APPENDIX G – SPECIFICATIONS

APPENDIX G – SPECIFICATIONS

TABLE OF CONTENTS

Exhibits

APPENDIX G – SPECIFICATIONS

1 GENERAL

1.1 Location of the Site

The Site Preparation: North Bank project is located within the Site C Dam site and Wuthrich Quarry as shown on Appendix K – Drawings and Plans ("drawings"). The Contractor will also be required to access West Pine Quarry for the Work.

The Site is shown on the Safety Area Map in Appendix H – Safety. Work will be limited to the Site.

1.2 Standard Specifications

Except as expressly set out otherwise, the British Columbia Ministry of Transportation and Infrastructure's ("BC MOTI") 2012 Standard Specifications for Highway Construction and the Special Provision Amendments to the 2012 Standard Specifications for Highway Construction apply to this Contract as specified in these Specifications.

(a) http://www.th.gov.bc.ca/publications/const_maint/contract_serv/standard_specs/Volume_1_SS2012.pdf

(b) http://www.th.gov.bc.ca/publications/const_maint/contract_serv/standard_specs/Volume_2_SS2012.pdf

(c) http://www.th.gov.bc.ca/publications/const_maint/contract_serv/standard_specs/Special_Provisions_Appendix_2012SS.pdf

References to the "Standard Specifications" or "SS" will mean the 2012 SS for Highway Construction Volumes 1 and 2, as issued by BC MOTI.

SS101 Quality Management, SS 135 Construction Site Safety, SS 165 Protection of the Environment do not apply to work under this Contract.

1.3 Definitions

In this Appendix G – Specifications, unless the context otherwise requires, capitalized terms have the meaning set out in Appendix A – General Conditions (Construction). The following definitions will apply in this Appendix G – Specifications:

"**Grubbing**" means work involving excavation and removal of stumps and roots to not less than 0.6 m below ground level and collecting these materials for mulching or disposal, by other contractors, in an area designated by Hydro's Representative.

"**Heritage Specialist**" has the meaning set out in Section 1.9(c) of this Appendix G – Specifications.

"**Hold Point**" is a mandatory verification point beyond which work cannot proceed without written approval by Hydro's Representative. The work cannot proceed until Hydro's Representative is able to verify the quality of the completed work and releases the hold by means of written approval.

"**Left Bank**" means the north bank of the Peace River.

"**Organic Stripping**" means the stripping of topsoil and organics including, but not limited to, surficial soils containing sod, roots or other vegetative matter.

"**PAG**" means Potentially Acid Generating bedrock material to be excavated, contained, and then hauled and stored in designated RSEM areas by other contractors.

"**Reference Concept**" means a conceptual design provided for information only.

"**RSEM**" means Relocated Surplus Excavated Material including, but not limited to, excavated overburden to be stored in designated RSEM areas.

"**Survey Plan**" has the meaning set out in Section 1.18.1 of this Appendix G – Specifications.

"**Topsoil**" means the uppermost soil unit composed of mostly organic material.

"**Upper Gravel and Sand**" or "**UGS**" means Upper Gravel and Sands material generally consisting of gravels, cross-bedded sands and silts on the Left Bank. The UGS contains occasional boulders.

1.4 Value Engineering

Value Engineering proposals will be in accordance with SS 125 Value Engineering – Proposal Guidelines.

1.5 Availability of Site or Right-of-Way

The Site is available for commencement of the Work in accordance with Appendix F – Work Program and Schedule, except as noted in this Appendix G – Specifications. [redacted]

1.6 Access

Access to the Site will be gained via Old Fort Road, 240 Road, and 269 Road; and via the driveway to gravel pit located at the eastern area of the Site off of Old Fort Road.

Access to Wuthrich Quarry from Highway 97 can be gained by 271 Road, north of Highway 97. West Pine Quarry is located approximately 65 kilometres southwest of Chetwynd off Highway 97.

The Contractor is restricted from hauling material and equipment using commercial vehicles (weights exceeding 11,759kg) to and from the Site via Old Fort Road, 240 Road, 269 Road, 271 Road or 85th Avenue on school days during scheduled school bus pick-up and drop-off times. This school bus schedule is typically in effect Monday to Friday, excluding statutory holidays, between the hours of 7:15am and 8:15am, and 2:30pm and 3:30pm. The Contractor will confirm the school bus schedule with School District 60's Transportation Supervisor on a monthly basis during the school year and include it in its Traffic Management Plan. The Contractor will also include, in the Traffic Management Plan, an outline of how it will communicate the restricted haul period to its employees and suppliers. The Contractor will demonstrate, at BC Hydro's request, its compliance with this requirement.

For this Contract, during load restriction periods, BC MOTI has advised it will not restrict loads below 100% of legal axle loading on 271 Road between Wuthrich Quarry and Highway 97, or on Old Fort Road between Highway 97 and the gravel pit driveway, or on 240 Road, or on 269 Road

The Contractor will submit an access route plan, outlining the Contractor's temporary access roads and haul routes to Hydro's Representative prior to mobilization and update the plan as required during construction. Access roads approved by Hydro's Representative may be retained for use in future BC Hydro contracts, except where specified to be decommissioned or as directed by Hydro's Representative. Access routes will be located outside Other Contractors' areas of responsibility unless agreed upon in writing.

The Contractor will maintain the access roads and trails within the Site for use by its vehicles and equipment, BC Hydro's vehicles, and Other Contractors' vehicles and equipment until the issuance of the certificate of Substantial Completion. The Contractor will not block or restrict use of the access roads and trails within the Site without the prior written consent of Hydro's Representative. If the Contractor re-constructs existing roads and trails in order to complete the Work, then it will construct such roads and trails to a condition, including alignment, cross-section, structure and provision for drainage, equal to or better than that of the existing condition.

The Contractor will construct a haul road in the designated haul corridor shown on the drawings. The designated haul corridor will be cleared by Other Contractors by August 30, 2015. The Contractor may use UGS material from the Left Bank Excavation as road base, and may use UGS for any other haul road. The Contractor will decommission the designated haul road upon completion of the RSEM Area L3 fill works. Decommissioning will include removing the UGS material employed in its construction to a stockpile at the granular laydown area as shown on the drawings, contouring, restoring drainage patterns and revegetation. UGS material that cannot be recovered from the designated haul road, or from other roads on which it has placed UGS material, and stockpiled will be considered lost. Hydro's Representative will deduct the volume lost and will reduce the overall volume of UGS material. All Work to construct and decommission a haul road within the designated haul corridor will be considered incidental to Left Bank Excavation and no additional compensation will be made.

Upon completion of the River Road Zone A embankment, the Contractor will allow BC Hydro and Other Contractors to use River Road for access and egress, including but not limited to access to the Peace River Construction Bridge and waterway booms, and will not interfere with or impede such access and egress.

Should the Contractor access In-River Excavation #1 via the north bank, it will design and construct a temporary haul route, including a temporary crossing to maintain fish connectivity between the main stem of the Peace River and the back channel. The Contractor will decommission the crossing upon completion of its Work at In-River Excavation #1. The access route must be located 150 metres away from the existing raptor nest shown on the Environmental Features Drawings in the Electronic Data Site.

The costs of construction, maintenance and decommissioning of access and egress for the Work will be included in the bid item for Mobilization.

1.7 Mobilization

The Contractor will perform mobilization in accordance with SS 145.08.

[redacted]

(a) Work Program and Schedule;

(b) Work Resource Histogram;

(c) Projected Contract Cash Flows;

(d) Quality Management Plan;

(e) Site Specific Safety Management Plan;

(f) Survey Plan;

(g) Subcontractor Supplier List; and

(h) Environmental Protection Plans (EPPs) for:

(i) Erosion Prevention and Sediment Control;

(ii) Groundwater Protection;

(iii) Soil Management, Site Restoration, and Revegetation;

(iv) Spill Prevention and Response;

(v) Surface Water Quality Management;

(vi) Vegetation and Invasive Plant Management; and

(vii) Waste Management.

[redacted]

(i) Work Program and Schedule updates;

(j) Work force report;

(k) Quality reports;

(l) Aboriginal inclusion plan;

(m) EPP and environmental reporting; and

(n) Monthly reports outlined in Appendix B – Supplementary General Conditions.

1.8 Hours of Work

Work hours at the Site are unrestricted. The Contractor's construction schedule will be communicated to Hydro's Representative daily for the duration of the Work and will set out the full twenty-four hour schedule.

Hours of work outside the Site will adhere to local municipal or regional district bylaws.

1.9 Environmental Protection

The Contractor will prepare for and perform the Work taking into account the following:

(a) Works in the main stem of the Peace River do not need to be isolated, however the Contractor will comply with the requirement to salvage and relocate fish, amphibians and invertebrates as outlined in the CEMP.

(b) Water quality criteria for the Work will be based on measurable total suspended solids (TSS) and nephelometric turbidity units (NTU) using the severity of ill-effects (SEV) model (Model #2 for adult salmonids), developed by Newcombe and Jensen in the 1996 North American Journal of Fisheries Management article "Channel Suspended Sediment and Fisheries: A Synthesis for

Quantitative Assessment of Risk and Impact" (available at: http://www.meds-sdmm.dfo-mpo.gc.ca/sp-ps/eng/Publication/Details/2114).

The Contractor will maintain the following water quality standard in the Peace River:

- Project sediment releases must not cause the 30-day SEV index to exceed 9.0. However, if SEV 9.0 is exceeded under background conditions, up to 10% of the current 24 hour day average background TSS concentration may be released by works, provided that SEV 10.0 is not exceeded. A maximum daily average of 500 mg/L TSS will be permitted when background flow conditions are clear; constrained by the above requirements.

For the period June 1st through July 31st, BC Hydro has determined that the background SEV index for the Peace River at the proposed water quality monitoring station has exceeded SEV 9.0 at times in five out of nine years between 2000 and 2009 (excluding 2002). The Contractor will consider the potential for elevated SEV levels in June and July, and schedule the Work accordingly to manage TSS discharges within the required standard.

The Contractor's EPP will include procedures and rationale for real time measurement of turbidity as a surrogate for TSS.

The Contractor will submit to Hydro's Representative proposed turbidity monitoring station locations both upstream and downstream of the Work and, once such Submittal is endorsed Accepted, the Contractor will monitor turbidity in real time at such locations.

The Contractor's EPP will include a plan to advise construction staff to modify construction and resulting levels of TSS and turbidity generated based on observed turbidity and the SEV values.

BC Hydro will monitor compliance based on water samples taken at the locations shown on drawing 1016-C14-A7727 Proposed Water Quality Monitoring Stations included in the CEMP. BC Hydro will share the results of water quality compliance monitoring with the Contractor.

(c) BC Hydro plans to complete all archaeological excavations required in accordance with *Heritage Conservation Act* (British Columbia) Permits, or any mitigation of historic heritage resources planned by BC Hydro, within the Contractor's Work Area in advance of the performance of the Work. BC Hydro will obtain any required Section 12 Site Alteration Permits issued under the *Heritage Conservation Act* (British Columbia) prior to the commencement of Work within known archaeological sites that are located within the Contractor's Work Areas.

BC Hydro has retained a heritage management firm who will act in the role of heritage specialist (the "**Heritage Specialist**") and provide 'Qualified Environmental Professional' services in respect of heritage resource management works under this Contract. For the performance of the Work within known archaeological sites, as shown on the environmental features drawings (as provided to the Contractor by Hydro's Representative):

(i) in snow free conditions, the Heritage Specialist will complete archaeological surface inspections (survey and collection of artifacts) after stripping, grubbing or excavation of the top 0.6 m soil horizon; and

(ii) if stripping, grubbing or excavation of the top 0.6 m soil horizon occurs during snow-covered conditions, the Heritage Specialist may be required to provide a QEP to monitor work in lieu of surface inspection, pending final requirements of *Heritage Conservation Act* permits.

The Contractor will coordinate and accommodate the Heritage Specialist to plan and undertake the heritage surface inspection or heritage monitoring described above. If archaeological excavations are required to recover artifacts, the Contractor will plan and coordinate its Work with the Heritage Specialist so as to avoid delay to the Work; and

(iii) during the course of excavations, for the purpose of paleontological mitigation, the Contractor will work with the Heritage Specialist to accommodate a Qualified Environmental Professional to conduct periodic surface inspection and collection of paleontological resources.

Any delay to the Work due to the coordination and undertaking of activities described in Sections 1.9(c)(i), 1.9(c)(ii) 1.9(c)(iii) will not be eligible for an extension of time for the performance of the Work or additional compensation.

If the Contractor anticipates delays associated with archaeological excavations, surface inspection and collection of paleontological resources it will notify Hydro's Representative in advance of such archaeological excavations, surface inspections or paleontological mitigation proceeding.

During construction activities the Contractor will be responsible for implementing heritage chance find procedures in accordance with BC Hydro's Heritage Resources Management Plan and the Contractor's EPP developed with respect to heritage matters, including training crews in the procedures and responding as required.

The Contractor will ensure that environmental monitors and crews retained by it are familiar with the conditions of BC Hydro's Heritage Resources Management Plan, the Contractor's heritage EPP (as described above), and all *Heritage Conservation Act* (British Columbia) Permits as applicable to the Contractor's Work.

(d) Channel flow velocity thresholds during construction and maintenance of the North Bridge Approach will be in accordance with Exhibit G-2 - Causeway Abutment River Velocity Measurement and Maintenance.

(e) BC Hydro will be applying for an authorization from fisheries agencies to conduct Site Preparation North Bank construction activities within watercourses. BC Hydro anticipates receiving fisheries agencies' approvals for work subject to the Fisheries Act by October 1, 2015.

All requirements for compliance with the environmental obligations will be considered incidental to the Work. No additional compensation will be made for this item of Work.

1.10 Obscure Hazards

The Contractor will continually assess, investigate and evaluate the Work and Site for potential hazards. Known obscure hazards specific to the Work are:

(a) natural hazards including potential landslides throughout the Project and rock-fall from slopes above the River Road;

(b) debris flow and ice jams on the Peace River;

(c) debris flow on creeks;

(d) rapid Peace River level fluctuations causing flooding at in-stream works or adjacent sites;

(e) colluvium materials slicking during rain events;

(f) previous geotechnical investigation equipment and borehole casings;

(g) sour and natural gas lines and appurtenances; and

(h) over-steepened slopes, holes, buried objects and structures in the gravel pit located at the eastern area of the Site off of Old Fort Road.

1.11 Work by Other Contractors in Project Area

Further to GC 4.7, the following parties are anticipated to be working on or near the Site:

Activity	Other Contractors	Location	Start Date
Clearing	BC Hydro retained contractor(s)	North bank	[redacted]
Peace River Construction Bridge and limited work on north and south bridge approach	BC Hydro retained Contractor	North bank, Peace River, South bank	[redacted]
South Bank Site Preparation	BC Hydro retained Contractor	South bank, West Pine Quarry	[redacted]
Worker Accommodation	BC Hydro retained contractor	North bank	[redacted]
Long term parking lot	BC Hydro retained contractor	North bank	[redacted]
Power and Lighting			
Power to location with one BC Hydro wooden pole complete with pole mounted transformer and davit luminaire.	BC Hydro (retained contractor or by other BC Hydro forces)	North Bank Road / Viewpoint Driveway intersection	[redacted]
Power to location with five BC Hydro wooden poles, transformers as required, five davit luminaires and all overhead cabling.	BC Hydro (retained contractor or by other BC Hydro forces)	Long Term Parking Lot entry, security gate and pullouts	[redacted]
Power to location with one BC Hydro wooden pole complete with pole mounted transformer and davit luminaire	BC Hydro (retained contractor or by other BC Hydro forces)	North Bank Road / River Road intersection	[redacted]
Telecommunication	BC Hydro	North bank	[redacted]
Waterway Barriers (buoys)	BC Hydro retained contractor	Peace River	[redacted]
Heritage Specialist	BC Hydro's archaeologist	North bank	[redacted]
Environmental Auditors	BC Hydro retained contractor	North bank	[redacted]
Site Security	BC Hydro retained contractor	North bank	[redacted]

Activity	Other Contractors	Location	Start Date
Main Civil Works	BC Hydro retained contractor	North bank, Peace River, South bank, West Pine Quarry, Wuthrich Quarry	[redacted]
Surveyor (BC Hydro Audit)	BC Hydro retained contractor	North bank, Peace River, South bank, West Pine Quarry, Wuthrich Quarry	[redacted]

The Contractor will construct both the North Bridge Approach between station 510+486 and station 510+600 and the Tote Road to the underside of bridge end fill, or elevation 416.5 m, as shown on the drawings, on or before the applicable milestone date for this Work in Appendix F – Work Program and Schedule. The North Bridge Approach and Tote Road will then be turned over to the Peace River Construction Bridge contractor in order that bridge construction may commence. The North Bridge Approach and Tote Road will be returned to the Contractor on or before [redacted] for completion of all remaining Work, including construction of the North Bridge Approach between station 510+486 and station 510+540 between the underside of bridge end fill and bottom of subgrade, as shown on the drawings, on or before the applicable milestone date for this Work in Appendix F – Work Program and Schedule.

The Worker Accommodation contractor will be treating the noxious weeds located in the noxious weed containment area shown on drawing 1016-C09-06012, commencing [redacted].

The following parties are anticipated to be working adjacent to the Site:

Activity	Owner	Location
Old Fort Road widening and realignment	BC MOTI	Old Fort Road from Highway 97 to River Road
269 Road upgrade and paving	BC MOTI	240 Road to the North Bank Road Limit of Construction
271 Road widening	BC MOTI, BC Hydro retained contractor	Highway 97 to Wuthrich Quarry
240 Road upgrading and paving	BC MOTI	Old Fort Road to 269 Road
Road Maintenance	BC MOTI, PRRD, and Fort St. John	Roads throughout Fort St. John and Peace River Regional District
Wuthrich Quarry	BC MOTI	Wuthrich Quarry
West Pine Quarry	BC MOTI, BC Hydro	West Pine Quarry
Penn West gas wells	Penn West	Adjacent to Wuthrich Quarry

Upgrades to Old Fort Road between Highway 97 and 240 Road, 269 Road, and 271 Road will commence [redacted] and continue to [redacted]. The realignment of Old Fort Road between 240 Road and the entrance to the gravel pit located at the eastern area of the Site off of Old Fort Road will commence [redacted]. The Contractor can anticipate single lane alternating traffic during construction.

The works by Other Contractors and the Contractor's performance of its Work will be interdependent. Further to GC 4.7, the Contractor will coordinate and cooperate with all other parties to ensure:

(a) that the other parties have access at all times to their work site;

(b) that the Work Program and Schedule submitted and maintained by the Contractor is realistic, and that its schedule and the other parties' schedule are mutually consistent and are also consistent with the availability of the Site;

(c) that works by other parties are not being delayed by the Contractor's scheduling and performance of the Work; and

(d) that works by other parties are not delaying the Contractor's performance of the Work.

The Contractor will notify Hydro's Representative immediately if it considers that its Work is being delayed by the failure of works by other parties to be completed in a timely manner.

The Contractor will provide Hydro's Representative and the appropriate party representatives at least fourteen days' notice prior to commencement of any portion of the Work impacting work by others within and adjacent to the Site.

The Contractor acknowledges that use of River Road for access and egress, including but not limited to access to the Peace River Construction Bridge and waterway booms, is critical to BC Hydro's own work and the work of Other Contractors on the Project. As such, immediately upon completion of the Zone A embankment, the Contractor will use its best efforts to provide BC Hydro and Other Contractors use of River Road for such access and egress.

1.12 Utilities

The relocation of existing power, telephone lines, poles and other utilities from their current to final design locations, unless specified in this Appendix G – Specifications as being part of the Work, will be performed by BC Hydro or third party utility owners.

The Contractor will physically confirm locations of all existing underground and overhead utilities in the vicinity prior to the commencement of Work. Information shown on the drawings is derived from existing record drawings and no responsibility is implied or assumed by BC Hydro as to its accuracy. The Contractor will ensure that all permitting required to perform the Work near utilities is obtained and adhered to regarding any conditions and requirements.

The Contractor will protect all existing and new utilities encountered during construction from damage. Any damage to utilities resulting from the Contractor's operation will be repaired by the Contractor at the Contractor's expense.

No additional compensation will be made for this item of Work.

1.13 Quality Management

Refer to Appendix J – Quality Management.

Payment will be at the Lump Sum for Item 1.2 "Quality Management" as set out in Appendix E – Schedule of Quantities and Prices. The Lump Sum for Quality Management will be full compensation for all costs resulting from the Quality Management requirements set out Appendix J – Quality Management. Payment will be made on a monthly basis prorated for the percentage of the total Work completed as determined by Hydro's Representative.

Table 1.13: Minimum Frequencies of Quality Control Testing / Inspection

Product	Description	Minimum QC Testing / Inspection Frequencies[1,2]	Acceptance Criteria
Survey/Layout	Staking Accuracy	1 per 20 stakes	SS 145 Benchmark Level loops: 2nd order: ±0.008 m √km Layout level loops: 3rd order: ±0.024 m √km Control Line Traverse: 1:10,000.
Traffic Control / Management		On-going monitoring during active work, spot check after hours	SS 194 and the CEMP
Concrete Roadside Barrier	Per SS 941	Materials and Concrete tests per SS 211, with all plastic concrete tests performed on each batch of concrete	Per SS 941
Roadway Aggregate Quality (other than gradation and fracture)	ASTM D 2419 Sand Equivalent	1 per aggregate source or if material changes	SS 202
	D 6928 Micro Deval	1 per aggregate source or if material changes	SS 202
	ASTM C 88 Mg SO_4 Soundness	1 per aggregate source or if material changes, if Micro Deval fails	SS 202
	SS 202 Appendix 2 - Petrographic Analysis Test	1 per source if the aggregate fails any of the above three tests	To the satisfaction of Hydro's Representative
Add'l test for High Fines Surfacing Aggregate	ASTM D 4318 Plastic Limit	1 per aggregate source	SS 202
During all Roadway Aggregate Production	ASTM C 136, Dry Sieve Analysis of Aggregates[2]	1 per hour per 300 t/hr. or part thereof of production	SS 202 or SS 531
	ASTM C 117, Sieve Analysis of Aggregates by Washing	1 per day	SS 202 or SS 531
	SS 202 Appendix 1 - Fracture Count on Coarse Aggregate (BCH 1-13)	1 for every second sample of dry sieve test for base aggregates	SS 202 or SS 531

Product	Description	Minimum QC Testing / Inspection Frequencies[1,2]	Acceptance Criteria
Compaction:			
Embankment (including berms)	Proof Roll	Stripped/sub-excavated grade, top of subgrade, top of base and as required by Hydro's Representative	To Hydro's Representative's satisfaction
	Test Strip	1 per material, repeat every 3 months or if material changes	To Hydro's Representative's satisfaction
	ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods or ASTM D1556 Density and Unit Weight of Soil in Place by Sand-Cone method or D2167 - 08 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method	3 tests per 20 m per lift, on centreline and on Lt and Rt fog lines	SS 201
	ASTM D1195 Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components	1 test per 100 m for every 1 m of fill placed and compacted (to be performed on centreline given consistent material. If material is found to be variable frequency will be increased to 1 test per 100 m.	To Hydro's Representative's satisfaction
River Road Embankment (below water)	Becker Penetration Test	1 every 200 m	To Hydro's Representative's satisfaction
Top 300 mm of Subgrade	ASTM D 698 Standard Test Method for Laboratory Compaction	1 per material	
	ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods	3 tests per 50 m per lift, on centreline and on Lt and Rt fog lines	SS 201
Base and sub-base aggregates	ASTM D 698 Standard Test Method for Laboratory Compaction	1 per 25,000 m^3 of each type of material and whenever the accepted gradation curve is changed	SS 202
	ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods	3 tests per 20 m per lift, on centreline on Lt and Rt fog lines	SS 202

Product	Description	Minimum QC Testing / Inspection Frequencies[1,2]	Acceptance Criteria
All other Items and Work	Per the Contract or Standard Specifications	Per the Contract. Where frequencies are not specified in the Contract, as mutually agreed between Hydro's Representative and the Contractor as necessary to ensure conformance with the specified quality requirements.	Per the Contract or Standard Specifications

[1] QC frequencies may be reduced below this level, subject to Hydro's Representative's written approval, should the Contractor's QC Plan be proven effective.

