YM-80004 Schedule Basis: Site C Implementation Phase

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Project Description

The project design for the Site C Clean Energy Project includes the following key components:

- Access roads in the vicinity of the site and a temporary construction access bridge across the Peace River at the dam site.
- Construction of two temporary cofferdams across the main river channel to allow for construction of the Earthfill dam.
- Two river Diversion tunnels each approximately 1 km in length and 11 metres in diameter.
- An Earthfill dam, approximately 1,050 metres long and 60 metres high above the riverbed.
- A generating station with six 183 MW generating units.
- An 83-kilometre-long reservoir that would be, on average, two to three times the width of the current river.
- The realignment of up to six segments of Highway 29 over a total distance of up to 30 kilometres.
- Shoreline protection at Hudson's Hope.
- Two new 500 kilovolt transmission lines that would connect the Site C facilities to the existing Peace Canyon Substation, along an existing right-of-way.
- Three new 138 kilovolt transmission lines 5L15, 5L16, and 5L17 that connect Site C Powerhouse to the Substation
- Worker accommodation includes one construction camps at the north dam site, with other workers being housed off site and in the region.

For further details see the Project Description in Project Plan.

Scope of Work

All items of the scope of work are shown in the Implementation phase WBS Rev 3.3 updated May 26 2016, appendix 1.

Schedule Execution Strategy

The strategy for delivering the Site C clean energy project will follow a phased release of design information to allow procurement and construction of several major phased contracts.

Site Preparations (SP) – These works are scheduled to take place during year one construction, with a phased completion through late 2015 and late 2016. The purpose of Site Preparation works is to enable access, accommodation, temporary power and communications (TY1506 project) to the site for the Main Civil Works (MCW) contractor from winter 2015/16 onwards.

Main Civil Works (MCW) – Contract was awarded December 2015 which was closely followed by contractors submittals and mobilization to site winter 2015/16. The construction period of the MCW contract is will cover years 2016 to 2023, with scope including Diversion Works, RCC Buttress, Approach Channel, and Earthfill Dam. Completion of the Earthfill Dam is scheduled for August 2022, with Reservoir filling in September 2022.

Turbines & Generating Equipment (TG) – Procurement of TG contractor included competitive model testing which was completed summer 2015. It was necessary to perform procurement of this equipment early in the project to determine the sizing requirements of Turbine pits which in turn influences the design requirement of the Powerhouse. TG Contract was awarded in March 2016. Delivery to site of embedded components will commence summer 2017 in advance of Powerhouse construction commencing spring 2018.

Generating Station & Spillway Civil (GSS Civil) – Following award of TG contractor in March 2016 final dimensions can be provided to the GSS design team to allow development of Implementation design throughout 2016/17. Tender design will be completed by September 2016 in parallel with the RFQ process. Competitive RFP submissions will be developed by contractors from September 2016 to March 2017, which will be followed by negotiations and anticipated contract award in July 2017. Contractor mobilization may take place prior to winter 2017/18, but it is not anticipated that substructure concrete will commence until the following spring 2018 due to temperature restrictions on conventional cast in place concrete. GSS construction will continue until 2022.

GSS Hydromechanical - RFP will be issued fall 2016 with contract award scheduled for May 2017. Scope includes Gates, Trashracks, Stoplogs and Gantry Cranes

GSS Powerhouse Bridge Crane Contract (GSS Cranes) – RFP will be developed in 2016, with RFP scheduled for summer 2017, and contract award in Sep 2017. Scope includes fabrication, installation and commissioning of Powerhouse Overhead Cranes.

GSS Completions Contract – RFP and contract award in 2018. Scope includes transformers, breakers, and auxiliary M&E systems.

STC & 500kV Transmission & Distribution (T&D) – Following stage 4 funding approval BCH Hydro transmission and distribution will commence design and procurement of Site C substation (STC) and two 500kV transmission lines (5L5 & 5L6). Completion of transmission lines and substation will be in advance of GSS and TG commissioning dates in 2022.

Listed below are the main contracts for Site C implementation phase;
Clearing Contracts
- LB Dam Site, year 1 Clearing (P Paquette)
- RB Dam Site, year 1 Clearing (P Paquette)
- Lower Reservoir Dam site to Moberly River, 2016/17 (4Evergreen)
- Reservoir Clearing Lower Reservoir to Cache Creek 2016/17/18
- Reservoir Clearing Cache Creek to Halfway River 2018/19
- Reservoir Clearing Halfway River to Hudson's Hope 2020/21

Site Preparation
- Site Preparations Left Bank (competitive RFP - Morgan)
- Site Preparations Right Bank (direct ward to FN – Duz Cho)
- Site Preparations Temporary Construction Bridge (direct award to FN - Ruskin)
- Construction Power (BC Hydro, project detailed cost/ schedule managed in TY-1505)
- Construction Telecommunications (BC Hydro, also TY-1506 project)
- Temporary Substation (BC Hydro, also TY-1506 project)
- Site Security (direct award to FN – Saulteau Security)
- Viewpoint & Viewpoint Road (direct award to FN)

WA - Worker Accommodation (P3 – ATCO Two Rivers Lodging)

MCW - Main Civil Works (competitive RFP - PRHP)

GSS - Generating Station and Spillway
- GSS Civil - Generating Station & Spillway Civil (competitive RFP)
- GSS Hydromech – GSS Hydromechanical (competitive RFP)
- GSS Crane – GSS Powerhouse Bridge Crane Contract (competitive RFP)
- GSS Completions – GSS Completions Contract (competitive RFP)

TG – Turbines & Generators (competitive RFP – Voith)

MOTI – Ministry of Transportation & Infrastructure
- 240, 269, OFR, 271 North Bank Approach Road (Tender by MOTI)
- Hwy 29 Realignments (Tender by MOTI)

T&D – Transmission & Distribution (project detailed cost + schedule managed in TY-1505 project)

- Two 500kV (5L5 + 5L6) Transmission Lines by BC Hydro
- Site C Substation (STC) and upgrades to Peace Canyon GIS building by BC Hydro
- De-commissioning of existing 138kV line, after STC and first 500kV (5L5) are in-service.

Key Dates

Any schedule work package milestones that are designated as levels 1-5 will be reported to Project Management, and coding of schedule milestones will be in alignment with PPM practices http://edmppmprt1:8080/ppmp/ppm_practices.htm#1p/2pm/guide/4milestones.htm?Highlight=milestone l. Examples of Level 1 to 5 milestones are identified below;

- Budget Approvals
- Regulatory Applications and Authorizations
- Engineering Design Releases
- Procurement Strategy and Contract Awards (>$3M)
- Contract Completion Dates
- Design Basis documented
- In Service Dates (CNO dates)

A list of Project Key Milestones dates for Site C Implementation Phase is listed below;

Environmental Certification (CEAA/BCEA)	14-Oct-2014
Provincial Government Investment Funding	16-Dec-2014
Approval of Batch 1 Permits (Year 1Land Based)	17-Jul-2015
Approval of Water Based Permits (Nav. Waters/ DFO)	30-Sep-2015
Land Based Construction Start	22-Jul-2015
Award WA Contract (LNTP)	05-Jun-2015
Award MCW Contract	18-Dec-2015
Award TG Contract	11-Mar-2016
Award GSS Civils Contract	31-Jul-2017
River Diversion	01-Sep-2020
First Power (ISD)	08-Dec-2023
All Units In-Service (ISD)	25-Nov-2024

Critical Path

The following series of activities represents the critical path contained within the YM-80004 project schedule. Any delay (unmitigated) to these activities would directly impact on project completion date. Generally the critical path is mainly through the right bank construction of the RCC buttress, until river diversion is achieved and then follows through the Earthfill dam construction.

Following the Government funding investment decision on December 16th, 2014 the critical path continues with obtaining Regulatory permits, and in parallel with procurement of Site Preparation and MCW contracts.

Critical construction clearing to the Left Bank commenced late July 2015 along existing roads, and the new North Bank road. This clearing enabled site access to the Worker Accommodation, Left Bank Stabilization and, RSEM L3 areas. Tree clearing continued to advance easterly along North Bank road and progress down to River Road to allow formation of new access roads leading to the future temporary Peace River Construction Bridge. Construction of the temporary bridge over the Peace River commenced Nov 2015 and was completed in March 2016. This enabled significant site access improvements and allowed MCW crews and equipment to mobilize to the right bank.

Temporary power and fibre optics were installed from Fort St John along 269 road, and North Bank road to service the Worker Accommodation. Commissioning of construction power and fibre optics were coordinated with WA phase 1 occupancy. Worker Accommodation phase 1 commenced construction July 2015 and was completed in February 2016, prior to MCW commencing site mobilization.

Right Bank Clearing and Site Preparations commenced concurrently with the Left Bank works and share the same objective of preparing an efficient infrastructure in advance of the MCW contractor arriving at site.
Critical construction clearing to the Right Bank included clearing of Septimus Rail Siding, South Bank Initial Access Roads, Approach Channel and Area A & K aggregate sources. It is essential for the clearing to be completed to the Right Bank roads, aggregate sources and Septimus siding area during the 2015/16 clearing season and prior to the MCW arrival at site spring 2016. It is anticipated that the MCW will need access to aggregates sources and commence RCC test mixes in summer 2016, prior start of RCC construction in 2017.

MCW contract award was achieved on 18-Dec-2015 which allowed MCW to proceed with development of work plans, submittals and commence mobilization to site March 2016.

MCW activities on the right bank will commence with the excavation of the Right Bank Drainage Tunnel that lies below the RCC buttress, and the excavation of the first 50 m of the Approach Channel. As part of the “Observational Method” instrumentation will be installed in the RCC Drainage Tunnel, this instrumentation is to be installed and a baseline set before excavation of the RCC can occur.

This first 50m of the Approach Channel will provide access and a work area for Contractors around the Powerhouse, Spillway, Intakes and Penstocks. After the completion of the excavation of the first 50m of the Approach Channel, work can continue on the remaining of the Approach Channel. The final foundation preparation and lining of the first 50m of the Approach Channel will be delayed until such time as the completion of this work and the resulting reduced access will not interfere with the completion of the Intake and Penstocks.

RCC work on the project will start in June2016 with the setup of the Crushing Plant, Batching Plants, and the first RCC test fill in the fall of 2016, which is prior to main RCC placement in 2017.

The sequence for the RCC placement is Powerhouse, Spillway and finally the Dam Section. This sequence has been chosen taking into account the time taken to complete the Powerhouse, Spillway and Dam portions of the project and allow for the earliest possible overall project completion date. It also allows for two years observation of the Buttress before final Dam RCC placement.

The RCC excavation will start with the Powerhouse in the Fall/Winter of 2016, with the powerhouse RCC being placed in the following summer of 2017. One of the project technical requirement stipulates the next section of RCC cannot be excavated until the previous section excavated has it’s RCC in place. Therefore excavation for the next section of RCC, the Spillway, will commence in the Fall/Winter of 2017, once the Powerhouse RCC placement has been completed. The Spillway RCC will be placed in the Sumer of 2018 and is the largest section of RCC to placed. It will be placed in one season and will require high rates of placement, making it a very time constrained activity for the project. The final section of RCC, for the Dam, will be excavated in the Fall/Winter of 2018 with the RCC placed in the Summer of 2019.

After river diversion in 2019 (target) construction of the remaining Earthfill Dam can then be completed behind the upstream and downstream cofferdams. Due to temperature restrictions on the placement of Dam granular and till materials can only occur between late March and early November of each calendar year. The Earthfill Dam will be completed throughout the non-winter months of 2020 and 2021, with the top granular portion and final till being placed in June 2022.

Reservoir filling can commence after completion of the Earthfill Dam and tunnel#2 conversion. The preferred window to commence reservoir filling is early September 2022 which is after the spring/ summer freshet and the end of nesting birds season.

Turbine & generator wet commissioning starts as soon as the reservoir level reaches 452 m (Oct 8, 2022) and the 1st turbine & generator can be operational as soon as the reservoir reaches the maximum normal reservoir level of 461.8 m in December, 2022(target). Subsequent commissioning of units 2-6 will continue sequentially until all units are in service by November 2023 (target).

Left Bank (near critical path)

Following MCW mobilization to site the sub critical path continues with the Left Bank Stabilization stage 1 excavations. The purpose this excavation is to make safe the area below where the inlet and outlet structures of the diversion tunnels will be constructed. Upon completion of the Left Banks Stabilization, the excavation and construction of the inlet portal can commence, and is closely followed by diversion tunnel excavations and concrete linings.

Tunnelling will commence from the upstream entrance of both diversion tunnels simultaneously. After tunnelling has progressed for the first 50metres the tunnelling crews and equipment would de-mobilize from the inlet portal and relocate downstream at the outlet portal entrance. The construction of the inlet structure can commence after equipment and forms have been removed from the inlet entrance. Once tunnelling and concrete lining has been completed and equipment has been removed, then the outlet structure can be constructed. The Left Bank Diversion work contain six month float which has been incorporated into the MCW contract. All Diversion civil construction should be completed six month prior to River Diversion as per MCW contract milestone M3.1.

After completion of the diversion tunnels and gates, the process of river diversion can commence during the month of September 2019 (target) at which time the Peace River is anticipated to be at its lowest levels. By closing off the initial portion of the upstream cofferdam the river will be diverted through the diversion tunnels.

