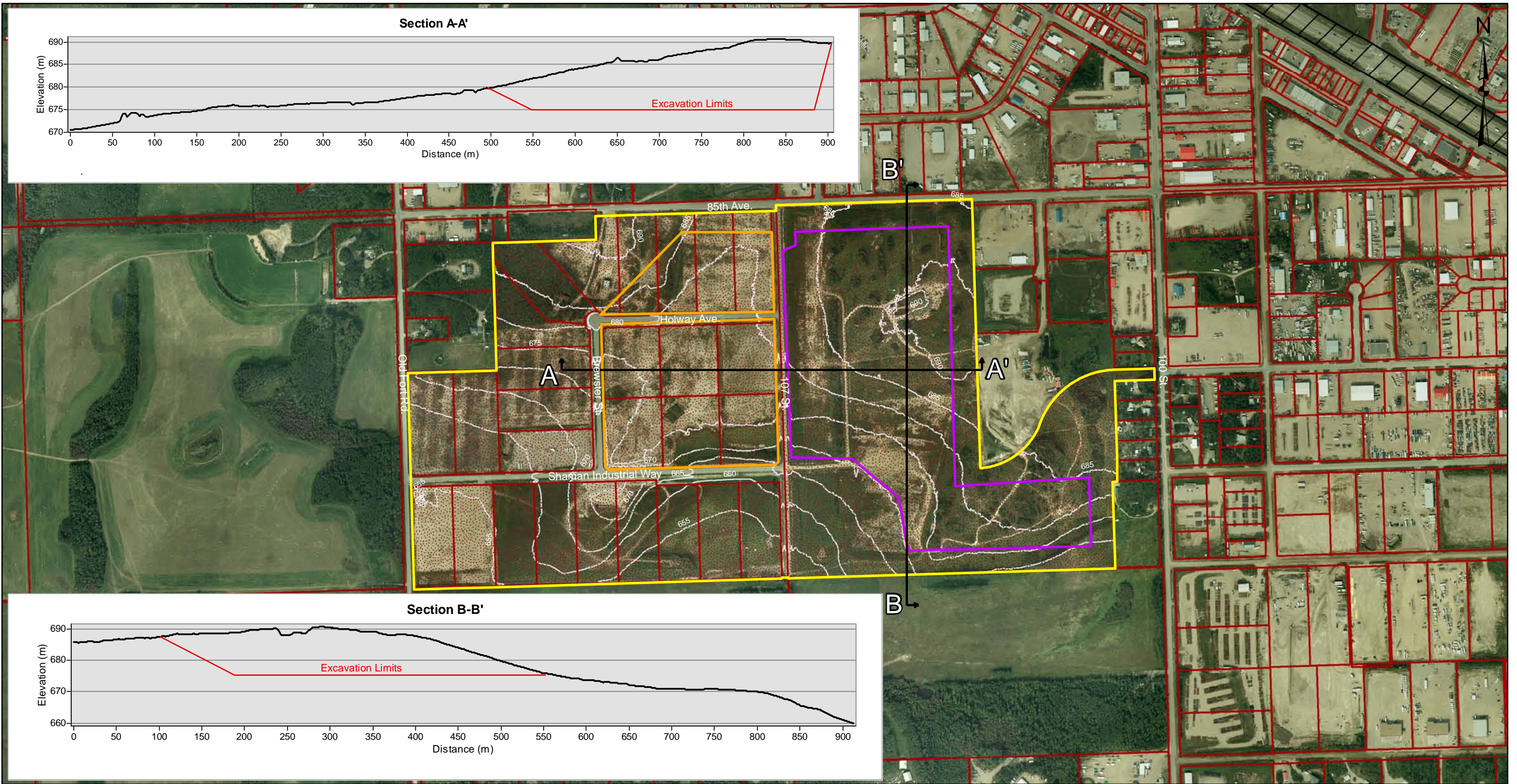
### 3.0 DEVELOPMENT PLAN BASIS

The development plan for the source of impervious core material is based on the following information:

- A drill and test pit program conducted in 2009 focused on confirming potential sources for obtaining the impervious till material. A total of 109 auger holes and seven test pits were completed.
- A further drill and test pit investigation was conducted in 2010 in the 85<sup>th</sup> Avenue Industrial Lands. A total of 15 auger holes and eight test pits were completed.
- It was determined that the material within the 85<sup>th</sup> Avenue source is within the ideal range for fines content for the dam core, the material is at a depth up to 30 metres, is thinly covered with overburden, and the material is consistent in nature.
- Preparations in the 85<sup>th</sup> Avenue Industrial Lands would occur in Year 2 and Year 3 concurrent with construction of the conveyor belt system which will transport the material to the dam site.
- The total excavated material would range from 2,921,000 cubic metres to 4,866,000 cubic metres depending on quality and processing requirements of the source.
- The 85<sup>th</sup> Ave site would provide 2,921,000 cubic metres for the dam core, and the remaining 414,000 cubic metres of till would be sourced from the dam site excavations.
- The yearly requirements beginning in Year 4 and ending in Year 7 would be 100,000 cubic metres, 1,521,000 cubic metres, 975,000 cubic metres, 325,000 cubic metres, respectively.
- Material placement would occur during the seasonal placing windows between May and October.
- A conveyor belt system will be used to transport the till material from the pit to the dam site.
- The final excavation is to be at an elevation of approximately 675 metres (as shown in Figure 3.1)
- The maximum slopes for excavation and embankments for overburden and surplus storage would be 2H:1V.

Bulking factors were applied to excavated and quarried volumes. A bulking factor represents the volume increase (expressed as a percent) that a material undergoes when removed from its natural state, and is applied to estimate the total volume of quarried or excavated material. Different materials have different bulking factors based on their ability to reconsolidate once excavated. A bulking factor of 1.2 means that a volume of naturally existing material would undergo an increase of 20 per cent once excavated and placed in its final location. Based on an understanding of similar materials within the province the following bulking factors were applied:

- The impervious till material bulking factor would be 1.1.
- The overburden bulking factor would be 1.0.



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011.  
 4. Property boundary locations are best available but should be considered approximate. Property information is a combination of surveyed data representing BC Hydro's current ownership records and ICIS data. Property data is current as of Sept 24th, 2012.

- Legend**
- 85<sup>th</sup> Avenue Industrial Lands Boundary
  - Additional Excavation Area
  - BC Hydro Owned (Leased)
  - Main Excavation Area
  - BC Hydro Owned
  - Contour - Major 5m
  - Crown Land
  - Section Profile
  - Private Land

1:8,000 0 250 m

<b>Figure 3.1:          Predicted Excavation Extents</b>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6126-6 R 0

## 4.0 85<sup>TH</sup> AVENUE INDUSTRIAL LANDS – OPERATIONS

### 4.1 PRODUCTION AND SCHEDULING ESTIMATES

The material production at the 85<sup>th</sup> Avenue Industrial Lands would be based on the scheduled impervious core material requirements at the proposed Site C Dam site (reference EIS Volume 1, Section 4.3). The development and excavation of the site would take place over a six year period. Preparation at the site would be required in order to prepare the area for material excavation. It is anticipated that preparation work at the 85<sup>th</sup> Avenue Industrial Lands and for the proposed haul route would be completed by early Year 2 in preparation for the commencement of transporting material.

The preferred excavation area would be east of 107<sup>th</sup> Street, which bisects the site. If this area does not produce the required quantities, excavation west of 107<sup>th</sup> Street would be required to obtain the remaining material. This approximately 20 hectare area is noted as “Additional Evacuation Area” in Figure 4.1.

Other activities and uses in the western half would include installation of facilities and infrastructure. The property would be fenced and gated to maintain site and public safety. Figure 4.1 illustrates a proposed development.

Placement of the impervious core material would begin in the spring of Year 4 and continue at a consistent rate until early fall of Year 7. Material placement (e.g., excavation and loading) would also occur during the seasonal placing windows from spring to early fall. The schedule would be weather dependent, where rain and frozen ground conditions would decrease or stop production in order to maintain quality. Table 4.1 illustrates the volumes of material that could be excavated and hauled during the four-year haul period.

**Table 4.1 Volume of Impervious Materials Placed and Compacted from 85<sup>th</sup> Avenue Industrial Lands**

Year of Operation	Volume Placed (compacted m <sup>3</sup> )
4	100,000
5	1,521,000
6	975,000
7	325,000
Total	2,921,000

Based on the estimated 2,921,000 cubic metres of impervious core material required for the proposed dam construction, it is estimated that till would be excavated 6 days per week, 12 hours per day between the months of May and October (approximately 170 days per year), for four years (Year 4 through Year 7).

## 4.2 OPERATIONS

The province's Aggregate Management Principles (MOEM 2009) have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

The annual placed volumes that would be hauled to the proposed dam site are shown in Table 4.1. Total extraction volumes would be based on the suitability and quality of the materials as they are processed. The unsuitable materials would remain within the site and would be stockpiled or leveled in conformance with the future land uses.

Potable water for the office and service area, and water to be used for moisture conditioning and dust control, would not be a substantial volume and would be brought to the site from an offsite location. Alternatively, a well may be established for the water supply.

The equipment required for operations would be as follows, with the number of equipment pieces to be determined at a later stage:

- Loaders and trucks or Scrapers (to remove and stock pile topsoil, excavate and haul material to the stockpile and moisture condition the material)
- Bulldozers (to push scrapers or material for stripping stockpiles and berm barriers)
- Disking Equipment (to mix and moisture condition the material)
- Loaders (to load material onto hopper or directly onto conveyor)
- Water Trucks (to control dust and add moisture to material as required)
- Personnel Site Pick-ups (for onsite mobility)
- Service vehicle (mechanic, fuel trucks)

The borrow area would operate starting with the extraction from the highest lands on the north eastern portion and remove the material in horizontal layers across a pit face.

Extraction would not require any drilling or blasting and, therefore, no explosives will be used. Only a relatively small volume of materials would require processing, such as screening, prior to being removed from the site. More than one area is predicted to be actively excavated with room in between to maintain equipment manoeuvrability and production rates. This would allow blending of the materials, if required, to produce a consistent material to meet the gradation specification required for the dam. The 85<sup>th</sup> Avenue Industrial Lands would include stockpiles for materials requiring moisture control, and stockpiles for materials ready to be moved to the dam site. The impervious core material would be transported to the proposed dam site by the conveyor belt system.

Site reclamation of the 85<sup>th</sup> Avenue Industrial Lands would be completed in Year 7. Section 4.5 of this development plan addresses site reclamation.

### **4.3 ACCESS**

Public access to the 85<sup>th</sup> Avenue Industrial Lands would be restricted during the extraction operations. Safety issues on the site would be related to the increased project traffic on the 85<sup>th</sup> Avenue Industrial Lands. Traffic disruption caused by the dedicated conveyor belt system would be limited to the two public roads near the borrow area: Old Fort Road and 240 Road (reference Volume 4 Appendix B Project Traffic Analyses Report). Underpass structures would be constructed for the conveyor belt system at Old Fort Road and at 240 Road to avoid traffic conflicts. With the installation of the underpasses, once the material has left the site and is on the conveyor belt system, the overlap with the public road system and area traffic would be removed.

### **4.4 SAFETY AND ENVIRONMENTAL MANAGEMENT DURING OPERATION**

In order to maintain worker safety and in consideration of adjacent lands, a safety and environmental management plan would be developed by the pit operator to manage safety, visual, noise, and operational needs.

The area would be surrounded by a fence along the entire perimeter. Gate access would be installed at two locations; at Shaman Industrial Way and Old Fort Road, and at 107<sup>th</sup> Street and 85<sup>th</sup> Avenue as shown on Figure 4.1.

As shown on Figure 4.1, berms would be constructed to provide a visual barrier and act as a noise attenuation feature. Other berm locations within the site may be considered as additional visual and noise attenuation features. The 85<sup>th</sup> Avenue Industrial Lands are located within the regional district so noise bylaws would not be applicable outside of the municipal boundaries. Best management practices in noise and visual attenuation will be implemented during the operational period.

Portable toilet facilities would be used within the borrow area and near the project site offices. These facilities would be maintained as required. The planning and installation of the lighting system required for the safe operation of the site would follow guidelines in the Aggregate Operators Best Management Practices Handbook (MOEM 2002). Lighting would be used to facilitate safe and secure operations for the extraction, processing and stockpiling locations while minimizing offsite visual nuisance. Lighting would be needed inside buildings and at their entrances, at working extraction faces, along haul roads, at stockpiles, and for equipment and vehicles. Lighting would be directed downward or shielded by buildings to minimize off-site spill and glare, and would be minimized during the off season. The lighting of road junctions and site entrances would be kept to the minimum required for safety purposes.