[2] For all standards based on production, specified frequencies are based on hours of crusher or plant production time. A *shift* is a production period of up to twelve hours duration.

1.14 Materials Supplied by BC Hydro

BC Hydro will supply the following materials:

Material	Quantity
Spur Sign Faces	20
Limestone riprap and bedding as required by Section 3.9 Limestone Riprap Lined Ditches	All
Seeds	All

BC Hydro will provide the spur sign faces and the seeds at a location in the Fort St. John area and the Contractor will make arrangements for pickup. Limestone riprap and bedding will be available in stockpile at West Pine Quarry.

Upon Total Completion of the Work, the Contractor, at the Contractor's sole cost and expense, will deliver all unused material that has been purchased by BC Hydro to BC Hydro's 85th Avenue site and place the material at the locations specified by Hydro's Representative.

1.15 Not Used

1.16 Not Used

1.17 Field Directions from Hydro's Representative

In these Specifications the words "directed by Hydro's Representative" mean that Hydro's Representative may give field directions to supplement the previously issued Contract Documents to take account of field conditions applicable to the performance of the Work. Compliance by the Contractor with such directions will be deemed to be a part of the Work, without payment of additional compensation or adjustment to the time for the performance of the Work.

1.18 Contractor Survey

1.18.1 General

The Contractor will establish secondary control, perform all staking and survey layout required for the completion of all Work, perform volume and quantity survey and calculations for the determination of payment quantities, and perform survey for record drawings.

All survey Work will be in accordance with the latest edition of the BC MoTI Construction Supervision Survey Guide, except as modified by this Appendix G – Specifications, which is available at: http://www.th.gov.bc.ca/publications/eng_publications/survey/Construction_Survey_Guide.pdf.

BC Hydro will audit the survey work from time to time. The Contractor may be required to adjust its construction activities to allow BC Hydro to perform these audits. Any areas of the survey or model that do not adequately reflect the requirements of the Contract Documents, as determined by Hydro's Representative, will be considered non-compliant Work and will be corrected by the Contractor, at its sole cost and expense.

The Contractor will submit a survey plan (a **"Survey Plan**") outlining its proposed survey techniques and equipment, survey locations, data management, and submission schedule. The Survey Plan will be updated as required during construction. The Contractor will designate a Survey Coordinator, who is available at the Site, to act as a single point of contact for liaison with Hydro's Representative on survey related matters.

The Contractor's quality products, process, and submittals for surveying and volume calculations will meet the requirements of BC MoTI Construction Supervision Survey Guide and Appendix J – Quality Management.

The Contractor may select its preferred survey and volume calculation software; however, data submitted to BC Hydro will be in a format compatible with AutoDESK Civil 3D.

Survey Work is considered incidental to the various Work items. No additional compensation will be made for survey, quantity calculations, and accommodation of auditing activities.

1.18.2 Existing Bench Marks and Legal Survey Markers

BC Hydro will provide primary control as shown on the drawings. The Contractor will establish a secondary control system in accordance with the Construction Supervision Survey Guide.

The Contractor will take all necessary precautions to protect and preserve existing benchmarks or legal survey pins on and adjacent to the Site. Costs to re-establish these existing benchmarks or legal survey pins will be paid for by the Contractor.

Various key marker posts and offset posts have been established for survey references throughout the Site. These will be preserved and protected by the Contractor in the same manner as legal iron pins and/or property posts. Such posts will be flagged by BC Hydro with an extended stake which is suitably prominently flagged.

1.18.3 Survey Layout

The Contractor will perform all staking and survey layout required for the completion of all Work, as shown on the drawings or as directed by Hydro's Representative, and to effect incidental field adjustments, such as calculation and staking of embankments and culverts to match post-stripping ground lines and actual field drainage patterns.

The Contractor will provide Hydro's Representative a copy of the stakeout information and construction grades prior to the start of earthwork operations.

The Contractor's survey layout will conform, at a minimum, to the requirements outlined in the Exhibit G-3 – Survey Layout Services and Products.

1.18.4 Quantity Survey

Quantities will be calculated from the design lines shown on the drawings, adjusted to incorporate design changes and field adjustments authorized by Hydro's Representative, and verified by quantity survey.

For all earthworks and granular aggregates, the Contractor will survey the original ground line and any subsequent material horizons. The original ground will be surveyed prior to the commencement of the Work and provided to Hydro's Representative for review. BC Hydro will compare the original ground survey to the current design model and may adjust the design as necessary. The Contractor and Hydro's Representative will mutually agree on original ground, post stripping, excavation, and subexcavation models as the basis for quantity payments. For items such as excavation where the upper boundary of a cut cannot be determined until the completion of stripping, the design line will be revised to reflect the actual bottom of stripping line as determined by the Contractor's survey and agreed upon by Hydro's Representative.

In addition to quantity survey of the payment items, the Contractor will complete hydrographic survey of In-River Excavations original ground and any subsequent material horizons and topographical survey of Pits and Quarries prior to and upon completion of excavation and riprap production.

The Contractor will submit raw and processed survey data as the Work proceeds, and volumes for completed sections of Work for support of payment with its Progress Payment Estimate, or at any time upon Hydro's Representative's request. The Contractor will not proceed with the next stage of any construction until Hydro's Representative has received completed survey for the previous works.

The Contractor's survey shall incorporate the requirements of tolerances, visual referencing, staking, point codes and string as described in the BC MoTI Construction Supervision Survey Guide and the BC MoTI Standard Specifications.

1.18.5 Record Drawings Survey

Hydro's Representative will require survey of all completed Work, including disposal areas, excavated areas, embankments, and berms generally to confirm the Work and identify changes from original design to final configurations. The Contractor will complete a ground survey of the final grade prior to Substantial Completion and incorporate the survey into the record drawings.

Any survey information collected for field adjustments during the Work will be incorporated into the record drawings.

1.18.6 Quantity Calculations

The Contractor will calculate quantities based on average-end-area calculations based on cross-sections extracted from the survey-derived digital terrain model or by using prismoidal volumes between surfaces in the model. Any material placed or excavated beyond the design lines will be considered unauthorized work and will not be compensated.

The Contractor will provide calculations in support of payment with its Progress Payment Estimate, upon completion or completed sections of items of Work or at any time upon Hydro's Representative's request.

Where agreeable and accepted by Hydro's Representative the Contractor may propose alternative methods of determining payment quantities.

2 GRADING

2.1 Clearing

The Contractor will clear the Left Bank Excavation, River Road, North Bank Road gully (between station 71+960 and station 72+160), and Wuthrich Quarry as shown on the drawings in accordance with SS200.

BC Hydro has retained a forestry contractor that will clear and dispose of material in the Site including RSEM Area L3, North Bank Road (excluding between station 71+960 and station 72+160), the designated haul corridor, and the Granular Laydown Area including stockpile locations. Clearing by Other Contractors will commence on or before [redacted] and will be complete by [redacted]. The Contractor may commence grubbing and stripping operations [redacted], provided a 300 metre separation is maintained from all clearing and disposal work by Other Contractors. The Contractor will schedule its Work accordingly.

The Contractor will stockpile cleared material in designated areas as shown on the drawings such that existing and proposed facilities and construction activities will not be impacted. Cleared material will be mulched and disposed by Other Contractors.

The Contractor will clear Wuthrich Quarry in accordance with its Pit Development Plan (see Section 2.12.1 of this Appendix G – Specifications for the requirement for a Pit Development Plan). Clearing will be in accordance with SS 200. The Contractor will stockpile cleared material at an accessible location within the Quarry.

[redacted]

2.2 Grubbing

The Contractor will grub Wuthrich Quarry, the drainage features and foundation preparation locations in RSEM Area L3, all of the North Bank Road gully (between station 71+960 and station 72+160) and River Road as shown on the drawings. Grubbing will be in accordance with SS 200.03, and as specified in this Appendix G – Specifications. Stumps and roots will be stockpiled in designated areas where shown on the drawings such that existing and proposed facilities and construction activities will not be impacted. Grubbed Material from Wuthrich Quarry will be stockpiled in the quarry in accordance with the Contractor's Pit Development Plan.

Stumps and roots will be mulched and disposed by Other Contractors.

Hydro's Representative may direct the Contractor to adjust the grubbing boundaries as necessary in order to accommodate creeks, wetlands, utilities, and similar features.

North Bank Road (excluding between station 71+960 and station 72+160), the designated haul corridor, and the Granular Laydown Areas including stockpile locations will be grubbed by the Other Contractors. The Contractor will schedule its work accordingly. Grubbing by Other Contractors will commence on or before [redacted] and will be complete by [redacted].

[redacted]

2.3 Organic Stripping

The Contractor will strip topsoil and organics (surficial soils containing sod, roots or other vegetative matter; often light brown to black in colour) to the limits shown on the drawings and in accordance with SS 165.06, SS 201.12 and SS 751.31.01.

Organic stripping on road alignments and the Left Bank Excavation will be windrowed or stockpiled by the Contractor, then placed on completed embankments in accordance with SS 201.12. Surplus stripped organic materials will be hauled to the designated disposal sites as shown on the drawings. Organic material will be used as a surface dressing on the embankments and at the designated disposal locations. Organic stripping from Wuthrich Quarry will be stockpiled in the quarry in accordance with the Contractor's Pit Development Plan.

Organic stripping from In-River Excavation #3 will be loaded and transported to gravel pit located at the eastern area of the Site off of Old Fort Road for stockpiling.

Organic stripping for the stilling basin, diversion berm, and underdrain shall be in accordance with Section 2.5 Foundation Preparation. Organic stripping for the Left Bank Excavation shall be in accordance with Section 2.4 Left Bank Excavation and RSEM Area L3.

[redacted]

2.4 Left Bank Excavation and RSEM Area L3

2.4.1 Definitions

The following definitions will apply in this Section 2.4 Left Bank Excavation and RSEM Area L3:

"**Excavation**" means excavation of all materials including Topsoil, clay, silt, sand, gravel, boulders or loose rock smaller than 1.0 m average diameter and friable or weathered rocks that can be ripped with a 225 kW crawler tractor equipped with a single shank, short tip ripper. Common Excavation also includes excavation into existing stockpiles and waste piles.

"**Excavation Line**" means the line within which no unexcavated material shall be permitted to remain.

"**Over Excavation**" means excavation beyond the Excavation Line.

2.4.2 General

The Work will include supply of all labour, materials, plant, equipment, inspection and testing services to complete the Left Bank Excavation and the construction of RSEM Area L3 as shown on the drawings and in this Appendix G – Specifications or as required by Hydro's Representative.

The Work comprises organic stripping and excavation of the overburden materials to a minimum volume and lines specified on the drawings.

The removal of overburden materials to specified or approved grade lines. Over excavation in select areas at RSEM Area L3 may also be required and will be directed by Hydro's Representative.

No later than four weeks prior to starting the Work, the Contractor will submit a Construction Plan which includes proposed excavation methods and sequences including temporary drainage and treatment works, maximizing the re-use of excavated materials for fills, and restoration for material source, stockpile, laydown, disposal and work areas. The Construction Plan will include drawings at various stages of excavation illustrating how access for Other Contractors is maintained through the excavation area and how water management is implemented at each stage.

2.4.3 Execution

(a) The Contractor will conform to the following general guidelines for all excavation activities:

(i) Develop excavation methods, techniques, and procedures with due consideration for safety, environmental hazards, geological hazards, archaeological areas, and the nature of materials to be excavated particularly in saturated areas.

(ii) The Contractor will manage geological hazards and potential slips throughout the Work. All necessary control measures are considered incidental to the Work.

(iii) Avoid/Prevent excavation beyond the Excavation Lines shown on the drawings unless otherwise approved.

(iv) Dispose of all excavated material in RSEM Area L3 and/or the approved designated areas. Under no circumstance will water or material be discharged, ponded or stockpiled outside of designated areas. The Contractor's surface water management systems will discharge water at designated discharge points in accordance with the approved Construction Plan.

(v) Existing road access to the Peace River shore is to be kept throughout the Work as shown on the drawings. The Contractor will re-construct existing roads and trails in order to complete the Work, then it will construct such roads and trails to a condition, including alignment, cross-section, structure and provision for drainage, equal to or better than that of the existing condition.

(vi) The Contractor will maintain the existing access road to the Peace River shore throughout the Work and will allow for the unrestricted use of the existing access road, or re-constructed access road, by BC Hydro and other contractors.

(vii) Outer berms are to be built for all roads and benches.

(viii) Benches will be sloped to the inside with minimum grade of 0.5%.

(ix) All necessary water control and sediment control measures within and around the excavations are considered incidental to the Work and will be implemented in accordance with Erosion Prevention and Sediment Control Management of the CEMP. Pumps may be required to control runoff during storms and water may need to be contained for treatment if water quality is not satisfactory. The Contractor will provide personnel throughout the work to maintain drainage and sediment controls, including off days, if needed.

(x) The construction of temporary roads, ramps, or fills to allow equipment access to certain areas may be required, and will be identified in the Construction Plan by the Contractor. The Contractor will be responsible for construction, deconstruction and safe disposal in approved areas of all such temporary structures, all at no extra cost to BC Hydro.

(xi) The Contractor will clean up spillage and maintain roads for safe travel. The Contractor will select suitable construction techniques and equipment that minimise leakage and spillage during transport of excavated material throughout the duration of the Works, and in accordance with the requirements of Appendix I – Environmental Obligations.

(b) Excavation: The Contractor will excavate overburden materials from the Work area to the depths and limits shown on the drawings or as directed by Hydro's Representative and hauled to the designated stockpile or disposal areas.

The Contractor will monitor all excavated slopes for signs of movement or sloughing and report any such signs immediately to Hydro's Representative. Slope stabilization measures will be undertaken by the Contractor, following Hydro's Representative directions.

The Contractor will make all trenches and excavations with side slopes conforming to the drawings, codes, standards, or as directed by Hydro's Representative.

The Contractor will carry out excavations in such a way that no temporary slopes are steeper than 2H:1V and higher than 10 m unless otherwise approved. The Contractor will maintain all temporary and permanent excavations at all times in a sound and stable condition as indicated on the drawings.

The Contractor will make all excavations to the lines, grades, and dimensions shown on the drawings or established by Hydro's Representative. All necessary precautions will be taken by the Contractor to preserve the material in the soundest possible condition below and beyond the line of all excavations.

Except as otherwise shown on the drawings, the Contractor will maintain excavation tolerances of +0.00 m to –0.15 m (over excavation) of specified or approved lines and levels.

The Contractor will notify Hydro's Representative of any over excavation. Any measures deemed necessary by Hydro's Representative, including geotechnical services, to correct the over excavation will be at the expense of the Contractor.

UGS material excavated during the Work will be incorporated into the Work or stockpiled in accordance with the approved Construction Plan, or as directed by Hydro's Representative.

Except as otherwise shown on the drawings, areas with unacceptable soil or material such as organic or deleterious substances, will be sub-excavated by the Contractor as directed by Hydro's Representative.

When excavating bedrock, the Contractor will comply with the requirements shown on the drawings and BC Hydro's Acid Rock Drainage and Metal Leachate Management Plan in the CEMP.

(c) Water Management and Sediment Control: The Contractor will, in compliance with the Erosion Prevention and Sediment Control Management of the CEMP, furnish all materials for constructing and maintaining all necessary drains, sumps, other temporary diversions, and protective works; and will furnish, install, maintain, and operate all necessary pumping and other equipment for the removal of water. The Contractor will prevent ponding of water within excavations.

The Contractor will be responsible for control of the works to minimize the release of suspended sediments in surface runoff water. The Contractor will ensure that sediment ponds allow soil particles in the surface water to settle and be discharged at designated discharge points shown in the Construction Plan.

The Contractor will be responsible for the design and implementation of a discharge water system from the sediment ponds or any other area of the excavation as shown typically on the drawings.

The Contractor will be responsible for the correct conveyance and discharge of surface water so as to not affect infrastructure, roads or the environment outside of the excavation limits.

The Contractor will build surface water control berms at the edge of the benches of the excavation and as shown on the drawings.

The Contractor will be responsible and make good of any damage whatsoever caused by floods, water, failure of equipment, inadequate equipment, and/or failure of any part of his diversion or protective works.

2.4.4 Geotechnical Investigation Drill Holes

(a) General: Within the Site there are a number of historical drill holes (shown on the drawings), or as might otherwise be discovered during the course of the Work.

Drill holes contain protective steel borehole casing ranging in diameter from 89 mm to 910 mm. Steel drill hole casing typically extends from the ground surface through overburden to bedrock. In some circumstances steel drill hole casing is present at shallow depth below ground surface.

Where the Work, including but not limited to clearing, grubbing and excavation, coincides with or is adjacent to historical drill holes:

(i) the Contractor will be responsible to execute the Work safely and securely in the vicinity of historical drill holes; and

(ii) the Contractor will physically confirm locations of all drill holes in the vicinity of the Work prior to the commencement of Work.

Information with respect to historical drill holes shown on the drawings is indicative and for reference only, and BC Hydro assumes no responsibility for the accuracy of such information or the location of historical drill holes.

(b) Drill Holes Located Outside the Left Bank Excavation: The Contractor will protect and prevent damage to all historical drill holes located outside the boundary of the Left Bank Excavation during the course of the Work.

(c) Drill Holes Located Within the Left Bank Excavation: Table 2.4.4(c) lists known historical drill holes anticipated to contain steel drill hole casing within the Left Bank Excavation. Information provided in Table 2.4.4(c) is indicative, and the actual number of bore holes within the excavation may differ.

Following completion of the Left Bank Excavation, the Contractor will ensure all drill holes with steel casing located within the excavation conform to the following:

(i) the steel casing will be left such that the top of the steel casing is no shorter than 1.1 m and no higher than 1.3 m above ground surface,

(ii) if the steel casing in any drill hole cannot be left as described in Section 2.4.4(c)(i) above, all drill holes with steel casing will, at a minimum, have the casing exposed at ground surface with the location clearly marked by stakes or equivalent;

(iii) all drill holes with steel casing will not be left such the steel casing is bent or bent over; and

(iv) the Contractor will install drill hole caps on top of all drill holes.

Table 2.4.4(c): Historical Drill Holes with Steel Casing Located with the Left Bank Excavation

ID	Easting	Northing	Hole Depth (m)	Reference Elevation (m)
DH11-23	630061.07	6230314.66	171.91	569.31
DH11-26A	629731.60	6230495.12	217.2	584.89
DH77-21	629737.84	6230516.07	229.51	585.4
DH78-1	629575.24	6230709.87	200.56	590.18
DH80-16	629896.44	6230360.58	180.44	582.24
DH89-1	629815.02	6230476.48	189.6	582.75
DH89-10	629807.15	6230420.92	219.9	582.87
DH89-2	629811.69	6230443.54	195.5	582.87
DH89-3	629809.05	6230431.06	165.04	582.8
RDH80-87	629732.34	6230491.97	183.36	585.28
RDH80-90	629689.34	6230439.17	146.93	554.41
RDH80-91	629601.24	6230507.27	137.69	549.5
RDH80-94	629670.04	6230585.97	183.32	583.87
RDH80-95	630094.74	6230187.68	153.04	549.07
RDH80-96	629964.34	6230293.78	146.83	552
RDH81-1	629807.24	6230419.07	177.14	582.81
RDH81-18	630154.20	6230253.80	177.12	568.11
RDH81-40	629663.00	6230709.90	158.75	588.17
RDH81-41	629541.64	6230672.97	169.89	565.24
RDH81-42	629593.14	6230627.27	171.18	562.83
RDH81-43	629497.20	6230621.90	140.5	534.16
RDH89-1	629797.84	6230382.68	189	562.31
RDH89-2	629596.64	6230510.27	152	548.81
SNDH08-1	629839.12	6230400.73	122.83	582.23
SNDH08-2	629573.91	6230624.55	67.67	559.59
SNDH08-3	630051.80	6230310.22	112.16	568.21
SDH89-4	629844.22	6230348.27	89.9	563.02

[redacted]

[redacted]

2.5 Foundation Preparation

The Contractor will be required to prepare the foundation for the construction of the diversion berm, underdrain and stilling basin structures. The extent of the foundation preparation areas will be directed by Hydro's Representative.

The Contractor will prepare foundation levels to the lines and grades shown on the drawings or as directed by Hydro's Representative. With prior approval, grade lines may be adjusted in the field to suit local topography or ground conditions, and the Contractor will ensure that they are free of abrupt or sharp changes unless otherwise specified. The Contractor will be responsible for survey control to specified accuracy. Prior to fill placement, the Contractor will proof roll surfaces with a compactor as specified in Section 2.6.5 Execution. The Contractor will grade the underdrain area with suitable equipment (no proof rolling required). Prepared surfaces will be inspected by Hydro's Representative and will be approved in writing by Hydro's Representative prior to placing fills upon them. Areas showing excessive rutting or weaving will be excavated by the Contractor to firm soil or rock, and the proof rolling repeated. Groundwater seepage encountered during foundation preparation will be reported by the Contractor to Hydro's Representative for assessment. The Contractor will be responsible for managing surface and seepage water conditions.

[redacted]

2.6 RSEM Area L3

2.6.1 Definitions

The following definitions will apply in this Section 2.6 RSEM Area L3:

"**Engineered Fill**" means all soil or rock materials specified in this section (including select coarse fill, filter material, riprap), except RSEM material.

2.6.2 General

The Work involved in this section includes the supply, processing, hauling, placing, moisture conditioning (as needed), and compaction of Engineered Fill to specified requirements, and the material source area development, maintenance, and restoration, including haul and access roads.

The Contractor will provide a Source and Embankment Construction Plan to Hydro's Representative, for review and for acceptance in accordance with GC. 4.21 submittals a minimum thirty days before commencing excavation as defined in Section 2.7.7 Embankment Material.

2.6.3 Standards

Work will conform to the current version of the following standards as applicable:

ASTM D422	Particle Size Analysis of Soils
ASTM D698 – Procedure A, B or C	Laboratory Compaction Characteristics of Soil Using Standard Effort (Standard Proctor Density Test)
ASTM D854	Specific Gravity of Soils
ASTM D1556	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2167	Density and Unit Weight of Soil in Place by Rubber Balloon Method
ASTM D2216	Water (Moisture) Content in Soil and Rock
ASTM D2487	Classification of Soils for Engineering Purposes
ASTM D4718	Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
Minnesota Technical Release 3	Loose Riprap Protection, Soil Conservation Service, US Department of Agriculture, July 1989

2.6.4 Materials

Engineered Fill will consist of hard, durable rock or soil particles from an approved area that are not subject to deterioration during handling or placement. The Contractor will use the source areas as shown on the drawings or otherwise approved and the Contractor will ensure that they be free of organic or other deleterious materials.

PAG material as determined by Hydro's Representative will not be used by the Contractor unless specifically approved in writing.

The specified gradations apply to materials placed in the Work following compaction.

The Contractor may use material marginally outside of the specified limits, subject to acceptance in accordance with GC 4.21 - Submittals and depending upon the intended location within each fill zone. Materials from required excavations which are suitable for construction, either directly or by processing, will be stockpiled by the Contractor in approved areas or placed directly in the Work, as directed.

Fill characteristics for the various zones are summarized in Table 2.6.4.