Construction of the upstream cofferdam will then be formed to an elevation of 422m prior to 15-Oct-2019 which is in advance of upstream PCN and GMS must run periods. The next crucial stage of construction requires the upstream cofferdam to be built to a maximum elevation of 427 by mid-January. The upstream cofferdam must, therefore, be constructed higher than 427 m prior to mid-January to prevent possible overtopping from ice jams. This condition may only occur once every 12 years on average based on historic data and the ice front could reach Site C between mid-January and late February.

Planning Basis

- Project Work Breakdown Structure (WBS) for the Implementation Phase was developed in collaboration with project team members, cost and finance analysts and Project Managers.
- WBS Levels 1-5 were built in SAP and synchronised to Primavera P6.
- Work Package Activity Planning sheets were prepared by each Work Package Manager.
- Work Package Activity sheets describe the Work Package Activities, their duration and identify the quantity of necessary Resources and Expenses.
- Together, these form the planning basis and estimates of the Schedule.
- The information from WP Activity Planning sheets and the Cost Estimate were entered into P6 and a Resource-Loaded Schedule was produced.
- Reviews based on High Level Schedule on critical path activities by IET Construction Planner and SNC Lavalin.
- Resource Histogram developed by SNC Lavalin for Worker Accommodation curves.

Progression

The monthly progression of the Schedule represents a large component of Project Delivery performance reporting. A monthly reporting calendar is laid out with the key activities required by role.

The Project Manager, WPMs and Scheduler are responsible for progressing and forecasting the Schedule monthly to reflect actual progress and to make any changes in planned future activities. The progressed Schedule is compared against the Performance Measurement Baseline (PMB) and other baselines to identify and address any variances that have occurred during the execution of the project work. Significant and permanent variances that cannot be resolved by the project team must be managed following the Change Control Procedure.

The High Level review schedule; The Level 1 schedule, which is located here:

Level 1 Schedule

will be updated monthly prior to leads progression and signed off for approval by [redacted] and [redacted] post leads progression, and then published in the Accountability package. A one pager commentary on the schedule will also accompany the schedule package on a monthly basis.

A copy of the monthly progressed Schedule is made to create the Prior Month Forecast Baseline (PMFB) for reporting purposes. The Scheduler must follow the steps described in the Project Schedule Progress Checklist before taking the PMFB. The Project Schedule Work Day 12 Progress Checklist for Site C is located on the share point site:

Site C Work Day 12 Checklist

As of April 03, 2017, and in accordance with the Site C Work Day 12 Checklist, back-up copies of the Site C PMFB schedules older than 6 months will be exported as .xer files and saved in the share point site:

Site C PMFB xer Backup Files

Contractors' Schedules

Contractors' or third party schedule information shall be represented in the project schedule. These schedules will include any engineering, production, manufacturing, installation, testing and commissioning schedules, and other 3rd party schedules. The level of detail for integrating contractor schedule information will be agreed with the Project Manager and WPM.

Once the contractor's schedule is accepted as a baseline, the contractor's schedule will be integrated into appropriate work packages. The level of integration is flexible depending on the level of detail the work package manager would like identified in the project schedule and is able to support and progress activities on a regular basis. Integration of a contractor's schedule may result in a Performance Measurement Baseline update if the work package milestone dates are exceeded.

The assigned work package manager will ensure that any third party schedule follows the procedures for the development, control, and maintenance of schedules. The assigned Scheduler will be responsible for checking for conformance with the RFP and contract requirements.

Monthly contractors schedule updates should be submitted by WD3 and verified with their respective work package managers before reflecting this progress information in the project schedule.

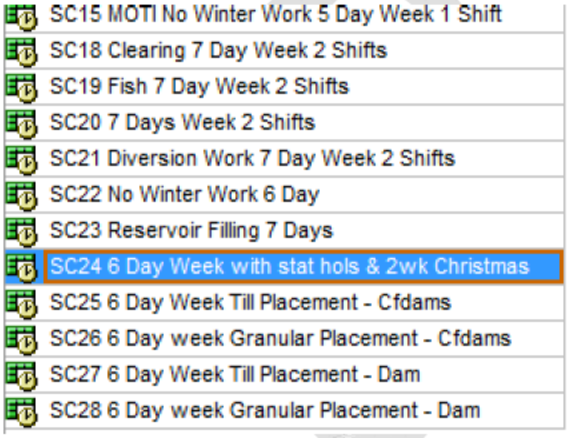
Calendars

The Primavera scheduling tool allows project activities to be assigned to different work calendars. Calendars are assigned to activities to compute activity durations from dates and vice versa, Since PPM uses task dependant activities, the activity calendar is automatically assigned to the resource. It is the purpose of various calendars to limit or restrict activities to their specifically allocated work days.

The default calendar for YM-80004 schedule is the PPM Global Calendar “Z1-BC Hydro five day calendar with Canadian Holidays”. This calendar will be used for the majority of work packages under the General Management System as these activities will be expected to be completed on a typical 5 day business week with British Columbia statutory holidays. A list of PPM compliant Global calendars are listed below;

Z1 - BCHydro Calendar with Canadian Holidays	☑
Z1 - BCHydro Calendar with Canadian Holidays (DO N	☐
Z3 - 7x10 No Holidays	☐
Z4 - 7x7.5 No Holidays	☐
Z5 - Standard 5 Day Workweek	☐
Z7 - Standard 24/7 Workweek	☐
Z9 - 6x10 No Holidays	☐

Project calendars have been developed for site activities that may require continuous working or be restricted by seasonal weather and environmental constraints. Should be assigned to any activities then SAP transfer must be set to “false”. As an example office based activities such as design production will be based on a five day working week, whereas site based activities will be scheduled on a six day week.
The default calendar for site based work will be based on a 6 day working week, although it is expected that the site will operate a 7day working week. This creates a minor contingency of 14% per working week for site based activities. A list of project specific calendars is listed below.



SC15 MOTI No Winter Work 5 Day Week 1 Shift
SC18 Clearing 7 Day Week 2 Shifts
SC19 Fish 7 Day Week 2 Shifts
SC20 7 Days Week 2 Shifts
SC21 Diversion Work 7 Day Week 2 Shifts
SC22 No Winter Work 6 Day
SC23 Reservoir Filling 7 Days
SC24 6 Day Week with stat hols & 2wk Christmas
SC25 6 Day Week Till Placement - Cfdams
SC26 6 Day week Granular Placement - Cfdams
SC27 6 Day Week Till Placement - Dam
SC28 6 Day week Granular Placement - Dam

Cost Basis

- Budget costs are based upon the June 18th 2014, estimate refresh, presented to the BC Hydro Board of Directors on July 2nd 2014.

- First Full Funding (FFF) baseline based on Final Investment Decision cashflow model.

Risks & Opportunities

- Risk – Phased approval of Leave to Construct permits prior to MCW construction activities.
- Risk - Closing the upstream cofferdam for River Diversion 7day x 20hr working required.
- Risk - Tunnel #2 conversion for reservoir filling 7day x 20hr working required.

Assumptions

- Clearing/Birds Calendar assumes that clearing can only commence between months of August to March inclusive.

- River diversion can only take place after Labour Day holiday (first Monday in Sep) and must be completed by mid-September (TECHNICAL MEMORANDIUM – CONSTRAINTS ON STAGE 2 DIVERSION COFFERDAM).

- Reservoir filling dates and sequencing are consistent with TECHNICAL MEMORANDUM

  RESERVOIR FILLING PLAN - REVISION 1 dated June 2014.

- Weather statistics at site are assumed to be consistent with information contained within the definition design basis.

Baseline Changes & Reconciliation

- 24-Sep-2015 Site C Implementation Phase Baseline FFF (First Full Funding)

- 23-Dec-2015 Site C Clean Energy Project Impl Phase PMB (Performance Measurement Baseline includes general management, mit & comp budget following Summer 2015 re-org.

- 28-Jan-2016 Site C Clean Energy Project Impl Phase PMB modified A.02.004 Properties Prepared for Flooding (Work Package is deleted – contained budget of $1.09 charge code)

- 19-Feb-2016 Activity 3092 Split in to two activities (3091 and 3092) to account for Earthfill Dam construction period of non-work during Winter 2019/20 which was creating an error in BW reporting.

- 25-Feb-2016 - Cost account changed from 0000999631 to 0000635020 on activities 9931 + 1393

- 18-Apr-2016 – Approved CNs 01, 02, 05, 07, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 26, 27, 28 30, 32, 34, 36, 37, 40 added to the PMB
  Actual cost adjustment fix of $76k in IDC, and turn contingency inflation off as per KY email of 11-Apr-2016.

For complete evolution of schedule please refer to Final Investment Decision Reconciliation to Performance Measurement Baseline.

Schedule Contingency

Schedule Contingency is more frequently referred to as float or "extra" additional time available to complete an activity. The Critical path is the sequence of logically linked activities such that, if one of these activities were to be delayed, then the completion date of the entire project would be delayed. There are 5 key critical activity dates:

1. Completion of PH RCC Oct 15 2017
2. Completion of SW RCC Placement – Oct 15 2018
3. Completion of Dam RCC Placement – Oct 15 2019
4. River Diversion – Sept 1, 2019
5. Ready for Reservoir Filling Sept 2022

A number of key construction activities need to be completed in order to meet the above five key critical activity dates. If the key construction activities are completed before the critical dates then this duration from the point of early completion to the key critical date is referred to as float.

The below construction activities are highlighted because the amount of float (or lack of float) could have a significant impact on project objectives:

- A six month duration from completion of the diversion tunnels civil works (01-Mar-19) to the target river diversion window (01-Sep-19) is contained with the MCW contract under milestone M3.1.

- A three month schedule float is available from the completion of the Hydro Mechanical work for the installation of the diversion gates (May 2019) to the target diversion window (01-Sep-19).

- Completion of the 500kV Transmission Lines need to be completed before the wet commissioning of the first unit. Currently there is three months from completion of the transmission line (23-Jun-2022) to the start of wet commissioning of the first unit (08-Oct-2022).

- The default project calendar for site based work is based on a 6 day working week with shutdowns for statutory holidays plus a Christmas break. Although it is expected that the site will operate a 7 day working week throughout the majority of the year, this creates a contingency of 14% per working week for site based activities.

APPENDICIES;

Appendix 1 WBS ; link to Site C implementation phase WBS http://ppm/projects/YM-80004/ProjectDocuments/Forms/AllItems.aspx?RootFolder=%2fprojects%2fYM%2d80004%2fProjectDocuments%2fYM%2d80004%2e4%2eZ%2fYM%2d80004%2e4%2eZ%2e01%2fYM%2d80004%2e4%2eZ%2e01%2e001%2fWBS&FolderCTID=0x0120005FE75B0FD1CA154CA005BD2149530EAC

Appendix 2 : TECHNICAL MEMORANDIUM – CONSTRAINTS ON STAGE 2 DIVERSION COFFERDAM).

Appendix 3: Reservoir filling dates and sequencing are consistent with TECHNICAL MEMORANDUM RESERVOIR FILLING PLAN - REVISION 1 dated June 2014 (See Appendix).

Appendix 4: Diversion Tunnel Orifices construction methods.

Appendix 5 : Site Manpower resource requirements

Appendix 1

Site C Clean Energy Project Work Breakdown Structure - Implementation Phase (YM80004)

Rev 3.5 – for internal distribution

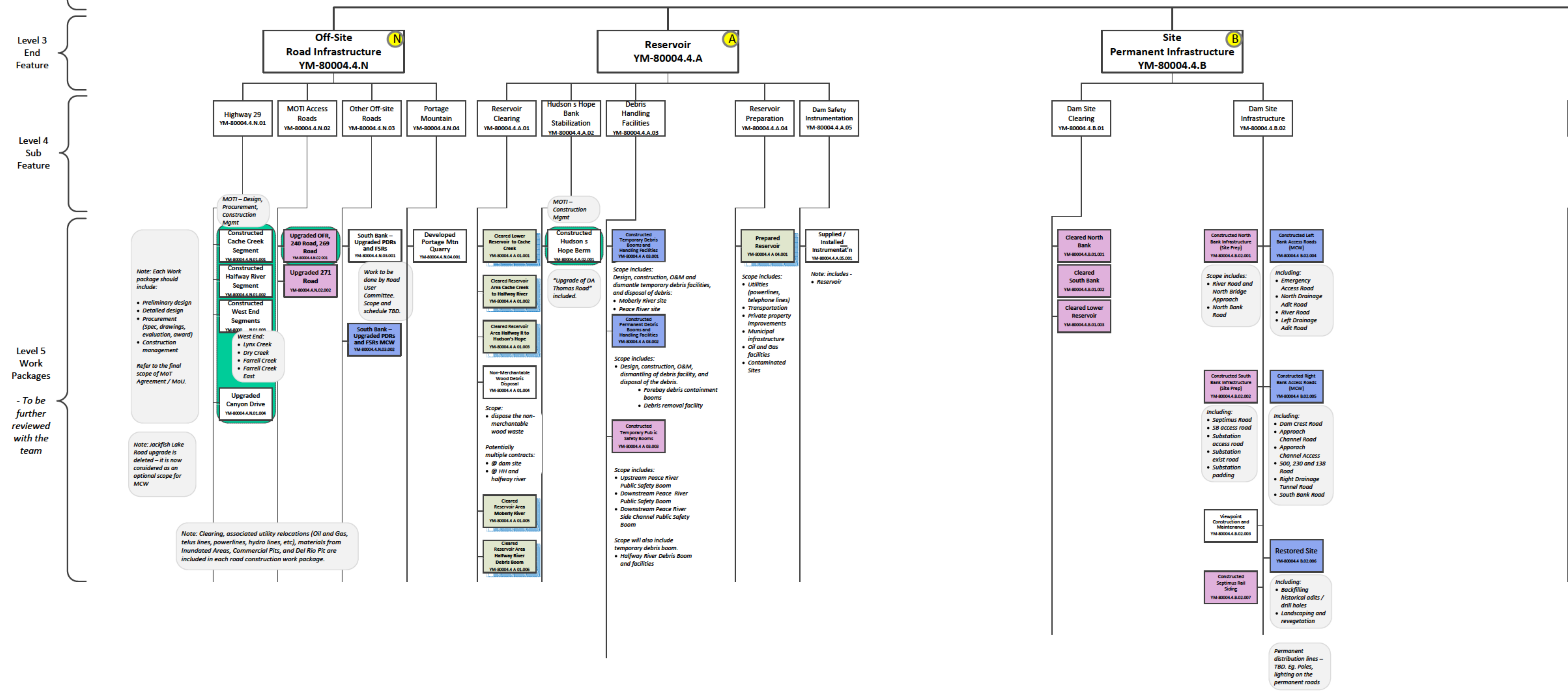
UPDATED August 1, 2017
FOR DISCUSSION PURPOSES

DRAFT WBS for discussion purposes only.