Other best management practices would include:

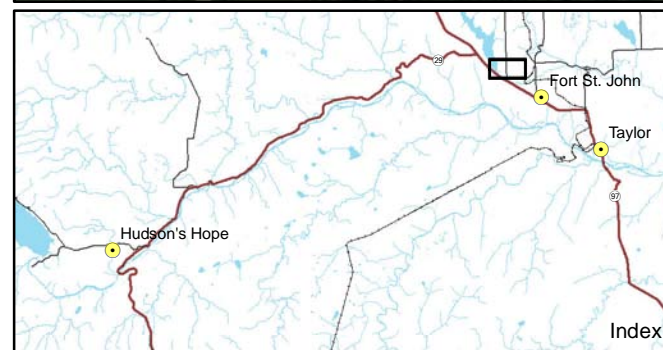
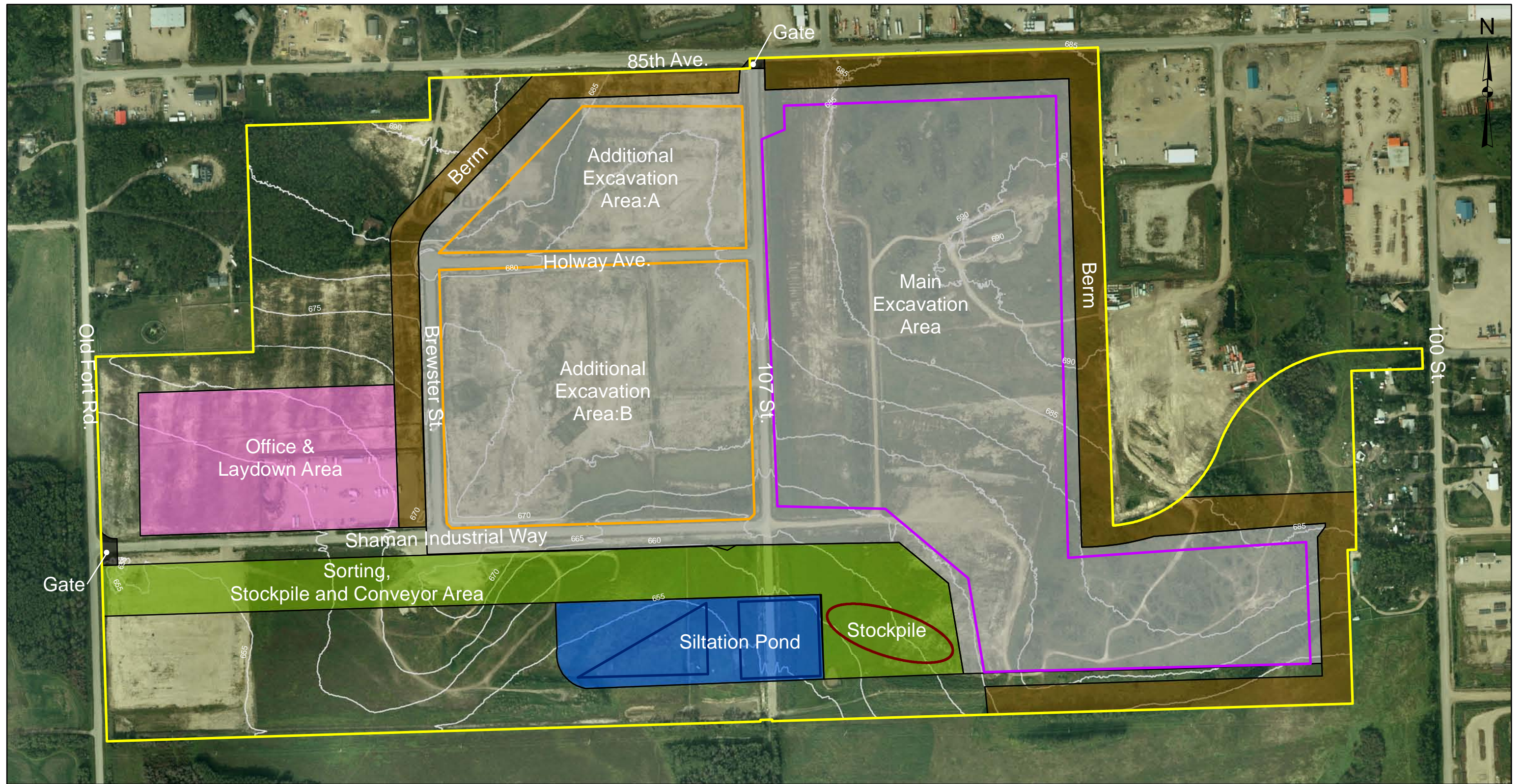
- Sediment control, and oil control separation
- Control of noxious weeds through vegetation cover or seeding, and the provision of a truck wash station as required

- Maintenance of road surfaces to reduce vibration
- Control of air emissions and wind generated dust

#### **4.5 SITE RECLAMATION AND FUTURE USE**

As the operation progresses, slopes would be stabilized and drainage features would be established to control drainage. Seeding to control noxious weeds would be done on soil slopes and surplus material stockpiles and berms.

The site is located within the Peace River Regional District and adjacent to the City of Fort St. John, the future use of the site should be considered in relation to the official community plans of both the regional and local government.



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011.

**Legend**

- 85<sup>th</sup> Avenue Industrial Lands Boundary
- Gate
- Office & Laydown Area
- Potential Area of Extraction & Laydown
- Siltation Pond
- Sorting, Stockpile, and Conveyor Area
- Berm
- Main Excavation Area
- Additional Excavation Area
- Stockpile
- Siltation Pond
- Contour - Major 5m

1:4,500 0 250m

<p><b>Figure 4.1: Proposed Development of 85<sup>th</sup> Avenue Industrial Lands Impervious Core Source</b></p>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6126-4 R 0



## 5.0 REFERENCES

Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM). 2009. November 2009. Aggregate Management Principles., <http://www.empr.gov.bc.ca/Mining/Aggregate/BMP/Pages/default.aspx>

BC Mines Act and the Mine Health, Safety and Reclamation Code for Mines in British Columbia, (MOEM). 2008  
<http://www.empr.gov.bc.ca/MINING/HEALTHANDSAFETY/Pages/HSRC.aspx>

Ministry of Energy, Mines and Petroleum Resources (MOEM) Mining and Minerals Division, 2007, Health and Safety: A Practical Guide for Aggregate Operations.

Ministry of Energy and Mines. (MOEM) April 2002. Aggregate Operators Best Management Practices Handbook for British Columbia, Volumes 1 (Introduction and Planning) and Volume 2 (Best Management Practices).  
<http://www.empr.gov.bc.ca/Mining/Aggregate/BMP/Pages/default.aspx>

# **SITE C CLEAN ENERGY PROJECT**

## **QUARRY DEVELOPMENT PLAN**

### **WUTHRICH QUARRY**

**Doc EIS-1A-010**

**[Final]**

**Prepared for BC Hydro by**

**Tetra Tech**

**November 2012**

**SITE C CLEAN ENERGY PROJECT**

**QUARRY DEVELOPMENT PLAN**

**WUTHRICH QUARRY**

**Doc EIS-1A-010  
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**TABLE OF CONTENTS**

**1.0 INTRODUCTION AND PURPOSE ..... 1**

**2.0 BACKGROUND ..... 3**

**3.0 DEVELOPMENT PLAN BASIS ..... 4**

**4.0 WUTHRICH QUARRY – OPERATIONS ..... 6**

    4.1 Production and Scheduling Estimates ..... 6

    4.2 Quarry Operations During Construction..... 6

    4.3 Access..... 7

    4.4 Safety and Environmental Management During Operations ..... 7

    4.5 Site Reclamation and Future Use ..... 8

**5.0 REFERENCES..... 11**

**LIST OF FIGURES**

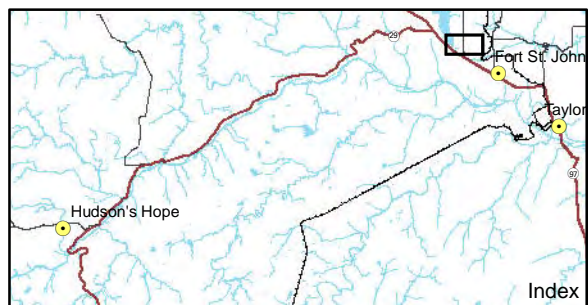
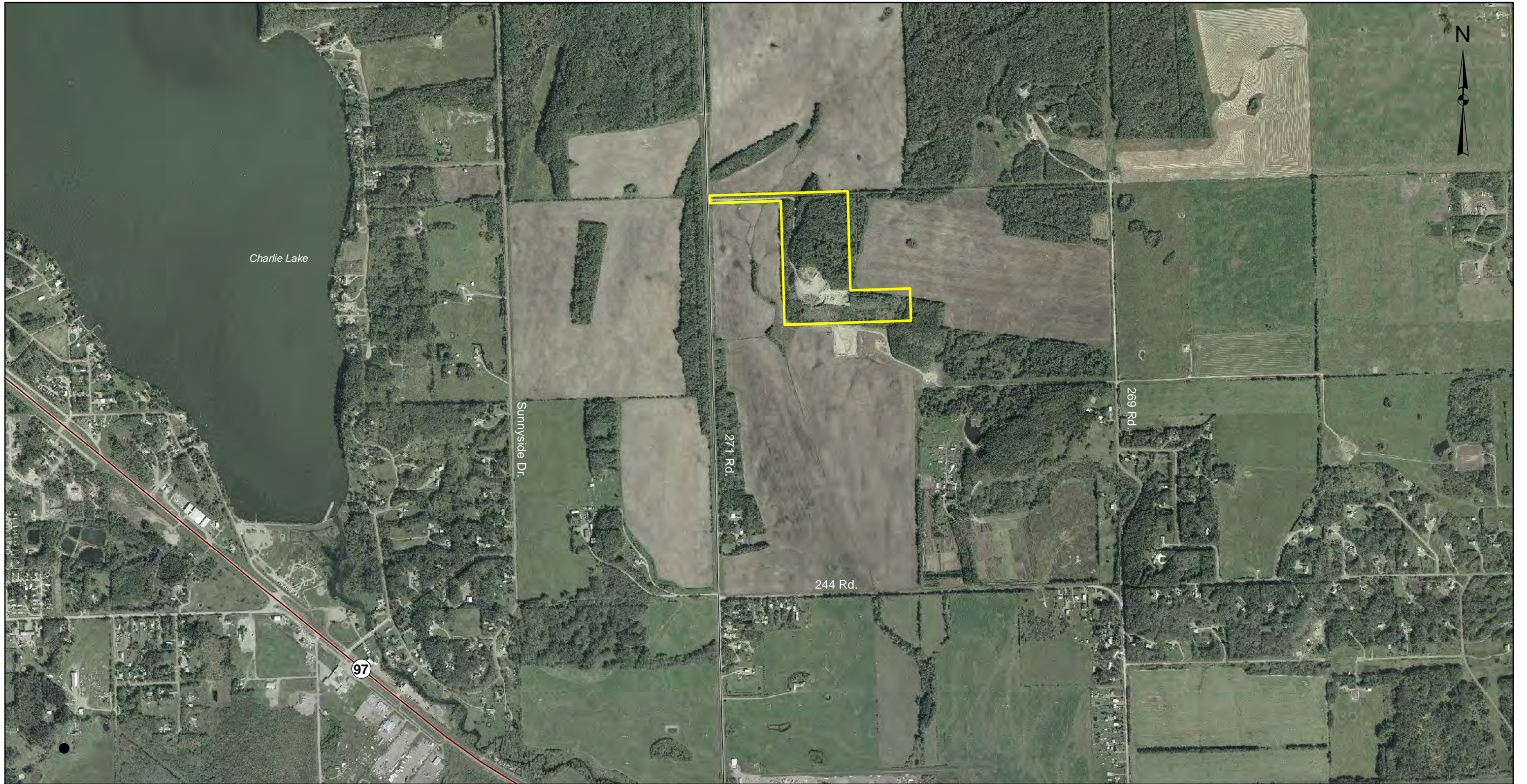
**FIGURE 1.1 KEY PLAN – LOCATION OF WUTHRICH QUARRY..... 2**  
**FIGURE 4.1 CURRENT DEVELOPMENT PLAN OF WUTHRICH QUARRY ..... 9**  
**FIGURE 4.2 PROPOSED DEVELOPMENT PLAN OF WUTHRICH QUARRY ..... 10**

## 1.0 INTRODUCTION AND PURPOSE

If the Site C Clean Energy Project (the Project) proceeds, it would require temporary riprap material for constructing the temporary cofferdams, lining the inlet and outlet channels of the diversion tunnels, and installing erosion protection for the access road along the north bank of the Peace River. A source of this material in close proximity to the dam site is preferred to minimize transportation requirements. A detailed description of the Project components and activities is provided in the Project Description (Section 4.3)

Wuthrich Quarry, an existing riprap source operated by the BC Ministry of Transportation and Infrastructure (MOTI), has been identified as the preferred source of temporary riprap. The quarry is located seven kilometres northwest of Fort St. John, BC, along 271 Road, approximately three kilometres north of the Alaska Highway as shown in Figure 1.1 Key Plan – Location of Wuthrich Quarry

The objective of this plan is to: 1) facilitate environmental assessment approvals; 2) support permitting requirements; and 3) plan for guiding use of the quarry site during construction and operation.





Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: TRIM

**Legend**

- Wuthrich Quarry Boundary
- Road
- Highway

1:15,000 0 500 m

				
<p><b>Figure 1.1: Key Plan Location of Wuthrich Quarry</b></p>				
Date	Nov. 22, 2012	DWG NO	1016-C14-B062-1	R 0



## 2.0 BACKGROUND

The Wuthrich Quarry is an existing quarry owned and operated by the MOTI. Geotechnical information from a November 1987 drill program conducted by the MOTI and a subsequent memorandum (MOTI 1988) had been initially used by MOTI to determine the viability of the quarry. The site is on a bedrock ridge which rises out of a field and runs back into higher ground to the northeast. The area is mostly treed, except for the active quarrying area, with small and large poplar trees along with low vegetation surrounded by agricultural lands. The rock formation is part of the Dunvegan formation of the upper Cretaceous period. The sandstone rock is fairly fine grained and interlaced with thin bedded planes. Existing large blocks (2 to 3 cubic metres) in size are present near the rock face. The quarry was activated to produce riprap materials for MOTI construction projects and became a source of rock for the MOTI Peace District for maintenance purposes.

An agreement in principle has been reached with MOTI that would allow BC Hydro to obtain temporary riprap material from the Wuthrich Quarry. Site C would require approximately 254,000 cubic metres of riprap and 97,000 cubic metres of riprap bedding for construction of temporary dam components. Most of the material would be required in the first four years of the dam construction schedule, with a smaller amount required after reservoir filling has commenced. This volume of material could be produced within the existing boundaries of the quarry.

In a normal quarrying operation, all material in the quarry is used; the larger rock (greater than 200 millimetres) for riprap, smaller rock (i.e., less than 200 millimetres) for riprap bedding, with smaller rock being processed through screens or crushed to produce other finer rock products. For the Project, only the larger riprap product and a smaller amount of riprap bedding would be used. All other rock material would be considered surplus. The surplus material and the remaining intact bedrock would be available for use by MOTI.

The quarry site would remain an active quarry under the control of MOTI so storage of the surplus material is an important consideration for MOTI.

### 3.0 DEVELOPMENT PLAN BASIS

This Plan has been developed based on the following information:

- The development plans for the quarry were based on the following: Approximately 350,000 cubic metres of temporary riprap and riprap bedding would be required for the Project
- The yearly riprap requirements beginning in Year 1 and ending in Year 4 would be 16,000 m<sup>3</sup>, 89,000 m<sup>3</sup>, 132,000 m<sup>3</sup>, and 16,000 m<sup>3</sup> respectively;
- The yearly riprap bedding requirements would be approximately 32,000 m<sup>3</sup> in Year 3, 61,000 m<sup>3</sup> in Year 4 and 5,000 m<sup>3</sup> in Year 7;
- The yield of usable riprap from blasting operations is estimated to be 20 percent. Therefore, approximately 1.27 million cubic metres of rock would have to be excavated to produce the required riprap volume. The total surplus rock, net of the temporary riprap and bedding material, is estimated to have a volume of 915,000 cubic metres
- The riprap and bedding material used for the Project would be hauled from the quarry as it is produced
- The riprap bedding material would be taken from the coarser surplus material
- A test drill program by MOTI in 1987, drilled to a depth of 31 metres below original ground. The drill logs indicate overburden, then, interlacing between fair to good quality sandstone and more competent and massive sandstone
- Overburden depths range from 4.1 metres to 1.0 metres in the north to south direction of the site's southern panhandle, and ranged from 7.1 metres to 1.0 metres in the east to west direction of the main quarry
- The final pit floor base would be at an approximate elevation of 735 metres, 30 metres below original ground. This is consistent with the MOTI Report on Quarry Development Design for Wuthrich Rock Quarry
- Quarrying boundaries were determined from the MOTI Report on Quarry Development Design for Wuthrich Rock Quarry. Setback boundaries range from 5 to 44 metres from the property line.
- The quarry development design would include a wall slope of 0.25H:1V, and a 5 metre bench for every 10 metres of elevation change. This is consistent with the MOTI Report on Quarry Development Design for Wuthrich Rock Quarry report
- Overburden and surplus storage embankments would have a maximum slope of 2H:1V and a maximum elevation of 785 metres in both the panhandle and middle of the pit storage areas

Bulking factors were applied to excavated and quarried volumes. A bulking factor represents the volume increase (expressed as a percent) that a material undergoes when removed from its natural state, and is applied to estimate the total volume of quarried or

excavated material. Different materials have different bulking factors based on their ability to reconsolidate once excavated. A bulking factor of 1.2 means that a volume of naturally existing material would undergo an increase of 20 per cent once excavated and placed in its final location. Based on an understanding of similar materials within the province the following bulking factors were applied:

- Bedrock Bulking Factor would be 1.3
- Overburden Bulking Factor would be 1.0.

## **4.0 WUTHRICH QUARRY – OPERATIONS**

### **4.1 PRODUCTION AND SCHEDULING ESTIMATES**

In order to produce the amount of temporary riprap material that would be necessary for dam construction, areas for storage of surplus rock and overburden would need to be created within the quarry site. Figure 4.1 illustrates the current development of Wuthrich Quarry and the boundaries of the property. As the quarry site was developed, overburden would be cleared from areas of rock extraction and stockpiled for eventual quarry site reclamation. In addition to the overburden material, a significant volume of surplus rock would also need to be stored.

The Plan would be to remove the existing vegetation and excavate and stockpile the overburden so that the surplus rock stockpile is stored directly on the bedrock material. This would facilitate future operations of the quarry, once the surplus rock stockpile was depleted.

### **4.2 QUARRY OPERATIONS DURING CONSTRUCTION**

The quarry is an existing operation run by MOTI and would be operated in a consistent manner. The Province's Aggregate Management Principles have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

Following is a summary of quarry operation considerations:

- The main areas for excavation would be in the southern portion of the site and stockpiling would be in the northern half of the site as shown in Figure 4.2
- The maximum volumes proposed for extraction would be based on the suitability and quality of the materials as they were processed. The materials unsuitable for use for dam construction would remain within the site and would be stockpiled for future use by the MOTI
- The site would contain a trailer office, maintenance and storage area and sediment/erosion control measures
- Potable water for the office and service area and water for dust control would be brought to the site from an offsite location
- Extraction requires drilling, blasting and processing, such as screening, prior to riprap being removed from the site. More than one area would be active with room in between sites to maintain equipment manoeuvrability and production rates
- Blasting materials would be available from commercial material supply companies. Delivery would be by bulk mix and loading pump trucks and properly equipped trucks to

deliver the primary explosives. The materials would be delivered prior to loading the holes with the explosives, then the equipment would leave the site. No explosives would be stored on site. Blasting activities would be in accordance with WorksafeBC, the *Mines Act* (BC) the *Explosives Act* (Canada), the Transportation of Dangerous Goods Regulations (Canada) and the *Motor Vehicle Act* (BC)

- The material would be delivered to the dam using highway-legal haul trucks. Haul trucks or loaders would move between the areas on the site, as required
- The equipment required for operations would be as follows with the number of equipment pieces to be determined at a later stage:
  - Loaders (to loosen and remove material and process material at the screening and crushing plants, and stock pile)
  - Bulldozers (to push material for stripping stockpiles and loosen blasted materials)
  - Rock drills
  - Highway legal haul trucks (to transport the material to the dam site)
  - Water Trucks (to control dust as required)
  - Personnel Site Pick-ups (for onsite mobility)
  - Service vehicle (mechanic, fuel trucks)

#### **4.3 ACCESS**

Access to Wuthrich Quarry is currently restricted by MOTI by means of a gated access and signage. Access would continue to be closed to the public and/or controlled during the length of the extraction operations. Safety issues on the site would be related to the increased traffic and blasting within the quarry operation. Truck haul would be limited to the public roads near the quarry area to the dam site, namely 271 Road, Alaska Highway and Old Fort Road.

#### **4.4 SAFETY AND ENVIRONMENTAL MANAGEMENT DURING OPERATIONS**

Management measures to be implemented during quarry operation would include:

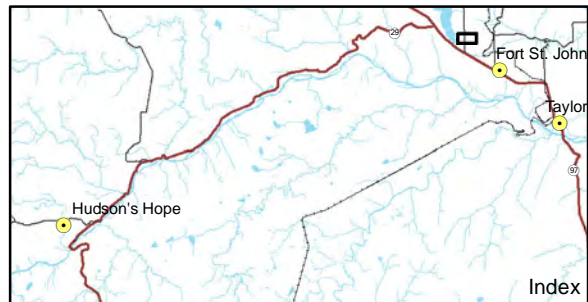
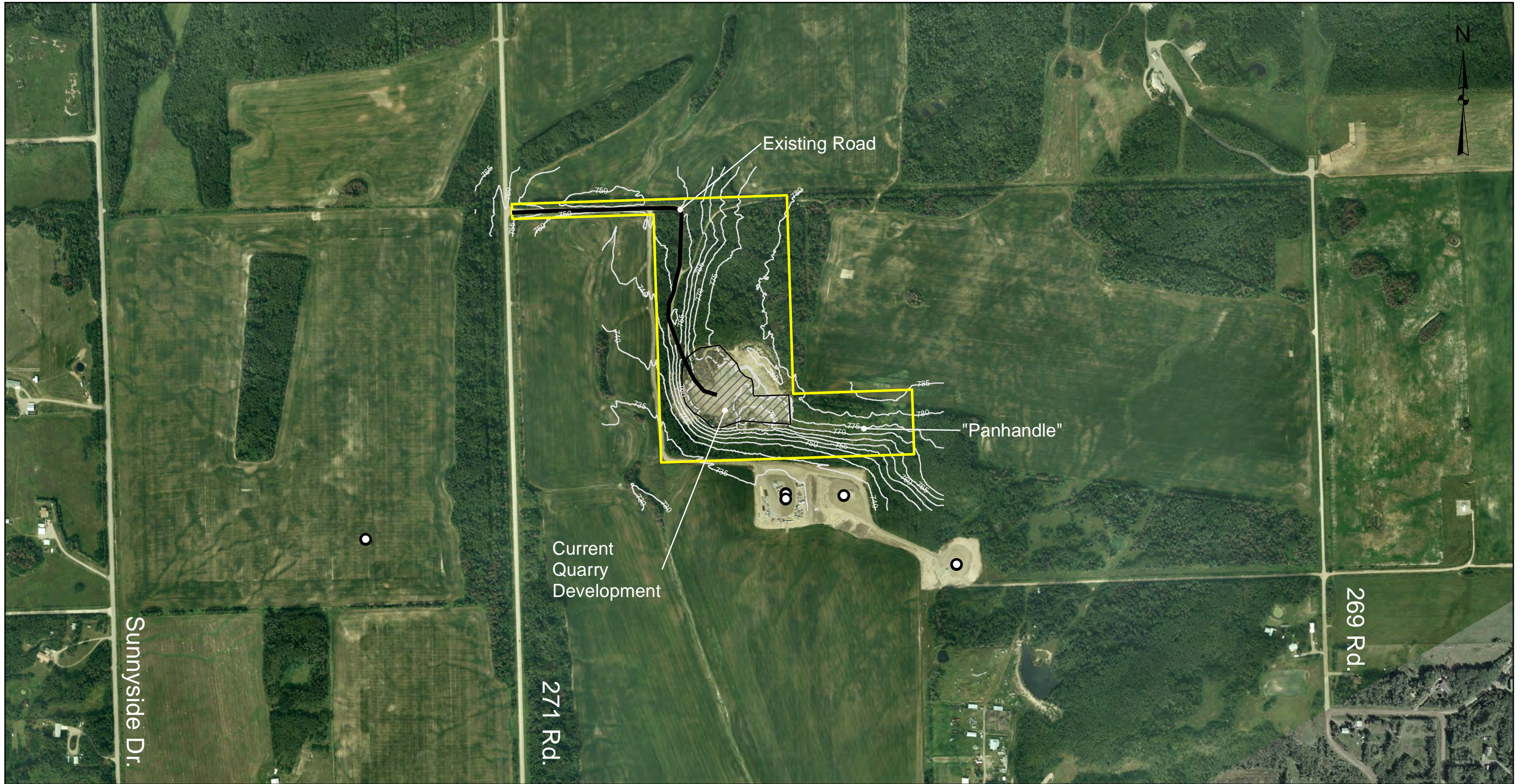
- Gate access would be maintained to control access
- Berms would be constructed at the top edges of excavations to control movement within the quarry
- Portable toilet facilities would be used within the quarry area and near the project site offices. These facilities would be maintained as required. If trailer type washroom stations were to be used onsite, the grey water created would be disposed of into a suitable tank and then pumped out and trucked to the municipal treatment location
- The planning and installation of a lighting system, if required, for the safe operation of the site would follow guidelines in the Aggregate Operators Best Management Practices

Handbook (MOEM 2002). The goal would be to facilitate safe and secure operations for the extraction, processing and stockpiling locations while minimizing offsite visual nuisance. Lighting would be needed for the quarry property, inside buildings and their entrances, extraction faces, haul roads, stockpiles, equipment, and vehicles. Lighting would be directed downward or shielded by buildings to minimize off-site spill and glare. The lighting of road junctions and site entrances would be kept to the minimum required for safety purposes

- Other site management features would include:
  - Sediment control, and oil control separation
  - Control of noxious weeds through vegetation cover or seeding where required
  - The provision of a truck wash for noxious weeds control
  - Maintenance of road surfaces to reduce vibration
  - Control of air emissions and wind generated dust

#### **4.5 SITE RECLAMATION AND FUTURE USE**

Wuthrich Quarry would continue to operate as a rock quarry under the jurisdiction of the MOTI. Slopes would be stabilized and drainage features would be established to control drainage. Seeding to control noxious weeds would be done on soil slopes and overburden stockpiles.