Table 2.6.4 Engineered Fill Zones

Fill Zone	Description		Source
I	Select Coarse Fill	Select Coarse Fill (< 150 mm with fines content 50%	Left Bank Excavation
II	Drainage Material (pipe backfill)	Well graded sand or gravelly sand (SW), less than 3% fines, 56 mm minus	Left Bank, Road and In-River Excavations

Fill Zone	Description		Source
IV	Riprap Filter	D_{85} = 21 mm , D_{50} = 5 mm, D_{15} = 0.5 mm	Left Bank Excavation, Road and In-River Excavations
V	Granular Material	Random Granular Material (D_{100} = 300 mm with fines content 0% to 15%).	Left Bank Excavation, Road and In-River Excavations
VI	Riprap Bedding	D_{85} = 100 mm , D_{50} = 70 mm, D_{15} = 35 mm	Wuthrich Quarry
VII	Riprap 10kg Class	MoT Riprap Class 10 kg Class D_{50} = 200 mm (Refer to Section 2.12.1 General)	Wuthrich Quarry
VIII	Riprap 500kg Class	MoT Riprap Class 500 kg D_{50} = 735 mm (Refer to Section 2.12.1 General)	Wuthrich Quarry
IX	RSEM	Relocated Excavated Surplus Material (overburden only)	Left Bank Excavation and other excavations

Note: Fines content is material finer than #200 sieve (75-µm) per ASTM D422.

2.6.5 Execution

(a) Stockpile and Disposal Areas: Before starting the Work, the Contractor will obtain written acceptance in accordance with GC 4.21 - Submittals of stockpile and disposal areas from Hydro's Representative.

The Contractor may stockpile processed materials provided they are placed in such a manner as to prevent erosion, contamination, and segregation.

The Contractor will select suitable construction techniques and equipment that minimise leakage and spillage during transport of excavated material throughout the duration of the Works, and in accordance with the requirements of Appendix I – Environmental Obligations. All necessary precautions will be taken by the Contractor to preserve the stockpiled material in the soundest possible condition.

The Contractor will construct all stockpiles in a neat and orderly fashion with maximum 3H:1V side slopes. Material being stockpiled or disposed of will be compacted by the Contractor with a minimum of one pass of D6 dozer or similar heavy construction equipment. The Contractor will ensure that lift thickness between compaction be a maximum of 5.0 m.

The Contractor will provide positive surface drainage of stockpile and disposal fills. The Contractor will ensure that disposal fills will have temporary slopes no steeper than 2H:1V, and permanent slopes no steeper than 3H:1V, be stable within themselves, and will not cause instability of adjacent natural slopes or any part of the Work.

(b) Source Areas: The Contractor will submit a Source and Embankment Construction Plan in accordance with Section 2.7.7 Embankment Material. The Contractor will dispose of unsuitable material as fill in RSEM Area L3.

(c) Processing: The intent is to use available materials with minimal processing. However, some processing by the Contractor may be required to meet design requirements. Processing may include: separating material into various sizes, blending one material with another, scalping oversize material, drying or moisture conditioning, and screening. The Contractor will thoroughly mix materials in such a manner that a homogeneous fill of specified quality is achieved. The Contractor will remove oversize material from the fill either prior to being placed or after it is dumped and spread but before compaction begins.

(d) Engineered Fill Placement:

(i) *Compaction Equipment*: The Contractor will use compaction equipment of the appropriate size and type to achieve the specified fill densities. A minimum 10t vibratory compactor will be available for use during the Work, as provided by the Contractor. Smaller, hand operated compactors will be used by the Contractor in restricted areas and adjacent to pipes and similar elements. Notwithstanding the requirements stated above, the equipment and compaction procedures will be subject to approval by Hydro's Representative.

(ii) *Moisture Conditioning*: Equipment used by the Contractor to apply water to fill materials will be designed to apply water uniformly. The Contractor will use water trucks equipped with positive shutoff valves that prevent leakage from the nozzles when the equipment is not operating. Moisture conditioning, if required, will include mixing and/or drying of the soil by discing or blending with a grader to distribute moisture evenly throughout the material prior to compaction or as directed.

(iii) *Engineered Fill Placement*: In general, Engineered Fill placement will start at the lowest foundation level and progress laterally and upward. The elevation differential between adjacent lifts of the fill surface will not exceed the allowable lift thickness, unless approved. The Contractor will place material as indicated in Table 2.6.5(d).

The Contractor will place, spread and level fill in such a manner as to avoid segregation and to obtain a well-graded mass.

Compactor passes will overlap by at least 0.3 m.

When compacting fill on a slope, the material will be compacted by the Contractor by running a dozer in an up-slope direction. The Contractor will ensure that slopes are no steeper than 3H:1V.

Traffic routing on the fill will be controlled by the Contractor to prevent cross contamination of adjacent zones. Areas contaminated, as determined by Hydro's Representative, will be repaired by the Contractor prior to placing the next lift in the affected area.

The Contractor will prevent runoff or water from any other source from eroding fill materials, and will repair any erosion damage.

The Contractor will remove or rework any placed fill which does not meet the specified requirements until it meets specified requirements.

The Contractor will scarify and moisture condition completed lifts immediately prior to the placement of the overlying lift.

In restricted areas and adjacent to structures, small, hand operated compactors will be used by the Contractor and the Contractor will reduce lift thickness as appropriate to produce the specified density. Necessary precautions will be taken by the Contractor when operating compaction equipment, to avoid damage to adjacent structures and instrumentation devices and their leads, and to avoid disturbing the foundation. Any damage or disturbance will be repaired or remedied by the Contractor at its own expense.

When ambient temperatures are less than 0°C, fill placement will cease except as may be allowed under closely monitored conditions, as long as specified results are achieved.

Table 2.6.5(g) Quality Control Testing of Engineered Fill

Fill Zone	Material	Area	Test Frequency; minimum 1 test per			
			Field Density and Moisture Content NDM	Lab Moisture Content	Gradation	Standard Proctor Max, Dry Density[1] (%)
I	Select Coarse Fill	All areas	500 m^3	1000 m^3	1000 m^3	3,000 m^3
II	Drainage Material	All areas	0	0	2,000 m^3	0
V	Granular Material	Closure Cover	0	0	2,000 m^3	0
		Underdrain	0	0	2,000 m^3	0

Notes:

[1] Based on maximum dry density determined by ASTM D-698.

Fill that does not meet the specified requirements, on the basis of the sampling and testing, will be removed by the Contractor and replaced with conforming material. Rejection of fill material may be made at source, in transporting vehicles, or in place.

[redacted]

2.7 Dam Site Access Roads Excavation and Embankment

2.7.1 Allowance for Cold Weather Construction and Alternative Methods

Notwithstanding any other reference, the Contractor can construct embankment using granular material during cold weather, under the following conditions:

(a) the excavated native subgrade surface may be partially frozen when embankment construction begins. This will require that the Contractor expose the native subgrade and start embankment construction within the same time frame, providing a continuous operation. The Contractor will not

allow the subgrade to be exposed for a period of time allowing frost penetration at depth without removing the accumulated frozen subgrade prior to embankment placement. No additional payment will be made for the Contractor to take measures to minimize freezing of the subgrade surface.

(b) where water is infiltrating the excavation from sources which cannot be readily identified and controlled, the first lift of borrow embankment material may exceed the specified thickness of 150 mm by up to 600 mm, as required to push the water away from the embankment area. This lift thickness will be kept to the minimum necessary, and will be compacted using a static sheep's foot roller;

(c) embankment built during sub-zero temperatures may be built up to an elevation of 500 mm below design subgrade elevation. Subsequent lifts will be constructed in accordance with the Standard Specifications;

(d) borrow material used for embankment construction will be monitored to ensure the amount of frozen material is negligible. Lifts will be spread quickly and compacted immediately thereafter before frost penetrates the lift;

(e) the Contractor will ensure that frost penetration does not occur on partially built up embankments, and therefore construction of embankments that cannot be completed to the desired top elevation within a normal day's work schedule may need to be built under a continuous twenty-four hours per day schedule, or otherwise extended work operation as required; and

(f) compaction effort for required density may be determined by establishing acceptable rolling patterns for the borrow embankment material.

Approval of the above cold weather construction technique may be withdrawn at any time by Hydro's Representative in which case the Contractor will cease said construction.

The Contractor, with the written acceptance of Hydro's Representative, will ensure that the embankment constructed during cold weather using these techniques demonstrates acceptable strength for long term road performance through the use of proof rolling and nuclear moisture density testing of selected sample areas at variable depths. Embankment that does not demonstrate adequate strength and compaction will be reconstructed by the Contractor at the Contractor's expense. No additional compensation will be made for this item of Work.

2.7.2 Overburden Excavation

The Contractor will excavate overburden material at Wuthrich Quarry and stockpile overburden material in the quarry in accordance with the Contractor's Pit Development Plan.

[redacted]

2.7.3 Type A Excavation

The Contractor will excavate Type A material to the lines and grades shown on the drawings and in accordance with SS 201, SS 204 and as specified in this Appendix G – Specifications. The Contractor will rip or blast using controlled blasting and retain a blasting consultant in accordance with SS 204. Contrary to SS 201, intact shale rock encountered in the excavations shall be considered Type A regardless of how it is excavated.

All excavated shale is potentially acid generating and will be stored in its temporary location. The Contractor will comply with the requirements of BC Hydro's Acid Rock Drainage and Metal Leachate Management Plan in the CEMP.

Type A excavation is restricted to the limits shown on the drawings. Type A excavation for temporary features will not be permitted.

[redacted]

(a) Temporary Storage of Excavated Rock: Type A Excavation is Potential Acid Generating rock and will be stored at the designated site for ultimate disposal by others. The Contractor will design and maintain the temporary storage site for the excavated rock, including perimeter drainage works to keep the rock dry from surface drainage, and maintain a membrane over the rock to keep the rock dry from precipitation and not in contact with the atmosphere. The storage design and maintenance shall, at a minimum, include the following:

(i) Type A Excavation will be performed in a continuous fashion to ensure that treatment of exposed and excavated rock is complete within 30 days of the start of Type A Excavation.

(ii) In all directions the temporary storage site will be graded with positive drainage away from the pile and towards the ditch at a slope of 0.5% to 2.5%.

(iii) A minimum of 300 mm of compacted clay or clayey silt overburden with fines content greater than 70% will be compacted in two lifts over the graded surface. Compaction will be performed on each lift with at least a single pass of a static roller weighing at least 10,000 kg. The Contractor may taper and thin the edge of the compacted clay or clay silt into the ditch. The Contractor may use an equivalent geosynthetic liner, with a minimum design life of five years, including but not limited to a 60mm HDPE liner, 60mm LDPE liner, or a geosynthetic clay liner. In all cases the Contractor will place the liner with sufficient overlap or field weld the seams to maintain an impermeable boundary that directs any water towards the perimeter ditch. Any horizontal overlap will be sufficient to create a 25 mm vertical offset. If an artificial liner is used the Contractor will be responsible to use it in a manner that does not damage the integrity of the liner. The Contractor will repair any perforations.

(iv) The Contractor will construct and maintain for the duration of the Work a perimeter V-shaped ditch at least 1.5 meters deep. The ditch will outlet to the drainage system while maintaining a minimum of 0.5 meters of water in the ditch when drainage is occurring. The ditch grade will have to be designed and constructed so that it does not erode.

(v) The Type A rock will be placed on the prepared clay or clayey silt layer a minimum of 2 meters from the ditch edge.

(vi) The material may be placed at a maximum slope of 2H:1V to a maximum height of 10 meters. Not later than one week following placement at any location all excavated rock at that location will be covered with an impermeable membrane.

(vii) The membrane will be low density polyethylene such as Enviroflex 20 mil or approved equivalent. Any approved equivalent must have a design life of at least 5 years.

(viii) Any plateau surface of the pile will be graded in a manner that maintains surface drainage off the membrane away from adjacent uncovered newly placed rock.

(ix) The membrane may be overlapped at the top of a pile. The membrane may be overlapped on the sides of a pile provided 2 metres of overlap is used and graded in a manner to flow away from the overlap.

(x) The membrane must be weighted down to protect from wind with sand bags or equivalent. Piercing the membrane with anchors is not acceptable.

(xi) The membrane must cover the excavated rock and end at an elevation lower than the adjacent rock so that water flows off the membrane into the ditch without contacting the rock.

(xii) Any breach of the membrane must be repaired by the Contractor within 12 hours of discovery.

[redacted]

(b) Drainage Control: The Contractor will be responsible for drainage control. A separate Drainage Control Plan, specific for the Type A Excavation and temporary storage works, will be submitted a minimum two weeks before commencing Type A Excavation and reviewed on a weekly basis by Hydro's Representative and the Contractor. At a minimum the Drainage Control Plan will include the following:

(i) A description of the construction staging and associated procedures that will be used to control drainage.

(ii) A schedule for the proposed activities, including Type A Excavation and stockpiling.

(iii) A description of the site specific measure for drainage management, including sizing of temporary culverts, ditches, and berming.

(iv) A description of the drainage control to be implemented in emergency situations.

(v) A description of the drainage control monitoring procedures applied during the excavation.

2.7.4 Type D Excavation

The Contractor will excavate Type D material to the lines and grades shown on the drawings, in accordance with SS 201 and as specified in this Appendix G – Specifications. Suitable excavated material, as defined in Section 2.7.7 Embankment Material, will be utilized by the Contractor as embankment fill. The Contractor will dispose of unsuitable excavated material at the designated disposal locations shown on the drawings.

[redacted]

[redacted]

The following Hold Points will apply:

(a) The Contractor must receive BC Hydro's acceptance of the native subgrade before proceeding with the embankment placement. Depending on the materials encountered at the native subgrade further excavation may be required to be performed by the Contractor, or in some areas the design of the road embankment may need to be adjusted, and will be provided to the Contractor by Hydro's Representative.

(b) For every 50 m length of the road cut to the side slopes and grades shown on the drawings, the Contractor must receive Hydro's Representative acceptance of the side slopes before proceeding with the next portion of slope cutting. Depending on the material exposed along the side cuts, the cut slope design may be revised by Hydro's Representative and the revised design will be constructed by the Contractor.

2.7.5 Colluvium Excavation

The Contractor will excavate colluvium deposits encountered beneath River Road to the alluvial gravel horizon as shown on the drawings and at the direction of Hydro's Representative.

The Contractor will dispose of excavated colluvium material at the colluvium disposal locations shown on the drawings or at the direction of Hydro's Representative. The colluvium thickness is not known and is expected to vary. The Contractor will demonstrate that colluvium is no longer present by providing Hydro's Representative with a visual inspection of excavated material.

[redacted]

The following Hold Points will apply:

(a) The Contractor must receive BC Hydro's acceptance of the native subgrade before proceeding with the embankment placement. Depending on the materials encountered at the native subgrade further excavation may be required to be performed by the Contractor, or in some areas the design of the road embankment may be adjusted by Hydro's Representative and the revised design will be constructed by the Contractor. For inspection purposes the area does not need to be isolated or dewatered.

2.7.6 Drainage Blanket

The Contractor will construct drainage blankets at the locations shown on the drawing and as specified in this Appendix G – Specifications. The lowest 0.6 m of embankment fills will conform to SS 202 - Select Granular Sub-Base (SGSB) fill material and will be compacted by the Contractor to 95% of the laboratory density. SGSB will be produced in accordance with SS 202. The foundation of embankment fills may consist of sensitive soils. The Contractor will perform placement of the initial lift in accordance with SS 201.37. The Contractor will connect this SGSB layer to the ditch lines on either side of the road embankment if the elevation of the base of this layer is higher than the ditch line. If the elevation of the

base of this layer is lower than the ditch lines on either side, the Contractor will ensure that positive drainage is maintained along the road and that drainage is provided into the ditches at a lower elevation.

[redacted]

2.7.7 Embankment Material

(a) General: Embankment construction will be performed by the Contractor in accordance with SS 201 and as modified in this Appendix G – Specifications. Embankment material will meet the requirements of SS201.44, except for those areas that SGSB is required as drainage blanket. The Contractor will source embankment material from Type D Excavations, UGS material, In-River Excavation #1, In-River Excavation #3, and processed surplus rock from Wuthrich Quarry. The Contractor will construct embankments to neatlines and grades. Finished surfaces will be left in a roughened condition in order to promote erosion control and vegetation growth.

The Contractor will provide a Source and Embankment Construction Plan to Hydro's Representative for review and written acceptance, in accordance with GC. 4.21 – Submittals, a minimum of thirty days before commencing excavation and embankment works. The Source and Embankment Construction Plan will be incidental to the Work. No additional compensation will be made for this item of Work. The plan will include, at a minimum, the following information:

(i) Schedule for source and in-river excavations;

(ii) Schedule for quarry development;

(iii) Schedule for embankment per station;

(iv) Anticipated quantities extracted; and

(v) A description of how the Work will be completed in accordance with the applicable Environmental Protection Plan (EPP) as described in Section 2.7.8 River Road and North Bridge Approach Embankment.

The Contractor will compact the material with a moisture content that does not deviate from the optimum moisture content (determined by ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort) by more than 2%. Further to SS 201.37 a significant portion of material for the performance of the Work is anticipated to be above or below optimum moisture content. For material at or a few percent above optimum moisture content drying by the Contractor may be required prior to its use. Drying will be considered incidental to the Work. No additional compensation will be made for this item of Work. For material below optimum moisture content; the addition of water by the Contractor may be required prior to compaction. Adding water will be considered incidental to the Work. No additional compensation will be made for this item of Work.

The Contractor will place and compact the material in lifts with loose thickness not exceeding 300 mm. Maximum aggregate particle size will not exceed 50% of the lift thickness (i.e., 150 mm). The Contractor will achieve friction angles of 38 degrees for the granular fill. The friction angle will

be determined by the Contractor by performing bearing plate tests (ASTM test method D1195) and proof rolling.

The top 300 mm below subgrade elevation will be compacted to a minimum of 100% of the laboratory density obtained by the current ASTM test method D698 prior to placement of SGSB. Contrary to SS 201.97, no separate payment will be made for increased compaction to 100% of the laboratory density. This work will be considered incidental to the placement of SGSB. No additional compensation will be made for this item of Work.

A waiting period may be required before placing the next layer of fill for the North Bank Road between station 71+960 and 72+160 above elevation 492 m. This waiting period is expected to be approximately two days. The Contractor will allow for this waiting period in its Work Program and Schedule. Fill rates will not be restricted below elevation 492 m.

The following Hold Points will apply:

(i) Upon the full exposure of the subgrade (i.e. after clearing, grubbing and stripping), the Contractor must receive Hydro's Representative's acceptance of the native subgrade before proceeding with fill placement. Depending on the materials encountered at the native subgrade further excavation to be performed by the Contractor may be required, or in some areas the design of the road embankment may need to be adjusted and will be provided to the Contractor by Hydro's Representative.

(b) Proving Friction Angles by Bearing Plate Test: The Contractor will prove the friction angles of the fill embankment material in accordance with the frequency of testing specified in Section 1.13 Quality Management unless the requirement is waived or reduced by Hydro's Representative. The Contractor will perform the bearing plate load test as per the requirements of the ASTM D1195 except that the Contractor will ensure that the diameter of the plate will be the larger of 305 mm or six times the maximum aggregate size. The Contractor will ensure that the bearing plate will consist of a set of circular steel bearing plates not less than 25 mm thick, machined so that they can be arranged in pyramid fashion to provide rigidity, and having diameters ranging from 75 mm to 305 mm. The diameters of the adjacent plates in the pyramid arrangement will not differ by more than 75 mm.

The Contractor will perform the bearing plate test on level ground conditions, where at least 1m of embankment fill is present below the grade and under the bearing plate. The Contractor will ensure that the grade will be level and will be at the same elevation as the bearing plate test for a minimum of 2 m around the test location. The Contractor will not place reaction (i.e., tires, reaction beams, etc.) on the ground adjacent to the bearing plate within 2 m of the test location, unless otherwise accepted by Hydro's Representative.

The Contractor will ensure that the bearing plate will be seated initially on ground as per the requirements of ASTM D1195 to establish zero displacement conditions. After the initial seating, the Contractor will perform the bearing plate test by applying loads at given deflections of 1 mm, 3 mm, 6 mm, 12 mm, 24 mm, 50 mm, 100 mm and 200 mm until a maximum bearing pressure of 400kPa is reached. After each given deflection, the same load will be maintained by the Contractor constantly until the rate of deflection is 0.03 mm per minute or less for three continuous minutes. The Contractor will record the displacements at all dial gauges at one minute

intervals throughout each loading step. The Contractor will submit test results (including a sketch showing the test setup and the location of various gauges) to Hydro's Representative for evaluation of the bearing pressure at failure. Once the bearing pressure is determined by Hydro's Representative, the friction angle can be estimated from the following table.

Bearing Pressure under Plate at Failure (kPa)	Friction Angle (degrees)
175	38
105	36
60	33
35	30
20	27

No additional compensation will be made for this item of Work.

2.7.8 River Road and North Bridge Approach Embankment

(a) General: The Contractor will construct the River Road and North Bridge Approach embankment in accordance with Section 2.7.7 Embankment Material and as specified herein.

Zone A and Zone B embankment material for River Road and the North Bridge Approach will be sourced from In-River Excavation #1 and In-River Excavation #3, and may be sourced from Wuthrich Quarry. The Contractor will complete in-river excavations in accordance with Appendix I – Environmental Obligations and the approval required under Section 9 of the *Water Act* and the authorization under the *Fisheries Act.* The Contractor will excavate In-River Excavation #1 and In-River Excavation #3 to the limits shown on the drawings.

The Contractor will include in an EPP (prepared in accordance with Appendix I – Environmental Obligations) proposed excavation techniques, sedimentation mitigation measures, and process for stockpiling and drying of material, scour protection measures, and environmental monitoring and testing.

The Contractor will construct the North Bridge Approach and the Tote Road to the underside of bridge end fill (elevation 416.5m) from station 510+486 to station 510+600 as shown on the drawings, on or before the applicable milestone date for this Work in Appendix F – Work Program and Schedule.

(b) Zone A Embankment: The Contractor will use excavated material from In-River Excavation #1 and In-River Excavation #3 as compacted alluvial gravel to construct the initial starter embankment portion of River Road and the North Bridge Approach below the water line (Zone A, as shown on the drawings).

The Contractor may construct Zone A embankment with compacted embankment rock available from Wuthrich Quarry. The Contractor will request and receive written acceptance from Hydro's Representative prior to use. Compacted embankment rock generated from riprap production will consist of well graded rock fill with a minimum aggregate size of 50 mm and maximum aggregate size of 150 mm. Pursuant to Section 36(3) of the *Fisheries Act*, use of ammonium-nitrate fuel mixtures are prohibited in the production of materials which is to be used in streams.

Compacted alluvial gravel will achieve a friction angle of 36 degrees within the Zone A embankment. Dynamic Compaction (DC) or other approaches may be required to be performed by the Contractor to achieve the friction angle requirements. The friction angle will be confirmed by the Contractor by performing Becker Penetration Tests on the embankment. The Contractor will construct a limited portion of the initial embankment, carry out the Becker Penetration Test,

and prove the friction angle to the satisfaction of Hydro's Representative before carrying out with the next segment of initial embankment.

Construction of the North Bridge Approach embankment below the water level at time of construction between Station 510+486 and Station 510+680 will not require compaction. Upon reaching water level at time of construction, the haul equipment shall compact using a minimum 3 passes to compact that surface for the entire surface.

The following Hold Point will apply:

(i) Upon construction of a limited portion of the initial starter embankment, the Contractor will perform a Becker Penetration Test to prove the friction angle. The Contractor will submit the results to Hydro's Representative for acceptance and must not proceed with construction of the next portion of embankment until Hydro's Representative accepts the results and provides written authorization.

(c) Zone B Embankment: The Contractor will use excavated material from In-River Excavation #1 and In-River Excavation #3, as compacted alluvial gravel to construct the embankment portion of River Road and the North Bridge Approach above the waterline (Zone B as shown on the drawings). The Contractor will leave in stockpile alluvial gravel left over from the In-River Excavation #3 and not incorporated into Zone B, adjacent to and upstream of the North Bridge Approach as shown on the drawings.