LEGEND:
- Shaded boxes in (various colors) – Scope being considered for each potential major contract packages
- Shaded boxes in GREY – Notes

Procurement:

Main Civil Work Contract	Early Works	Worker Accommodation Contract	Other Contracts
Generating Station & Spillways Contract	MoTI Involved Contracts	Clearing Contract(s)	
Turbines and Generators Contract	Transmission Lines & Stations Contract	Completions Contract	



- **Off-Site Road Infrastructure YM-80004.4.N** (N)
  - Highway 29 YM-80004.4.N.01
    - *MOTI – Design, Procurement, Construction Mgmt*
    - Constructed Cache Creek Segment YM-80004.4.N.01.001
    - Constructed Halfway River Segment YM-80004.4.N.01.002
    - Constructed West End Segments YM-8000 .N.01.003
      - *West End:*
        - *Lynx Creek*
        - *Dry Creek*
        - *Farrell Creek*
        - *Farrell Creek East*
    - Upgraded Canyon Drive YM-80004.4.N.01.004
  - MOTI Access Roads YM-80004.4.N.02
    - Upgraded OFR, 240 Road, 269 Road YM-80004.4.N.02 001
    - Upgraded 271 Road YM-80004.4.N.02.002
  - Other Off-site Roads YM-80004.4.N.03
    - South Bank – Upgraded PDRs and FSRs YM-80004.4.N.03.001
      - *Work to be done by Road User Committee. Scope and schedule TBD.*
    - South Bank – Upgraded PDRs and FSRs MCW YM-80004.4.N.03.002
  - Portage Mountain YM-80004.4.N.04
    - Developed Portage Mtn Quarry YM-80004.4.N.04.001

Note: Each Work package should include:
- *Preliminary design*
- *Detailed design*
- *Procurement (Spec, drawings, evaluation, award)*
- *Construction management*

Refer to the final scope of MoT Agreement / MoU.

Note: Jackfish Lake Road upgrade is deleted – it is now considered as an optional scope for MCW

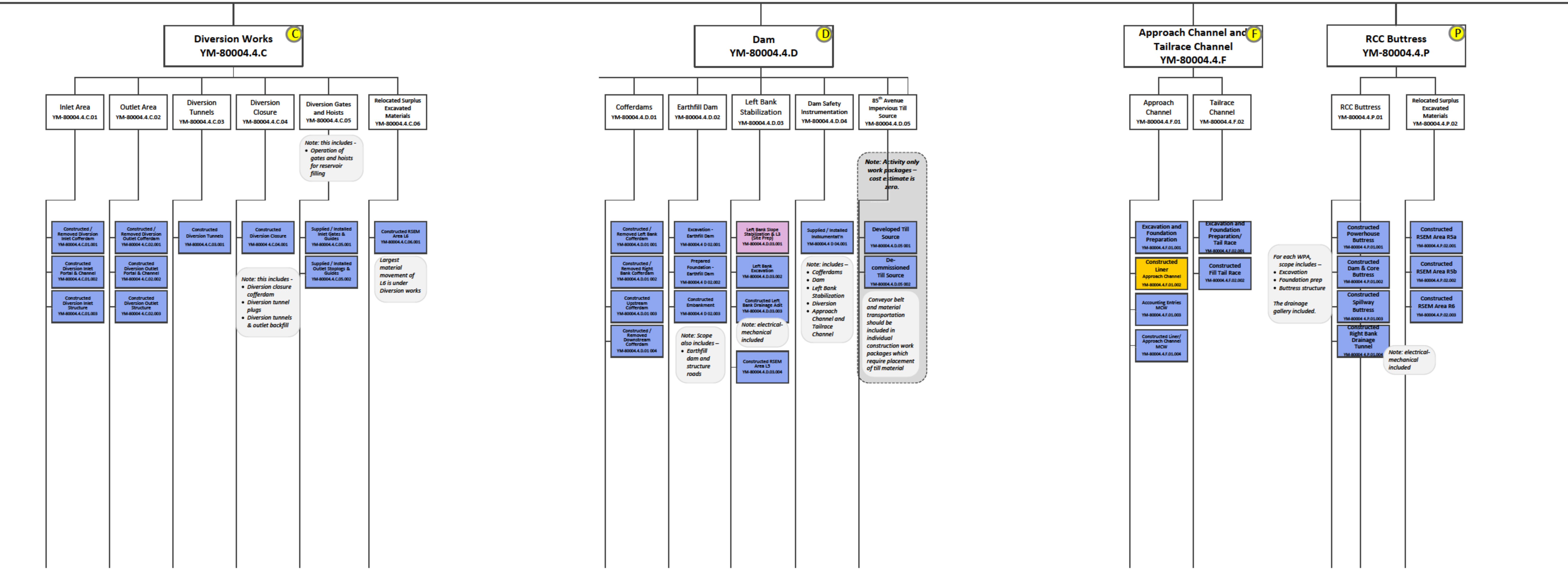
Note: Clearing, associated utility relocations (Oil and Gas, telus lines, powerlines, hydro lines, etc), materials from Inundated Areas, Commercial Pits, and Del Rio Pit are included in each road construction work package.

- **Reservoir YM-80004.4.A** (A)
  - Reservoir Clearing YM-80004.4.A.01
    - Cleared Lower Reservoir to Cache Creek YM-80004.4 A 01.001
    - Cleared Reservoir Area Cache Creek to Halfway River YM-80004.4 A 01.002
    - Cleared Reservoir Area Halfway R to Hudson's Hope YM-80004.4 A 01.003
    - Non-Merchantable Wood Debris Disposal YM-80004.4 A 01.004
      - *Scope:*
        - *dispose the non-merchantable wood waste*
      - *Potentially multiple contracts:*
        - *@ dam site*
        - *@ HH and halfway river*
    - Cleared Reservoir Area Moberly River YM-80004.4 A 01.005
    - Cleared Reservoir Area Halfway River Debris Boom YM-80004.4 A 01.006
  - Hudson s Hope Bank Stabilization YM-80004.4.A.02
    - *MOTI – Construction Mgmt*
    - Constructed Hudson s Hope Berm YM-80004.4.A.02.001
      - *"Upgrade of DA Thomas Road" included.*
  - Debris Handling Facilities YM-80004.4.A.03
    - Constructed Temporary Debris Booms and Handling Facilities YM-80004.4 A 03.001
      - *Scope includes:*
      - *Design, construction, O&M and dismantle temporary debris facilities, and disposal of debris:*
        - *Moberly River site*
        - *Peace River site*
    - Constructed Permanent Debris Booms and Handling Facilities YM-80004.4 A 03.002
      - *Scope includes:*
        - *Design, construction, O&M, dismantling of debris facility, and disposal of the debris.*
          - *Forebay debris containment booms*
          - *Debris removal facility*
    - Constructed Temporary Pub ic Safety Booms YM-80004.4 A 03.003
      - *Scope includes:*
        - *Upstream Peace River Public Safety Boom*
        - *Downstream Peace River Public Safety Boom*
        - *Downstream Peace River Side Channel Public Safety Boom*
      - *Scope will also include temporary debris boom.*
        - *Halfway River Debris Boom and facilities*
  - Reservoir Preparation YM-80004.4.A.04
    - Prepared Reservoir YM-80004.4 A 04.001
      - *Scope includes:*
        - *Utilities (powerlines, telephone lines)*
        - *Transportation*
        - *Private property improvements*
        - *Municipal infrastructure*
        - *Oil and Gas facilities*
        - *Contaminated Sites*
  - Dam Safety Instrumentation YM-80004.4.A.05
    - Supplied / Installed Instrumentat'n YM-80004.4.A.05.001
      - *Note: includes -*
        - *Reservoir*

- **Site Permanent Infrastructure YM-80004.4.B** (B)
  - Dam Site Clearing YM-80004.4.B.01
    - Cleared North Bank YM-80004.4.B.01.001
    - Cleared South Bank YM-80004.4.B.01.002
    - Cleared Lower Reservoir YM-80004.4.B.01.003
  - Dam Site Infrastructure YM-80004.4.B.02
    - Constructed North Bank Infrastructure (Site Prep) YM-80004.4.B.02.001
      - *Scope includes:*
        - *River Road and North Bridge Approach*
        - *North Bank Road*
    - Constructed South Bank Infrastructure (Site Prep) YM-80004.4.B.02.002
      - *Including:*
        - *Septimus Road*
        - *SB access road*
        - *Substation access road*
        - *Substation exist road*
        - *Substation padding*
    - Viewpoint Construction and Maintenance YM-80004.4.B.02.003
    - Constructed Septimus Rail Siding YM-80004.4.B.02.007
    - Constructed Left Bank Access Roads (MCW) YM-80004.4 B.02.004
      - *Including:*
        - *Emergency Access Road*
        - *North Drainage Adit Road*
        - *River Road*
        - *Left Drainage Adit Road*
    - Constructed Right Bank Access Roads (MCW) YM-80004.4 B.02.005
      - *Including:*
        - *Dam Crest Road*
        - *Approach Channel Road*
        - *Apporach Channel Access*
        - *500, 230 and 138 Road*
        - *Right Drainage Tunnel Road*
        - *South Bank Road*
    - Restored Site YM-80004.4 B.02.006
      - *Including:*
        - *Backfilling historical adits / drill holes*
        - *Landscaping and revegetation*

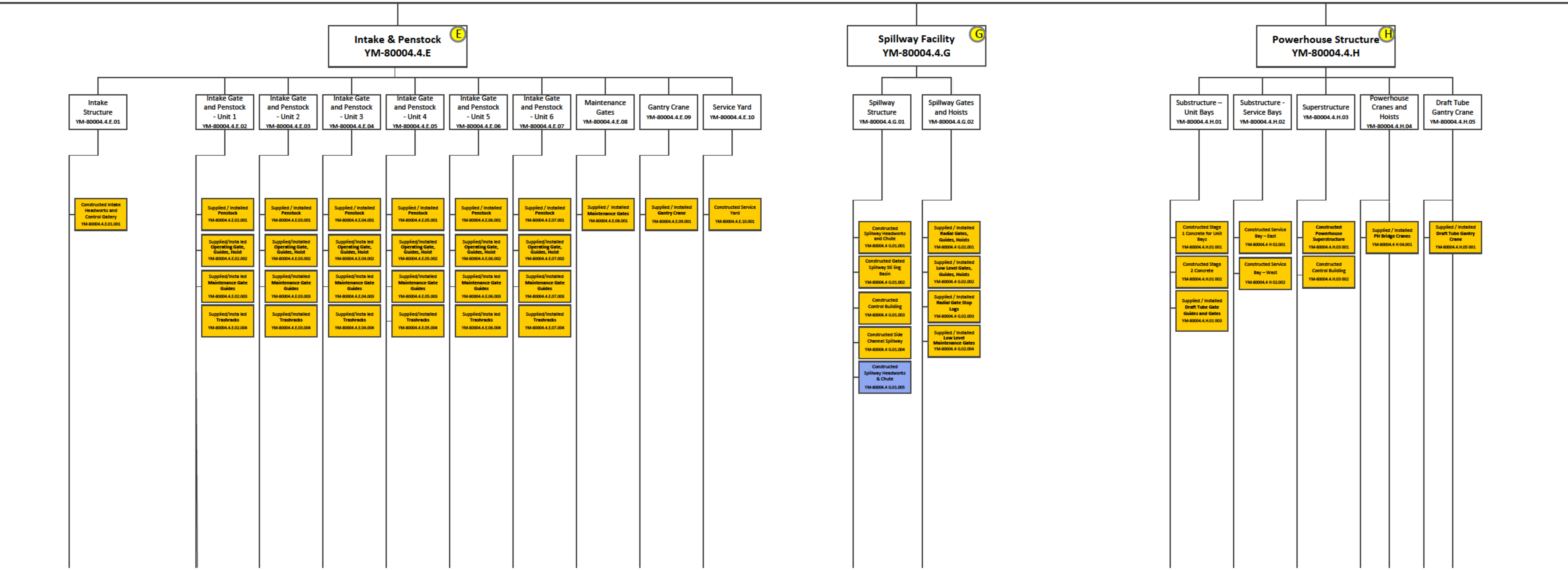
Permanent distribution lines – TBD. Eg. Poles, lighting on the permanent roads