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011; TRIM

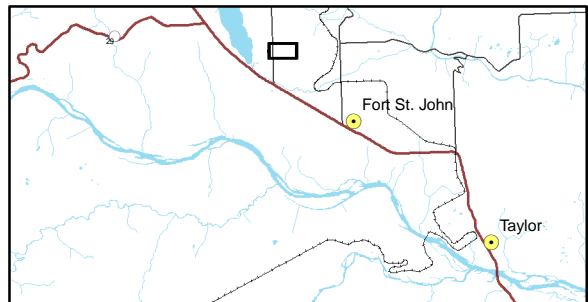
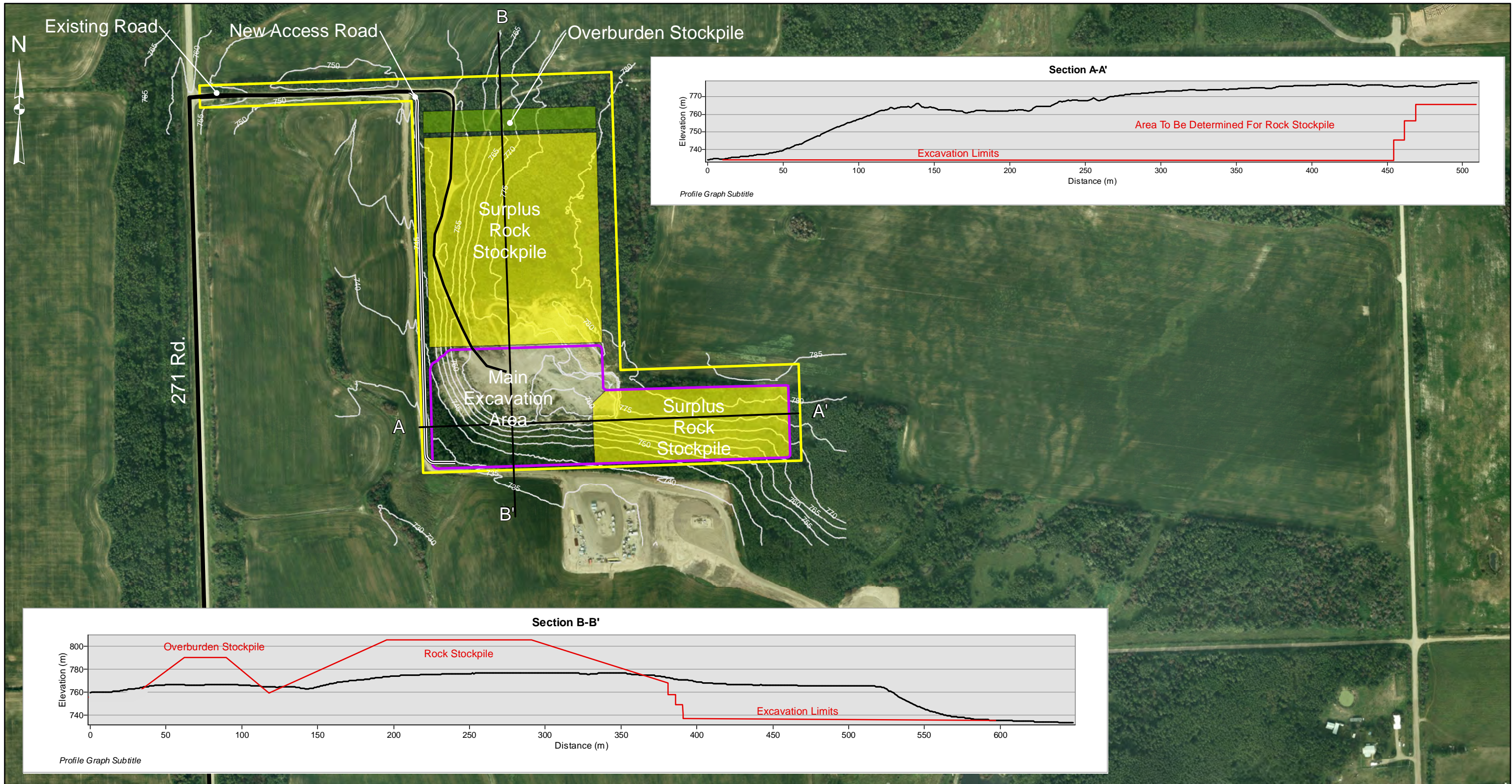
© BC Hydro 2012 - all rights reserved. This map is for information purposes only and accuracy is not guaranteed.

- Legend**
- Wuthrich Quarry Boundary
  - Current Quarry Development
  - Existing Road
  - Well Sites
  - Contour - Major 5m

1:7,500      0      250m

<p><b>Figure 4.1: Current Development Plan of Wuthrich Quarry</b></p>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6062-2      R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011

**Legend**

- Wuthrich Quarry Boundary
- Surplus Rock Stockpile
- Overburden Stockpile
- Main Excavation Area
- New Access Road
- Existing Access
- Contour - Major 5m

1:5,000  0  250m

<p><b>Figure 4.2: Proposed Development Plan of Wuthrich Quarry</b></p>			
Date	Dec. 5, 2012	DWG NO	1016-C14-B6062-3 R 0



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# **SITE C HYDRO PROJECT**

## **QUARRY DEVELOPMENT PLAN**

### **PORTAGE MOUNTAIN QUARRY**

**Doc EIS-1A-011**

**[Final]**

**Prepared for BC Hydro by**

**Tetra Tech**

**November 2012**

**SITE C HYDRO PROJECT**

**QUARRY  
DEVELOPMENT PLAN**

**PORTAGE MOUNTAIN QUARRY**

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by  
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November 2012**

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**TABLE OF CONTENTS**

**1.0 INTRODUCTION AND PURPOSE ..... 1**

**2.0 BACKGROUND ..... 3**

**3.0 QUARRY MAP RESERVE ..... 4**

**4.0 DEVELOPMENT PLAN BASIS ..... 5**

**5.0 PORTAGE MOUNTAIN QUARRY – OPERATIONS ..... 8**

    5.1 Riprap production ..... 8

    5.2 Production and Scheduling Estimates ..... 8

    5.3 Quarry Operations During Construction ..... 9

    5.4 Access ..... 10

    5.5 Safety an Environmental Management During Operations ..... 10

    5.6 Site Reclamation and Future Use ..... 11

**6.0 REFERENCES ..... 12**

**LIST OF TABLES**

**TABLE 5.1 PORTAGE MOUNTAIN QUANTITIES AND PRODUCTION YEARS ..... 8**

**LIST OF FIGURES**

**FIGURE 1.1 KEY PLAN – LOCATION OF PORTAGE MOUNTAIN QUARRY ..... 2**

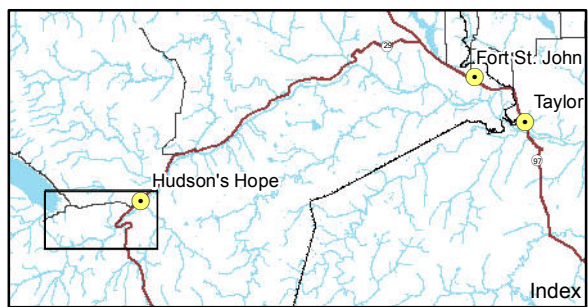
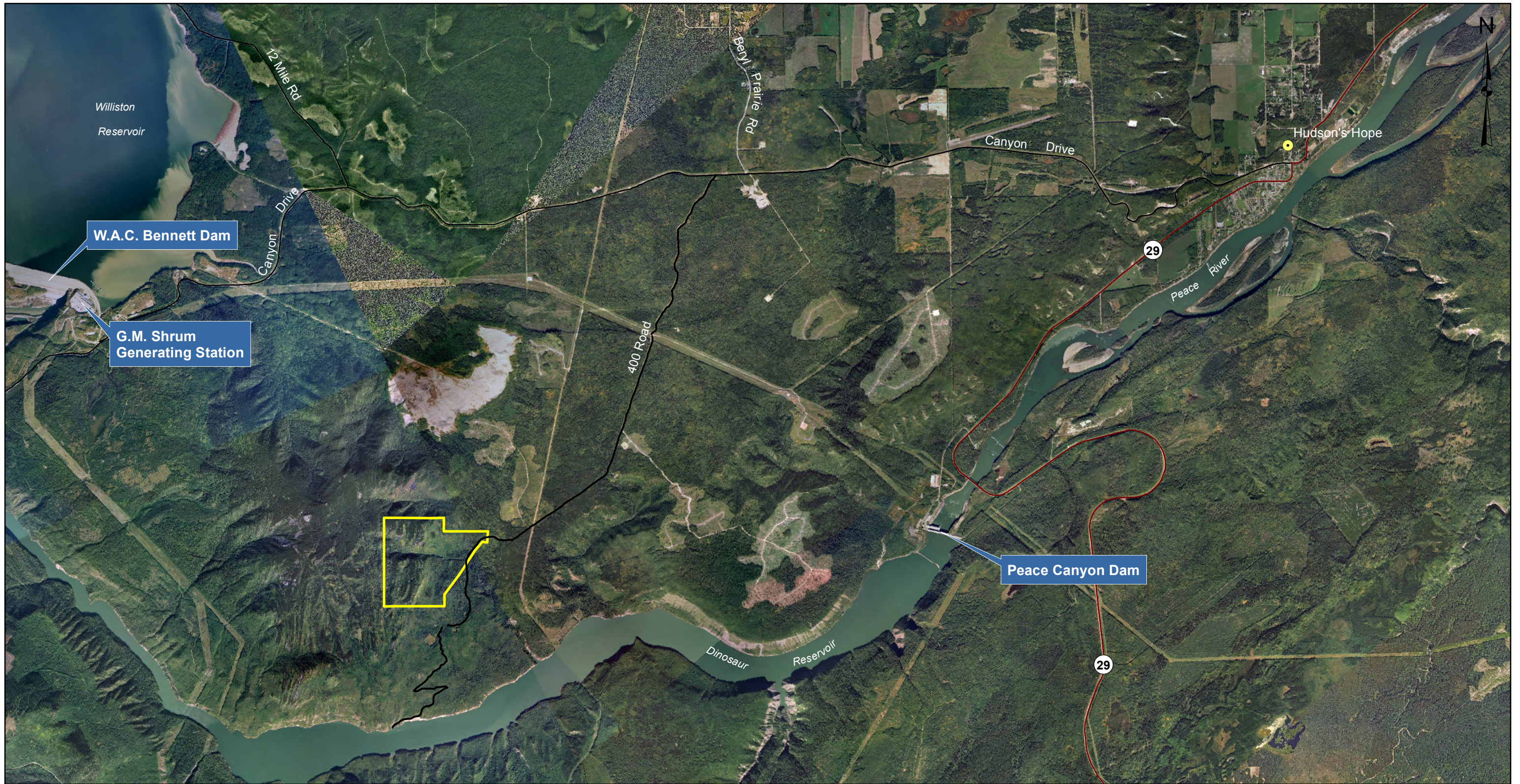
**FIGURE 4.1 PROPOSED DEVELOPMENT PLAN OF PORTAGE MOUNTAIN QUARRY ..... 7**

## **1.0 INTRODUCTION AND PURPOSE**

If the Site C Clean Energy Project (the Project) proceeds, it would require permanent riprap material for construction of the Highway 29 realignment sections and the Hudson's Hope Berm, and the Project may require riprap material for reservoir protection during filling. A source of this material in close proximity to the Hudson's Hope area is preferred to minimize transportation requirements.

The proposed Portage Mountain Quarry is a potential riprap source that was identified during a reconnaissance of the area near the Gordon M. Shrum Generating facility. The Site C project team reviewed documentation on potential sources and conducted a preliminary geological investigation of sites on Portage Mountain in 2011. Portage Mountain has been identified as the source most likely to produce the quality and quantity of riprap necessary for the proposed work. It is located approximately 14 kilometres from Hudson's Hope and is accessed via Canyon Drive and south on 400 Road as shown in Figure 1.1. The area is situated on Crown land and would require land tenure and permit approvals.

The objective of this plan is to: 1) facilitate environmental assessment approvals; 2) support permitting requirements; and 3) plan for guiding the use of the quarry site during construction and operation.





Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007; 1:15,000 taken Aug 26th 2011; TRIM

**Legend**

- Portage Mountain Quarry Boundary
- Highway
- Road

1:55,000 
0
2.5 km

			
<p><b>Figure 1.1: Key Plan Location of Portage Mountain Quarry</b></p>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6127-1 R 0



## **2.0 BACKGROUND**

A geological site reconnaissance undertaken in September 2011 (RF Binnie and AMEC 2012) confirmed the presence of thick beds of sedimentary rock at Portage Mountain. The potential quarry site is on a ridge of sandstone which projects out of a side of the mountain, approximately at the 1,000 metre elevation, and runs back into higher ground to the west. The area is treed, with pine and aspen trees with sparse low vegetation.