The Contractor will compact the material with a moisture content that does not deviate from the optimum moisture content (determined by ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort) by more than 2%.

The Contractor will place and compact the material in Zone B in lifts with loose thickness not exceeding 300 mm. A friction angle of 38 degrees and unit weight of 20kN/m^3 will be achieved by the Contractor within this zone. The friction angle will be confirmed by the Contractor by performing bearing plate tests as specified in Section 2.7.7 ii) Proving Friction Angles by Bearing Plate Test. Field density tests or method compaction specifications may be performed by the Contractor instead of the bearing plate tests depending on the type and gradation of the fill material and only if accepted by Hydro's Representative prior to fill placement. The Contractor will submit the material description and gradation to Hydro's Representative for evaluation. The Contractor will not perform the bearing plate tests when the ground is frozen.

Except to construct the channel depressions shown on drawing 1016-C09-06010, the Contractor will not excavate below elevation 406.0 m at In-River Excavation #3 without first receiving written authorization from Hydro's Representative. The Contractor will notify Hydro's Representative a minimum of one month prior to excavating below the specified grade and may not commence operations until Hydro's Representative has provided written authorization.

A waiting period may be required before placing the next layer of fill for the River Road. This waiting period is expected to be approximately four days. The Contractor will allow for this waiting period in the Work Program and Schedule.

Measurement will be on a neat line basis of compacted alluvial gravel in embankment or left in stockpile. Payment for alluvial gravel from In-River Excavation #1 and In-River Excavation #3 in

embankment will be made at the Unit Price for Item 5.11 “Zone B Embankment” per cubic metre, as set out in Appendix E – Schedule of Quantities and Prices, and will be accepted as full compensation for everything furnished and done including, temporary access, excavating, loading, hauling, placing, watering, and compaction.

[redacted]

(d) Proving Friction Angles by Becker Penetration Test: The requirements for proving the friction angles by Becker Penetration Tests may be waived or reduced depending on the type and gradation of the material used for construction of the embankment rock or compacted gravel below water. The Contractor will submit the description of the granular fill placed as well as the gradation to Hydro’s Representative to assess the need for Becker Penetration Tests.

Proving the friction angle by Becker Penetration Test will only be required for the fill placed below water level at River Road, where the thickness of the fill placed below water is greater than or equal to 2 m. The lowest elevation of Becker Penetration Tests will correspond to the bottom of the colluvium excavation, or 2m below original ground, however the Contractor’s Becker Penetration drill will be capable of reaching 8m depth. The Contractor will perform the Becker Penetration Test with the frequency specified in Appendix J – Quality. The Contractor will perform the Becker Penetration Test after the embankment is approximately 1 m above the water level and will not proceed with raising the embankment until the Becker Penetration Test is performed and the results are accepted by Hydro’s Representative. The Contractor will perform the Becker Penetration Test at a setback of 3 m from the crest of the slope. The location of the Becker Penetration Test will be accepted by Hydro’s Representative before testing commences. The Contractor will not perform the Becker Penetration Test when the ground/fill is frozen.

The Contractor will measure and record bounce chamber pressure as well as the number of blows per 305 mm of penetration during the Becker Penetration Test. The Contractor will convert the results to the equivalent Standard Penetration Test (SPT) blow counts using the Harder and Seed (1986) approach. The Contractor will ensure that a minimum equivalent SPT blow count of twenty blows per 305 mm of penetration is achieved for the fill placed below water.

[redacted]

2.7.9 Instrumentation

(a) Installation: Instrumentation including piezometers (push-in and borehole installed), inclinometers, toe pegs and settlement hubs will be supplied and installed by the Contractor as required at the following locations:

Location	Instrumentation Required
River portion of River Road and north approach embankment	Toe Pegs Piezometers (Push-In) Inclinometers
Upper portion of River Road	Settlement Hubs
North Bank Road (71+975 to 72+175)	Toe Pegs Piezometers (Borehole Installed) Inclinometers

Push-in piezometers will consist of RST VW2100-DP Vibrating Wire Piezometers with a maximum pressure range of 0.7MPa (available from RST Instruments Ltd. – Phone No. 604-540-1100), or approved equivalent. The Contractor will install the push-in piezometers close to the north crest of the finished River Road or north approach embankment, as shown on the drawings, in the areas where colluvium is more than 2 m thick and not entirely sub-excavated. The Contractor will push-in the push-in piezometers a minimum of 750 mm into the colluvium. If practical refusal is reached at shallower penetrations, the Contractor will extend and use the piezometer at another location. The Contractor will ensure that the push-in piezometers are equipped with a protector riser pipe around the cable. The Contractor will place the fill around the riser pipe in a manner not to damage the piezometer or the cable. The Contractor will ensure that the riser pipe and the cable extend 1.5 m above the final grade. The elevation of the piezometer tip will be recorded by the Contractor upon initial installation and the Contractor will clearly mark on the riser pipe with permanent marking. The wiring of the piezometers will extend beyond the top of the riser pipe and will be affixed by the Contractor to the riser pipe by tape. The Contractor will ensure that in areas with extensive colluvium, the maximum distance between push-in piezometers will not be more than 75 m. Installation details of the push-in piezometers are shown on the drawings.

Borehole installed piezometers will consist of RST VW2100 Vibrating Wire Piezometers with a maximum pressure range of 0.7MPa (available from RST Instruments Ltd.) or approved equivalent. The Contractor will install the piezometers down a cased borehole near the crest of the finished fill embankment, as shown on the drawings to the depths specified by Hydro's Representative. The Contractor will install the vibrating-wire transducer within a sand filter zone capped by a bentonite seal 2 m thick. The Contractor will equip the borehole-installed piezometers with a protector riser pipe around the cable. The Contractor will place the fill around the riser pipe in a manner not to damage the piezometer or the cable. The Contractor will ensure that the riser pipe and the cable will extend 1.5 m above the final grade. The elevation of the piezometer tip will be recorded by the Contractor upon initial installation and will be clearly marked by the Contractor on the riser pipe with permanent marking. The Contractor will ensure the wiring of the piezometers will extend beyond the top of the riser pipe and will be affixed to the riser pipe by tape. The maximum distance between borehole installed piezometers will not be more than 50 m at the North Bank Road. Installation details of the borehole installed piezometers are included in the drawings.

The Contractor will install slope inclinometers under the supervision of Hydro's Representative that will consist of 70 mm diameter RST High Endurance Inclinometer Casing (available from RST Instruments Ltd.), or approved equivalent. Details of the inclinometer installation are shown on the drawings. The Contractor will install Inclinometers down a cased borehole to a depth of at

least 3 m into bedrock, and secure at the base of the hole using an inclinometer casing anchor (available from RST Instruments or approved equivalent). The Contractor will ensure that probe grooves on the inside of the casing will be aligned in the anticipated direction of movement. The annulus between the borehole wall and inclinometer casing will be backfilled by the Contractor with a cement/bentonite grout compatible with the surrounding soil. The Contractor will place the grout backfill around the outside of the inclinometer casing in a manner not to damage or distort the casing (the use of grout ports to grout through the inclinometer casing is discouraged). Regardless of the method used, the Contractor will not apply weight or force to the top of the inclinometer casing to hold it in place during grouting. The Contractor will ensure that the upper portion of the inclinometer installation is protected by a 100 mm diameter outer steel casing to the dimensions shown on the drawings. The inclinometer casing, and the 100 mm diameter outer steel casing, will extend a minimum of 0.5 m above the final grade. At the completion of installation the horizontal orientation (azimuth) of the probe grooves will be measured by the Contractor using a compass and the primary ('A-A') groove clearly marked on the casing with permanent marking. The Contractor will also carefully lower a sounding tape or "dummy" probe to the bottom of the completed installation, in a manner to prevent damage to the casing, in order to confirm there are no obstructions. The depth and elevation of the inclinometer tip will be recorded by the Contractor upon initial installation and will be clearly marked by the Contractor on the casing with permanent marking. The Contractor will install slope inclinometers at the following locations:

(i) Along the outer edge of the initial starter embankment at the river portion of River Road (i.e., Zone A as shown on the drawings) in the areas of extensive colluvium, where the entire colluvium layer is not being entirely excavated. The Contractor will ensure that in this area the distance between adjacent slope inclinometers will not be more than 150 m; and

(ii) Along the outer edges of the fill embankment across the creek under the North Bank Road (71+975 to 72+175). The Contractor will ensure that in this area the distance between adjacent slope inclinometers will not be more than 75 m.

Toe pegs will consist of wooden posts installed into the road fill at the edge of the fill embankment and a set top wooden piece oriented horizontally and attached to the top of the vertical post, as shown on the drawings. Care must be taken by the Contractor not to damage the toe pegs after installation. The Contractor will install toe pegs at a maximum spacing of 20 m at the following locations:

(i) Along the outer edge of the initial starter embankment at the river portion of River Road and north approach embankment (i.e., Zone A as shown on the drawings); and

(ii) Along the outer edges of the fill embankment across the creek under the North Bank Road (71+975 to 72+175).

Settlement hubs will consist of wooden stakes installed to depth below finished grade, as shown on the drawings. The Contractor will install settlement hubs at a maximum spacing of 20 m immediately after reaching the final design elevation along the centre of the embankment fills in the areas where paving the road with asphalt is anticipated within three months after the end of the construction (e.g., the upper portion of the River Road).

(b) Monitoring and Surveying of Toe Pegs, Piezometers and Slope Inclinometers: The Contractor will monitor and read the instrumentation including position and elevation of the toe pegs, slope inclinometers and piezometers at the following time intervals:

(i) One day before placement of any lift;

(ii) Immediately after placement and compaction of any lift;

(iii) Three days after placement of the lift;

(iv) Six days after placement of the lift; and

(v) Once a week after the first week of placement if required.

The monitoring data will include:

(vi) surveyed locations and elevations of the top of the monitoring points and toe pegs;

(vii) surveyed locations and elevations of the top of fill adjacent to toe pegs;

(viii) piezometer readings in kPa units; and

(ix) slope inclinometer readings in Microsoft Excel format.

The Contractor will perform baseline readings upon installation of the monitoring equipment and will consist of three independent sets of readings. Successive base readings will not vary by more than 5 mm.

The monitoring data will be provided by the Contractor to Hydro's Representative in a consistent format within twenty-four hours after reading of the instruments. The Contractor will use consistent reference elevations and reference numbers for the toe pegs, piezometers and slope inclinometers. The decision on timing of the fill placement will be made based on the monitoring data by Hydro's Representative. The Contractor will not place additional lifts unless indicated otherwise by Hydro's Representative. It is anticipated at this point that the wait time between lifts will be approximately one week.

(c) Monitoring and Surveying of Settlement Hubs: The Contractor will survey the location and elevation of the settlement hubs at the following time intervals:

(i) Immediately after installation of the hubs upon reaching the design elevation; and

(ii) Every seven days during the first month, and every fourteen days during the second month and monthly after.

The monitoring data will include surveyed locations and elevations of the top of the settlement hubs and top of fill adjacent to the settlement gauges. The Contractor will perform baseline readings upon installation of the settlement hubs and will consist of three independent sets of readings. Successive base readings will not vary by more than 5 mm.

The monitoring data will be provided by the Contractor to Hydro's Representative in a consistent format within twenty-four hours after reading of the instruments. The Contractor will use consistent reference elevations and reference numbers for the settlement hubs.

[redacted]

The Contractor will observe precautions necessary for protection of instrumentation devices. After instrumentation devices have been installed, the Contractor will replace at its own cost any equipment that is damaged or becomes unreliable as a result of its negligence. Damaged monitoring equipment will be repaired or replaced by the Contractor at the sole cost of the Contractor.

2.8 Non-woven Geotextile on Subgrade

The Contractor will supply and install non-woven geotextile as shown on the drawings or as directed by Hydro's Representative. The non-woven geotextile will meet the following minimum average roll values:

Grab Tensile Strength	> 670N	ASTM test D4632
CBR Puncture	> 1800N	ASTM test D6241
Trapezoidal Tear	> 275N	ASTM test D4533
Apparent Opening Size	210+/- 20um	ASTM test D4751

Securing pins will be supplied and installed by the Contractor. Securing pins will be a minimum of 9 mm in diameter, of steel, pointed at one end, and fabricated with a head to retain a washer having an outside diameter of no less than 100 mm. The length of the pins will be no less than 300 mm.

The Contractor will insert securing pins with washers through both strips of overlapped fabric at not greater than 5 m intervals, along a line through the midpoint of the 0.5 m overlap. The Contractor will also install securing pins with washers at 5 m intervals along the outside edges of the Geotextiles. The Contractor will install additional pins regardless of location as necessary to prevent any slippage of the fabric.

2.9 Not Used

2.10 Granular Aggregates

2.10.1 General

The Contractor will produce, haul, place, compact, and stockpile granular materials in accordance with SS 201 and SS 202 unless otherwise modified in this Appendix G – Specifications. Granular aggregates will be produced by the Contractor to the gradation requirements specified in Table 202-C, and will conform to the requirements of SS 202 in all other respects.

All granular processing operations will be limited to the areas shown on the drawings.

The Contractor will use the available site sources including UGS excavated from the Left Bank Excavation, In-river Excavations, Wuthrich Quarry, and Type D Excavation for the production, stockpiling

and handling of granular materials. Historical geotechnical reports and drill logs are included in the Electronic Data Site.

When producing, crushing, stockpiling and handling granular materials, the Contractor will comply with all provisions of the *Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia, available from the Ministry of Energy, Mines and Petroleum Resources at www.em.gov.bc.ca/Subwebs/mining/Healsafe/mxready/mxcode01.htm.

The Contractor will use all the material available within the source, including oversized material, and will use a primary crusher as part of its aggregate production operation. The Contractor is advised that, depending upon time of production heating the aggregate screens may be required to be performed by the Contractor to produce the specified material. The Contractor will stockpile material produced under this Contract a minimum of three days prior to haul to allow BC Hydro to perform Quality Assurance testing. The Contractor will dispose of all unsuitable material resulting from the production of granular aggregates in RSEM Area L3. Disposal will be incidental to the unit prices for granular aggregates.

Processed granular materials will be stockpiled adjacent to the Viewpoint Road and North Bank Road intersection (Viewpoint Road Stockpile), in the Granular Laydown Area (North Bank Road Stockpile), in the Worker Accommodation site, and in the gravel pit located at the eastern area of the Site off of Old Fort Road (River Road Stockpile). The Contractor will strip the area to limits directed by Hydro's Representative, then grade and compact the in-situ material to produce a planer surface prior to the placement of any material. BC Hydro will survey the original ground and final stockpile for measurement and payment. The Contractor will level off the top of the stockpiles at the completion of stockpiling to allow for accurate survey measurements. Stripping and base preparation at the stockpile site will be considered incidental to the Work. No additional compensation will be made for this Work. Frozen material and snow shall be kept to a minimum in the stockpile. Snow removal is considered incidental to the stockpile construction.

Watering is considered incidental to the various Work items. No additional compensation will be made for watering.

2.10.2 Select Granular Sub-Base (SGSB)

The Contractor will produce and place Select Granular Sub-Base (SGSB) at the locations shown on the drawings. The Contractor will also produce and stockpile SGSB at the Viewpoint Road Stockpile and the River Road Stockpile as shown on the drawings.

SGSB will be produced, placed, and stockpiled in accordance with SS 202. The gradation of the aggregate will meet the requirements of SS 202 Table 202C, SGSB, Sub-base Aggregates.

Pursuant to SS 202.05.02 Rut Resistance, any aggregate not meeting rut resistance criteria will be removed and replaced or blended with crushed aggregate, to meet the gradation and rut resistance requirement.

[redacted]

[redacted]

2.10.3 25 mm - Well Graded Base Course (WGBC)

The Contractor will produce and place Well Graded Base Course (WGBC) at the locations on the drawings. The Contractor will also produce and stockpile WGBC at the Viewpoint Road Stockpile, the North Bank Road Stockpile, and the River Road Stockpile as shown on the drawings.

WGBC will be produced, placed, and stockpiled in accordance with SS 202. The gradation of the aggregate will meet the requirements of SS 202 Table 202C, 25 mm, Base Course.

[redacted]

2.10.4 High Fines Surfacing Aggregate (HFSA)

The Contractor will produce and place High Fines Surfacing Aggregate (HFSA) at the locations shown on the drawings. The Contractor will also produce and stockpile HFSA at the North Bank Road Stockpile and the River Road Stockpile as shown on the drawings.

HFSA will be produced, placed, and stockpiled in accordance with SS202. The gradation of the aggregate will meet the requirements of SS 202 Table 202C, HFSA, Surfacing Aggregates.

[redacted]

[redacted]

2.11 Bridge End Fill

The Contractor will produce bridge end fill in accordance with the requirements of the SS 201.40 "Bridge End Fill" and in accordance with the milestone date in Appendix F – Work Program and Schedule. The Contractor will perform all quality control, sampling and testing required to verify that the completed bridge end fill meets the specified requirements. Sampling and testing will include but may not necessarily be limited to: materials sampling, sieve analyses, and laboratory proctor density testing. The Contractor will place the bridge end fill in stockpile in the gravel pit located at the eastern area of the Site off of Old Fort Road, as designated by Hydro's Representative, for use by the Peace River Construction Bridge contractor.

[redacted]

2.12 Riprap

2.12.1 General

The Contractor will produce, haul, and place riprap at the locations shown on the drawings and as directed by Hydro's Representative. The Contractor will use Wuthrich Quarry as the source of riprap, except as specified in this Appendix G – Specifications.

The Contractor will produce riprap from Wuthrich Quarry to the gradation and average dimension requirements as specified in SS 205 Table 205-B, and modified in this Appendix G – Specifications.

Class (Kg)	Approximate Average Dimension (mm)*		
	15%	50%	85%
10	92	200	287
25	125	270	395
50	160	340	489
100	202	430	622
250	269	585	844
500	339	735	1059
750	383	843	1195
1000	429	930	1338
*this table has been upsized to account for a lower specific gravity of 2.39 in comparison to SS 205 Table 205-B			

In accordance with SS 145.26.02 Contractor Pit Manager, the Contractor is responsible to ensure that the Work in the pit or quarry is done in compliance with the requirements of the*Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia and its subsequent amendments.

The Contractor must provide to Hydro's Representative prior to the commencement of the Work the name of a person, or persons, who will act as the Pit Manager. This person will possess the qualifications established by the regulations or code, and attend daily at the pit or quarry when it is in operation. It is at BC Hydro's sole discretion to accept the person proposed by the Contractor to act as Pit Manager.

The Contractor will provide a Pit Development Plan including drilling, blasting, and sorting procedures for Wuthrich Quarry.

When producing, crushing, stockpiling and handling riprap, the Contractor will comply with all provisions of the *Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia.

2.12.2 Embankment Riprap

The Contractor will place riprap at the locations shown on the drawings. The Contractor will ensure that the class of riprap will be as shown on the drawings.

Measurement will be on a neat line basis of riprap in place using the thickness specified on the drawings.

2.12.3 RSEM Area L3

(a) Surface Preparation: The Contractor will grade areas to a uniform surface where riprap is required and depressions filled with approved material and compact to provide firm foundation.

(b) Placement: The Contractor will place bedding layers as specified on the drawings or otherwise approved. Bedding material will be placed as indicated in Table 2.12.3(b).

Table 2.12.3(b) Riprap Bedding Placement

Fill Zone	Material	Area	As Placed Moisture Content	Lift Thickness (mm)	Standard Proctor Maximum Dry Density(%)	Compactor Type (min. passes/lift)
IV	Riprap Filter	All areas	Moist	300	90	Not specified
VI	Riprap Bedding	All areas	Moist	300	95	Tamped in place with excavator bucket
VII	Riprap 10kg Class	All areas	n/a	Single layer	n/a	n/a
VIII	Riprap 500kg Class	All areas	n/a	Single layer	n/a	n/a

Placement of riprap will commence at the bottom of the channel or slope and continue working upslope.

The Contractor will place riprap to grade in a manner to prevent segregation of the pieces, and to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments fill the spaces between the larger rock fragments. The Contractor will place riprap such that the riprap surface is well keyed, dense, and uniform.

The Contractor will place riprap to its full zone thickness in one lift and in such a manner as to avoid displacing the foundation surface.

The Contractor will not place riprap in layers, by dumping into chutes, or by similar methods likely to cause segregation.

The Contractor will ensure that no equipment is run over a finished riprap surface.

Finished riprap tolerances: +0.1m to -0.0m of specified thickness.

(c) Quality Control: Riprap gradation will usually be assessed visually. The Contractor will prepare a riprap sample of each gradation by sorting, weighing, and remixing in proper proportions. The Contractor will store the sample near the Site to be used as a frequent reference for judging acceptability of the gradation of the riprap supplied. If required, gradation will be measured by the Contractor according to Minnesota Technical Release 3. The Contractor will provide equipment, a sorting site, and labor needed to assist in checking gradation.

Table 2.12.3(c) Quality Control Testing

Zone	Area	Test Frequency; minimum 1 test per			
		Field Density	Moisture Content	Gradation	Standard Proctor
Riprap Bedding	All areas	Method specification	-	1,500 m^3	-

BC Hydro's acceptance of riprap will be based on adequacy of the placed material, rock quality test results, gradation measurements, and surveys demonstrating compliance with specified requirements.

[redacted]

2.12.4 Filter Layer

Unless otherwise shown on the drawings, the Contractor will design and construct a filter layer using either a 300 mm thick layer of 25 kg riprap, or surplus rock no smaller than 50 mm or larger than 100 mm from Wuthrich Quarry, or non-woven geotextile as shown on the drawings.

The filter layer material type and gradation will depend on the gradation of the material used for the compacted gravel zone.

The type of the geotextile will depend on the gradation of the material used in the embankment. Non-woven geotextile will only be required to be placed by the Contractor if the following criteria cannot be met:

$D_{15} / d_{85} < 5$; and

$5 < D_{15} / d_{15} < 40$.

Where D_{15} is the size in mm that 15% of the riprap particles are smaller than, d_{15} is the size in mm that 15% of the fill material particles under the riprap layer are smaller than, and d_{85} is the size in mm that 85% of the fill material particles under the riprap layer are smaller than.

The Contractor will use the following guidelines for selection of the non-woven geotextile. The Contractor will submit the type and technical specifications of the non-woven geotextile to Hydro's Representative for review and written acceptance a minimum of fourteen days prior to ordering the geotextile.

The non-woven geotextile will meet the following minimum average roll values:

Grab Tensile Strength	> 900N	ASTM test D4632
Elongation	> 15%	ASTM test D4632
CBR Puncture Strength	> 2300N	ASTM test D6241
Trapezoidal Tear	> 350N	ASTM test D4533
Ultraviolet Degradation at 500 hours	50% strength retained	ASTM test D4355
Permittivity	> $0.7sec^{-1}$	ASTM test D4491
Mass per Unit Area	> $0.25kg/m^2$	

The Contractor will ensure that Apparent Opening Size (AOS) of the geotextile will be less than 50% of the D_{85} of the retained fill material. D_{85} is the size that 85% of the soil particles (by mass) are smaller than which are finer than that. The Contractor will ensure that permeability of the geotextile will be greater than the permeability of the embankment fill material or as accepted in writing by Hydro's Representative.

An overlap of a minimum of 0.5 m is required for all joints of the geotextile. Securing pins will be supplied and installed by the Contractor. The Contractor will supply securing pins that are a minimum of 9 mm in diameter, of steel, pointed at one end, and fabricated with a head to retain a washer having an outside diameter of no less than 100 mm. The Contractor will ensure that the length of the pins will be no less than 300 mm. The Contractor will insert securing pins with washers through both strips of overlapped fabric at not greater than 5.0 m intervals, along a line through the midpoint of the 0.5 m overlap. The Contractor will also install securing pins with washers at 5.0 m intervals along the outside edges of the geotextiles. The Contractor will install additional pins regardless of location as necessary to prevent any slippage of the fabric.