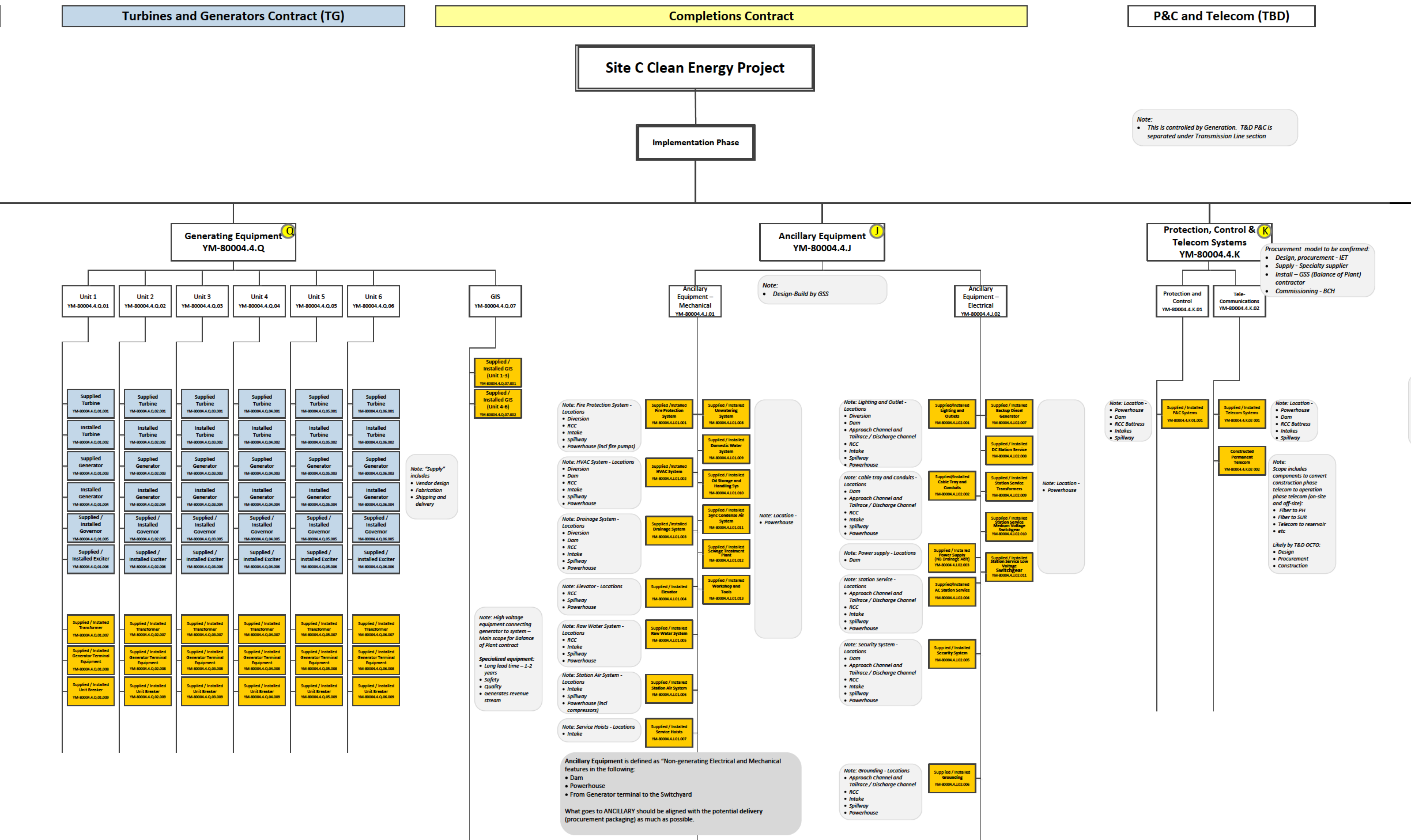
Main Civil Works Contract (MCW)



- **Diversion Works** YM-80004.4.C C
  - Inlet Area YM-80004.4.C.01
    - Constructed / Removed Diversion Inlet Cofferdam YM-80004.4.C.01.001
    - Constructed Diversion Inlet Portal & Channel YM-80004.4.C.01.002
    - Constructed Diversion Inlet Structure YM-80004.4.C.01.003
  - Outlet Area YM-80004.4.C.02
    - Constructed / Removed Diversion Outlet Cofferdam YM-80004 4.C.02.001
    - Constructed Diversion Outlet Portal & Channel YM-80004 4.C.02.002
    - Constructed Diversion Outlet Structure YM-80004 4.C.02.003
  - Diversion Tunnels YM-80004.4.C.03
    - Constructed Diversion Tunnels YM-80004.4.C.03.001
  - Diversion Closure YM-80004.4.C.04
    - Constructed Diversion Closure YM-80004 4.C.04.001
    - *Note: this includes -*
      - *Diversion closure cofferdam*
      - *Diversion tunnel plugs*
      - *Diversion tunnels & outlet backfill*
  - Diversion Gates and Hoists YM-80004.4.C.05
    - *Note: this includes -*
      - *Operation of gates and hoists for reservoir filling*
    - Supplied / Installed Inlet Gates & Guides YM-80004.4.C.05.001
    - Supplied / Installed Outlet Stoplogs & Guides YM-80004.4.C.05.002
  - Relocated Surplus Excavated Materials YM-80004.4.C.06
    - Constructed RSEM Area L6 YM-80004.4.C.06.001
    - *Largest material movement of L6 is under Diversion works*
- **Dam** YM-80004.4.D D
  - Cofferdams YM-80004.4.D.01
    - Constructed / Removed Left Bank Cofferdam YM-80004.4.D.01 001
    - Constructed / Removed Right Bank Cofferdam YM-80004.4.D.01 002
    - Constructed Upstream Cofferdam YM-80004.4.D.01 003
    - Constructed / Removed Downstream Cofferdam YM-80004.4.D.01 004
  - Earthfill Dam YM-80004.4.D.02
    - Excavation - Earthfill Dam YM-80004.4 D 02.001
    - Prepared Foundation - Earthfill Dam YM-80004.4 D 02.002
    - Constructed Embankment YM-80004.4 D 02.003
    - *Note: Scope also includes –*
      - *Earthfill dam and structure roads*
  - Left Bank Stabilization YM-80004.4.D.03
    - Left Bank Slope Stabilization & L3 (Site Prep) YM-80004.4.D.03.001
    - Left Bank Excavation YM-80004.4.D.03.002
    - Constructed Left Bank Drainage Adit YM-80004.4.D.03.003
    - *Note: electrical-mechanical included*
    - Constructed RSEM Area L3 YM-80004.4.D.03.004
  - Dam Safety Instrumentation YM-80004.4.D.04
    - Supplied / Installed Instrumentat'n YM-80004.4 D 04.001
    - *Note: includes –*
      - *Cofferdams*
      - *Dam*
      - *Left Bank Stabilization*
      - *Diversion*
      - *Approach Channel and Tailrace Channel*
  - 85th Avenue Impervious Till Source YM-80004.4.D.05
    - ***Note: Activity only work packages – cost estimate is zero.***
    - Developed Till Source YM-80004.4.D.05 001
    - De-commissioned Till Source YM-80004.4.D.05 002
    - *Conveyor belt and material transportation should be included in individual construction work packages which require placement of till material*
- **Approach Channel and Tailrace Channel** YM-80004.4.F F
  - Approach Channel YM-80004.4.F.01
    - Excavation and Foundation Preparation YM-80004.4.F.01.001
    - Constructed Liner Approach Channel YM-80004.4.F.01.002
    - Accounting Entries MCW YM-80004.4.F.01.003
    - Constructed Liner/ Approach Channel MCW YM-80004.4.F.01.004
  - Tailrace Channel YM-80004.4.F.02
    - Excavation and Foundation Preparation/ Tail Race YM-80004.4.F.02.001
    - Constructed Fill Tail Race YM-80004.4.F.02.002
- **RCC Buttress** YM-80004.4.P P
  - *For each WPA, scope includes –*
    - *Excavation*
    - *Foundation prep*
    - *Buttress structure*
  - *The drainage gallery included.*
  - RCC Buttress YM-80004.4.P.01
    - Constructed Powerhouse Buttress YM-80004 4.P.01.001
    - Constructed Dam & Core Buttress YM-80004 4.P.01.002
    - Constructed Spillway Buttress YM-80004 4.P.01.003
    - Constructed Right Bank Drainage Tunnel YM-80004 4.P.01.004
    - *Note: electrical-mechanical included*
  - Relocated Surplus Excavated Materials YM-80004.4.P.02
    - Constructed RSEM Area R5a YM-80004.4.P.02.001
    - Constructed RSEM Area R5b YM-80004.4.P.02.002
    - Constructed RSEM Area R6 YM-80004.4.P.02.003

Generating Station and Spillways Contract (GSS)





Turbines and Generators Contract (TG)

Completions Contract

P&C and Telecom (TBD)

Site C Clean Energy Project

Implementation Phase

Note:
- This is controlled by Generation. T&D P&C is separated under Transmission Line section

Generating Equipment YM-80004.4.Q

- Unit 1 YM-80004.4.Q.01
  - Supplied Turbine YM-80004.4.Q.01.001
  - Installed Turbine YM-80004.4.Q.01.002
  - Supplied Generator YM-80004.4.Q.01.003
  - Installed Generator YM-80004.4.Q.01.004
  - Supplied / Installed Governor YM-80004.4.Q.01.005
  - Supplied / Installed Exciter YM-80004.4.Q.01.006
  - Supplied / Installed Transformer YM-80004.4.Q.01.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.01.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.01.009
- Unit 2 YM-80004.4.Q.02
  - Supplied Turbine YM-80004.4.Q.02.001
  - Installed Turbine YM-80004.4.Q.02.002
  - Supplied Generator YM-80004.4.Q.02.003
  - Installed Generator YM-80004.4.Q.02.004
  - Supplied / Installed Governor YM-80004.4.Q.02.005
  - Supplied / Installed Exciter YM-80004.4.Q.02.006
  - Supplied / Installed Transformer YM-80004.4.Q.02.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.02.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.02.009
- Unit 3 YM-80004.4.Q.03
  - Supplied Turbine YM-80004.4.Q.03.001
  - Installed Turbine YM-80004.4.Q.03.002
  - Supplied Generator YM-80004.4.Q.03.003
  - Installed Generator YM-80004.4.Q.03.004
  - Supplied / Installed Governor YM-80004.4.Q.03.005
  - Supplied / Installed Exciter YM-80004.4.Q.03.006
  - Supplied / Installed Transformer YM-80004.4.Q.03.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.03.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.03.009
- Unit 4 YM-80004.4.Q.04
  - Supplied Turbine YM-80004.4.Q.04.001
  - Installed Turbine YM-80004.4.Q.04.002
  - Supplied Generator YM-80004.4.Q.04.003
  - Installed Generator YM-80004.4.Q.04.004
  - Supplied / Installed Governor YM-80004.4.Q.04.005
  - Supplied / Installed Exciter YM-80004.4.Q.04.006
  - Supplied / Installed Transformer YM-80004.4.Q.04.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.04.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.04.009
- Unit 5 YM-80004.4.Q.05
  - Supplied Turbine YM-80004.4.Q.05.001
  - Installed Turbine YM-80004.4.Q.05.002
  - Supplied Generator YM-80004.4.Q.05.003
  - Installed Generator YM-80004.4.Q.05.004
  - Supplied / Installed Governor YM-80004.4.Q.05.005
  - Supplied / Installed Exciter YM-80004.4.Q.05.006
  - Supplied / Installed Transformer YM-80004.4.Q.05.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.05.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.05.009
- Unit 6 YM-80004.4.Q.06
  - Supplied Turbine YM-80004.4.Q.06.001
  - Installed Turbine YM-80004.4.Q.06.002
  - Supplied Generator YM-80004.4.Q.06.003
  - Installed Generator YM-80004.4.Q.06.004
  - Supplied / Installed Governor YM-80004.4.Q.06.005
  - Supplied / Installed Exciter YM-80004.4.Q.06.006
  - Supplied / Installed Transformer YM-80004.4.Q.06.007
  - Supplied / Installed Generator Terminal Equipment YM-80004.4.Q.06.008
  - Supplied / Installed Unit Breaker YM-80004.4.Q.06.009
- GIS YM-80004.4.Q.07
  - Supplied / Installed GIS (Unit 1-3) YM-80004.4.Q.07.001
  - Supplied / Installed GIS (Unit 4-6) YM-80004.4.Q.07.002