The rock formation is part of the Cadomin or Gething formation of the Bullhead Group. The outcrops observed were medium to thickly bedded (e.g., with some beds exceeding 3 metres in thickness), consisting of medium to coarse grained, strong to very strong, fresh to slightly weathered sandstone inter-bedded with pebble conglomerate. Talus, in the form of large angular boulders often exceeding 3.5 cubic metres, has developed at the toe of the southern portion of Ridge 3 over a distance of approximately 200 metres. The size of the boulders indicates the durability of the rock.

The sedimentary rock has the potential to produce the size of riprap blocks that would be required for the Highway 29 realignments, Hudson's Hope Berm and for protection during reservoir filling. An investigative drilling program has been completed in Fall 2012 to confirm the suitability of the material for the intended purpose. Laboratory testing will be performed on the material samples obtained during this investigation and will be available in early 2013.

Should the source prove to meet the quality requirements, a test blast may be considered in order to determine block sizes, yield potential, and to help determine costs to aid in preparation for procurement.

### **3.0 QUARRY MAP RESERVE**

Portage Mountain is an undeveloped source. A Section 16 Map Reserve (FNLRO 2012) for geotechnical investigation purposes has been established on those parts of District Lot 276 and the NW ¼ of District Lot 1039, together with that parcel or tract of unsurveyed Crown land in the vicinity of Portage Mountain east, containing approximately 148 hectares as shown in Figure 1.1. Additional provincial Land Act permits would be required to investigate or develop the quarry.

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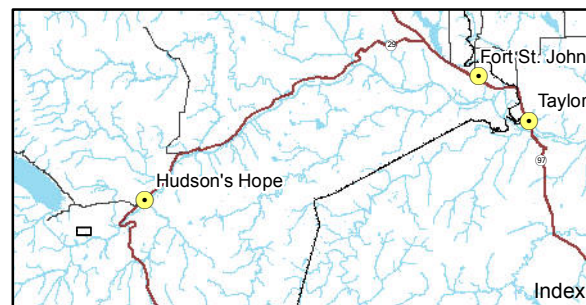
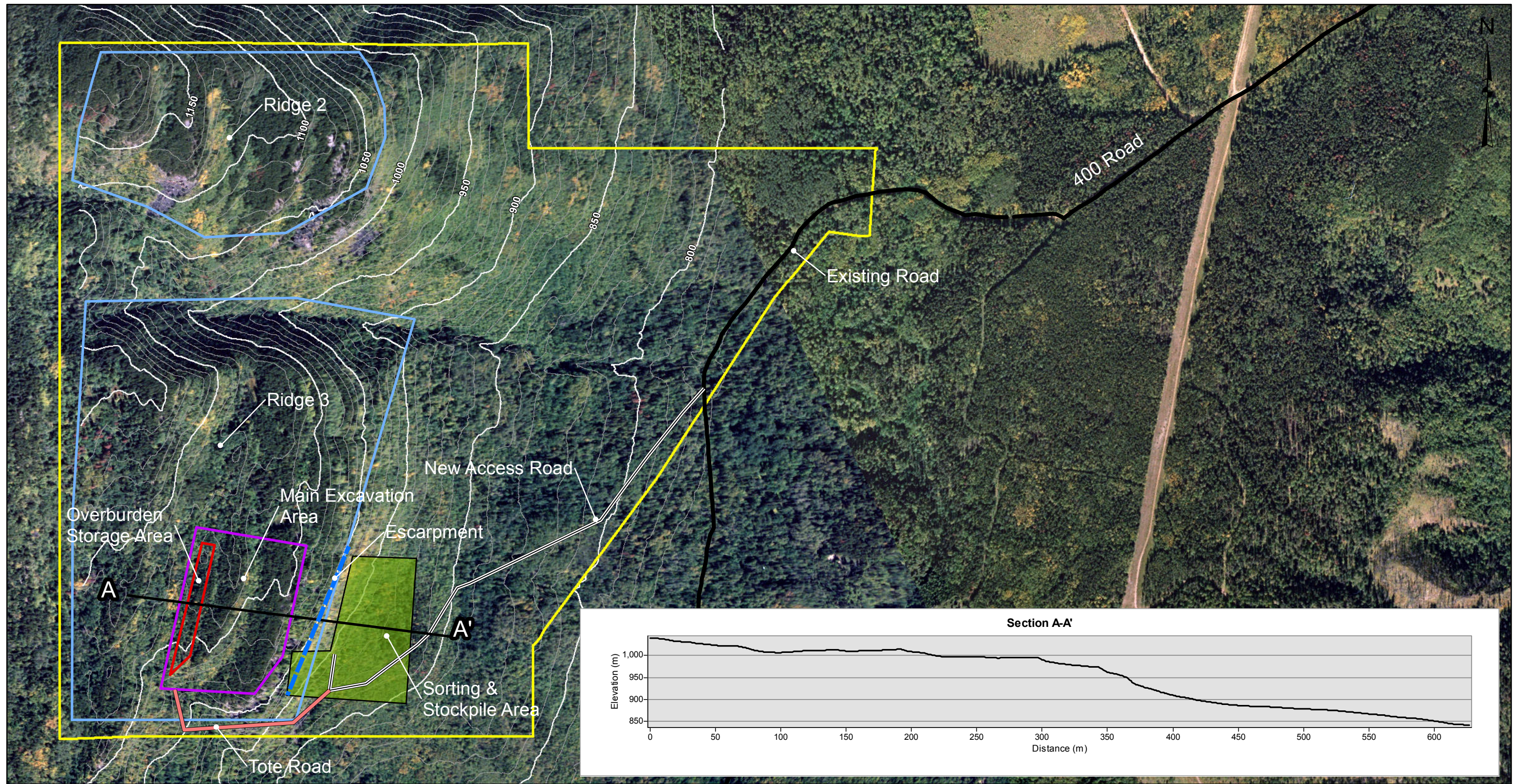
## 4.0 DEVELOPMENT PLAN BASIS

The development plans for the quarry were based on the following information:

- Approximately 197,000 cubic metres of riprap and riprap bedding would be required for Highway 29 realignment.
- Approximately 172,000 cubic metres of riprap and riprap bedding would be required for the Hudson's Hope berm.
- Approximately 250,000 cubic metres of riprap and riprap bedding would be required for areas along the reservoir requiring protection during the reservoir filling.
- The riprap and bedding materials would be hauled from the quarry as they are produced.
- The estimated yield of useable riprap would be 35% of the total quarried material.
- The riprap bedding material would be taken from the coarser surplus material.
- There is rock interlacing between thin bedded, good quality sandstone to more competent and massive sandstone layers. A test drill program is planned for Fall 2012, drilling to 30 metres below original ground at the southern end of the site to 60 metres at the north end of the proposed site.
- The final pit floor base would be at an elevation of 970 metres, between 12 to 40 metres below original ground.
- The excavation area boundaries would be within the proposed area identified in Figure 4.1 and based on the drill program and laboratory testing confirming the most suitable location.
- The main excavation area would be up to 320 metres long south to north, up to 200 metres wide west to east and up to 16 metres deep near the southern end of the rock escarpment.
- The riprap would be removed from the escarpment face on the east side of the proposed quarry.
- The blasted rock would be collected at the base of the escarpment for sorting and processing at the stockpile locations as shown in Figure 4.1.
- The quarry development design would include a wall slope of 0.25H:1V, and a 5 metre bench for every 10 meters of elevation change.
- Overburden and surplus storage embankments would have a maximum slope of 2H:1V.
- Overburden is at depths ranging from at rock surface in the southern portion and to 2.0 metres in the north portion of the site with an average depth of 0.5 metres
- The overburden would be stored on the west edge of the quarry and the surplus materials would be located near the base of the rock escarpment.

Bulking factors were applied to excavated and quarried volumes. A bulking factor represents the volume increase (expressed as a percent) that a material undergoes when removed from its natural state, and is applied to estimate the total volume of quarried or excavated material. Different materials have different bulking factors based on their ability to reconsolidate once excavated. A bulking factor of 1.2 means that a volume of naturally existing material would undergo an increase of 20 per cent once excavated and placed at its final location. Based on an understanding of similar materials within the province the following bulking factors were applied:

- The Bedrock Bulking Factor would be 1.3.
- The Overburden Bulking Factor would be 1.0.





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**Legend**

- Portage Mountain Quarry
- Main Excavation Area
- Overburden Storage Area
- Sorting and Stockpile Area
- Ridge
- Escarpment
- New Access Road
- Tote Road
- Existing Road
- Contour-Major 50m
- Contour-Minor 10m
- Section Profile

1:7,000 0 250 m

			
<p><b>Figure 4.1: Proposed Development Plan of Portage Mountain Quarry</b></p>			
Date	Nov. 22, 2012	DWG NO	1016-C14-B6127-3 R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

## 5.0 PORTAGE MOUNTAIN QUARRY – OPERATIONS

### 5.1 RIPRAP PRODUCTION

BC Hydro has estimated an approximate 35% yield of usable riprap from the blasting operations. Approximately 619,000 cubic metres of rock would be produced for the required riprap and bedding material. The larger rock would be used for various sizes of riprap and would be sorted prior to the smaller rock being processed through screens. Some of the smaller rock would be used for riprap bedding. Bedding material is a by-product of riprap production and would be obtained from the surplus rock left on site. Screened materials too small for bedding and any other rock material not suitable for use would be considered surplus and would be stored in stockpile at the base of the proposed quarry for future use. The total surplus rock is estimated to have a volume of 463,000 cubic metres.

The surplus material and the remaining intact bedrock would be used during operations, as required, by BC Hydro over the longer term for routine maintenance of Hudson's Hope Berm and the relocated Highway 29 segments. The site would remain an active quarry under the control of BC Hydro for its use.

### 5.2 PRODUCTION AND SCHEDULING ESTIMATES

In order to produce the amount of riprap material that would be necessary for Highway 29 and Hudson's Hope berm construction purposes and for reservoir protection (as shown in Table 6.1), areas for storage of surplus rock and overburden would need to be created within the quarry site. As the quarry site is developed, overburden would be cleared from areas proposed for rock extraction and stockpiled for eventual quarry site reclamation. In addition to the overburden material, a volume of surplus rock would also need to be stored.

An area at the base of the escarpment would be developed to collect, sort and stockpile the riprap and bedding materials. The surplus rock material would be stored in the same stockpile area.

**Table 5.1 Portage Mountain Quantities and Production Years**

Section	Riprap (m <sup>3</sup> )	Bedding (m <sup>3</sup> )	Total (m <sup>3</sup> )	Year 1 (m <sup>3</sup> )	Year 2 (m <sup>3</sup> )	Year 3 (m <sup>3</sup> )	Year 4 (m <sup>3</sup> )	Year 5 (m <sup>3</sup> )	Year 6 (m <sup>3</sup> )
Cache Creek/Bear Flat	30,465	5,985	36,450	20,000	16,450				
Halfway River	46,950	10,665	57,615			28,808	28,808		
Farrell Creek	10,275	3,090	13,365			6,683	6,683		
Dry Creek	6,345	2,565	8,910				8,910		
Lynx Creek	65,685	14,445	80,130				26,710	26,710	26,710
Hudson's Hope Berm	18,780	153,280	172,060					153,280	18,780

Section	Riprap (m <sup>3</sup> )	Bedding (m <sup>3</sup> )	Total (m <sup>3</sup> )	Year 1 (m <sup>3</sup> )	Year 2 (m <sup>3</sup> )	Year 3 (m <sup>3</sup> )	Year 4 (m <sup>3</sup> )	Year 5 (m <sup>3</sup> )	Year 6 (m <sup>3</sup> )
Reservoir Shoreline areas	200,000	50,000	250,000		50,000	50,000	50,000	50,000	50,000
<b>Total</b>	378,500	240,030	618,530	20,000	66,450	85,490	121,110	229,990	95,490

### 5.3 QUARRY OPERATIONS DURING CONSTRUCTION

The Province's Aggregate Management Principles (MOEM 2009) have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

Following is a summary of quarry operation considerations:

- The main excavation area would be the southern portion of the site and the stockpiling would be at the base of the escarpment below the excavation as shown in Figure 4.1.
- The maximum volumes proposed for extraction would be based on the suitability and quality of the materials as they were processed. The materials unsuitable for construction would remain within the site and would be stockpiled for future use.
- The site would contain a trailer office, maintenance and storage areas for fuel and explosives.
- Potable water for the office and service area, and water to be used for dust control would not be a substantial volume and would be brought to the site from an offsite location.
- Extraction requires drilling, blasting and processing, such as screening, prior to riprap being removed from the site. More than one area would be active with room in between sites to maintain equipment manoeuvrability and production rates.
- Blasting materials would be available from commercial material supply companies. Delivery would be by bulk mix and loading pump trucks and properly equipped trucks to deliver the primary explosives. The materials would be delivered prior to loading the holes with the explosives; the equipment would then leave the site. No explosives would be stored on site. Blasting activities would be in accordance with *WorksafeBC*, the *Mines Act* (BC) the *Explosives Act* (Canada), the *Transportation of Dangerous Goods Regulations* (Canada) and the *Motor Vehicle Act* (BC).
- Access to the quarry would be required for the rock drills, excavators and bulldozers. The rock materials produced would be pushed to the escarpment quarry bench.