The area required for overlapping adjacent strips will be considered incidental. No additional compensation will be made for this item of Work.

2.12.5 Riprap Slope Armouring

The Contractor will place Class 50 riprap and non-woven geotextile as slope armouring on the North Bank Road embankment slope between Stations 71+960 and 72+160 and on the Gully Maintenance Road between Stations 2+000 and 2+050, as shown on the drawings, or as directed by Hydro's Representative. Riprap will be placed in accordance with SS 205. The non-woven geotextile will meet the following minimum average roll values:

Grab Tensile Strength	> 900N	ASTM test D4632
Elongation	> 15%	ASTM test D4632
CBR Puncture Strength	> 2300N	ASTM test D6241
Trapezoidal Tear	> 350N	ASTM test D4533
Ultraviolet Degradation at 500 hours	50% strength retained	ASTM test D4355

Permittivity	> 0.7sec^{-1}	ASTM test D4491
Mass per Unit Area	> 0.25kg/m^2	

[redacted]

2.12.6 Riprap in Stockpile

The Contractor will produce Class 10, Class 25, and Class 50 riprap and stockpile in Wuthrich Quarry.

[redacted]

2.13 Rock Spurs

The Contractor will construct rock spurs as shown on the drawings.

[redacted]

2.14 Concrete Block Wall

The Contractor will construct a concrete block wall at the location shown on the drawings.

Blocks will be precast monolithic inter locking concrete blocks with the following nominal dimensions: 750 mm x 750 mm x 1500 mm +/- 6 mm long chamfered on all sides. All exposed surfaces will have a smooth finish conforming to CSA CAN3-A23.4-00 Section 24.2.5 Grade A. Blocks will have a manufacturers' legible identification for mold number and manufacturer. Blocks will have adequate engineered shear key with approximately 12 mm clearance around the shear key; and galvanized steel lifting loops. The lifting loop will be engineered by a Registered Engineer in the Province of BC and anchored sufficiently into the block to limit pull out.

Concrete will be poured monolithically with fresh concrete having nominal design strength of a minimum of 25 MPa at 28 days, entrained air content of 4 to 7% as tested by plastic concrete testing.

The top block may have a smooth top without protruding shear key but will have a galvanized steel lifting loop that does not protrude above the finished surface.

A 300 mm thick layer of 19 or 25 mm granular base course material compacted to at least 98% Standard Proctor Density will be used for a leveling pad for the first layer of blocks.

Concrete block elements will be placed at the inclination shown in the drawings on a graded and compacted base to within the tolerances stated below:

(a) Vertical and horizontal alignment $\pm$ 20 mm in 3000 mm;

(b) Overall vertical tolerance $\pm$ 20 mm (measured from top to bottom).

Component placement will not vary more than 25 mm in plan or more than 12 mm from grade.

At the wall section ends fill will cover the vertical surface of all exposed 750 by 750 sides and wrap neatly against the wall forming a transition between the near vertical wall and the adjacent ditch slope.

[redacted]

3 DRAINAGE

3.1 Culverts

The Contractor will supply and install polymer laminated corrugated steel pipe culverts, or equivalent high density polyethylene pipe, as shown on the drawings and in accordance with SS 303 and SS 320, except as modified in this Appendix G – Specifications.

Any damage to pipe coating caused by the Contractor's installation or backfilling procedures shall be repaired to the satisfaction of Hydro's Representative and in accordance with the manufacturer's specifications and repair procedures for the specific coating.

[redacted]

3.2 Fish Baffles

The Contractor will install Armtec Poseidon Fish Baffles, or approved equivalent, in the River Road 3000mm diameter culvert at Station 12+350, as shown on the drawings. Installation will be in accordance with Exhibit G-4 - Fish Baffle Assembly Drawing. The Contractor will place alluvial substrate between baffles to simulate a natural stream bottom.

[redacted]

3.3 Headwall

The Contractor will supply a precast or cast-in-place concrete headwall at the inlet end of the 3000 mm diameter culvert at Station 12+350 on River Road, as shown on the drawings. The concrete headwall is to be either a proprietary product suitable for the specified pipe diameter or designed and detailed by a Professional Engineer registered with APEGBC. The Contractor will supply and install a steel pedestrian pipe rail along the top of the concrete headwall as shown on the drawings. The Contractor will supply and install the steel pipe railing in accordance with SS 741 and SP741-07.01.

[redacted]

3.4 Debris Rack

The Contractor will construct Debris Racks as detailed and at the locations shown on the drawings.

[redacted]

3.5 Finger Drains / Cut-off Ditch

The Contractor will construct finger drains and cut-off ditches at the locations shown on the drawings. The Contractor will perform construction of finger drains and cut-off ditch excavation in accordance with SS 201. The actual locations and sizes of the finger drains and cut-off ditch may differ from the drawings in order to suit Site conditions at the time of construction.

[redacted]

3.6 Riprap – Inlet/Outlet Protection

The Contractor will construct culvert inlet and outlet riprap protection at the locations shown on the drawings or as directed by Hydro's Representative. The Contractor will obtain limestone riprap for culvert inlet and outlet protection on River Road between Stations 12+340 and 13+280 in accordance with Section 3.9 Limestone Riprap Lined Ditches, otherwise the Contractor will use riprap from Wuthrich Quarry for culvert inlet and outlet protection. The Contractor will construct culvert outlet riprap protection from the class of riprap shown on the drawings and non-woven geotextile. The non-woven geotextile will meet the following minimum average roll values:

Grab Tensile Strength	> 900N	ASTM test D4632
Elongation	> 15%	ASTM test D4632
CBR Puncture Strength	> 2300N	ASTM test D6241
Trapezoidal Tear	> 350N	ASTM test D4533
Ultraviolet Degradation at 500 hours	50% strength retained	ASTM test D4355
Permittivity	> 0.7sec^{-1}	ASTM test D4491
Mass per Unit Area	> 0.25kg/m^2	

The Contractor will produce riprap at Wuthrich Quarry in accordance with Section 2.12 Riprap and place it in accordance with SS 205. Non-woven geotextile material will be placed along the exposed subgrade. A minimum 0.3 m overlap is required between adjacent strips of material.

[redacted]

3.7 Ditch Blocks

The Contractor will construct ditch blocks at the locations shown on the drawings or as directed by Hydro's Representative. The Contractor will construct ditch blocks from approved native backfill armored with Class 25 riprap as shown on the drawings. The Contractor will produce Class 25 riprap at Wuthrich Quarry in accordance with Section 2.12 Riprap and place it in accordance with SS 205.

[redacted]

3.8 Riprap Lined Ditches

The Contractor will place riprap to line ditches at the locations and using the riprap class shown on the drawings or as directed by Hydro's Representative. The Contractor will produce riprap at Wuthrich Quarry in accordance with Section 2.12 Riprap and place it in accordance with SS 205. Non-woven geotextile will meet the following minimum average roll values:

Grab Tensile Strength	> 900N	ASTM test D4632
Elongation	> 15%	ASTM test D4632
CBR Puncture Strength	> 2300N	ASTM test D6241
Trapezoidal Tear	> 350N	ASTM test D4533
Ultraviolet Degradation at 500 hours	50% strength retained	ASTM test D4355
Permittivity	> $0.7sec^{-1}$	ASTM test D4491
Mass per Unit Area	> $0.25kg/m^2$	

[redacted]

3.9 Limestone Riprap Lined Ditches

The Contractor will place limestone riprap and bedding to line ditches on River Road between Stations 12+340 and 13+280 and the cut slope at Station 12+440 (left) as shown on the drawings, or as directed by Hydro's Representative. Riprap will be Class 50 and bedding will be surplus rock from no smaller than 50mm or larger than 100mm. Riprap and bedding material will be available in stockpile at West Pine Quarry and placed in accordance with SS 205 and as specified in this Appendix G – Specifications. For every 50 metres of Type A Excavation completed, the Contractor will complete the corresponding 50 metres of riprap lined ditching. The Contractor will notify Hydro's Representative 30 days in advance when it requires riprap and bedding.

3.10 Left Bank Excavation and RSEM Area L3

3.10.1 General

The Contractor will design, supply and install the Left Bank Excavation surface water management components, including drainage, sediment control, water quality and conveyance of storm flows to discharge locations.

Reference Concept Temporary Diversion Pipe Option 1 and Option 2, as shown on the drawings, is For Information Only. The Contractor will design, supply, install and maintain RSEM Area L3 temporary water management components, including but not limited to, conveyance of the unnamed creek 3, perforated underdrain pipe, surface water drainage, sediment control, water quality, and conveyance of storm flows to discharge locations shown in the Construction Plan.

3.10.2 Requirements

(a) Left Bank Excavation: The Contractor will use design criteria in accordance with the following:

1. Design Life	5 years minimum
2. Design Codes and Guidelines	BC MOTI Supplement to CHBDC S6-06. CSPI Handbook of Steel Drainage and Highway Construction Products (2007). RTAC Drainage Manuals Volume 1 (1982) and Volume 2 (1987). Guidance for Assessing the Design, Size and Operation of Sedimentation Ponds used in Mining, Ministry Environment, Lands and Parks, BC (2001).
3. Additional Information	The design of the surface water management components will accommodate a 1 in 10 year return event storm period. The Contractor will ensure that the design will be in accordance with "Erosion and Prevention and Sediment Control" of the CEMP. For items not covered by the sources above or the references in those sources, additional guidelines may be considered with precedence given to those most applicable to BC and Canada.

The Contractor will construct the Left Bank Excavation surface water management components as shown on the drawings and in accordance with 2012 SS for Highway Construction Volumes 1 and 2, BC MOTI.

(b) RSEM Area L3 Reference Concept Temporary Diversion Pipe Options 1 and Option 2 and Perforated Underdrain Pipe: The Contractor will use design criteria that are in accordance with the following:

1. Design Life	100 years minimum for pipes constructed within the Engineered Fill Zones of RSEM Area L3. 5 years minimum for all other pipes.
2. Design Codes	BC MOTI Supplement to CHBDC S6-06; CAN/CSA S6-06; AASHTO LRFD 2006 CSPI Handbook of Steel Drainage and Highway Construction Products (2007); RTAC Drainage Manuals Volume 1 (1982) and Volume 2 (1987) For items not covered by CAN/CSA S6-06 or the BC MOTI Supplement to CHBDC, AASHTO will govern.
3. Additional Information	The design of the temporary diversion pipe will accommodate a 1 in 2 year return event storm period. A debris rack will be installed by the Contractor at the pipe intake to prevent debris from entering the pipe. The debris rack will be capable of passing 2.0 m^3/s flow. It will be structurally designed by the Contractor to withstand full hydrostatic load on the upstream side in the event of a blockage. The design provided by the Contractor will be in accordance with "Erosion and Prevention and Sediment Control" of the CEMP.

Pipes will be supplied and installed by the Contractor as shown on the drawings and in accordance with SS 317, SS 318 and SS 320 except as modified in this Appendix G – Specifications.

The Contractor will ensure that the perforated underdrain pipe as shown on the drawings are HDPE drainage tubing, Armtec Big O with filter sock, 0.375 m nominal diameter, or an approved equivalent, including all required fittings. The filter sock will have a Permittivity (min.) of 8.6 sec-1 in accordance with ASTM D4491. The filter sock will also be tested by the Contractor in accordance with ASTM D6707 "Standard Specification for Circular-Knit Geotextile for use in Subsurface Drainage Applications". The Contractor will use the manufacturer's recommended pipe connectors.

Work will not start until applicable approvals are obtained from Hydro's Representative in writing.

Upon completion of the Work, the Contractor will submit survey points in electronic format (northing, easting, elevation) for the pipe inlet and outlet.

3.10.3 Design Report

The Contractor will prepare and submit a Design Report consisting of all information necessary for the design, fabrication, transportation, quality control and installation of the Left Bank Excavation surface water management components, RSEM Area L3 temporary water management components and perforated underdrain pipe. The Design Report will include but not necessarily be limited to the following:

(a) Covering letter sealed by the Contractor's design engineer;

(b) Complete set of design calculations;

(c) Design methodology and applicable design codes and standards;

(d) A list of all assumptions made in the design;

(e) Constraints;

(f) Complete material and construction specifications;

(g) Plan views showing information required for the layout;

(h) Elevation views with elevations and dimensions required to perform the Work;

(i) Details and typical sections of all associated components;

(j) Notes listing design codes, design criteria and material and construction specifications;

(k) Written confirmation of the product availability and delivery schedule to Site;

(l) Manufacturer's demonstration of effectiveness for each approved supplier:

(m) Detailed backfill procedures including a determination of allowable deflections and procedures for monitoring deflections during construction; and

(n) Quality control procedures.

The Contractor will submit four complete copies of the Design Report to Hydro's Representative a minimum of four weeks prior to commencement of the Work. The Design Report will be sealed by the proprietor's design engineer, who will be a professional engineer, registered in the province of British Columbia, with experience in the design and construction of similar structures.

If modifications are required, Hydro's Representative will return one marked-up copy of the Design Report to the Contractor. The Contractor will make the appropriate revisions and resubmit four complete copies of the revised Design Report to Hydro's Representative for further review. The review process will continue in this manner until Hydro's Representative provides written confirmation of the acceptance of the Design Report in accordance with GC. 4.21 - Submittals.

3.10.4 Execution

(a) Pipe Transportation and Storage: The Contractor will store pipe (singular or bundled) on a flat surface.

The Contractor will stack lengths in piles to reduce storage area required.

The Contractor will not stack crates or bundles of pipe greater than two units (as transported by the manufacturer) high on a flat surface.

The Contractor will ensure that pipe is moved by hand with approved safety gear, or nylon straps ("belly bands") to lift the pipe. Chains and/or cables will not be permitted. The Contractor will ensure that nylon straps are attached in such a way as to support the pipe length at the third points.

(b) Pipe Installation: The Contractor will perform pipe installation in accordance with the manufacturer's requirements and to Hydro's Representative's satisfaction.

When installing perforated pipe, the Contractor will ensure that one set of pipe perforations coincide with the pipe invert when buried.

The Contractor will inspect pipe ends for any damage, deformation, or irregularities prior to joining. The Contractor will strictly adhere to the manufacturer's written instructions for joining pipes.

The Contractor will provide a completed installation that is watertight (in the case of unperforated pipe), free of depressions and drains freely.

If a laser beam is used to maintain grade, the Contractor will use manual survey methods to check the pipe invert at several intermediate locations and at the termination points.

Any damage to the pipe coating caused by the Contractor's installation or backfilling procedures will be repaired to the satisfaction of Hydro's Representative and in accordance with the manufacturer's specifications and repair procedures for the specific coating.

(c) Backfilling: The Contractor's filling procedures will be consistent with the manufacturer's recommendations and the drawings.

The Contractor will not commence fill placement operations until the installed pipes have been inspected and approved in writing by Hydro's Representative and any identified defects are rectified.

The Contractor will prevent damage to the pipe during fill placement. The Contractor will not allow compaction equipment to come into direct contact with the pipe.

The Contractor will not allow construction equipment to pass over the pipe until a minimum cover of 500 mm, or greater if necessary to prevent damage to the pipe, of compacted fill has been placed.

The Contractor will prevent displacement of the pipe during fill placement operations.

The Contractor will maintain the interior of the pipes free of foreign material.

(d) Quality Control Testing: The Contractor is responsible for Quality Control testing and will visually inspect each piece for the following:

(i) Coating type and thickness.

(ii) Corrugation profile.

(iii) Staining or damage.

(iv) Each coupling for damage and coupling type before and after installation.

The Contractor will measure each pipe for diameter.

[redacted]

[redacted]

3.11 Cistern

The Contractor will supply and install a cistern at the location shown on the drawings. The cistern will consist of a 1200 mm diameter precast concrete manhole and open grate manhole lid and will be in accordance with SP582-03.01 and SS 582.

4 PROPRIETARY PIPE: DESIGN, SUPPLY AND INSTALL

4.1 General

The Contractor will design, fabricate, supply and install a 3000 mm diameter steel multi-plate pipe under the North Bank Road as shown on the drawings. The scope of Work with respect to the proprietary pipe will include all Work required to design and construct the pipe, and the concrete inlet headwall complete with steel fencing, within the payment envelope as shown on the drawing.

4.2 Project Requirements

The Contractor will design and construct the pipe to satisfy the following:

(a) The proprietary structure supplier will be pre-qualified and included in the current edition of the BC MOTI Recognized Products List under the heading “Proprietary Structures” in the category for “Arches and Pipes”. The list of qualified suppliers may be viewed at:

http://www.th.gov.bc.ca/publications/eng_publications/geotech/Recognized_Products_Book.pdf

(i) AIL Super-Cor Bolt-a-Plate (655);

(ii) Armtec Multi-Plate Super Span;

(iii) Armtec Bridge-Plate (821);

(iv) Armtec Mini-Span (843);

(v) RECO Tech Span;

(b) Structural backfill within the payment envelope shall be specified by the Contractor’s design engineer. Light weight fill may be used at the discretion of the Contractor to modify the soil loading profile on the steel pipe structure. Any proposed use of light weight fill will be subject to review and approval by Hydro’s Representative;

(c) The Contractor shall supply the pipe in accordance CSA G401-14, with a thermoplastic copolymer coating and zinc rich primer coating per section 4.5.5 of CSA G401-14, and shall be supplied by a manufacturer having a valid certificate from the Corrugated Steel Pipe Institute (CSPI). The Contractor will be responsible for determining the thickness of steel to achieve the 100 year service life. The Contractor will repair any damage to the pipe or coating in accordance with CSA G401-14 and CSPI recommendations. Reference CSPI Technical Bulletin 13, Performance Guideline for Buried Steel Structures (http://www.cspi.ca/sites/default/files/download/cspiTECThirteen_120.pdf);

(d) The structure will conform to the drawings and any other details shown on the drawings. The Contractor will maintain all references to horizontal and vertical alignments as shown. The Contractor will incorporate all details, including cast-in-place concrete coping, etc., into the final design; and

(e) The Contractor's design criteria will be in accordance with the following:

1. Design Life	100 years minimum
2. Design Codes (in descending order of precedence)	BC MOTI Supplement to CHBDC S6-06; CAN/CSA S6-06; AASHTO LRFD 2014 For items not covered by CAN/CSA S6-06 or the BC MOTI Supplement to CHBDC, AASHTO will govern.
3. Corrosion	The Contractor shall review the water quality test reports provided in the Electronic Data Site and determine appropriate corrosion rates for the interior of the pipe taking into account water pH, chloride content and abrasion potential. The Contractor will compute the corrosion rate for each exposed surface in contact with non-aggressive backfill soils: Galvanization loss is equal to: - 15 micrometres / year for first 2 years - 4 micrometres / year for subsequent years Carbon steel loss is equal to: - 12 micrometres / year after zinc depletion Corrosion rates will be determined by a corrosion specialist for aggressive soil types. Reference AASHTO. The Contractor shall reference Technical Bulletin 1 – Performance Guideline for Corrugated Steel Pipe Culverts (300mm to 3,600mm Diameter) – August 2013, published by CSPI when considering solutions to achieve the 100 year service life.
4. Additional Information	*Note: The Contractor will reference Geotechnical and Hydraulic documents as applicable and include pertinent design parameters and references that may not be shown on the drawings.*

4.3 Proprietary Structure Design Report

The Contractor will prepare and submit a Proprietary Structure Design Report consisting of all information necessary for the design, fabrication, transportation, quality control and installation of the proprietary pipe, concrete headwall, steel fencing, and riser pipe, including the following:

(a) Covering letter sealed by the proprietary design engineer;

(b) Complete set of design calculations;

(c) Design methodology and applicable design codes and standards;

(d) A list of all assumptions made in the design;

(e) Geotechnical constraints;

(f) Seismic design;

(g) Force diagrams showing the magnitude, location and direction of all forces for each load case;

(h) Diagrams showing all foundation loads including load inclination angle, effective width of footing and bearing pressure for each load case;

(i) Service life calculation in accordance with the design criteria for corrosion rates;

(j) Backfill envelope details and material type;

(k) Complete material and construction specifications;

(l) Fabrication and installation drawings (as specified below);

(m) Fabrication location and schedule;

(n) Delivery details and schedule;

(o) Detailed backfill procedures including a determination of allowable deflections and procedures for monitoring deflections during construction;

(p) Details for temporary construction bracings if required; and

(q) Quality control procedures.

Fabrication and installation drawings will conform to the following:

(r) Format:

(i) The Contractor will produce drawings in accordance with Exhibit G-5 - L2 User Requirements: Drawings; and

(s) Contents:

(i) Plan views showing information required for the layout of the pipe structure, concrete headwall, steel fencing, and riser pipe;

(ii) Elevation views with elevations and dimensions required to perform the Work;

(iii) Details and typical sections of all proprietary and associated components;

(iv) Notes listing design codes, design criteria, unfactored applied loads and material and construction specifications;

(v) Backfill specifications;

(vi) Limits of excavation and structural backfill required by the pipe designer;

(vii) Component layout;

(viii) Equipment to be used and any temporary support and bracings if required for installation including details of any excavation protection works; and

(ix) Identification of the materials and other work required under this item, identifying, where applicable:

(A) Materials and work which will be provided by a proprietary structure supplier and are included in their price quotation to the Contractor, and

(B) Materials and other work which will not be provided by a proprietary structure supplier and which the Contractor will have to supply and install.

The Contractor will submit a draft copy of the Proprietary Structure Design report at the 70% design stage four weeks prior, and four complete copies of the Proprietary Structure Design Report to Hydro's Representative a minimum of two weeks prior to commencement of the pipe component and concrete headwall fabrication work. The Proprietary Structure Design Report will be sealed by the proprietor's design engineer, who will be a professional engineer registered in the province of British Columbia, with experience in the design and construction of similar structures.

Incomplete Proprietary Structure Design Report submissions may, at the sole discretion of Hydro's Representative, be returned to the Contractor for resubmission without review. Any delays to the Work Program and Schedule caused by incomplete submissions will be the sole responsibility of the Contractor to remedy.

BC Hydro will review the submissions for general compliance with the Contract Documents.

If modifications are required, Hydro's Representative will return one marked up copy of the Proprietary Structure Design Report to the Contractor. The Contractor will make the appropriate revisions and resubmit four complete copies of the revised Proprietary Structure Design Report to Hydro's Representative for further review. The review process will continue in this manner until Hydro's Representative provides written confirmation of the acceptance of the Proprietary Structure Design Report in accordance with GC. 4.21 - Submittals.

If no exceptions are taken, Hydro's Representative will return one set of the reviewed Proprietary Structure Design Report to the Contractor. The Contractor will forward an additional two copies of the reviewed report to Hydro's Representative.

Any work done or materials ordered prior to the completion of the review process will be at the Contractor's risk. The Contractor will not proceed with the installation of the pipe prior to the completion of BC Hydro's review of the Proprietary Structure Design Report nor prior to submission of the Letter of Assurance for design signed and sealed by the proprietor's professional engineer.

BC Hydro's review of the Proprietary Structure Design Report will not relieve the Contractor from its obligation to perform the Work in accordance with the Contract.

4.4 Quality Control

The Contractor will implement a quality control program to the following requirements:

Component	Requirement
Cast-in-Place Concrete	The Contractor will provide concrete mix designs and strength test results to Hydro's Representative in accordance with SS 211.
Precast Concrete	The Contractor will provide concrete mix designs, aggregate test results and strength test results in accordance with Quality Control as required in SS 415.
Steel	The Contractor will provide copies of the following to Hydro's Representative: Mill certificates giving chemical and physical properties. Test reports confirming galvanizing to CAN/CSA G164.

Component	Requirement
Structural Backfill	The Contractor will provide test results to Hydro's Representative to verify that the structural backfills meet all material, placement and compaction criteria as specified in the Contract Documents and are in compliance with the requirements of the proprietary structure designer. Tests on structural backfill materials will include but may not necessary be limited to sieve analysis, electrochemical tests, laboratory proctor density tests, aggregate density tests and in-situ density tests.