Note: "Supply" includes
- *Vendor design*
- *Fabrication*
- *Shipping and delivery*

Note: High voltage equipment connecting generator to system – Main scope for Balance of Plant contract

Specialized equipment:
- *Long lead time – 1-2 years*
- *Safety*
- *Quality*
- *Generates revenue stream*

Ancillary Equipment YM-80004.4.J

Note:
- *Design-Build by GSS*

Ancillary Equipment – Mechanical YM-80004.4.J.01

- Supplied /Installed Fire Protection System YM-80004.4.J.01.001
- Supplied /Installed HVAC System YM-80004.4.J.01.002
- Supplied /Installed Drainage System YM-80004.4.J.01.003
- Supplied / Installed Elevator YM-80004.4.J.01.004
- Supplied / Installed Raw Water System YM-80004.4.J.01.005
- Supplied / Installed Station Air System YM-80004.4.J.01.006
- Supplied / Installed Service Hoists YM-80004.4.J.01.007
- Supplied / Installed Unwatering System YM-80004.4.J.01.008
- Supplied / Installed Domestic Water System YM-80004.4.J.01.009
- Supplied / Installed Oil Storage and Handling Sys YM-80004.4.J.01.010
- Supplied / Installed Sync Condense Air System YM-80004.4.J.01.011
- Supplied / Installed Sewage Treatment Plant YM-80004.4.J.01.012
- Supplied / Installed Workshop and Tools YM-80004.4.J.01.013

Note: Fire Protection System - Locations
- *Diversion*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse (incl fire pumps)*

Note: HVAC System - Locations
- *Diversion*
- *Dam*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Drainage System - Locations
- *Diversion*
- *Dam*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Elevator - Locations
- *RCC*
- *Spillway*
- *Powerhouse*

Note: Raw Water System - Locations
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Station Air System - Locations
- *Intake*
- *Spillway*
- *Powerhouse (incl compressors)*

Note: Service Hoists - Locations
- *Intake*

Note: Location -
- *Powerhouse*

Ancillary Equipment – Electrical YM-80004.4.J.02

- Supplied/Installed Lighting and Outlets YM-80004.4.J.02.001
- Supplied/Installed Cable Tray and Conduits YM-80004.4.J.02.002
- Supplied / Insta led Power Supply (NB Drainage Adit) YM-80004 4.J.02.003
- Supplied/Installed AC Station Service YM-80004.4.J.02.004
- Supp ied / Installed Security System YM-80004.4.J.02.005
- Supp ied / Installed Grounding YM-80004.4.J.02.006
- Supplied / Installed Backup Diesel Generator YM-80004.4.J.02.007
- Supplied / Installed DC Station Service YM-80004.4.J.02.008
- Supplied / Installed Station Service Transformers YM-80004.4.J.02.009
- Supplied / Installed Station Service Medium Voltage Switchgear YM-80004.4.J.02.010
- Supplied / Installed Station Service Low Voltage Switchgear YM-80004.4.J.02.011

Note: Lighting and Outlet - Locations
- *Diversion*
- *Dam*
- *Approach Channel and Tailrace / Discharge Channel*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Cable tray and Conduits - Locations
- *Dam*
- *Approach Channel and Tailrace / Discharge Channel*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Power supply - Locations
- *Dam*

Note: Station Service - Locations
- *Approach Channel and Tailrace / Discharge Channel*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Security System - Locations
- *Dam*
- *Approach Channel and Tailrace / Discharge Channel*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Grounding - Locations
- *Approach Channel and Tailrace / Discharge Channel*
- *RCC*
- *Intake*
- *Spillway*
- *Powerhouse*

Note: Location -
- *Powerhouse*

Ancillary Equipment is defined as "Non-generating Electrical and Mechanical features in the following:
- Dam
- Powerhouse
- From Generator terminal to the Switchyard

What goes to ANCILLARY should be aligned with the potential delivery (procurement packaging) as much as possible.

Protection, Control & Telecom Systems YM-80004.4.K

Procurement model to be confirmed:
- *Design, procurement - IET*
- *Supply - Specialty supplier*
- *Install – GSS (Balance of Plant) contractor*
- *Commissioning - BCH*

Protection and Control YM-80004.4.K.01

- Supplied / Installed P&C Systems YM-80004.4.K 01.001

Note: Location -
- *Powerhouse*
- *Dam*
- *RCC Buttress*
- *Intakes*
- *Spillway*

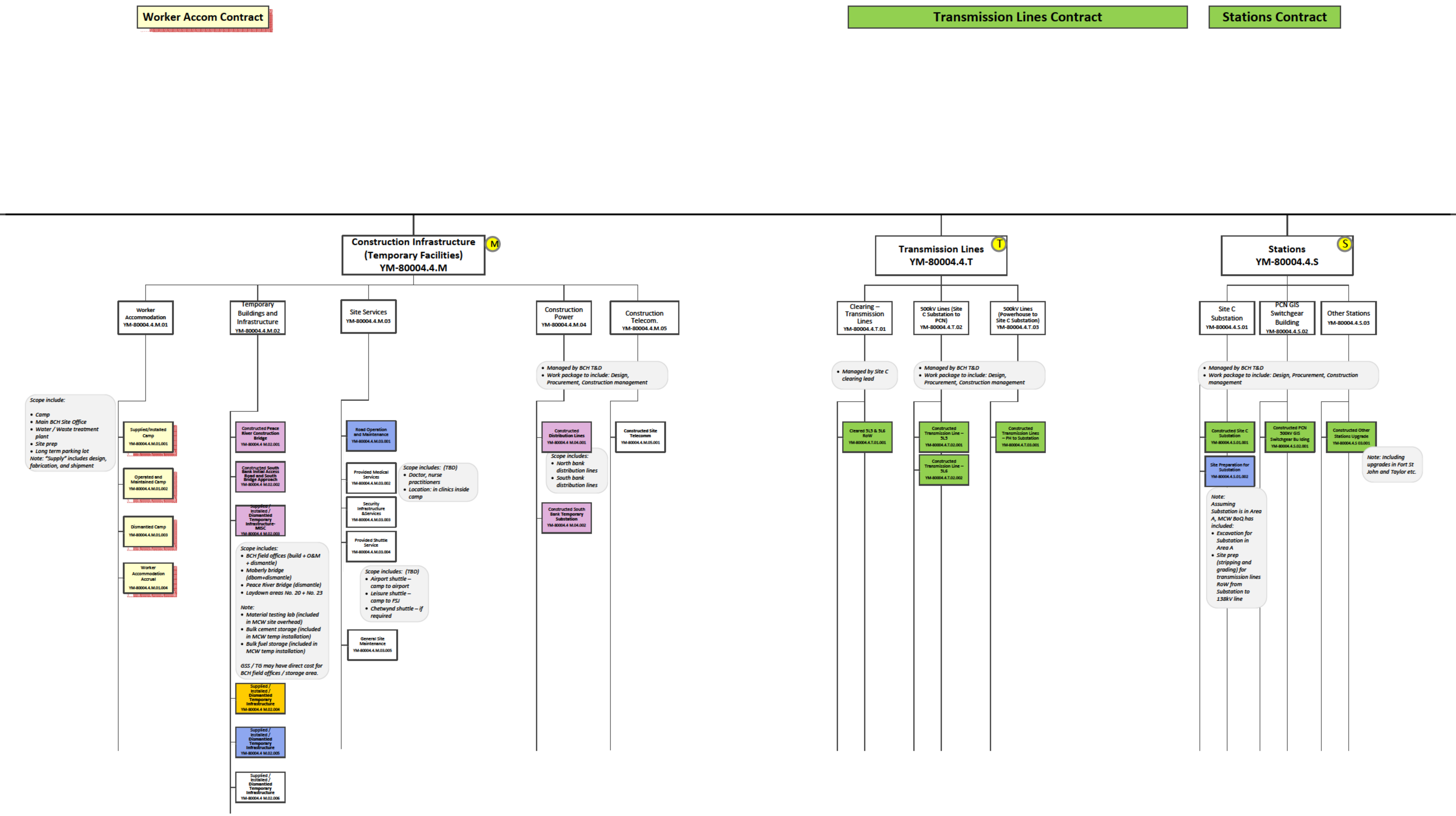
Tele-Communications YM-80004.4.K.02

- Supplied / Installed Telecom Systems YM-80004.4.K.02 001
- Constructed Permanent Telecom YM-80004.4.K.02 002

Note: Location -
- *Powerhouse*
- *Dam*
- *RCC Buttress*
- *Intakes*
- *Spillway*

Note:
Scope includes components to convert construction phase telecom to operation phase telecom (on-site and off-site):
- *Fiber to PH*
- *Fiber to SUR*
- *Telecom to reservoir*
- *etc*

Likely by T&D OCTO:
- *Design*
- *Procurement*
- *Construction*



Worker Accom Contract

Transmission Lines Contract

Stations Contract

Construction Infrastructure (Temporary Facilities) YM-80004.4.M M

- Worker Accommodation YM-80004.4.M.01
  - Supplied/Installed Camp YM-80004.4.M.01.001
  - Operated and Maintained Camp YM-80004.4.M.01.002
  - Dismantled Camp YM-80004.4.M.01.003
  - Worker Accommodation Accrual YM-80004.4.M.01.004

Scope include:

- *Camp*
- *Main BCH Site Office*
- *Water / Waste treatment plant*
- *Site prep*
- *Long term parking lot*

Note: "Supply" includes design, fabrication, and shipment

- Temporary Buildings and Infrastructure YM-80004.4.M.02
  - Constructed Peace River Construction Bridge YM-80004.4 M.02.001
  - Constructed South Bank Initial Access Road and South Bridge Approach YM-80004.4 M.02.002
  - Supplied / Installed / Dismantled Temporary Infrastructure-MISC YM-80004.4 M.02.003
  - Supplied / Installed / Dismantled Temporary Infrastructure YM-80004.4 M.02.004
  - Supplied / Installed / Dismantled Temporary Infrastructure YM-80004.4 M.02.005
  - Supplied / Installed / Dismantled Temporary Infrastructure YM-80004.4 M.02.006

Scope includes:
- *BCH field offices (build + O&M + dismantle)*
- *Moberly bridge (dbom+dismantle)*
- *Peace River Bridge (dismantle)*
- *Laydown areas No. 20 + No. 23*

Note:
- *Material testing lab (included in MCW site overhead)*
- *Bulk cement storage (included in MCW temp installation)*
- *Bulk fuel storage (included in MCW temp installation)*

GSS / TG may have direct cost for BCH field offices / storage area.

- Site Services YM-80004.4.M.03
  - Road Operation and Maintenance YM-80004.4.M.03.001
  - Provided Medical Services YM-80004.4.M.03.002
  - Security Infrastructure &Services YM-80004.4.M.03.003
  - Provided Shuttle Service YM-80004.4.M.03.004
  - General Site Maintenance YM-80004.4.M.03.005

Scope includes: (TBD)
- *Doctor, nurse practitioners*
- *Location: in clinics inside camp*

Scope includes: (TBD)
- *Airport shuttle – camp to airport*
- *Leisure shuttle – camp to FSJ*
- *Chetwynd shuttle – if required*

- Construction Power YM-80004.4.M.04
  - Constructed Distribution Lines YM-80004.4 M.04.001
  - Constructed South Bank Temporary Substation YM-80004.4 M.04.002
- Construction Telecom. YM-80004.4.M.05
  - Constructed Site Telecomm YM-80004.4.M.05.001

- *Managed by BCH T&D*
- *Work package to include: Design, Procurement, Construction management*

Scope includes:
- *North bank distribution lines*
- *South bank distribution lines*

Transmission Lines YM-80004.4.T T

- Clearing – Transmission Lines YM-80004.4.T.01
  - Cleared 5L5 & 5L6 RoW YM-80004.4.T.01.001
- 500kV Lines (Site C Substation to PCN) YM-80004.4.T.02
  - Constructed Transmission Line – 5L5 YM-80004.4.T.02.001
  - Constructed Transmission Line – 5L6 YM-80004.4.T.02.002
- 500kV Lines (Powerhouse to Site C Substation) YM-80004.4.T.03
  - Constructed Transmission Lines – PH to Substation YM-80004.4.T.03.001

- *Managed by Site C clearing lead*

- *Managed by BCH T&D*
- *Work package to include: Design, Procurement, Construction management*