- 
- The equipment required for the operations would be as follows with the number of equipment pieces to be determined at a later stage:
    - Excavators (to pre-sort riprap)
    - Rock Drills
    - Loaders (to move material and process material at the screening and crushing plants, and stockpile)
    - Bulldozers (to push material for stripping stockpiles and loosen blasted materials)
    - Highway legal haul trucks (to transport the material)
    - Water Trucks (to control dust as required)
    - Personnel Site Pick-ups (for onsite mobility)
    - Service vehicle (mechanic, fuel trucks)

#### **5.4 ACCESS**

Access to Portage Mountain would utilize an existing forestry road (400 Road). An additional road to the quarry site, approximately 700 metres in length, would need to be constructed. A further 800 metres on-site tote road would be required to reach the quarry location (as shown on Figure 4.1). Access would be closed to the public and/or controlled during the length of the extraction operations.

Truck haul would utilize the roads near the quarry area, 400 Road, Canyon Drive, Highway 29 and some streets in Hudson's Hope (as shown on Figure 4.1).

#### **5.5 SAFETY AN ENVIRONMENTAL MANAGEMENT DURING OPERATIONS**

Management measures during quarry operation would include:

- A gate would be installed to control access.
- Berms would be constructed at the top edges of excavations and sorting area to control movement within the quarry.
- Portable toilet facilities would be installed near the project site offices. If trailer type washroom stations were to be used onsite, the grey water created would be disposed of into a suitable tank and then pumped out and trucked to the municipal treatment location.
- The planning and installation of a lighting system, if required, for the safe operation of the site would follow guidelines in the Aggregate Operators Best Management Practices Handbook (MOEM 2002). The goal would be to facilitate safe and secure operations for the extraction, processing and stockpiling locations while minimizing offsite visual nuisance. Lighting would be needed for the quarry property, inside buildings and their entrances, extraction faces, haul roads, stockpiles, equipment, and vehicles. Lighting would be directed downward or shielded by buildings to minimize off-site spill and glare.



The lighting of road junctions and site entrances would be kept to the minimum required for safety purposes.

- Other site management features would include:
  - Sediment control, and oil control separation
  - Fuel would be stored on site
  - Explosives would not be stored on site. Explosives would be prepared on site on an as required basis – blasting caps and charge would be stored at the suppliers off site bunker location.
  - Control of noxious weeds through vegetation cover or seeding where required
  - Maintenance of road surfaces to reduce vibration
  - The provision of a truck wash for noxious weed control
  - Control of equipment generated air emissions and wind generated dust

#### **5.6 SITE RECLAMATION AND FUTURE USE**

BC Hydro would continue to operate the Portage Mountain Quarry. Slopes would be stabilized and drainage features would be established to control drainage. Seeding to control noxious weeds would be done on soil slopes and overburden stockpiles.

## 6.0 REFERENCES

- WAC Bennett Dam – Riprap Upgrade Reconnaissance of Potential Riprap Sources, November 2011, BC Hydro (MER No. 2011-088)
- FNLRO. 2012. Notice of Establishment of Section 16 Map Reserve, FNLRO – BC Hydro, dated July 18, 2012 – Map Reserve # R128006, file # 8015510
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# **SITE C CLEAN ENERGY PROJECT**

## **WEST PINE QUARRY DEVELOPMENT PLAN**

**Prepared by**

**Klohn Crippen Berger Ltd. and SNC-Lavalin Inc.**

**For**

**BC Hydro**

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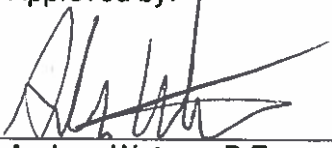
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## SITE C CLEAN ENERGY PROJECT

### WEST PINE QUARRY DEVELOPMENT PLAN

#### CONTENTS

<u>Section</u>	<u>Subject</u>	<u>Page</u>
1.	INTRODUCTION AND PURPOSE .....	6
2.	BACKGROUND .....	7
3.	INPUT INFORMATION.....	9
4.	WEST PINE QUARRY – OPERATIONS .....	11
4.1	Production and Scheduling Estimates .....	11
4.2	Quarry Development and Layout .....	11
4.3	Activities of Quarry Operations .....	12
4.4	Equipment for Quarry Operations .....	13
4.5	Quarry Access .....	13
4.6	Safety and Environmental Management during Operations.....	14
4.7	Site Reclamation and Future Use .....	15
5.	REFERENCES .....	16

#### TABLES

Table 4.1	Annual riprap placement and production schedule.....	11
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#### FIGURES

Figure 1.1	– Proposed development plan of the west pine quarry.....	17
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## 1. Introduction and Purpose

The construction of the proposed dam and generating station at Site C would require approximately 869,100 m<sup>3</sup> of high quality permanent riprap rock (594,500 m<sup>3</sup> riprap and 274,600 m<sup>3</sup> riprap bedding). Riprap rock would be required from Year 1 until Year 7 of the project construction. A detailed description of the project components and activities is provided in Volume 1 Section 4 Project Description.

Based on the available geotechnical studies, the West Pine Quarry was identified as the closest source of acceptable riprap for the permanent dam site structures for the Project. The West Pine Quarry is located 75 km southwest of Chetwynd along Highway 97. It is approximately 162 km by highway and 149 km by rail from the dam site area. The inset in Figure 1.1.1 shows the location of the West Pine Quarry.

The objectives of this plan are to:

- 1) Facilitate environmental assessment approvals
- 2) Support permitting requirements
- 3) Plan for guiding the use of the quarry site during construction and operation



## 2. Background

The British Columbia Ministry of Transportation and Infrastructure operates an active quarry on crown land under a map reserve, file number 8005674. In order to expand the quarry, BC Hydro applied for and was granted two map reserves for the purpose of quarrying by the British Columbia Ministry of Forests, Lands and Natural Resources Operations, file numbers 8003167 and 8003168. These quarrying tenures and extent of the proposed expanded West Pine Quarry are shown in Figure 1.1.

As shown in Figure 1.1.1 quarrying operations would overlap on Ministry of Transportation and Infrastructure and BC Hydro tenures. The Ministry of Transportation and Infrastructure and BC Hydro have agreed that BC Hydro can develop the lower ridge along the Canadian National Rail line as well as stockpile and load in areas contained within their map reserve tenure. Coordination between the Ministry of Transportation and Infrastructure and BC Hydro regarding quarry development is ongoing.

The West Pine Quarry can be accessed by Highway 97 and Canadian National Rail as both are parallel to the southern boundary of the quarry. There is also a rail siding along the southern boundary of the quarry, as shown in Figure 1.1.

Field investigations and evaluations identified the rock to be a highly metamorphosed limestone with high strength. The limestone unit contained two intersecting joint sets yielding a blocky appearance; dip and dip direction of the joint sets were approximately 70-80°/090° and 30-35°/225°. Joint spacing ranged from 0.3 m to 3.0 m. The average rock density was about 2,700 kg/m<sup>3</sup>, which is an adequate density value for permanent riprap.

A preliminary and conservative estimate indicates that about 3,000,000 m<sup>3</sup> of riprap could be obtained from the quarry which exceeds the required estimated 869,100 m<sup>3</sup>.

For the Project, only the larger riprap product and a smaller amount of riprap bedding would be used. All other rock material would be considered surplus. The surplus material and the remaining intact bedrock, however, would be available for use by Ministry of Transportation and Infrastructure. Storage of the surplus material is an important consideration for Ministry of Transportation and Infrastructure.

Following construction, the West Pine Quarry would continue as an active Ministry of Transportation and Infrastructure quarry.

The West Pine Quarry may be used as a source of riprap during the operations phase of the Project, if riprap on the dam, generating station or spillway require repairs in the future. Small quantities of riprap for could be purchased from the Ministry of Transportation and Infrastructure. If more material is required in the future than the Ministry of Transportation and Infrastructure could supply under its permits, a separate permit would be obtained by BC Hydro at that time.

### 3. Input Information

This Plan has been developed based on the following information:

- Approximately 869,100 m<sup>3</sup> of high quality permanent rock riprap (594,500 m<sup>3</sup>) and riprap bedding (274,600 m<sup>3</sup>) would be required for the Project
- The diameter of permanent riprap would range between 300 mm and 1,200 mm and riprap bedding would range between 40 mm and 150 mm. Approximately 35% of the riprap would be equal to or larger than 600 mm in size, and the balance 65% would be less than 600 mm
- The yield of useable riprap is estimated to be 30% by weight. Therefore, on average, the total weight of rock excavated would be 3.33 times the weight of riprap required
- Riprap bedding materials would be screened from the coarser surplus material after riprap selection
- Bulking factors (the volume ratio of disturbed material to in-situ material) for rock and overburden are expected to be 1.6 and 1.2 respectively
- Densities are estimated as: 2.70 tonne/m<sup>3</sup> for in-situ rock; 1.9 tonne/m<sup>3</sup> for riprap; 2.20 tonne/m<sup>3</sup> for riprap bedding; and 2.0 tonne/m<sup>3</sup> for surplus material
- Processed riprap and riprap bedding would be hauled either by highway legal haul trucks or by Canadian National Rail. If hauled by rail to the dam site area, riprap and riprap bedding would be unloaded and stockpiled at Septimus Siding. If hauled by trucks, it is expected that 75% of the riprap and riprap bedding would be hauled directly to the structures for placement; the balance would be unloaded and stockpiled at Septimus Siding for future transferring to the structures
- Wastage quantities were calculated based on riprap haul by rail since rail haul would result in additional breakage from increased handling. Material wastage due to stockpiling, handling, over-building and hauling are estimated to be 15%, and 20% for riprap and riprap bedding, respectively

- Based on field observations, riprap up to 600 mm in diameter is stockpiled and large rock blocks, up to 1,200 mm in diameter, are available in limited supply
- Based on field observations, the thickness of overburden is less than 500 mm deep
- 1,600,000 m<sup>3</sup> of in-situ rock would need to be excavated in order to produce the permanent riprap and riprap bedding for the Project. After selecting and removing riprap rock, the remaining 1,150,000 m<sup>3</sup> of rock material would be stockpiled at West Pine Quarry for future use by others

## 4. West Pine Quarry – Operations

### 4.1 Production and Scheduling Estimates

According to the Project schedule (see Volume 1 Section 4 Project Description), riprap would be placed within the dam site area from Year 1 through Year 7. Table 4.1 summarizes the annual quantities of riprap placed at the dam site.

**Table 4.1 Annual riprap placement and production schedule**

Description	Unit	Year of Construction								Totals
		Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	
Permanent Riprap and Riprap Bedding Placed at the dam site										
Riprap and Bedding	m <sup>3</sup>	42,000	22,000	51,000	117,000	70,000	147,000	419,000	-	869,100
Potential Corresponding Production at West Pine										
Total In-situ Rock	m <sup>3</sup>									1,600,000
Total Surplus Rock	m <sup>3</sup>									1,150,000

Note: This schedule is based on Project planning at the time of preparation of the Environmental Impact Statement and could change as a result of procurement and project planning advancements.

In order to meet riprap requirements in Year 1, quarry development and riprap and bedding production would begin as soon as the Project receives environmental certification. If it is not possible to produce rock for Year 1, riprap would be purchased either at West Pine from the existing Ministry of Transportation and Infrastructure operation or from another source.

Twenty-six months (10 hours per day, 6 days per week) would be required to produce the total volume of riprap and bedding at West Pine Quarry. This work would not be continuous and it is expected that riprap production would occur mainly in the summer months.

Riprap would be produced to meet the dam, generating station, and spillways construction schedule. Contractor preferences would determine how to produce rock riprap to meet this schedule.

### 4.2 Quarry Development and Layout

The proposed West Pine Quarry area for the Project is shown in Figure 1.1.1. The major components of the West Pine Quarry include:

### **Stockpiles**

- Two temporary loading stockpiles for riprap and riprap bedding would be located adjacent to the rail siding prior to loading into rail cars or haul trucks
- Surplus material unsuitable for Project construction would be stockpiled for use by others. Surplus materials may also be disposed of along the excavated benches
- The Ministry of Transportation and Infrastructure would continue quarrying during the Project construction, this stockpile area is reserved for their work

### **Rock excavation area**

- The direction of rock excavation would be from the north-west corner of the existing area along the Canadian National Rail toward the body of the mountain
- The quarrying benches would be 10 m high with an 8 m wide berm
- Rock blasting would be designed to minimize blasting disturbance of the final wall to minimize rock fall

### **Area for access improvement**

- Twenty-eight rail cars would be required to haul riprap daily from the West Pine Quarry to the dam site area during peak periods, requiring 430 m of rail siding. The current rail siding is approximately long enough for loading a 28 car train. However, the siding may be extended within the quarry to increase capacity

### **Additional on-site structures**

- Haul roads would be constructed within the site to suit the 40 tonne rock trucks
- Supporting infrastructure such as office trailers and maintenance areas would also be on site

## **4.3 Activities of Quarry Operations**

The quarry operations at West Pine would include the following activities:

- Build haul roads within the quarry at different elevations leading to the benches to be quarried
- Clear the area to be quarried

- Grub and strip stumps and topsoil
- Mobilize equipment and setup riprap plant
- Drill and blast
- Excavate, haul, select, and feed rock to grizzly and screening plants
- Hoe ram oversized rock, if any
- Stockpile processed final riprap and bedding material to be hauled to the dam site area
- Stockpile surplus materials
- Load rail cars or trucks
- Reclaim the site at completion

#### 4.4 Equipment for Quarry Operations

The major equipment required for the quarry operations would be as follows with the number of equipment pieces to be determined at a later stage:

- Loaders (to feed riprap plants, stockpile material, load trucks and rail cars)
- Bulldozers (to stockpile materials)
- Rock drills
- Grizzly or riprap plant
- Highway legal haul trucks transferring material within quarry site
- Rail cars and locomotives (rail option) or highway legal rock haul trucks (truck option), to transport riprap rock final products to the dam site
- Water trucks (to control dust as required)
- Personnel site pick-ups (for onsite mobility)
- Service vehicles (mechanic, fuel trucks)

#### 4.5 Quarry Access

Access to West Pine Quarry is currently limited by Ministry of Transportation and Infrastructure. Access would be either closed to the public or controlled during quarrying operations. Safety issues on the site would be related to the increased traffic and blasting within the quarry operation.