The completed structure will meet the following tolerances:

Horizontal Dimensions	±6 mm
Elevations	±6 mm
Line on Coping	such that no abrupt deviations are visible

A minimum of two weeks prior to installation, the Contractor will submit a detailed program for monitoring construction for both erection safety and structural integrity of the completed installation. The program must be approved and endorsed by the proprietary structure supplier and the proprietor's designer, who must indicate that the proprietor's site representative will comply with the procedure.

The monitoring program will include but may not be limited to:

(a) Stages at which monitoring is to be performed by the Contractor;

(b) Method, frequency and location of measurement and testing;

(c) Allowable deflections or movement;

(d) Procedures to be followed by the Contractor if allowable deflection or tolerances are exceeded and, if procedures include a stoppage of work, details of corrective action to be taken by the Contractor as a prerequisite to resuming work;

(e) On site availability of documentation for review and reference including Letters of Assurance, WCB Inspection Reports, Site Erection Procedures and Quality Control Reports for off-site precast concrete or fabrication shops;

(f) Identification and relevant experience of the proprietor's designated site representative(s); and

(g) A detailed schedule updated at the start of each work week indicating when inspections will be performed by the Contractor and when the designated site representative(s) will be on site.

The Work will be inspected and supervised by the proprietor's site representative who will be:

(h) a Professional Engineer registered in the province of British Columbia with a minimum of five years' experience in the design and construction of the applicable proprietary structure; or

(i) a technician with a minimum of five years' experience in the design and construction of the specific proprietary structure and who is designated in writing by and working under the direction of a Professional Engineer registered in the province of British Columbia with a minimum of five years' experience in the design and construction of the applicable proprietary structure.

The qualifications of the proprietor's site representative will be subject to review by Hydro's Representative.

(j) The proprietor's site representative must be on site to supervise and inspect the installation of the proprietary structure on the following basis:

(i) As required by the Professional Engineer who has sealed the Proprietary Structure Design Report;

(ii) Continuously during the initial installation of the proprietary pipe structure to establish correct procedures for installation;

(iii) As required to allow the engineer to sign the Assurance of Professional Design and Commitment to Field Reviews; and

(iv) Final inspection of the completed installation.

4.5 Letters of Assurance

Prior to commencing installation of the proprietary structure, the Contractor will provide to Hydro's Representative, an Assurance of Professional Design and Commitment to Field Reviews form as referenced in the MOTI's Technical Circular T06/09. The form will be signed and sealed by the proprietor's professional engineer responsible for design of the proprietary structure.

The Contractor will also provide an Assurance of Professional Design – Post Construction, also as referenced in the MOTI Technical Circular T06/09, completed by the proprietor stating that the proprietor has reviewed the pipe structural backfill materials, in-situ test results and has monitored the installation of the structural components and certifies that the in-situ structure is in accordance with all installation requirements. The Assurance of Professional Design – Post Construction will be sealed by the professional engineer who performed or was responsible for supervising the site inspections. The forms are available at:

http://www.th.gov.bc.ca/publications/Circulars/lister.asp?set=Current&circ=T&year=2009

4.6 Quality Audit

BC Hydro will implement a quality audit program by auditing the Contractor's quality control and assurance program and by inspection at its discretion. Quality audit by BC Hydro will not relieve the Contractor from its obligation to perform the Work in accordance with the Contract.

Hydro's Representative may reject any of the Work which, in its opinion, does not comply with the requirements of the Contract. The Contractor will bear the cost of re-inspection of any rejected components of the Work.

The Contractor will notify Hydro's Representative at least fourteen days prior to fabrication or installation of each component of the Work. The Contractor will allow Hydro's Representative access to all parts of the Work and will supply such information and assistance as is required. The Contractor will provide samples of any materials as requested by Hydro's Representative.

4.7 Supply and Installation

The Contractor will perform the Work in accordance with the BC Hydro accepted Proprietary Structure Design Report, the Contractor's quality control and construction monitoring program and all other requirements set out in the Contract Documents.

(a) Cast-in-Place Concrete Components: All cast-in-place concrete supplied under this item will meet the requirements of SS 211.

(b) Precast Concrete Components: SS 415 will apply to supply and installation of precast concrete components as modified by this clause.

(c) Metal Components: SS 320 will apply to metal pipe components, except as modified by this clause.

The Contractor will ensure steel will be galvanized in accordance with ASTM A123. The Contractor will provide 610g/m^2 total both sides minimum mass of zinc coating to all metal fabrications.

(d) Polymer Coatings: Polymer coatings will be applied in accordance with manufacturer's recommended procedures.

(e) Steel Safety Fence: The steel pipe railing fence is to be fabricated, supplied and installed in accordance with SS 422, SS 741 and SP 741-07.01.

(f) Excavation to Accommodate Structural Fill: The Contractor will perform excavation within the payment envelope as shown on the drawings or below as required, to accommodate structural fill in accordance with SS 407, except as modified in this Appendix G – Specifications.

The Contractor will remove and dispose of all clay like materials within and below the payment envelope designated by Hydro's Representative, and as necessary to facilitate the construction of the pipe system. Backfill will be with material meeting the borrow specification SS201.44, unless designated otherwise by the proprietor's design engineer. The Contractor will ensure that foundation excavations will be no larger than reasonably necessary to permit access and construction.

Geologic mapping, 1.5 m auger holes, and seismic survey of the site have been conducted in the vicinity of the pipe to determine probable excavation limits under the structural backfill supporting the pipe. A field mapping memorandum and the seismic survey results are included in the Electronic Data Site. It is possible that sub-excavation below the payment envelope limits will be required in some areas along the length of the pipe. Should this be required, the Contactor will remove all clay like materials to shale or to competent foundation material, as determined by Hydro's Representative or his Geotechnical Engineer, and dispose of the material at designated locations.

The Contractor will protect excavations as necessary by barricades, shoring, dikes and/or berms. The design of back slopes and any excavation protection schemes will be the responsibility of the Contractor and will be constructed by the Contractor in compliance with the applicable WCB regulations for engineered slopes.

Upon completion of the excavation and prior to erection of the proprietary pipe structure or placement of backfill, the excavation will be inspected and approved by the proprietor's design engineer of record or his site designate.

(g) Accommodation of Creek Flow: The Contractor will redirect the existing creek away from the work area as required to facilitate the work using a combination of temporary piping and re-grading of the channel as required. As much as possible, the Contractor will retain the creek within its current channel.

(h) Structural Backfill: Structural backfill is defined as the volume of backfill material extending from the bottom of the foundation excavation, to the top of pipe, or higher, as required for controlled and monitored backfilling surrounding the pipe. Roadway embankment adjacent to the pipe which is placed prior to the installation of the pipe is not considered structural backfill.

When steel is used in contact with water or soil, the following electrochemical requirements for backfill will also be met by the Contractor:

(i) pH of 5 to 10;

(ii) Resistivity not less than 3,000 ohm centimetres;

(iii) Chlorides not greater than 100 ppm; and

(iv) Sulphates not greater than 200 ppm.

[redacted]

5 FINISHING

5.1 Road Signs and Sign Posts

The Contractor will supply and install trapezoidal concrete bases, perforated square galvanized steel sign post structures, and sign faces at the locations shown on the drawings and in accordance with SS 635.07 and SS 635.28.

[redacted]

5.2 Spur Safety Signs and Sign Posts

The Contractor will supply and install rock spur safety sign posts and install sign faces at the locations shown on the drawings and in accordance with SS 635.27 and drawing SP635-3.5.1. The Contractor will ensure that posts will be 6” x 6” yellow painted treated timber wooden posts. BC Hydro will supply sign faces in accordance with Section 1.14 Materials Supplied by BC Hydro. The Contractor will install sign faces a minimum of 8 feet from finished ground to bottom of sign face.

[redacted]

5.3 Concrete Barrier

The Contractor will supply and install the following precast barrier components at the locations shown on the drawings or at the direction of Hydro’s Representative, and in accordance with SS 941:

(a) Precast Concrete Bull-Nose – CBN-H (SP941-01.01.01);

(b) Precast Concrete Transition Barrier – CTB-1E (SP941-03.01.01);

(c) Precast Concrete Roadside Barrier – CRB-H and CRB-E (SP941-01.02.01 and SP941-01.02.02).

[redacted]

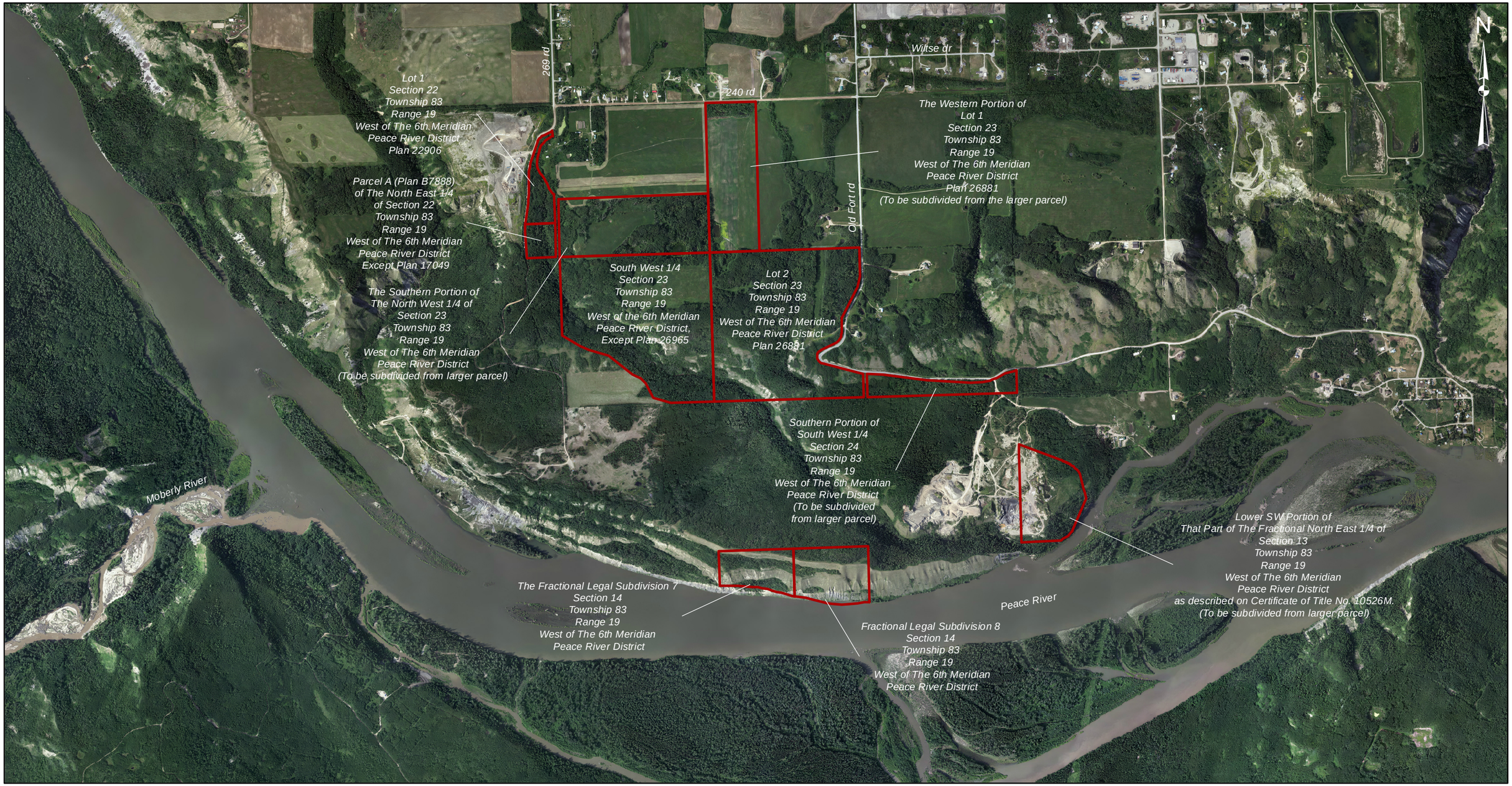
5.4 Revegetation

The Contractor will hydroseed shortly after sections of embankment and disposal locations are completed. If possible, the Contractor will avoid seeding during August and September. The Contractor may seed after October 31st, or at the onset of winter conditions. Seeding on top of snow over exposed mineral soil is acceptable. BC Hydro may direct the Contractor to complete one application of hydroseed on completed sections of embankment and disposal locations after the first snowfall.

Hydroseeding will be completed in accordance with SS 757, and as specified in this Appendix G – Specifications. BC Hydro will supply a native seed mix in accordance with Section 1.14 Materials Supplied by BC Hydro. The Contractor will apply at a rate of 100 pure live seeds per square metre in a mix of guar gum tackifier (50 kg/ha) and wood fibre mulch (200 kg/ha). The Contractor may wish to increase the amount of mulch applied later in the growing season (September-October) to increase the erosion control. Any increase must be approved by Hydro's Representative prior to application.

[redacted]

Exhibit - G1 Private Property Map



Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.
4. Orthophotos provided by City of Fort St. John, taken June 2012.
5. 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.

Legend

Private Land

1:20,000

0 1 km

BC hydro

SITE C CLEAN ENERGY PROJECT

Private Properties

Date	October 22, 2014	DWG NO	1016-C14-B7690	R 1

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

Path: X:\ArcGIS\Projects\ProjectManagerOffice\DamSite_PrivateLand_1016_C14_B7690.mxd

Exhibit - G-2 Causeway Abutment River Velocity Measurement and Maintenance

CAUSEWAY ABUTMENT RIVER VELOCITY MEASUREMENT AND MAINTENANCE

PART 1 – GENERAL

1.1 SUMMARY

A. The Contractor will construct and maintain the causeway and north abutment of the Peace River Construction Bridge to maintain:

Average velocities equal to or less than 2.0 m/s within 25 m of the north bank causeway abutment tip over a 120 meter distance and over the total flow depth, as shown on Figures 1 and 2, throughout construction and maintenance of the causeway structure.

B. Compliance with this requirement is specific to the Bull Trout upstream migration period of May 1 to July 31, and at discharges up to 1,500 m3/s, as measured at the Water Survey of Canada (WSC) gauge Peace River upstream of Pine River (Station ID: 07FA004).

C. The Contractor will implement a river velocity measurement program and provide velocity measurements to BC Hydro to confirm compliance with this requirement.

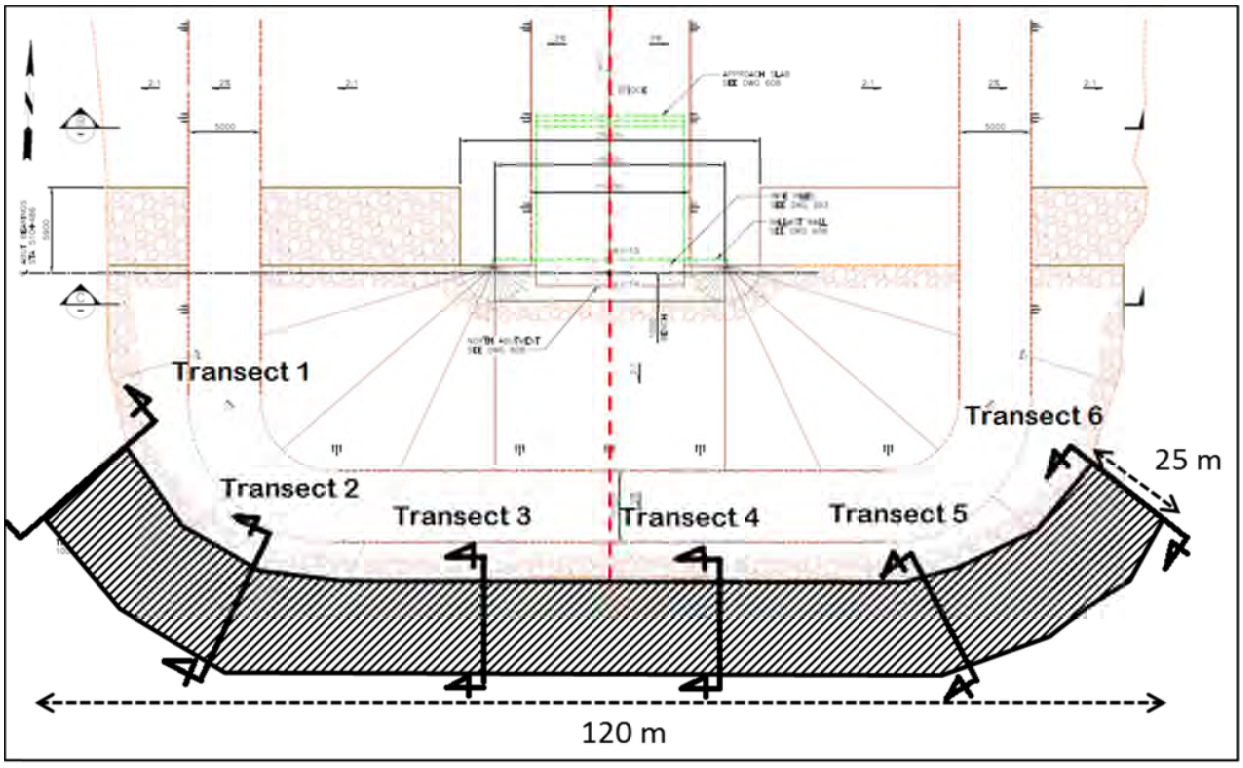


Figure 1 – Causeway North Abutment –Plan. Area for velocity specification shown with diagonal hatching.(Source: BC Hydro, Site C, Clean Energy Project, Peace River Construction Bridge, 95% Design, June 27, 2014)

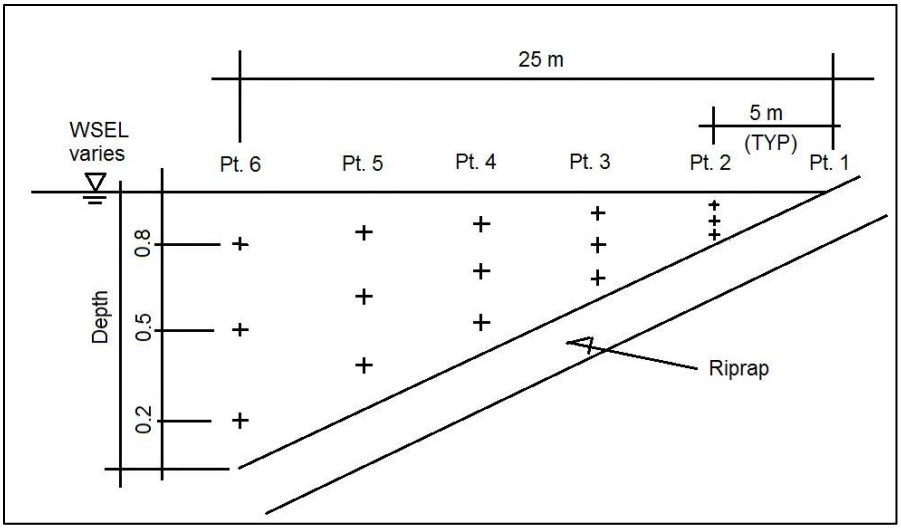


Figure 2 – Causeway Left Abutment – Section. Measuring Points Along Transect.

1.2 BACKGROUND

A. The North Bridge Approach referred to herein as the causeway, will have an extended abutment on the north bank. BC Hydro used the River 2D model to analyze the hydraulic conditions through the causeway during the range of anticipated river flows and across the anticipated stages of construction.

B. Design of the causeway has been developed to provide flow conditions that will be conducive for upstream fish passage throughout the construction and operation of the causeway. To confirm the channel flow velocities and associated fish passage conditions, additional flow velocity monitoring (as referenced above) is required by the Contractor throughout the construction and utilization of the causeway. This monitoring effort is to be focused on the edge of the river channel upstream, through, and downstream of the causeway abutment tip along a 120 m wide strip of the river channel (see Figure 2).

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with GC4.21 Submittals.

B. Provide a flow monitoring implementation plan for review and approval by Hydro's Representative for conducting the velocity measurements. The plan shall include the following:

1. Site plan drawing that illustrates the causeway structure, proposed construction sequence, and the location of field velocity measurements sites along the causeway abutment tip from 60 m upstream to 60 m downstream of the causeway centerline.
2. Proposed equipment used to collect the velocity measurements.

C. Provide a plan for review and approval by Hydro's Representative of proposed correction measures for reducing the velocity along the causeway bank if average velocities exceed 2.0 m/s.

PART 2 – PRODUCTS

2.1 FLOW MEASUREMENT EQUIPMENT

The Contractor will use a current meter design specifically for collection of water velocity in river channels. Acceptable products include:

A. USGS Type AA Model 6200

B. FP101 & FP102 Digital Water Flow Probe, manufactured by Global Water Instrumentation, Inc.

C. equivalent instrument approved by BC Hydro.

2.2 CHANNEL MODIFICATIONS

A. If velocity measurements are shown to exceed an average of 2.0 m/s along with the identified causeway area, the channel shall be modified in the high velocity area to reduce the velocity. The acceptable mitigation measures to accomplish a reduction in flow velocity include (but are not limited to) the following:

1. Adjusting the construction sequencing for instream excavation and causeway construction,
2. Repositioning or placing additional riprap within the high velocity area to provide channel roughness, and localized refuge areas for fish,
3. Other measures acceptable to BC Hydro.

B. All riprap placed in the channel shall be in accordance with Appendix G – 2.13 Riprap.

PART 3 – EXECUTION

3.1 FIELD MEASUREMENTS

A. The Contractor will collect measurements along the abutment for a distance of 60 m upstream and downstream from the causeway centerline. The measurements will be taken at each of the six (6) transect locations as shown on Figure 1. The measurements will be taken at a maximum of 5 m on center along the transect with measurements located at areas of major velocity change or zones of higher velocity.

B. Velocity measurements will be taken at the 0.2 m, 0.5 m and 0.8 m points of the total flow depth. The measurements will extend a maximum of 25 m from the intersection point of the river water surface with the causeway into the river as shown on Figure 2. Average velocities will be calculated at each depth measurement point along the transect. The Contractor will provide all raw data to BC Hydro in addition to the calculated average velocities.

C. The Contractor will use an approved flow meter as specified in paragraph 2.1.

D. The Contractor will provide photographs of the river at each section clearly illustrating the hydraulic conditions observed during the field measurements.

E. The initial field measurements will be obtained at river flows near 500 m^3/s, 1,200 m^3/s and 1,500 m^3/s.

3.2 REPORTING

A. The results of the field measurements will be provided to Hydro's Representative within 48 hours of the measurements.

B. The average velocity will be calculated at each depth measurement point across the transect width. The average velocity will be determined as the sum of the measured velocity at the 0.2 m, 0.5 m, and 0.8 m depth measurements, divided by three. A total of five average velocities must be provided at each transect location. If three out of the five average velocity measurements at a given transect exceed 2 m/s, the Contractor will implement corrective measures as presented in paragraph 3.2 C.

C. If the measured velocities exceed an average of 2.0 m/s, the Contractor will include a sketch and description of the proposed measures to reduce the velocity with the affected stream reach and submit to Hydro's Representative for review prior to applying corrective actions. As noted in paragraph 3.1 B, the Contractor will provide all raw velocity data to BC Hydro along with their proposed corrective action. BC Hydro will provide confirmation of the Contractor's proposed plan or a variation if required based on the provided data. The Contractor will not implement any flow modifications without prior approval of the proposed measures by BC Hydro.

D. At the completion of the annual construction season, the Contractor will provide a report summarizing the flow data measurements collected throughout the course of the construction season. The data will be provided in a tabular format with the station, river flow, and flow velocity measurements clearly indicated at each specified date. The reportwill also summarize flow modification measures implemented, if and as required..