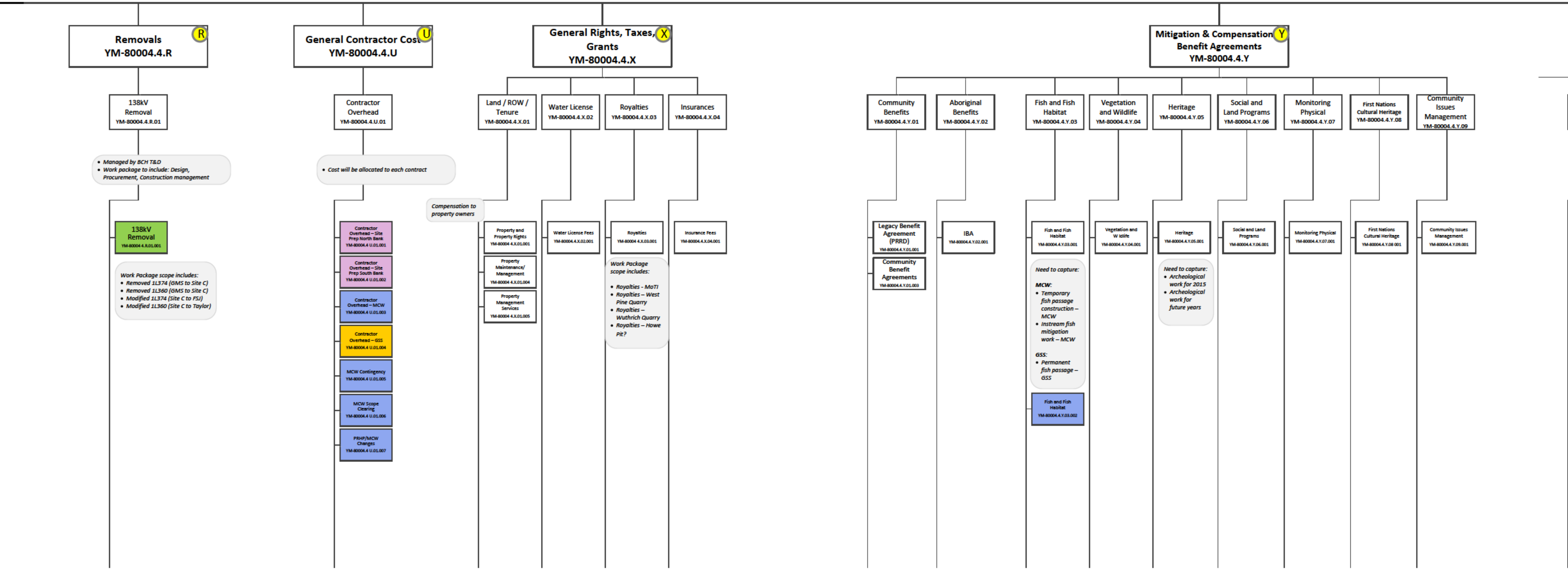
Stations YM-80004.4.S S

- Site C Substation YM-80004.4.S.01
  - Constructed Site C Substation YM-80004.4.S.01.001
  - Site Preparation for Substation YM-80004.4.S.01.002
- PCN GIS Switchgear Building YM-80004.4.S.02
  - Constructed PCN 500kV GIS Switchgear Building YM-80004.4.S.02.001
- Other Stations YM-80004.4.S.03
  - Constructed Other Stations Upgrade YM-80004.4.S 03.001

- *Managed by BCH T&D*
- *Work package to include: Design, Procurement, Construction management*

Note:
Assuming Substation is in Area A, MCW BoQ has included:
- *Excavation for Substation in Area A*
- *Site prep (stripping and grading) for transmission lines RoW from Substation to 138kV line*

Note: Including upgrades in Fort St John and Taylor etc.

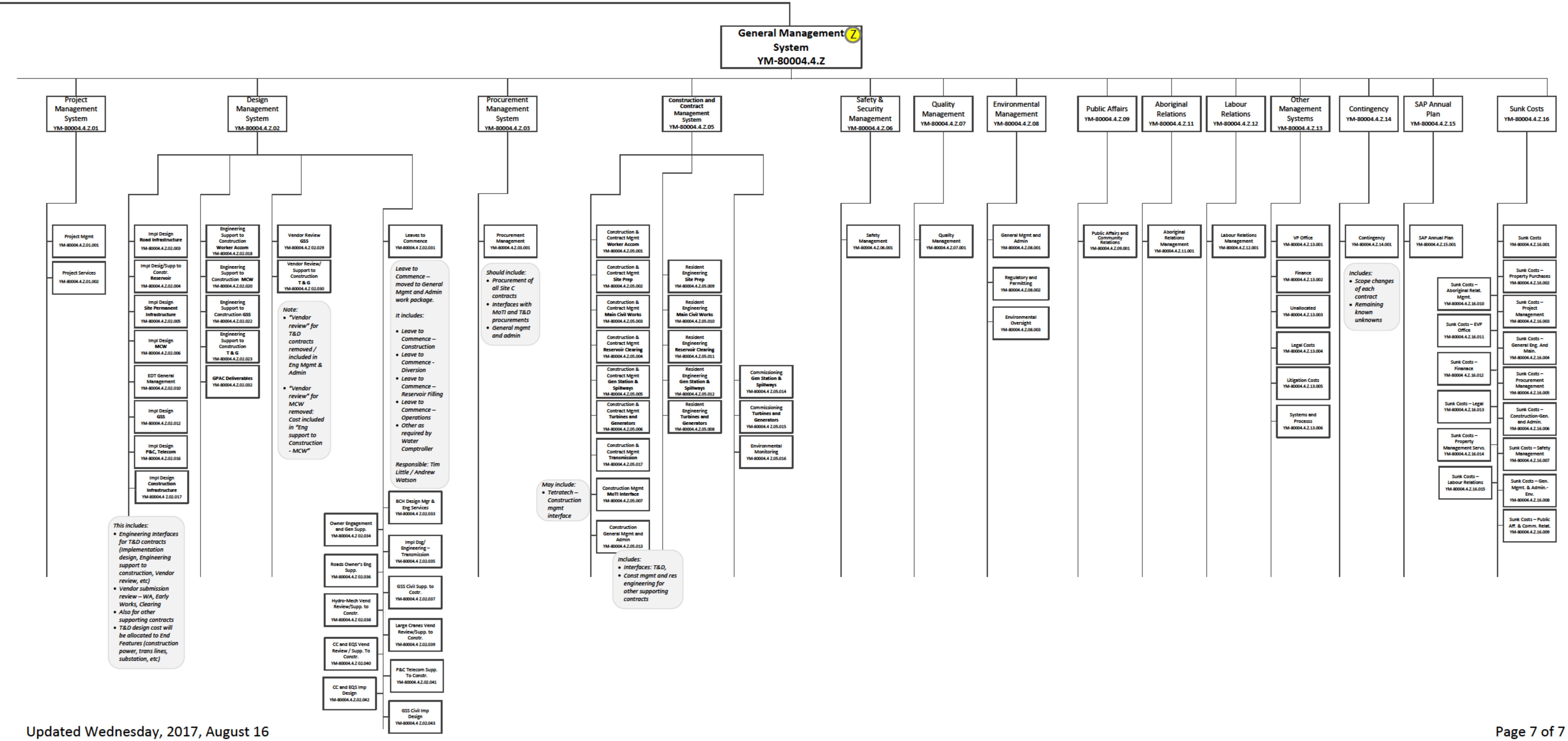

Removals
YM-80004.4.R
R
138kV
Removal
YM-80004.4.R.01
Managed by BCH T&D
Work package to include: Design, Procurement, Construction management
138kV
Removal
YM-80004 4.R.01.001
Work Package scope includes:
Removed 1L374 (GMS to Site C)
Removed 1L360 (GMS to Site C)
Modified 1L374 (Site C to FSJ)
Modified 1L360 (Site C to Taylor)
General Contractor Cost
YM-80004.4.U
U
Contractor
Overhead
YM-80004.4.U.01
Cost will be allocated to each contract
Contractor Overhead – Site Prep North Bank
YM-80004.4 U.01.001
Contractor Overhead – Site Prep South Bank
YM-80004.4 U.01.002
Contractor Overhead – MCW
YM-80004.4 U.01.003
Contractor Overhead – GSS
YM-80004.4 U.01.004
MCW Contingency
YM-80004.4 U.01.005
MCW Scope Clearing
YM-80004.4 U.01.006
PRHP/MCW Changes
YM-80004.4 U.01.007
General Rights, Taxes, Grants
YM-80004.4.X
X
Land / ROW / Tenure
YM-80004.4.X.01
Water License
YM-80004.4.X.02
Royalties
YM-80004.4.X.03
Insurances
YM-80004.4.X.04
Compensation to property owners
Property and Property Rights
YM-80004 4.X.01.001
Property Maintenance/ Management
YM-80004 4.X.01.004
Property Management Services
YM-80004 4.X.01.005
Water License Fees
YM-80004.4.X.02.001
Royalties
YM-80004 4.X.03.001
Work Package scope includes:
Royalties - MoTI
Royalties – West Pine Quarry
Royalties – Wuthrich Quarry
Royalties – Howe Pit?
Insurance Fees
YM-80004.4.X.04.001
Mitigation & Compensation Benefit Agreements
YM-80004.4.Y
Y
Community Benefits
YM-80004.4.Y.01
Aboriginal Benefits
YM-80004.4.Y.02
Fish and Fish Habitat
YM-80004.4.Y.03
Vegetation and Wildlife
YM-80004.4.Y.04
Heritage
YM-80004.4.Y.05
Social and Land Programs
YM-80004.4.Y.06
Monitoring Physical
YM-80004.4.Y.07
First Nations Cultural Heritage
YM-80004.4.Y.08
Community Issues Management
YM-80004.4.Y.09
Legacy Benefit Agreement (PRRD)
YM-80004.4.Y.01.001
Community Benefit Agreements
YM-80004.4.Y.01.003
IBA
YM-80004.4.Y.02.001
Fish and Fish Habitat
YM-80004.4.Y.03.001
Need to capture:
MCW:
Temporary fish passage construction – MCW
Instream fish mitigation work – MCW
GSS:
Permanent fish passage – GSS
Fish and Fish Habitat
YM-80004.4.Y.03.002
Vegetation and W ldlife
YM-80004.4.Y.04.001
Heritage
YM-80004.4.Y.05.001
Need to capture:
Archeological work for 2015
Archeological work for future years
Social and Land Programs
YM-80004.4.Y.06.001
Monitoring Physical
YM-80004.4.Y.07.001
First Nations Cultural Heritage
YM-80004.4.Y.08 001
Community Issues Management
YM-80004.4.Y.09.001

The WBS Level 4 and 5 will be set up at the project teams' discretion.

Sample WBS levels and 4 and 5 elements are provided to illustrate examples of level 3 scope decomposition.

Level 5 elements require a noun suffix such as Constructed, Supplied, Installed or the like.

* Bold = non discretionary



This includes:

- *Engineering Interfaces for T&D contracts (Implementation design, Engineering support to construction, Vendor review, etc)*
- *Vendor submission review – WA, Early Works, Clearing*
- *Also for other supporting contracts*
- *T&D design cost will be allocated to End Features (construction power, trans lines, substation, etc)*

Note:

- *"Vendor review" for T&D contracts removed / included in Eng Mgmt & Admin*
- *"Vendor review" for MCW removed: Cost included in "Eng support to Construction - MCW"*

Leave to Commence – moved to General Mgmt and Admin work package.

It includes:

- *Leave to Commence – Construction*
- *Leave to Commence - Diversion*
- *Leave to Commence – Reservoir Filling*
- *Leave to Commence – Operations*
- *Other as required by Water Comptroller*

Responsible: Tim Little / Andrew Watson

Should include:

- *Procurement of all Site C contracts*
- *Interfaces with MoTI and T&D procurements*
- *General mgmt and admin*

May include:

- *Tetratech – Construction mgmt interface*

Includes:

- *Interfaces: T&D,*
- *Const mgmt and res engineering for other supporting contracts*

Includes:

- *Scope changes of each contract*
- *Remaining known unknowns*

Appendix 2

CONSTRAINTS ON STAGE TWO DIVERSION COFFERDAM SCHEDULE. Rev 8 May 2014

PART 1 Start and Finish Constraints

Start and finish constraints include

a. Start after freshet flooding.
b. Finish before winter low temperature limits fill placement.
c. Finish before high water levels due to ice formation.
d. Manage environmental constraints

1. Freshet Constraint - freshet season is normally May 15th to July 15th, but local storm floods can occur in August. Assume September 1st as a safe date.

2. Winter low temperature

   a. Main Dam - Impervious material should not be placed when air temperature is below -2 degrees, and granular material cannot be placed when air temperature is below -5 degrees. The average (1953 to 2112) range of dates with these temperatures is as follows.

Impervious Fill at above -2 degrees	Start 25 March	Finish 6 November
Granular Fill at above -5 degrees	Start 16 March	Finish 12 November

   b. Cofferdams – Impervious material should not be placed when air temperature is below -5 degrees, and granular material cannot be placed when air temperature is below -10 degrees. The average (1953 to 2112) range of dates with these temperatures is as follows.

Impervious Fill at above -5 degrees	Start 16 March	Finish 12 November
Granular Fill at above -10 degrees	Start 1 March	Finish 30 November

3. Downstream ice formation – floods due to ice backup can raise effective tailwater levels by approximately 6 m above normal levels to a maximum of El. 417.0 m. This rise in tailwater levels would generate a corresponding rise in headwater levels at the upstream cofferdam to a maximum elevation of 425.7 by mid-January at the earliest. The upstream cofferdam must, therefore, be constructed higher than 425.7 m prior to mid-January to prevent possible overtopping. This ice jam condition would only occur once every 12 years on average based on historic data and the ice front could reach Site C between mid-January and late February.

4. Environmental - Mitigation and monitoring required to manage critical risk windows for aquatic and terrestrial wildlife.