The quarry can be accessed by both Highway 97 and Canadian National Rail. If the riprap and bedding are transported by rail, the material would be loaded at the existing siding on site and transported to the dam site area and unloaded at Septimus Siding. If the riprap and bedding are transported by truck haul, the route would be limited to the public roads from the quarry area to the dam site, namely Highway 97, Jackfish Lake Road, and the Project Access Road.

#### **4.6 Safety and Environmental Management during Operations**

The quarry is an existing operation run by Ministry of Transportation and Infrastructure and would be operated in a consistent manner. The quarry operations would follow the Province's Aggregate Management Principles that have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

In addition, the quarry operations at West Pine Quarry would:

- Comply with applicable environmental management plans outlined in Volume 5 Section 35 Summary of Environmental Management Plans
- Minimize clearing to the areas to be used for quarrying
- Source blasting materials from specialized suppliers. Blasting activities would be undertaken in accordance with WorksafeBC, the Explosives Act (Canada), the Transportation of Dangerous Goods Regulations (Canada) and the Motor Vehicle Act (BC)
- Install proper lighting facilities as described in the guidelines of the Aggregate Operators Best Management Practices Handbook (MOEM 2002)
- Install office and lab trailers, rest trailers, portable toilets for the operators working at the quarry
- Provide traffic control personnel on Highway 97 to facilitate safe access and egress of trucks, if material would be transported by road



#### **4.7 Site Reclamation and Future Use**

West Pine Quarry would continue to operate as a rock quarry under the jurisdiction of the Ministry of Transportation and Infrastructure. At completion of quarrying, slopes would be stabilized and drainage features would be established at the quarries areas. Seeding to control noxious weeds would be done on soil slopes and overburden stockpiles.

## 5. References

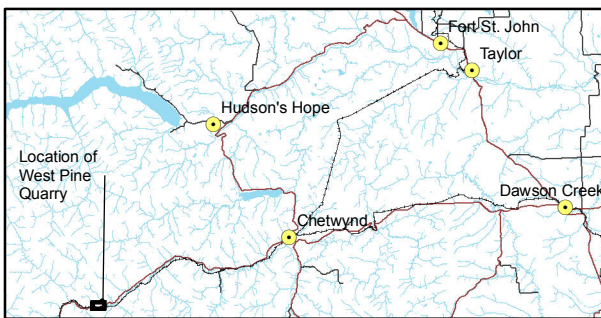
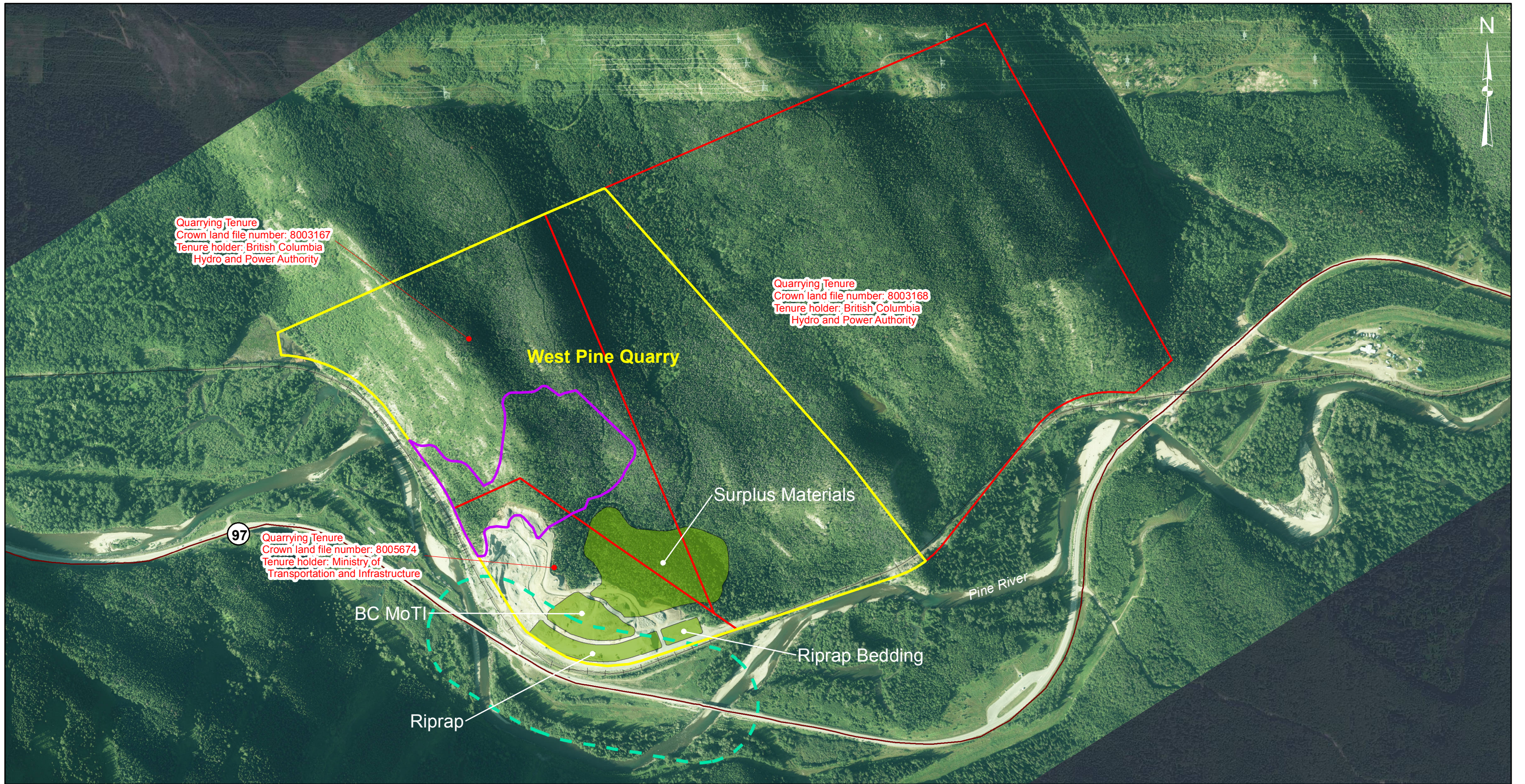
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Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Base Data: Province of B.C.  
 4. Orthophotos created from 1:15,000 photos taken Aug. 26th 2011; Bing Aerial Maps.

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**Legend**

- West Pine Quarry
- Main Excavation Area
- Stockpile Area
- Potential Area for Access Improvement
- Tenure - Map Reserve
- Existing Highway
- Existing Railway

1:9,500



<p><b>Figure 1.1</b>  <b>Proposed development plan</b>  <b>of the west pine quarry</b></p>				
Date	Nov. 23, 2012	DWG NO	1016-C14-B6098	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification

# **SITE C CLEAN ENERGY PROJECT**

## **PIT DEVELOPMENT PLAN**

### **DEL RIO PIT**

**Doc EIS-1A-014**

**[Final]**

**Prepared for BC Hydro by**

**Tetra Tech**

**November 2012**

**SITE C CLEAN ENERGY PROJECT**

**PIT DEVELOPMENT PLAN**

**DEL RIO PIT**

**Doc EIS-1A-014  
[Final]**

**Prepared for BC Hydro  
by  
Tetra Tech  
November 2012**

**Lead Author:**

**Barry Bergstrom** 

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**TABLE OF CONTENTS**

**1.0 INTRODUCTION AND PURPOSE ..... 1**

**2.0 BACKGROUND ..... 3**

**3.0 DEVELOPMENT PLAN BASIS..... 4**

**4.0 DEL RIO PIT – OPERATIONS ..... 5**

    4.1 Production and Scheduling Estimates ..... 5

    4.2 Pit Operations During Construction ..... 5

    4.3 Access..... 6

    4.4 Safety and Environmental Management During Operations ..... 6

    4.5 Site Reclamation and Future Use ..... 7

**5.0 REFERENCES..... 9**

**LIST OF FIGURES**

**FIGURE 1.1 KEY PLAN – LOCATION OF DEL RIO PIT..... 2**  
**FIGURE 4.1 PROPOSED DEVELOPMENT PLAN OF DEL RIO PIT ..... 8**

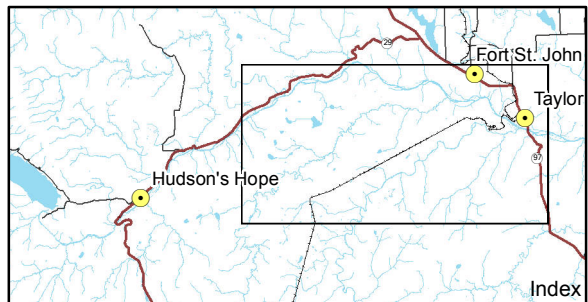
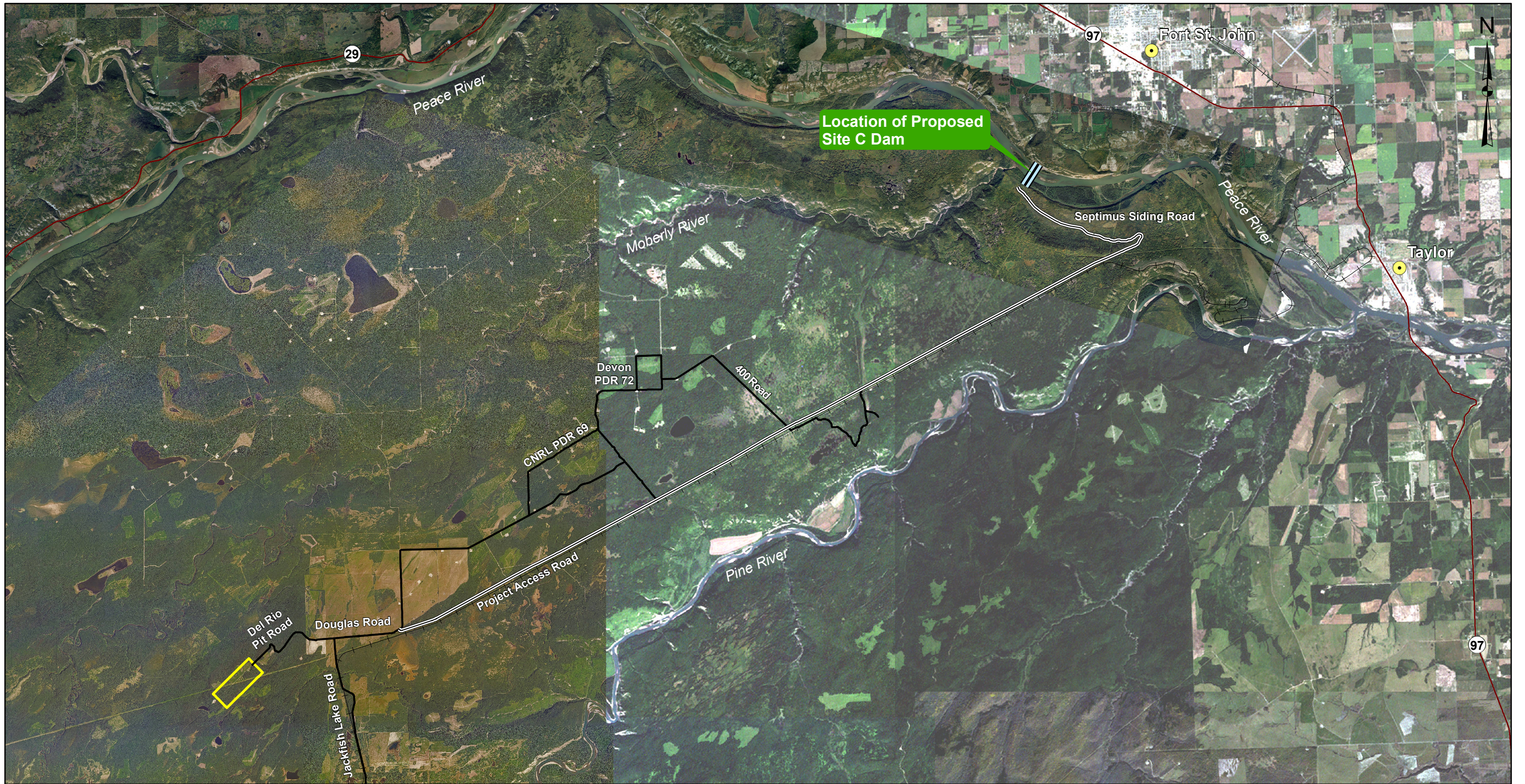


## **1.0 INTRODUCTION AND PURPOSE**

If the Site C Clean Energy Project (the Project) proceeds, it would require granular embankment and granular road base materials for the construction of the Project Access Road, Jackfish Lake Road and other south bank roads. A source of this material in close proximity to the road is preferred to minimize transportation requirements. A detailed description of the Project components and activities is provided in the Project Description (Section 4.3).