E. Following the initiation of the field flow measurements program, the Contractor will conduct field flow measurements at the following frequencies:

1. During Construction. Monthly during the Bull Trout fish passage period of May 1 through July 31, as described above.

Exhibit - G-3 Survey Layout Services and Products

APPENDIX - SURVEY LAYOUT SERVICES AND PRODUCTS ❶

Survey Layout	Maximum Interval	Product
Right-of-way ❷	At each point of deflection and at sufficient points between as to be continuously visible.	Stake showing station and offset, or flagging.
Clearing and Grubbing	Same as Right-of-way.	Same as Right-of-way.
Grading - Slope Stakes	10 m in rock cuts; 20 m in all other cases.	One slope stake each side, at top of cut or bottom of fill, showing station, offset, vertical dimension to subgrade, and slope, plus cut/fill transition stake. Non-standard ditches will be staked separately. An additional slope stake, where applicable, at the top of a rock cut after the removal of overburden.
Grading - Subgrade	20 m.	One stake at each side of the subgrade, showing station, offset and grade at the stake location, one at each break point, and one at centreline.
Top of Sub-base	20 m.	One stake at each side of the sub-base course, showing station, offset and grade at the stake location, one at each break point, and one at centreline.
Each Base Course	20 m.	One stake at each side of the base course, showing station, offset and grade at the stake location, one at each break point, and one at centreline.
Final Base Course only	10 m.	"Blue tops" ❸ at each break point across the base course surface, or final grade stakes.
Culverts	Inlet and outlet.	One stake at each end of the culvert, plus an offset line, showing invert elevation.
Storm Drainage, Subdrain, Watermain or Sanitary Sewer		Stakes showing locations of manholes, catch basins and other structures, and invert locations of pipe inlets and outlets.
Retaining Walls	Not more than 10 m, and at alignment changes.	One stake showing control line location and either the elevation at the top of wall or the elevation at the bottom of footing excavation.
Paving	100 m on tangent, 20 m on curves, and at each deflection point.	Reference points.
Concrete Barriers	Same as paving.	Same as paving.
Signs		Stake at each sign location.
Curb and Gutter	10 m and at alignment changes. Curb returns: 5 m or at quarter points, whichever is less.	Offset hub and nail with cut/fill to gutter grade.
Median/Island Curb	Continuous.	Paint line at face/edge of curb.

APPENDIX - SURVEY LAYOUT SERVICES AND PRODUCTS ❶

Survey Layout	Maximum Interval	Product
Sidewalk or Path	5 m and at alignment changes. No layout required if parallel to curb.	Offset stake or nail with cut/fill to grade.
Electrical Pedestal, Junction Box, Sign Structure	Per installation.	Offset stake or nail with cut/fill to top of pedestal, or junction box; with additional stake to show orientation.
Detection Loops	Per installation.	Survey crew will lay out locations of cross walks, lane lines and stop bars; Contractor to derive location of loop.
Irrigation Preduct	Per installation	One stake at each end of the preduct, and offset line showing lowest elevation.
Pavement Marking (temporary and permanent)	at all alignment break points; 100 m maximum on tangent; 20 m maximum on curves; gores.	Reference points.

Notes:

❶	This table shows layout details for general situations; particular circumstances may require more or less staking.
❷	The right-of-way limit will be laid out only where there is work, including utility relocation, to be performed within three metres of it.
❸	"Blue top" - a stake driven so that its top surface is at the required elevation for the finished surface of the work.

Exhibit - G-4 Fish Baffle Assembly Drawing

(REDACTED IN ENTIRETY)

Exhibit - G-5 L2 User Requirements: Drawings

Project Title:	Site C Clean Energy Project
Topic:	Dam Site Access Roads, Contractor-Prepared Drawing Requirements

1. General

- This User Requirements document applies to drawings produced for the Site C Project that depict permanent facilities and are to be issued through the BC Hydro drawing vault under Site C station code 1016.
- It is desirable and recommended that practices outlined in this User Requirements document are utilized to the fullest extent possible for:
    - drawings produced and used in pre-award procurement processes (i.e. RFQ/RFP drawings, Tender drawings, and contract drawings);
    - drawings produced and used in post-award procurement processes (i.e. drawing submittals); and,
    - figures used in Site C reports.

2. Contractor Drawing Requirements

2.1 CAD Software

- Electronic drawing files produced for Site C are required to be prepared and delivered using the Autodesk suite of CAD products. Currently, AutoCAD 2014 and Civil 3D 2014 are used within the IET.
- Given the length of the Project, the need and decision to move to a future version of AutoCAD and/or Civil 3D is left to the discretion of the Integrated Engineering Team (IET) in consultation with BC Hydro.
- The electronic cable schedule produced for Site C is required to be prepared and delivered using BC Hydro's in-house CableBase software.
- Use of modern 3-dimensional drafting techniques should be utilized to enhance visualization during design, safety engineering, and constructability activities, and also to allow for improved detection of design errors before they are built.

2.2 Language and Units of Measure

- All primary text on drawings produced for Site C is required to be in English.
- If it is significantly more efficient for a contractor or manufacturer to work in another language, this text is required to be shown in brackets next to the English text.
- The International System of Units (the "SI" system, commonly referred to as the metric system) is required to be used for all measurements on Site C drawings.
- Metric unit prefixes are required to reflect engineering units (i.e. a power of ten that is an integer multiple of three, such as "micro", "milli", "kilo", "mega").
- If it is significantly more efficient for a contractor or manufacturer to use non-SI units of measure, it is acceptable to show the equivalent measure in non-SI units in brackets next to the SI measure.

2.3 Drawing Sizes

- Drawing size requirements for electronic and hard-copy drawings produced for Site C are as follows:
    - 8.5" x 11" is required to be used only for cover sheet drawings used to issue the following documents in the BC Hydro drawing vault:

- Instruction, maintenance, and operation manuals.
- Equipment software.
- The Site C cable schedule.

- ISO A0 size is required to be used for all other drawings that will be issued in the BC Hydro drawing vault under station code 1016.

2.4 Drawing Borders and Title Blocks

- Electronic drawing borders and title blocks included in QSP 4015-Site C "Drawing Preparation" (included in Appendix II) are required to be used for Site C drawings that will be issued in the BC Hydro drawing vault under station code 1016.
- Electronic Site C drawing border files are required to be provided to and used by Contractors, to ensure consistency of drawings produced for Site C and to minimize rework.
- A designated area above the Site C title block is required to be provided for Contractors to place their own title block. It is unacceptable to place a Contractor's entire drawing border within the Site C drawing border, as this practice takes up much of the drawing space and can distort scale of the Contractor's drawing, causing rework.

2.5 Drawing Titles & Terminology and the Site C Component Hierarchy

The Site C IET has produced the Site C Component Hierarchy, which is a hierarchical list of facility areas, components, structures, systems, and equipment. This list is intended to provide standardization across the project in a number of areas, is currently in use, and will be maintained throughout the Project.

- Titles of drawings produced for Site C, as well as terminology used within drawings, are required to follow the Site C Component Hierarchy to ensure standardization and searchability.
- The Site C Component Hierarchy is required to be provided to an used by Contractors, in order to minimize rework associated with drawing titles and terminology.

2.6 Drawing Numbering

Drawings produced for Site C are required to follow a pre-designed drawing numbering framework, to be designed and maintained by the Site C IET, considering relevant BC Hydro Engineering Standards and current practices.

- The drawing numbering framework is required to be designed to:
  - be subdivided into sections according to the Site C Component Hierarchy;
  - include approximately 30% spare drawing number capacity in each section as appropriate to accommodate future design activities; and,
  - consider BC Hydro Engineering Standards DP 45-Z0003 R02 (Generation Engineering – Preferred Drawing Number and File Name), and ES 10-A0020 R04 (Drawing Control – Engineering Drawing Numbering System); and,
  - be intuitive and efficient for users of the Site C drawings.
- Contractors' drawings that will be issued in the BC Hydro vault under station code 1016 are required to adhere to the drawing numbering framework.
- A master drawing list is required to be maintained by the Site C IET throughout the Project.

2.7 Drawing File Naming

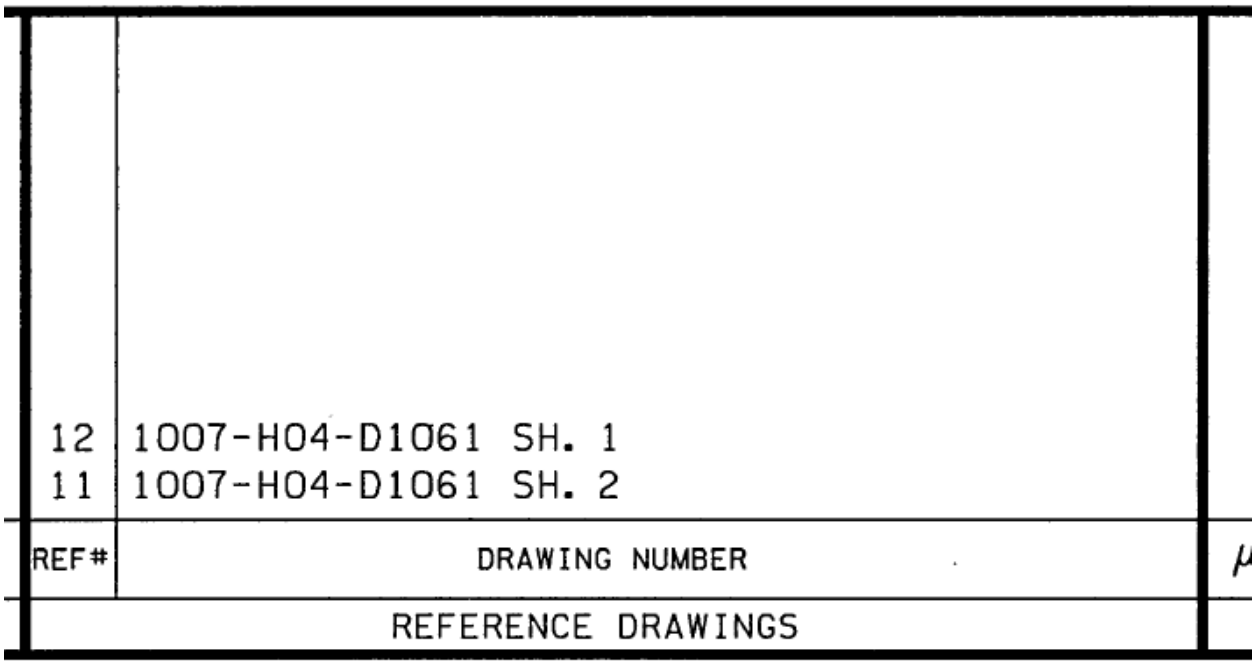
- Electronic file names for both .pdf files and file formats generated using Autodesk software are required to:
    - match the drawing and revision number;
    - consider using revision letters for pre-construction revisions;
    - make use of revision numbers, starting with 00, for “issued for construction” drawings, and any subsequent revisions; and,
    - make use of a leading zero in both the sheet and revision number, to permit correct sorting.
    - For example, for drawing number 1016-C04-00020 revision A, the electronic files delivered to BC Hydro would be 1016-C04-00020 R0A.dwg and 1016-C04-00020 R0A.pdf.
- Drawings with multiple sheets are required to be delivered as one electronic file per sheet, and the sheet designation is required to be indicated in the file name.
    - For example, for drawing 1016-M04-00104 sheet 2 Revision 0, the electronic files delivered to BC Hydro would be 1016-M04-00104-002 R00.dwg and 1016-M04-00104-002 R00.pdf.
- Contractors should be required to adhere to the above drawing file naming requirements, in order to facilitate clear and efficient drawing revision cycles between Contractors and the IET.

2.8 Unique Drawings for Components and Equipment

- A complete set of unique drawings is required to be created and supplied for each component or piece of equipment to be installed at Site C.
- Put another way, it is unacceptable to provide any drawings that represent more than one component or piece of equipment (e.g. a single drawing that represents a turbine governor control device for all six units is unacceptable – six unique drawings are required).
- The above requirements apply to all Site C equipment, structures, and systems, including equipment that may be identical in design and construction at Site C.

2.9 Drawing Cross-Referencing

- All drawings produced for Site C that will be issued in the BC Hydro drawing vault under station code 1016 are required to be fully cross-referenced, using BC Hydro drawing numbers:
    - Where part of a drawing is continued on another drawing, or where equipment shown on a drawing connects to equipment shown on another drawing, two-way referencing between the drawings, using their BC Hydro drawing numbers, is required to be provided.
    - If it is convenient for a Contractor or manufacturer to use their own internal drawing numbers for cross-referencing, these numbers must be shown in brackets next to the BC Hydro drawing number cross-reference.
    - Cross-reference drawing numbers are required to be listed in the designated “References” area of the Site C drawing border, along with an associated serial number (1,2,3,4,etc.). Cross-references contained in the body of the drawing are required to refer to the appropriate serial number in the “References” area of the drawing border (e.g. “REF 2”), rather than referring directly to the drawing number to be referenced. An example of a typical “References” area of a drawing border is provided below:



2.10 Hardcopy and Electronic Drawing Deliverables

- The following are required to be delivered to the BC Hydro drawing vault after Project completion:
  - Original, full-size, signed & sealed hardcopy record drawings.
  - Corresponding Autodesk drawing files, and all relevant external reference (.xref) files, named according to file naming requirements outlined in this document.
  - A scanned .pdf copy of each signed and sealed original drawing, named according to file naming requirements outlined in this document.
- Electronic files submitted are required to be rotated to the correct orientation (i.e. after opening a drawing file on a, it must not be necessary to electronically rotate it from within AutoCAD or Acrobat in order to view it in the correct orientation).
- Management of drawings prior to record issue will be handled by Site C document control.

2.11 Instruction, Maintenance, and Operation Manuals

- Final instruction, maintenance, and operation manuals are required to:
  - completely and thoroughly describe the associated equipment/system/structure, as well as recommended procedures for assembly, dismantling, maintenance, operation, testing and inspection;
  - accurately reflect the actual equipment/system/structure as it was delivered to Site C;
  - include a complete set of drawings and BOM;
  - be submitted using an 8.5” x 11” Site C cover sheet drawing for issuance in the BC Hydro drawing vault;
  - be submitted in both .pdf electronic format and hardcopy;
  - utilize 11”x17” size pages for any drawings included; and,

  - utilize 8.5” x 11” for all other pages.

- Hardcopy manual requirements are as follows:
  - A minimum of 10 hardcopies are required to be submitted for each manual.
  - Each hardcopy is required to be bound and indexed for easy navigation.
  - 11” x 17” drawings included in manuals are required to be folded twice, in order to fit the 8.5” x 11” size binder while allowing a reader to conveniently view each drawing title block in the bottom right-hand corner of the page.
- Electronic .pdf manual requirements are as follows:
  - All pages are required to be correctly oriented for electronic viewing.
  - A hierarchy of active (point-and-click) electronic bookmarks, identical to the manual’s table of contents, is required to be included with each manual, to allow rapid navigation throughout the document.
  - All pages are required to be generated electronically, so that they are clear and text-searchable (i.e. scanned pages are not acceptable).
  - All pages are required to be in colour.
- Draft manuals are required to be submitted well in advance of shipping of the relevant equipment, to allow enough time to review them against drawings and maintenance instructions, in order to verify acceptability and allow for any revisions that may be required of the Contractor.

2.12 Bills of Materials (BOMs)

- Bills of materials (BOMs) for equipment are required to:
  - completely specify equipment parts by clearly showing the BOM item number, the manufacturer, series numbers, model numbers, part numbers, and any other relevant information;
  - be sufficiently detailed, such that they allow for efficient and effective installation, operation, maintenance, disassembly, repair, upgrade or replacement of every maintainable component within the equipment;
  - be shown either on equipment drawings, or as a separate drawing numbered in sequence with the set of drawings that depict the equipment; and,
  - include a spare column, to be used for entry of a corresponding BC Hydro stores number to be assigned to each BOM item.

2.13 Cable Schedule and CableBase Software

- A cable schedule for Site C is required, which fully documents all electrical cables used throughout the facility, including cable type, length, routing, “to” and “from” locations, purpose, revision history, and any other relevant information.
- The Site C cable schedule is required to be generated using BC Hydro’s CableBase software.
- The Site C cable schedule is required to fully utilize CableBase’s capabilities to use pre-defined facility areas, locations, systems, and panels/cabinets as start/end and routing points for cables. Put another way, free-form text entry into the cable schedule is required to *not* be used (free-form entry of information is occasionally used for existing facilities, but will not be used for a green-field facility).

- Naming of CableBase areas, locations, systems, and panels/cabinets is required to follow the Site C Component Hierarchy.
- Cable numbering used for Site C is required to follow a pre-designed numbering framework, designed to:
    - be intuitive and efficient for users of the Site C cable schedule;
    - be subdivided into sections according to the Site C Component Hierarchy; and,
    - include approximately 30% spare cable number capacity in each section to accommodate future design activities at the facility.

2.14 Electrical and Protection & Control Drawing Standards

- In addition to other applicable standards discussed in this document, electrical and protection & control drawings produced for Site C are required to adhere to BC Hydro Engineering Standard DP 45-Z0007 R02 (Generation Engineering – P&C Design Documents Outline of Requirements).
- Drawings detailing electrical cable trays and buried or embedded electrical conduits are required to be separate from each other (i.e. details of electrical cable trays and conduits should not be shown on the same drawing). This practice allows for clarity when interpreting these drawings; in addition, embedded and buried conduits will almost certainly never change, whereas electrical cable tray is more likely to be modified or added to in the future.
- Drawings detailing above-ground or surface-mounted electrical conduits are not required.

3. Use of BC Hydro Engineering Drawing Standards

- Where there is any conflict between a BC Hydro Engineering Standard and this User Requirements document, this User Requirements document will govern.
- BC Hydro is currently in the process of migrating a number of its ES 10 standards to a new ES 12 series, which will be specific to generation. As the new ES 12 standards are issued, they will supersede, and should be used in place of, the corresponding ES 10 standards.

3.1 Required Standards

- The following BC Hydro Engineering Standards are required to be adhered to with regard to preparation of Site C drawings:
    - ES 10-A0020 R04 Drawing Control – Engineering Drawing Numbering System
    - ES 10-A0027 R02 Drawing Control – Spare Major Equipment Station Drawings
- The following BC Hydro Engineering Standards are required to be adhered to as closely as possible. Application of these standards is discussed in more detail in other sections of this User Requirements document.
    - DP 45-Z0003 R02 Generation Engineering – Preferred Drawing Number and File Name
    - DP 45-Z0007 R02 Generation Engineering – P&C Design Documents Outline of Requirements

4. Electronic Drafting Requirements

- The requirements below apply to drawings produced by contractors, the Site C IET and its consultants.

4.1 Standard Electronic Drawing Symbol Libraries

- Current drafts of standard electronic drawing symbols required to be used by the IET are included in Appendix III for reference. These symbol libraries will be updated at the IET's discretion throughout the Project, in consultation with BC Hydro.

4.2 Standard External Reference (.xref), Layer, and Block Naming

- A current draft of BC Hydro's standard external reference (.xref) file naming conventions required to be used by the IET is included in Appendix IV for reference. This naming convention will be updated at the IET's discretion throughout the Project, in consultation with BC Hydro.

4.3 Line Weight, Type, Style, and Colour Standards

- A current draft of BC Hydro's standard line weight, type, style, and colour conventions required to be used by the IET is included in Appendix V for reference. This convention will be updated at the IET's discretion throughout the Project, in consultation with BC Hydro.

4.4 Text styles

- The following practices with regard to line types and styles are required to be followed for drawings produced for Site C:
    - Designate four text styles with sizes as follows:
        - Grid-txt: 1.5mm (grid elevation text, contour text, coordinate grids, stationing).
        - Standard 2.5mm (notes, dimensions, annotations).
        - Sub-titles 3.5 mm.
        - Titles 4.5 mm.
    - Use the out of the box font of romans for all four text styles.

4.5 Abbreviations

- Abbreviations used on drawings should adhere to the following standard:
    - ES 10-A0425 R02 Abbreviations and Symbols – Designations and Letter Symbols – for Units and Decimal Prefixes

4.6 Paper Space vs. Model Space

The following general practices with regard to placement of drawing elements in paper or model space are required to be followed when generating electronic Site C drawings:

- All drawing elements that represent real-world objects should reside in model space.
    - Model space objects represented in plan view should be positioned at their true UTM NAD83 coordinate at 1:1 scale in metres.
    - Model space sectional and detail drawing information should be placed at the correct elevation in meters on the y axis of the model space drawing environment.
- All drawing annotations intended to guide the user of the drawing should reside in paper space.
    - Paper space drawing elements should be drawn at a 1:1 scale in millimetres.
    - Examples of annotations include: title blocks, object descriptors, general notes, legends, north arrow, section bubbles, detail bubbles, and dimensions.

- An exception would be contour elevation data which should be dynamically linked to a contour at its true UTM NAD83 coordinate and grid data needed for sections or vertical profiles. Both of these annotation type elements are required to reside in model space.

4.7 Use of WIPEOUT Command

- The AutoCAD WIPEOUT command is required to *not* be used on any drawings produced for Site C. WIPEOUT utilizes a drawing object that acts as a mask, to be utilized to hide other drawing objects. This function has proven problematic when drawings are converted to .pdf.
- Other acceptable methods of masking drawing objects include: text mask, XCLIP, and use of a solid hatch of color 255 (white).

APPENDIX I: Briefing Note – Engineering Drawing Size

BRIEFING NOTE FOR INFORMATION

Title: **Engineering Drawing Size**

- This briefing note discusses selection of the engineering drawing size to be used for Site C.

Background

The vast majority of BC Hydro's engineering drawings are American National Standards Institute D size (ANSI D): 22 inches tall by 34 inches wide. In the past, BC Hydro has also made use of an in-house "U" size drawing: 22 inches tall by 41.25 inches wide (a ~21% wider ANSI D drawing, which is not an ANSI standard). Both ANSI D and BC Hydro "U" size drawings were used for historical reasons. BC Hydro also uses standard letter size (8.5"x11") "cover sheet" engineering drawings for issuing equipment instruction manuals and software (these drawings contain no schematic depictions of equipment or structures, only text).

ANSI standard engineering drawing sizes are based on 8.5"x11" letter size paper. International Organization for Standardization (ISO) standard engineering drawing sizes are based on the largest drawing size (A0) having an area of 1 m^2 and a page aspect ratio of $1:\sqrt{2}$. Both systems work by dividing a large drawing into the next smaller size by bifurcating it on its long dimension; however, the ISO system carries the mathematical property that the page aspect ratio is *identical* for all sheet sizes. This ensures that a drawing can be scaled between any ISO drawing size without requiring letterboxing (wasted drawing space).

Discussion

The Site C Integrated Engineering Team (IET) has identified a number of advantages associated with adopting an engineering drawing size larger than ANSI D, including:

- the ability to fit more information on a drawing, reducing the number of drawings required to be produced for the Project;
- associated enhancements to productivity and Project cost performance;
- enhanced visualization, especially with regard to structures, which tend to require the use of multiple sheets simultaneously to view an entire structure; and,
- the opportunity to adhere to a metric drawing size standard (Site C is a metric project).

ANSI E, ISO A0, and BC Hydro "U" size drawings are all larger than ANSI D, and were discussed as candidates for use on Site C. These drawing sizes are summarized here:

	ANSI D	ANSI E	ISO A0	BCH "U"
Height	558.8 mm (22 in)	863.6 mm (34 in)	841 mm (33.11 in)	558.8 mm (22 in)
Width	863.6 mm (34 in)	1117.6 mm (44 in)	1189 mm (46.81 in)	1047.8 mm (41.25 in)
Area	0.4826 m^2 (748 in^2)	0.9652 m^2 (1496 in^2)	1 m^2 (1549.9 in^2)	0.5855 m^2 (907.5 in^2)
Half Size	ANSI B	ANSI C	ISO A2	None

A number of factors were considered in order to evaluate the three candidate drawing sizes, including: usability of reduced size drawings during design and construction activities, potential impact on Contractors, compatibility with existing BC Hydro systems and infrastructure, and potential cost implications.