PART 2 Water Level Constraints during construction

5. Maximum flows are to be regulated to 600 cms (Stage 2 headwater elevation 410 m) to allow river closure to be initiated for one week in September, and slowly increased over next five weeks to normal. (Briefing Note for Information, Oct 18 2013).

6. Mean river flows September, October, November are 1000 to 1400 cms, corresponding elevations of headwater are el 412.0 m to 414.6 m. The maximum flow in Sep/Oct is approximately 1650 cms (El. 416.5 m) so getting the cofferdam above this level ASAP would allow normal operations to resume. In Nov/Dec the maximum flows increase to 2050 cms (El. 421 m) so the cofferdam would have to be higher to continue normal operations.

7. November 15th to February 15th is the window that the Peace River flows are regulated to develop stable ice cover downstream from Site C. During this window flows in the river downstream of Site C are to be maintained greater than 900cms from November 15th to December 1st (900cms is El 412.4), and greater than 1450 + or - 100cm/s from December 1st to February 15th (1550cms is about El 416.5). Note that the window is variable depending on specific weather conditions. November 15 and February 15 are the outer boundaries based on historic data but the window often doesn't begin until mid to late December.

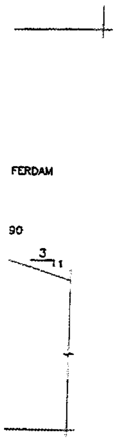
8. The downstream cofferdam must be above 412 m to resume normal upstream operations in Oct/Nov and must be above 413 m to continue normal upstream operations in Dec. It shall also be at the final elevation of 418 m by mid-January.

NOTE: All water levels presented above are assumed for Stage 2 diversion with the upstream and downstream cofferdams in place. Upstream water levels prior to river closure are generally lower than the Stage 2 levels presented for the same flow. Tailwater levels at the downstream cofferdam do not change significantly for the different stages of the project construction.

PART 3 Summary Dates

- Start in water fill placement – not before 1 September
- Water elevation controlled to be not higher than El 410 for first week, (1 to 7 September).
- Water level allowed to slowly rise to normal over next 5 weeks (ending 7 October).

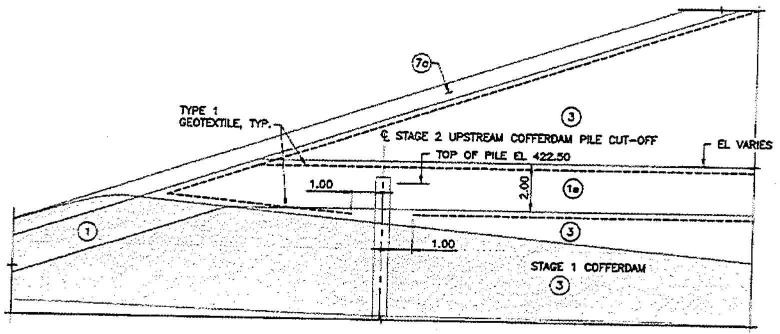
- Maximum normal river level in September /October is El 416.5.
- Normal river levels in September, October and November range from El 412 to El 414.6.
- Maximum river level in November / December is El 421.
- Impervious fill placement in Cofferdams 16 March and 12 November.
- Granular fill placement in Cofferdams 1 March and 30 November.
- Impervious fill placement in Main Dam 25 March and 6 November.
- Granular fill placement in Main Dam 16 March to 12 November.
- Ice backup in winter can raise water level up to El 425.7 by mid January.



DETAIL V
1:200
00219

DETAIL S
1:100
218

(STA 0+290 TO 0+527)



DETAIL T T
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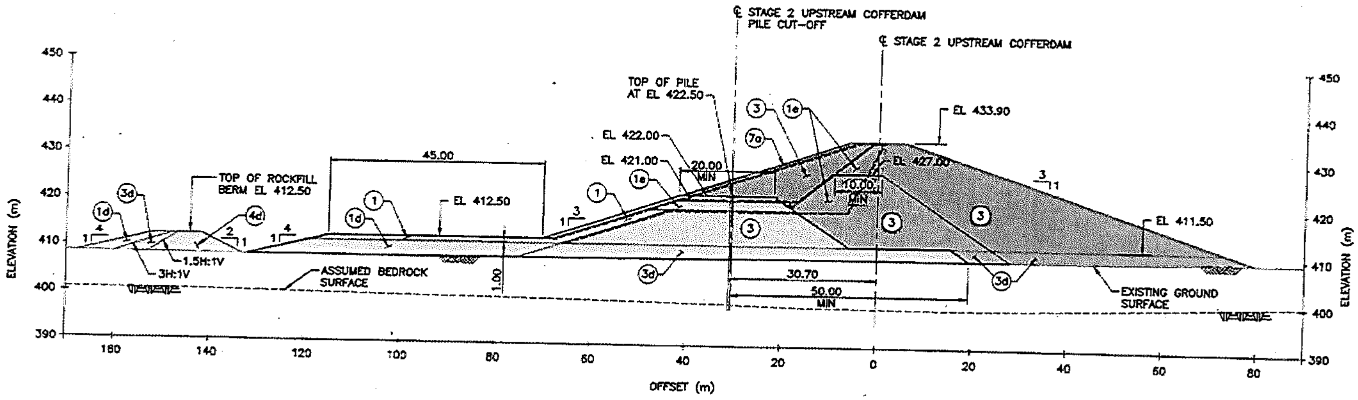
00218 00219

(STA 0+260 TO 0+290 AND 0+527 TO 0+551)



CONSTRUCTION SEQUENCE OF CLOSURE SECTION
1:500

NOTES:

1. FOR STAGE 2 COFFERDAM GENERAL NOTES, SEE DRAWING 101

LEGEND:

▨	STAGE 1 – COMPLETE BY 1 NOV 2019 422
▨	STAGE 2 – COMPLETE BY 15 JAN 2020 427
▨	STAGE 3 – COMPLETE BY 15 MAY 2020 433-9
☐	7a – TEMPORARY RIPRAP
☐	7b – TEMPORARY RIPRAP
①	IMPERVIOUS FILL (GLACIAL TILL)
1e	IMPERVIOUS FILL (GLACIOLACUSTRINE/CRUSHED SI
③	GRANULAR MATERIAL
5a	FINE RIPRAP BEDDING
—	SLURRY CUT-OFF WALL
—	PILE CUT-OFF WALL
- - -	TYPE 1 GEOTEXTILE

NOT FOR CONSTRUCTION

0 2m
1:50
0 5m
1:100
0 10m
1:200
0 25m
1:500

Appendix 3

SITE C CLEAN ENERGY PROJECT

TECHNICAL MEMORANDUM
RESERVOIR FILLING PLAN
REVISION 1

Prepared by

Klohn Crippen Berger Ltd. and SNC-Lavalin Inc.

For

BC Hydro

Klohn Crippen Berger

SNC·LAVALIN

BKS-03-055
June 2014

SITE C CLEAN ENERGY PROJECT

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SNC • LAVALIN

BKS-03-055
June 2014

SITE C CLEAN ENERGY PROJECT

TECHNICAL MEMORANDUM
RESERVOIR FILLING PLAN
REVISION 1

Prepared by: [redacted]
Klohn Crippen Berger Ltd.

Checked by: [redacted]
SNC-Lavalin Inc.

Reviewed by: [redacted]
BC Hydro

Approved by:

[redacted]
BC Hydro

[redacted]
Klohn Crippen Berger Ltd.

[redacted]
SNC-Lavalin Inc.

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ACROYNMS

GMS	GM Shrum
MNRL	Maximum Normal Reservoir Level
PCN	Peace Canyon Dam
RCC	Roller Compacted Concrete
TGP	Total Gas Pressure
WSC	Water Survey of Canada

SITE C CLEAN ENERGY PROJECT

TECHNICAL MEMORANDUM
RESERVOIR FILLING PLAN
REVISION 1

CONTENTS

SITE C CLEAN ENERGY PROJECT

TECHNICAL MEMORANDUM
RESERVOIR FILLING PLAN
REVISION 1

CONTENTS

TABLES

FIGURES

1. Introduction

The Site C reservoir would be filled after the earthfill dam and spillways are substantially completed. The purpose of this document is to describe the anticipated stages of the reservoir filling process and to outline estimated durations and potential scheduling windows and constraints for each stage. Key transition points during the reservoir filling process are also described including approximations of the flow changes that would be observed downstream of the dam site. The tunnel conversion period is also discussed in detail as it would be a key component of the reservoir filling process and would need to be scheduled together with reservoir filling to meet all relevant constraints.

The reservoir filling would raise the reservoir level to the maximum normal reservoir level of elevation 461.8 m which is approximately 50 m higher than the current average level of the Peace River at the Site C dam site. The Site C minimum outflow requirement during reservoir filling would be 390 m^3/s, which would be the same as the minimum flow requirement during the operational phase of the Project. During reservoir filling, the outlet structures at the Site C dam would be capable of discharging the minimum outflow of 390 m^3/s throughout the reservoir filling process.

Filling the Site C reservoir would take approximately 3 months depending on:

1) the time of year;
2) inflows to the Site C reservoir;
3) discharges from the Site C reservoir; and
4) the duration of reservoir hold points.

Table 1 shows the mean monthly flows measured at the Water Survey of Canada (WSC) gauge "Peace River above Pine River," which is located approximately 6 km downstream of the proposed Site C dam site. This gauge was used to provide historic flows at the proposed dam site. Table 1 is based on a representative sample of 10 years of data from 2000 to 2009.

Table 1 - Mean Monthly Peace River Flows

Peace River above Pine River (WSC Gauge #07FA004) data for 2000 to 2009												
Mean Monthly Flow (m^3/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AVG	1535	1612	1426	1238	929	901	1249	1079	1012	1166	1364	1633
MAX	1740	1760	1670	1480	1350	1290	2270	1390	1400	1380	1670	1850
MIN	1270	1400	1110	1010	689	640	699	616	611	861	821	1360

2. Tunnel Conversion Prior to Reservoir Filling

The capacity of Tunnels 1 and/or 2 would be too high to allow reservoir filling to occur with normal inflows from upstream. Therefore, the tunnel capacity must be restricted in order to fill the reservoir. This would be done by modifying one diversion tunnel (Tunnel 2) to reduce its capacity and then by completely closing the other diversion tunnel (Tunnel 1).

The preferred method chosen for reducing the tunnel capacity is to install a series of in-line orifices in Tunnel 2. After the orifices are installed and the tunnel is put back into service the risk of a flood overtopping the upstream cofferdam would increase. The earthfill dam, however, would be constructed to a higher elevation than the upstream cofferdam at the time of tunnel conversion increasing the headpond elevation for overtopping.

2.1 Tunnel Conversion Schedule

2.1.1 Preferred Conversion Schedule

The ideal time window for tunnel conversion is just prior to reservoir filling, to minimize the duration of tunnel operation at reduced capacity. Reservoir filling is scheduled to commence in mid-September (see Section 3.1). Therefore, the preferable time period for conversion is a two month window between mid-July and mid-September. The preferred window occurs at the tail end of the summer freshet. Local basin storms are possible during this period, however, the risk of an unregulated flood is higher during the period from mid-May to mid-July based on historic flow records. The risks associated with conversion from mid-July to mid-September are considered manageable within the scheduling constraints and with the assistance of flood forecasting models to predict the arrival of high consequence flood events. An independent constructability review was conducted with the goal of estimating the orifice construction schedule and possible methods. The review concluded that if orifice construction began on July 15th, it could be complete by September 22nd with a total duration of 2 months and 1 week.

Figure 1 illustrates the results of a one-dimensional flow model for the Site C construction headpond with one 10.8 m diameter tunnel in operation to simulate the conditions during tunnel conversion. Figure 1 illustrates the level of the construction headpond for the full water year based on a representative set of 10 years of historical data. It is evident that the water level remains below elevation 430 m during the preferred conversion window of mid-July to mid-September for all 10 years with the exception of 2002. The 2002 event was a regulated spill from GM Shrum (GMS) which involved a sustained period of outflows greater than 2000 cms with a peak above 3500 cms. GMS reservoir operations would be pre-planned to avoid this type of event during tunnel conversion. Therefore, the preferred conversion window from mid-July to mid-

September appears to be feasible in terms of tunnel capacity based on the 10 years of historic data used for this analysis.

2.1.2 Alternate Conversion Schedule

Alternate conversion windows were investigated in case conversion is required at a different time of year, based on construction progress. The windows that should be avoided for conversion are the following:

- November 15th to February 15th as this is the window that Peace River flows are regulated to develop stable ice cover downstream from Site C.
- May 15th to July 15th as this is the freshet window when the likelihood of an unregulated flood event from the local basin is the highest.

Figure 2 illustrates the historical advancement of the ice front in the Peace River. Initiation of the ice front occurs between November 15th and February 15th. During this period, high outflows from Site C are required to ensure the formation of a stable ice cover on the Peace River that allows for high discharges during winter power generation.

Figure 3 illustrates the two main time windows which should be avoided for conversion shaded in red overlaid on top of historical PCN and local basin flows for 2009 which was an average water year. Also labeled are the preferred conversion and reservoir filling windows and the environmental critical risk window which does not need to be avoided for tunnel conversion but is important to consider for reservoir filling. Therefore, tunnel conversion could be planned in between February 15th and May 15th without significant risk of high local basin inflows and without affecting ice formation at the town of Peace River.