Del Rio Pit, an existing gravel source operated by the BC Ministry of Transportation and Infrastructure (MOTI), has been identified as the preferred source of granular embankment and granular road base for the Project Access Road, Jackfish Lake Road and other south bank roads. The pit is located 50 kilometres north of Chetwynd, BC as shown in Figure 1.1.

The objective of this plan is to: 1) facilitate environmental assessment approvals; 2) support permitting requirements; and 3) plan for guiding the use of the quarry site during construction and operation.



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos created from 1:40,000 photos taken Sept. 10th 2007; TRIM

- Legend**
- Del Rio Pit Boundary
  - New Access Road
  - Existing Road
  - Highway
  - Railway

1:150,000    0    5 km

<p><b>Figure 1.1: Key Plan Location of Del Rio Pit</b></p>			
Date	Nov. 29, 2012	DWG NO	1016-C14-B6167-1    R 0

## 2.0 BACKGROUND

Del Rio Pit is an existing gravel reserve operated by the MOTI. The License of Occupation on Crown Lands for the gravel reserve spans approximately 142 hectares and is traversed by the BC Hydro Transmission Right of Way as shown in Figure 1.1.

The terrain in this area rises from the east to it's highest point at the Del Rio Pit reserve, at an elevation of approximately 830 metres, then gently slopes west until reaching the Moberly River three kilometres to the west. The lands contained within the reserve and extending southwest and northeast indicate the presence of granular materials of varying quality and composition. Geotechnical field investigation has been completed in Fall 2012 to confirm quantity and quality of materials. Laboratory testing results on material' samples obtained during investigations to verify quality will be available in early 2013.

Del Rio Pit Road enters the reserve from the north, continues southwest within the boundaries of the reserve, crosses the BC Hydro Transmission Line Right of Way, and continues southwest, allowing access to other Crown Land and private parcels to the south. A small area of approximately 2 hectares within the reserve has been utilized for granular materials, while the remaining lands are generally undisturbed. Conifer and deciduous trees and ground vegetation cover most of the remaining reserve.

An agreement in principle has been reached with MOTI that would allow BC Hydro to obtain material from Del Rio Pit. The Project would require approximately 328,000 cubic metres of road fill and borrow which is unprocessed material removed directly from the deposit and 334,000 cubic metres of processed granular aggregates of which approximately 250,000 cubic metres would be required from Del Rio Pit. This volume of granular material could be produced within the existing boundaries of the reserve.

Following completion of the proposed Project work, the pit would remain active under the control of MOTI.

### 3.0 DEVELOPMENT PLAN BASIS

The development plans for the quarry were based on the following information:

- The area will require logging, clearing and grubbing before any development can commence.
- Approximately 200,000 m<sup>3</sup> of road fill and borrow would be required for Project Access Road construction, upgrades to Jackfish Lake Road and other south bank roads.
- Approximately 50,000 m<sup>3</sup> of processed granular aggregates would be required for the Project from Del Rio Pit.
- The granular embankment materials used for the Project would be hauled from the pit as it is produced.
- The granular aggregates would be produced, stockpiled and hauled when required for the Project.
- A geotechnical field investigation program has been completed in Fall 2012.
- The final pit floor base would be at an approximate elevation of 820 metres, 10 metres below original ground.
- The quarry development design would include a final wall slope of 2H:1V. Temporary slopes and stockpiles to be trimmed to a 1.5H:1V slope.
- Overburden and surplus storage embankments would have a maximum slope of 2H:1V and would be adjacent to the pit face and to the west.
- Overburden depths may range from 0.3 metres to 1.0 metre.

## **4.0 DEL RIO PIT – OPERATIONS**

### **4.1 PRODUCTION AND SCHEDULING ESTIMATES**

In order to produce the amount of granular material that would be necessary for dam construction, areas for storage of overburden would need to be created within the site. Figure 4.1 illustrates the proposed development of Del Rio Pit and the boundaries of the property. As the pit site is developed trees would be cleared. Grubbing and overburden would be removed from areas of extraction and stockpiled for eventual pit site reclamation.

The gravel pit would provide aggregate materials for use in the construction of the Project Access Road and road base upgrades to Jackfish Lake Road and other south bank access roads. It is expected the Project Access Road would commence construction in Year 1 with construction beginning in the fall and continuing through the winter months, with completion in Year 2. Jackfish Lake Road improvements would take place later in the Project schedule, depending on Project requirements.

Pit operations could include activities such as excavating, sorting, crushing, and screening of materials. Heavy equipment and vehicles would be used to transport materials within the pit area and from the pit to road construction locations.

### **4.2 PIT OPERATIONS DURING CONSTRUCTION**

The Pit is an existing source managed by MOTI and would be operated in a consistent manner. The Province's Aggregate Management Principles have been established to ensure that aggregate activities are undertaken in compliance with health and safety standards and environmental protection requirements. The reference documents are:

- Aggregate Operators Best Management Practices Handbook for British Columbia, 2002, Ministry of Energy and Mines (MOEM 2002)
- Health and Safety: A Practical Guide for Aggregate Operations, 2007, Ministry of Energy, Mines and Petroleum Resources, Mining and Minerals Division (MOEM 2007)

Following is a summary of pit operation considerations:

- The main area for excavation would continue southeast from the existing pit face with any stockpiling in the northern half of the site, as shown in Figure 4.1.
- The maximum volumes proposed for extraction would be based on the suitability and quality of the materials as they were processed. The materials unsuitable for use for road embankment construction or gravels would remain within the site.
- The site would contain a trailer office, maintenance and storage area and sediment/erosion control measures.
- Potable water for the office and service area and water for dust control would be brought to the site from an offsite location.

- 
- The material would be delivered to the road construction sections using highway-legal haul trucks.
  - Haul trucks or loaders would move material between the areas within the pit, as required.
  - The equipment required for operations would be as follows with the number of equipment pieces to be determined at a later stage:
    - Screening and/or crushing plants
    - Loaders (to loosen and remove material and process material at the screening and crushing plants, and stock pile)
    - Bulldozers (to push material for grubbing and stripping of site and stockpiles and loosen in situ materials)
    - Highway legal haul trucks (to transport the material to the road construction sites)
    - Water Trucks (to control dust as required)
    - Grader (for haul road surface maintenance)
    - Personnel Site Pick-ups (for onsite mobility)
    - Service vehicle (mechanic, fuel trucks)

#### **4.3 ACCESS**

Access to Del Rio Pit is by Del Rio Pit Road. The road is not currently gated. Access control during pit operations would be achieved by the placement of berms and gated access into the pit extraction area and would be determined prior to development.

Del Rio Pit Road is a public road and would remain open to the public but controlled during extraction operations to allow access to lands beyond. Haul operations on this road would be traffic controlled and haul vehicles would be in radio communication.

#### **4.4 SAFETY AND ENVIRONMENTAL MANAGEMENT DURING OPERATIONS**

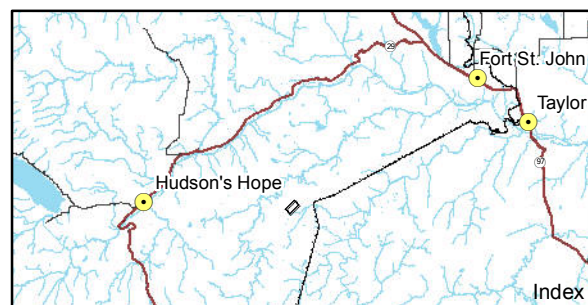
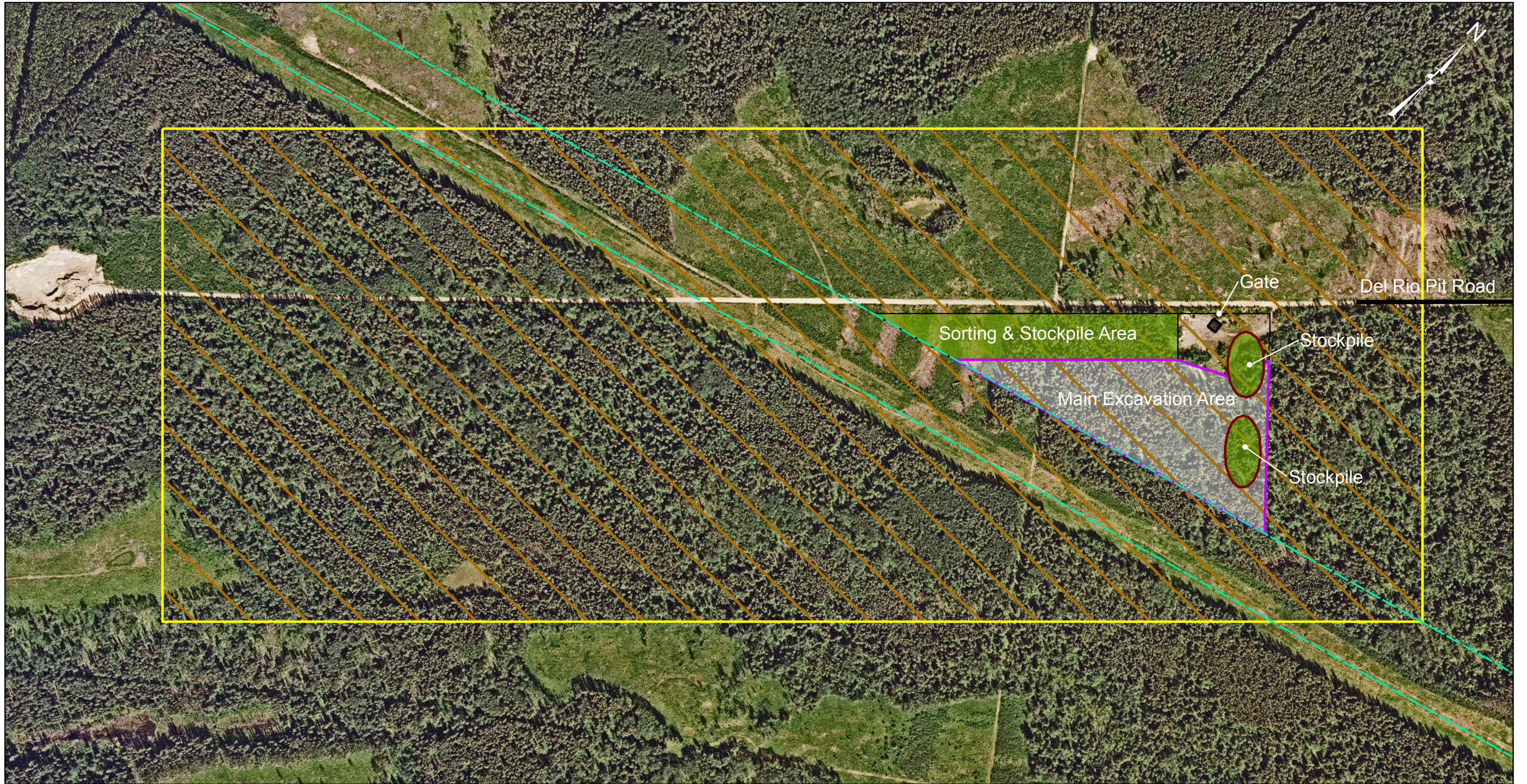
Management measures to be implemented during pit operation would include:

- Gate access would be installed to control pit operation access.
- Berms would be constructed at the top edges of excavations to control unauthorized access to the pit along the existing Del Rio Pit Road or where access can be achieved along the treed edges.
- Portable toilet facilities would be used within the quarry area and near the project site offices. These facilities would be maintained as required.
- The planning and installation of the lighting system, if required, for the safe operation of the site would follow guidelines in the Aggregate Operators Best Management Practices Handbook (MOEM 2002). Other site management features would include:

- Sediment control, and oil control separation
- Control of noxious weeds through vegetation cover or seeding where required
- Maintenance of road surfaces to reduce vibration
- Control of air emissions and wind generated dust

#### **4.5 SITE RECLAMATION AND FUTURE USE**

Del Rio Pit would continue as a gravel pit operation under the jurisdiction of the MOTI upon completion of the Project. Slopes would be stabilized and drainage features would be established to control drainage. Seeding to control noxious weeds would be done on soil slopes and overburden stockpiles as required.



Map Notes:  
 1. Datum: NAD83  
 2. Projection: UTM Zone 10N  
 3. Orthophotos: TRIM.

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**Legend**

- Del Rio Pit Boundary
- BC MoTI Map Reserve
- Gate
- Sorting and Stockpile Area
- Pit Excavation Area
- Stockpile Locations
- BC Hydro Right-of-Way
- Existing Road

1:6,000 0 250 m

<p><b>Figure 4.1: Proposed Development Plan of Del Rio Pit</b></p>				
Date	Nov. 22, 2012	DWG NO	1016-C14-B6167-2	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory approvals including environmental certification



## 5.0 REFERENCES

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