"U" size drawings were eliminated as a possibility for the following reasons:

- half-size drawings cannot be printed on a standard office printer (half-size "U" paper is not available, and standard office printers cannot accommodate it either);
- an unacceptable productivity burden would be imposed by requiring the use of drafting plotters to print half-size drawings;
- there would be associated Project cost impacts; and,
- "U" size drawings are not standard and not typically used in industry, so Site C Contractors would also face the issues outlined above.

Examination of the ISO A0 drawing size resulted in the following findings:

- ISO A0 offers more than double the drawing area of an ANSI D size drawing;
- ISO A0 is used by other utilities within BC, and is familiar to Contractors;
- ISO A2 (the half-size of ISO A0) is a convenient size drawing for use on the desktop or in the field as necessary;
- ISO A3 and A4 size drawings can be printed on a standard office printer with no letterboxing;
- drawings can be printed on 11x17 for inclusion in reports, albeit with some letterboxing; and,
- the ISO engineering drawing size standard is a metric standard.

While the ANSI D size has the advantage of being able to be printed in half-size on 11"x17" (ANSI B) paper with no letterboxing, the advantage of more than double the usable drawing area on an ISO A0 size drawing is judged to be far more valuable. The only instance when printing to 11"x17" size paper would be necessary (i.e. instead of ISO A3 or A4) would be for reports, where the impact of letterboxing is of little consequence.

Note that an ANSI E size drawing has a different aspect ratio than the 11"x17" ANSI B size. This means that an ANSI E size drawing would present with letterboxing when printed on 11"x17" paper for use in reports (i.e. the same issue as with the ISO A0 size).

Generation drafting has confirmed that use of ISO A0 or ANSI E size drawings can be managed electronically and physically using existing BC Hydro systems and infrastructure for drawing management.

Since the ISO A0 size offers slightly more usable drawing area, is based on a metric standard, and preserves page aspect ratio across all standard drawing sizes, it is favoured over the ANSI E size.

Operations considerations can be accommodated within the design of Site C at little to no cost. Considerations that have been identified include:

- sizing of fold-out drawing tables throughout the plant (noting that existing fold-out tables used at PCN and GMS are already large enough to accommodate ISO A0 drawings);
- sizing of filing cabinets for master site drawings; and,
- size of binders and storage shelves for ISO A3 reduced-size drawings (noting that an ISO A3 size is 11.69” x 16.54”, meaning that it is only slightly shorter width-wise and taller height-wise than an 11” x 17” half-size drawing).

Considering the above, ISO A0 is selected as the preferred drawing size for Site C. Standard 8.5” x 11” coversheet drawings will continue to be used only to document and issue equipment instruction manuals, software, and the Site C cable schedule through the BC Hydro drawing vault.

Next Steps

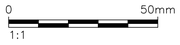
The Site C IET will proceed using the ISO A0 drawing size for engineering drawings on the Project. Standard letter size (8.5”x11”) cover sheet drawings will continue to be used only for Site C equipment instruction manuals, software, and cable schedule for issuing in the BC Hydro drawing vault.

References

1. ANSI/ASME Y14.1-2012 “Decimal Inch Drawing Sheet Size and Format”.
2. ISO 216:2007 “Writing paper and certain classes of printed matter -- Trimmed sizes -- A and B series, and indication of machine direction”.

APPENDIX II: Standard Electronic Drawing Symbol Libraries

NAME:
BCH–X–SCLE–METR–1xxx
METRIC 1 TO 1



LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–2.5x
METRIC 1 TO 2.5

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–2xxx
METRIC 1 TO 2

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–5xxx
METRIC 1 TO 5

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–10xx
METRIC 1 TO 10

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–20xx
METRIC 1 TO 20

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–25xx
METRIC 1 TO 25

LAYER: $$$–X–X–ANNO–BLOK

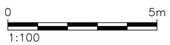
NAME:
BCH–X–SCLE–METR–50xx
METRIC 1 TO 50

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–75xx
METRIC 1 TO 75

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–100x
METRIC 1 TO 100

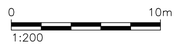


LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–125x
METRIC 1 TO 125

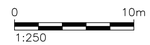
LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–200x
METRIC 1 TO 200



LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–250x
METRIC 1 TO 250



LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–500x
METRIC 1 TO 500

LAYER: $$$–X–X–ANNO–BLOK

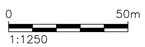
NAME:
BCH–X–SCLE–METR–750x
METRIC 1 TO 750

LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–1000
METRIC 1 TO 1000

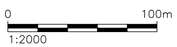
LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–1250
METRIC 1 TO 1250



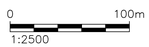
LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–2000
METRIC 1 TO 2000



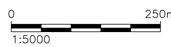
LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–2500
METRIC 1 TO 2500



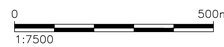
LAYER: $$$–X–X–ANNO–BLOK

NAME:
BCH–X–SCLE–METR–5000
METRIC 1 TO 5000



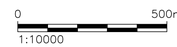
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–7500
METRIC 1 TO 7500



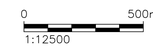
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–10000
METRIC 1 TO 10000



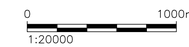
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–12500
METRIC 1 TO 12500



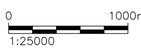
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–20000
METRIC 1 TO 20000



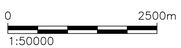
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–25000
METRIC 1 TO 25000



LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–50000
METRIC 1 TO 50000

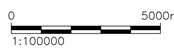


LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–75000
METRIC 1 TO 75000

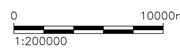
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–100000
METRIC 1 TO 100000



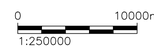
LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–200000
METRIC 1 TO 200000



LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SCLE–METR–250000
METRIC 1 TO 250000



LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–BEDR
BEDROCK

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–ERTH
EARTH

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–G–DRHL–AIRx–RTRY
DH–AIR ROTARY

LAYER: STE–G–E–DRHL–AIRx–RTRY

NAME: BCH–G–DRHL–AUGR
AH–AUGER HOLE

LAYER: STE–G–E–DRHL–AUGR

NAME: BCH–G–DRHL–BOCx
BOC–OPEN ENDED BECKER DRILL HOLE

LAYER: STE–G–E–DRHL–BOCx

NAME: BCH–G–DRHL–BPTx
BPT–BECKER PENETRATION TEST
(CLOSED ENDED BECKER)

LAYER: STE–G–E–DRHL–BPTx

NAME: BCH–G–DRHL–CPTx
CPT/PC–CONE PENETRATION

LAYER: STE–G–E–DRHL–CPTx

NAME: BCH–G–DRHL–CPxx
CP–DYNAMIC CONE PENETRATION

LAYER: STE–G–E–DRHL–CPxx

NAME: BCH–G–DRHL–MUDx–RTRY
DH–MUD ROTARY

LAYER: STE–G–E–DRHL–MUDx–RTRY

NAME: BCH–G–DRHL–OWxx
OW–BARBER DRILL HOLE
(OBSERVATION WELL)

LAYER: STE–G–E–DRHL–OWxx

NAME: BCH–G–DRHL–PDHx
PDH–PERCUSSION DRILL HOLE

LAYER: STE–G–E–DRHL–PDHx

NAME: BCH–G–DRHL–PWxx
PW–BARBER DRILL HOLE
(PUMPING WELL)

LAYER: STE–G–E–DRHL–PWxx

NAME: BCH–G–DRHL–RCPT
RESISTIVITY CONE PENETRATION

LAYER: STE–G–E–DRHL–RCPT

NAME: BCH–G–DRHL–SCPT
SEISMIC CONE PENETRATION

LAYER: STE–G–E–DRHL–SCPT

NAME: BCH–G–DRHL–SONC
DH–SONIC

LAYER: STE–G–E–DRHL–SONC

NAME: BCH–G–DRHL–TEST–PITx
TP–TEST PIT

LAYER: STE–G–E–DRHL–TEST–PITx

NAME: BCH–G–INST–BPxx
BP–BOREHOLE PACKER

LAYER: STE–G–E–INST–BPxx

NAME: BCH–G–INST–FPxx
FP–FIBRE OPTIC PIEZOMETER

LAYER: STE–G–E–INST–FPxx

NAME: BCH–G–INST–ICxx
IC–INCLINOMETER CASING

LAYER: STE–G–E–INST–ICxx

NAME: BCH–G–INST–PExx
PE–VIBRATING WIRE PIEZOMETER

LAYER: STE–G–E–INST–PExx

NAME: BCH–G–INST–PHxx
PH–HYDRAULIC PIEZOMETER

LAYER: STE–G–E–INST–PHxx

NAME: BCH–G–INST–PPxx
PP–PNEUMATIC PIEZOMETER

LAYER: STE–G–E–INST–PPxx

NAME: BCH–G–INST–PRWx
PRW–PRESSURE RELIEF WELL

LAYER: STE–G–E–INST–PRWx

NAME: BCH–G–INST–SMBx
SURVEY MONUMENT BENCHMARK

LAYER: STE–G–E–INST–SMBx

NAME: BCH–G–INST–SPxx
SP–STANDPIPE PIEZOMETER

LAYER: STE–G–E–INST–SPxx

NAME: BCH–G–INST–WIER
WIER

LAYER: STE–G–E–INST–WIER

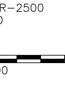
NAME: BCH–X–ZONE
ZONE NUMBER

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–AROS
ARROW SQUIGGLE

LAYER: $$$–X–X–ANNO–DIMS

NAME: BCH–X–BAYL–MULT
BAYLINE MULTIPLE



LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–BAYL–SNGL
BAYLINE SINGLE

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–BRKL
BREAKLINE

LAYER: $$$–X–X–ANNO–DIMS

NAME: BCH–X–DETL
DETAIL 2 OR 3 CHAR.

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SECT
SECTION ARROWS

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–DIMS–FEET
ALL DIMENSIONS ARE IN FEET

ALL DIMENSIONS ARE IN FEET, UNLESS OTHERWISE SHOWN

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–DIMS–INCH
ALL DIMENSIONS ARE IN INCHES

ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SHOWN

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–DIMS–METR
ALL DIMENSIONS ARE IN METRES

ALL DIMENSIONS ARE IN METRES, UNLESS OTHERWISE SHOWN

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–DIMS–MLMT
ALL DIMENSIONS ARE IN MILLIMETRES

ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS OTHERWISE SHOWN

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–DIMS–NTSx
DRAWING NOT TO SCALE

DRAWING IS NOT TO SCALE

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–LEGN
LEGEND

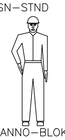
L E G E N D :

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–NRTH–ARRW
NORTH ARROW

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–PRSN–STND
PERSON STANDING



LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–SLPE
3 LINE SLOPE INDICATOR

LAYER: $$$–X–X–ANNO–BLOK

NAME: BCH–X–TREE
TREE PLAN

LAYER: $$$–X–X–ANNO–BLOK

SNC·LAVALIN
Klohn Crippen Berger

DSGN	XXXXXX
INDEP CHK	XXXXXX
DFTG	MN
DFTG CHK	XXXXXX
REPORT NO.	XXXXXX
DWG. NO.	XXXXXX
R	XXXXXX

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

BC hydro ENGINEERING

SITE C CLEAN ENERGY PROJECT

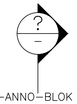
AUTOCAD BLOCKS

SHEET 1 OF 2

DATE 2013-11	FIG NO FIGURE XX
DWN MN	DWG NO XXX-XXX-XXX R

D

L:\12 Drawings\02 Drawing Standards\BCH_TEMP_BLOCKS\LIST of BLOCKS–MIKE.dwg
Layout: Sht_A1
2013/12/11 – 8:22am

NAME: BCH–X–TITL TITLE SUBTITLE  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–TITL–DETL DETAIL SUBTITLE  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–TITL–ELEV ELEVATION SUBTITLE  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–TITL–SECT SECTION SUBTITLE  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–SECT–BEND SECTION BEND  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–SECT–SNGL SINGLE SECTION  LAYER: **$$$**–X–X–ANNO–BLOK	NAME: BCH–X–LEGN–CONC–1STx–STAG 1ST STAGE CONCRETE  LAYER: **$$$**–X–X–ANNO–HTCH	NAME: BCH–X–LEGN–CONC–2NDx–STAG 2ND STAGE CONCRETE  LAYER: **$$$**–X–X–ANNO–HTCH
NAME: BCH–X–LEGN–CONC–EXST EXISTING CONCRETE  LAYER: **$$$**–X–X–ANNO–HTCH							

SNC·LAVALIN

Klohn Crippen Berger

DSGN	XXXXXX
INDEP CHK	XXXXXX
DFTG	MN
DFTG CHK	XXXXXX

REPORT NO.	XXXXXX	
DWG. NO.	XXXXXX	R XXXXXX

BC hydro ENGINEERING

SITE C CLEAN ENERGY PROJECT

AUTOCAD BLOCKS

SHEET 2 OF 2

DATE	2013-11	FIG NO	FIGURE XX
DWN	MN	DWG NO	XXX-XXX-XXX R

D

L:\12 Drawings\02 Drawing Standards\BCH_TEMP_BLOCKS\\LIST of BLOCKS–MIKE.dwg
Layout: Layout1
2013/12/11 – 8:24am

Subject: Site C Instrumentation Drawing Symbols	Designer: T. Kaempffer	TBA
	Reviewer: S. Taylor-Lane	
	Indep Rev:	
	Acceptor: J. Nunn	
Category: Standard	Date: 02 Dec 2013	

This Engineering Standard provides symbols for identifying all geotechnical instrumentation for Site C drawings.

Overview:

Unique symbols are required to identify instrumentation on drawings and the standardization of these symbols will ensure consistency across drawings for different disciplines.

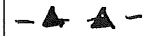
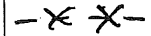
Introduction:

One of the processes which must be undertaken after the completion of the exploration or investigation is the production of records and drawings to preserve the information in a format which is both easy to access and comprehend. For Site C, it is imperative that Instrumentation Design, IFC and As-Built drawings be created with consistent symbols. This consistency will ensure instrumentation is clearly identified for all contractors, designers and owners.

Standard Instrumentation Labelling:

Exploratory investigation drillholes that have instrumentation installed in them retain the formal drillhole name as outlined in the *Site C Drillhole and Test Pit Nomenclature Standard*. Design, IFC and As-Built drawings will also clearly identify instrumentation locations with the use of the following symbols:

Category	*Symbol*	*Type*
Survey		Control Monument
		Survey Monuments or Survey Target
Water Pressure		Standpipe Piezometer
		Direct Burial Piezometer (PE, PF, PP, PH)*

		Pressure Relief Well
		Weir
		Hydraulic Tubing
Settlement/Movement		Inclinometer
		Extensometer
		Joint Meter or Crack Meter
		Fiber Optic Cable
		Total Earth Pressure Cell (PE, PF, PP)
		Strong Motion Accelerograph
Temperature		Thermistor or Thermocouple
Weather		Weather Station
ADAS		HDPE Conduit
		PVC Conduit
		Flexible Conduit**
		Direct Burial Cable
		Signal Cable
		Pull Box
		Junction Box
		Datalogger

*Where: PE = Electric Piezometer (either Vibrating Wire or Strain Gauge)
PF: Fiber Optic Piezometer
PP: Pneumatic Piezometer
PH: Hydraulic Piezometer

**Were: Liquid Tite or other corrugated conduit for wire protection

Additional Symbols:

When additional symbols are required, the person will request the new symbol from the Instrumentation and Drafting Design leads who will subsequently update this document.

APPENDIX III: Standard External Reference (.xref), Layer, and Block Naming

APPENDIX IV: Line Weight, Type, Style, and Colour Standards

BCH - COLORS AND LINE THICKNESS FOR FULL SIZE PLOTTING

CTB Filenames: BCH-Fullsize-color.ctb, BCH-Fullsize-bw.ctb, BCH-Halfsize-color.ctb, BCH-Halfsize-bw.ctb

TEXT, DIMENSIONS AND SYMBOLS

07	0.18	DIMENSION LINES, BAYLINE, CENTERLINE (NOT STEEL), CONTOUR TEXT
08	0.20	PHASED WORK
09	0.20	PHASED WORK
17	0.20	CLIENT INFO.
21	0.20	FUTURE WORK
220	(Mapped to black) 0.70	HOLDS, CLOUDS, REVS
232	(Mapped to black) 0.35	TEXT (HEADINGS), DIMENSION TEXT
252	0.20	GRID LINES (NORTHERN AND EASTING)
253	0.09	GRID LINES (SECTIONS AND PROFILES)

HATCH PATTERNS

82	0.18	CONCRETE HATCH, 1ST STAGE CONCRETE HATCH, 2ND STAGE CONCRETE HATCH
101	0.18	EXISTING CONCRETE HATCH
151	0.18	WATER HATCHING
242	0.18	STEEL HATCHING
255	0.25	SHADE FILL AND SHADE BOUNDARY

MECHANICAL

07	0.18	SCHEMATICS - EQUIP (VALVES, PUMPS, FANS, ETC.)
181	0.25	HVAC EQUIPMENT (FANS, DAMPERS, ETC.)
191	0.25	DUCT
196	0.20	VALVES, PUMPS, STRAINERS, MISC. EQUIP
200	0.25	MECH EQUIP (COMPRESSORS, HPU'S, ETC.)
201	0.25	SCHEMATICS - DUCT
202	0.30	PIPES & FITTINGS (EMBEDDED)
210	0.30	PIPES & FITTINGS (GENERAL)
216	0.25	PIPES & FITTINGS (BY OTHERS)

HYDROTECHNICAL

140	0.20	DITCHES
140	0.20	LAKES, PONDS
151	0.18	WATER HATCHING
155	0.25	WATERSTOPS HIDDEN
157	0.60	WATERSTOPS IN SECTION
170	0.40	RIVERS
172	0.35	RIVER NAMES, WATER LEVEL TEXT
182	0.25	MIN. OPERATING LEVEL (WATER LEVEL LINE)

STRUCTURAL CONCRETE

03	0.60	CONC IN SECTION
60	0.60	2ND STAGE CONC IN SECTION
61	0.20	RCC LIFTS
62	0.40	2ND STAGE CONCRETE - PLAN AND ELEVATION
70	0.40	CONCRETE - PLAN AND ELEVATION
71	0.30	2ND STAGE CONCRETE FINISHED FLOOR
82	0.18	CONCRETE HATCH, 1ST STAGE CONCRETE HATCH, 2ND STAGE CONCRETE HATCH
91	0.25	2ND STAGE CONCRETE HIDDEN
94	0.20	ALL JOINTS (CONTR, CONSTR,EXP) HIDDEN
94	0.20	ALL JOINTS (CONTR, CONSTR,EXP)
100	0.25	CONCRETE HIDDEN
101	0.18	EXISTING CONCRETE HATCH
106	0.20	EXISTING CONCRETE
108	0.40	ROLLER COMPACTED CONCRETE (RCC) PLAN AND ELEVATION

STRUCTURAL STEEL

01	0.25	TURBINES, GENERATORS, SCROLLCASE, TRASHRACKS, GATES, DRAFT-TUBE
10	0.30	ALL NEW STEEL, MISC STEEL
12	0.20	DRAIN,, GUTTER, GRATING,
13	0.20	ALL STEEL-HIDDEN, EXIST EMBED STEEL, EXISTING STEEL (DRAFT TUBE GATE)
22	0.30	LADDER, STAIRS, HANDRAILS, DOOR (USE WHEN SHOWN ON CONCRETE OUTLINES)
222	0.25	STRUCTURAL STEEL
240	0.40	STEEL IN SECTION,
241	0.25	BOLTS, NUTS, WASHERS
242	0.18	STEEL HATCHING, STEEL CENTERLINES, WELDS,
244	0.20	EXISTING STEEL
244	0.20	EXISTING STEEL HIDDEN

REBAR

11	0.30	EXISTING REBAR
20	0.50	NEW REBAR, NEW REBAR HIDDEN (-----)
243	0.50	DOWELS
245	0.30	EXISTING DOWELS

CIVIL AND GEOTECHNICAL

251	0.25	EXISTING SURFACE MAJOR CONTOURS
252	0.20	EXISTING SURFACE MINOR CONTOURS
49	0.35	NEW SURFACE MAJOR CONTOURS
15	0.20	NEW SURFACE MINOR CONTOURS
160	0.35	BATHYMETRIC MAJOR CONTOURS
141	0.20	BATHYMETRIC MINOR CONTOURS
28	0.25	EXISTING ROADS MAJOR CONTOURS
29	0.20	EXISTING ROADS MINOR CONTOURS
25	0.35	BEDDING PLANE MAJOR CONTOURS
12	0.20	BEDDING PLANE MINOR CONTOURS
19	0.35	BEDROCK MAJOR CONTOURS
14	0.20	BEDROCK MINOR CONTOURS
24	0.35	NEW ROADS MAJOR CONTOURS
32	0.20	NEW ROADS MINOR CONTOURS
56	0.35	NEW DYKE MAJOR CONTOURS
38	0.20	NEW DYKE MINOR CONTOURS
107	0.35	SLURRY WALL MAJOR CONTOURS
113	0.20	SLURRY WALL MINOR CONTOURS
42	0.18	MINIMUM LINE OF EXCAVATION
27	0.50	NEW FILL SURFACE BREAKLINES AND TOE LINE
30	0.50	NEW EXCAVATION SURFACE BREAKLINES AND TOE LINE

25	0.35	BEDDING PLANE SURFACE PROFILE LINE, CROSS-SECTION LINE
19	0.35	BEDROCK SURFACE PROFILE LINE, CROSS-SECTION LINE
27	0.50	NEW FILL SURFACE PROFILE LINE, CROSS-SECTION LINE
30	0.50	NEW EXCAVATION PROFILE LINE, CROSS-SECTION LINE
39	0.35	EXISTING EXCAVATED SURFACE PROFILE LINE, CROSS-SECTION LINE
160	0.35	BATHYMETRIC PROFILE LINE, CROSS-SECTION LINE
251	0.25	EXISTING SURFACE PROFILE LINE, CROSS-SECTION LINE
07	0.18	CONTOUR TEXT PROFILE AXIS LINES, CROSS-SECTION AXIS LINES, STATION TICKS PROFILE TEXT, CROSS-SECTION TEXT ALIGNMENT, ALIGNMENT TICKS (MAJOR), ALIGNMENT TEXT
251	0.25	PROFILE GRID LINES, CROSS-SECTION GRID LINES ALIGNMENT TICKS (MINOR)
32	0.20	BACK FILL (EXISTING)
35	0.25	FILL (EXISTING)
44	0.20	SAND BAR
46	0.20	TRAILS
64	0.20	MISC VEGETATION
55	0.25	ROCK OUTCROP
23	0.20	ROCKERY, ROCKS

UTILITIES

33	0.40	STORM MISCELLANEOUS FEATURES
45	0.40	STORM LINES
63	0.40	STORM MANHOLES
73	0.40	SANITARY MISCELLANEOUS FEATURES
96	0.40	SANITARY MANHOLES
98	0.40	SANITARY LINES
142	0.40	WATERMAIN MISCELLANEOUS FEATURES
161	0.40	WATERMAIN LINES
163	0.40	WATERMAIN MANHOLES
192	0.20	EXIST POWER POLES, ANCHORS, LIGHTS, ELEC BOX, O/H LINES
193	0.20	EXIST UTILITIES (STM, SAN, WATER & MISC OBJECTS)
221	0.25	EXISTING GAS LINES

MISCELLANEOUS ITEMS

36	0.60	WOOD, TIMBER, IN SECTION
37	0.40	WOOD, TIMBER - PLAN AND ELEVATION
54	0.40	CLADDING OUTLINE
57	0.25	CLADDING MISC