As described in Section 2.1.1 the preferred conversion window is between mid-July and mid-September just after the freshet. A feasible alternate conversion schedule could consist of performing the conversion prior to the freshet, re-opening Tunnel 2 and operating it with Tunnel 1 through one freshet season, then filling after the freshet. Figure 4 illustrates the construction headpond level based on historical inflows assuming Tunnel 1 and converted Tunnel 2 are in operation. Headpond levels would be higher than normal diversion levels, however, only the 2001 flood raises water levels significantly (ignoring the 2002 regulated outflow event from GMS). Even if a flood event similar in magnitude to the 2001 flood was to occur in the final freshet season, the water level would not reach the top of the upstream cofferdam crest. The 2001 flood is the local basin flood of record which consists of recorded flow measurement data from 1980 to 2012.

2.2 Conversion Sequencing

2.2.1 Tunnel 2 Closure

To perform the modification to Tunnel 2, it must first be closed; temporarily passing the full river flow through Tunnel 1. To shut off flow through Tunnel 2, the Site C headpond would be maintained at or below elevation 415 m. This elevation corresponds to approximately 1400 m³/s flow through both tunnels. The closure headpond elevation of 415 m was chosen to limit the hydraulic loading during gate operation. In addition, an elevation at 415 m or below for Tunnel 2 closure would ensure that the elevation of the headpond would not rise above the Tunnel 1 tower and access road. If inflows are greater than 1400 m³/s, reduced discharges may be required from PCN for one to two days to lower the headpond to elevation 415 m prior to Tunnel 2 closure.

With the headpond at or below elevation 415 m, the gate in Tunnel 2 would be closed to shut off flow (gate closure would take approximately 15 minutes). Immediately after closure of Tunnel 2, the headpond and the outflow from Tunnel 1 would begin to rise.

2.2.2 In-Line Orifice Construction

With the upstream gate closed, no flow would be passing through Tunnel 2. A temporary removable gate would then be installed in the gate slots at the outlet structure on Tunnel 2, allowing the tunnel to be dewatered.

Tunnel 2 would be modified by installing four orifices in series in the upstream half of the tunnel. The orifices would reduce the tunnel capacity to effectively perform the first stage of reservoir filling. Orifice construction including initial tunnel dewatering is estimated to take 2 months to complete. During the conversion period, the headpond would normally fluctuate between elevation 411 m and 429 m.

2.2.3 Tunnel 2 Re-Opening

After the construction of the orifices is completed, Tunnel 2 would be safely filled with water. The temporary outlet gate and the inlet gate would then be re-opened to place the modified tunnel (Tunnel 2) back in service. In order to re-open the gate on Tunnel 2 the Site C headpond elevation would be at or below elevation 415 m. Depending on inflows, reduced discharge from PCN may be required for a period of one to two days in order to lower the Site C headpond to elevation 415 m or lower. A constant headpond elevation of 415 m corresponds to a tunnel flow of 800 m³/s with only Tunnel 1 in operation. Elevation 415 m was chosen to reduce risk associated with the creation of a high speed jet of water during re-opening. At higher reservoir elevations and low gate openings a high speed jet would be issued from beneath the inlet gate which could reach the location of the first orifice and impact the lower portion of the orifice. The orifice structure would be designed to withstand this type of dynamic loading; however, it is prudent to minimize the head on the gate at this time. At a headpond elevation of 415 m, it is anticipated that the hydraulic jump would be submerged at the gate location throughout the gate opening, preventing the jet from reaching the location of Orifice #1. Small vibrations could occur at the gate; however, with the reduced head achieved by lowering the reservoir to elevation 415 m or below, the vibrations are not expected to be a concern.

During re-opening, small pockets of air may be trapped at the crown of the tunnel, in particular, at the locations of the orifices. Air vents would be provided through the orifices at the crown of the tunnel. These vents would allow the air pockets to travel either upstream or downstream and escape during the first several hours following re-opening.

With the modified tunnel placed back in service, the reservoir level would generally fluctuate between elevations 411 m and 425 m due to changes in the inflows to Site C, which are largely driven by the operation of GMS and PCN generating stations.

3. Reservoir Filling

Reservoir filling would take place in three stages:

1. Stage 1 up to elevation 440 m;
2. Stage 2 up to a reservoir hold point at elevation 452 m; and
3. Stage 3 up to the Maximum Normal Reservoir Level (MNRL) of 461.8 m.

During reservoir filling, downstream flows would be discharged by:

1) the diversion tunnels during Stage 1;
2) the spillway low level outlets during Stage 2; and
3) the spillway gates and/or the spillway low level outlets during Stage 3.

Figure 5 is a graph showing the reservoir level over time for the full reservoir filling process. Historical data has been used to model reservoir inflows over the reservoir filling period. A representative sample of 10 years of historical data was taken from 2000 through 2009. Three years were selected to plot a range of possible filling durations: 2006 was the minimum flow year; 2009 was the average flow year; and 2002 was the maximum flow year for the months of September through November. For Figure 5, it was assumed that reservoir filling would begin in early September which is the currently scheduled and preferred time period to initiate filling.

During reservoir filling there would be a number of short term changes in Peace River flows as described in the following subsections. Figure 6 is a plot of outflows from Site C during reservoir filling. Figure 6 corresponds to Figure 5 in terms of schedule and assumptions.

3.1 Reservoir Filling Schedule

Reservoir filling would be scheduled to meet the following constraints:

1. Maintain Peace River flows greater than 900 m^3/s during the beginning of the downstream ice formation window (November 15th to December 1st).
2. Maintain Peace River flows greater than 1450 ± 100 m^3/s depending on local inflow conditions during the period of Peace River freeze-up at the Town of Peace River (December 1st to February 15th), in accordance with current ice management agreements with Alberta.
3. Avoid the local basin spring freshet in order to ensure controlled reservoir filling.
4. Schedule spillway discharges during reservoir filling to minimize high total gas pressure (TGP) levels downstream from Site C by minimizing spillway discharges exceeding 600 m^3/s ± from the spillway low level outlets or 1200 m^3/s ± from a combination of the low level outlets and the gated spillway bays prior to the first generating unit being placed on-line.
5. Avoid filling during critical risk windows for aquatic and terrestrial wildlife of primary management concern in the Peace Region. Section 14.4.2 of the Site C Environmental Impact Assessment specifies that the window from April 1st through July 31st should be avoided to be in compliance with the Federal *Migratory Birds Convention Act* and the Provincial *Wildlife Act*.

Constraints 1 and 2 above for ice formation require that Stage 1 and Stage 2 of reservoir filling must be complete prior to November 15th. As shown on Figure 5, Stage 1 and Stage 2 combined would take approximately 3 to 7 weeks to complete depending on inflows. 7 weeks prior to November 15th is the last week in September which is the latest filling would begin without modifying upstream operations.

Constraint 3 may be flexible in a year with low snow accumulation because measurements of snow accumulation and flood forecasting would be available to determine the approximate potential for a large uncontrolled flood event in the local basin. If the flood potential is high, the period from May 15th to July 15th should be avoided for Stage 1 and Stage 2 filling.

Constraint 4 is critical from the start of Stage 2 filling until the first generating unit is online. Filling should, therefore, be scheduled so that inflows can be controlled, in particular, during the hold point and Stage 3.

Constraint 5 is critical for all three stages of reservoir filling until the reservoir reaches the maximum normal level at elevation 461.8 m. As shown on Figure 3, Constraint 5 overlaps Constraint 3 extending approximately 1 month on either side of the freshet. It has been assumed that tunnel conversion can occur during the critical risk window for aquatic and terrestrial life because impacts would be minimal other than a slight increase to normal water levels.

Based on construction scheduling and considering the constraints outlined above, the preferred reservoir filling schedule starts in the late summer or early fall. Assuming tunnel conversion also occurs during its preferred time window from July 15th to September 15th, the preferred reservoir filling window would start on September 15th and be complete to the maximum normal reservoir elevation of 461.8 m between November 15th and December 31st depending on inflows and turbine commissioning schedules.

Figure 7 illustrates the reservoir filling and tunnel conversion constraints on a plot of the construction headpond elevation and inflow for the 2009 water year which was an average water year.

3.2 Stage 1 Filling

3.2.1 Below Elevation 425 m

Stage 1 filling can begin when tunnel conversion is complete and Tunnel 2 is brought back into service. Depending on inflows, the headpond would be between elevation 411 m and 425 m. Once converted, Tunnel 2 is capable of passing the minimum downstream flow of 390 m^3/s from elevation 425 m to elevation 440 m.

If the headpond is lower than elevation 425 m at the start of filling, the currently anticipated method would be to increase discharges from PCN to raise the headpond to elevation 425 m with both Tunnel 1 and converted Tunnel 2 in operation and close Tunnel 1 when the reservoir level reaches elevation 425 m. If PCN outflows were increased to maximum power flow (1982 m^3/s), it would take between 2 and 4 days to raise the headpond from elevation 415 m to elevation 425 m. This method is illustrated on Figure 5.

Once elevation 425 m is reached, Tunnel 1 would be closed and Tunnel 2 would discharge the minimum downstream flow of 390 m^3/s. The discharge through Tunnel 2 would increase as the reservoir level rises above from elevation 425 m to elevation 440 m.

Two alternate options are presented here to reach elevation 425 m without imposing restrictions on upstream operations; however, as described below, both of these options involve risks that make them less desirable than the method above.

1. Partially close the gate on Tunnel 1 to reduce downstream discharge and raise the headpond to elevation to 425 m. Tunnel 1 would be closed at elevation 425 m. This option is not desirable as it would involve a moving hydraulic jump in the pressurized tunnel and potential vibrations of the Tunnel 1 operating gate (see discussion in Section 2.2.3 above).

2. Keep Tunnel 2 closed and allow the reservoir to fill to elevation 425 m with only Tunnel 1 in operation. Increased flows from PCN may be required. With the reservoir at elevation 425 m, Tunnel 2 would be opened just prior to the closure of Tunnel 1. This option is the least desirable because opening Tunnel 2 at a headpond elevation of 425 m would generate a high velocity jet under the gate that could impact Orifice #1 (see discussion in Section 2.2.3 above).

3.2.2 Elevation 425 m to 440 m

From elevation 425 m to elevation 440 m, converted Tunnel 2 would operate with limited control on rate of rise for the reservoir. Discharge through the tunnel would increase from 390 m³/s to approximately 550 m³/s. Depending on inflows this would take between 1 and 4 weeks (see Figure 5).

Figure 7 presents an estimate of the time between closure of each of the diversion tunnels and overtopping of the respective inlet tower. For Tunnel 1 this would be the time between reservoir elevation 425 m and 428 m which could vary from 0.8 days to 8.2 days depending on inflows. For Tunnel 2 this would be the time between reservoir elevation 440 m and 443 m which could vary from 2.1 days to 6.2 days depending on inflows. This timing would be important for gate closure considerations and salvage of gate equipment such as the hydraulic cylinder.

3.3 Stage 2 Filling

Stage 2 filling begins with the transfer of downstream flow releases from Tunnel 2 to the spillway low level outlets with no planned reservoir hold point. The downstream discharge would increase from approximately 550 m³/s to 1100 m³/s for about 1 hour when both the spillway low level outlets and Tunnel 2 are discharging. After it has been confirmed that the spillway discharge is greater than 550 m³/s, the gate in Tunnel 2 would be closed (gate closure would take approximately 15 minutes) reducing downstream flow to approximately 550 m³/s.

Stage 2 filling would increase the reservoir elevation from 440 m to 452 m and depending on reservoir inflows would take from 1 to 3 weeks. Downstream flows would be maintained by the spillway low level outlets. When the reservoir reaches elevation 450 m, the main spillway gates would be commissioned and could then be used in addition to the low level outlets to discharge downstream flows. When only the low level outlets are in operation, the maximum TGP level of ±120% would be exceeded if discharge was greater than approximately 600 m³/s, therefore, discharge would be kept below 600 m³/s if possible depending on inflows. After the main spillway gates have been commissioned, the maximum combined discharge increases to 1200 m³/s without exceeding TGP levels.

3.4 Hold Point

The reservoir would be held at elevation 452 m for about 4 weeks with downstream flows maintained by the main spillway gates and/or the spillway low level outlets. During this period, the penstocks would be filled with water and commissioning of the turbines/generators using flow from the Site C reservoir would begin. In order to hold the reservoir elevation constant, outflows from the spillway must match inflows. If inflows are greater than 1200 m³/s during this time, maximum TGP levels may be exceeded. Reservoir filling would be scheduled to attempt to minimize the possibility of exceeding maximum TGP levels, as described in Section 3.1.

The reservoir filling plan assumes that only a single hold point would be required at elevation 452 m. If required by dam safety, a second hold point as low as elevation 442 m could be incorporated into to the filling plan. TGP performance at 442 m would be undesirable. With discharge coming only from the spillway low level gates, maximum TGP levels would be exceeded for outflows greater than 600 m³/s ±. In order to hold the reservoir at 442 m, the spillway discharge must match inflows which would likely be higher than 600 m³/s.

3.5 Stage 3 Filling

The third stage of reservoir filling from elevation 452 m to the maximum normal reservoir level of elevation 461.8 m would take from 2 to 6 weeks depending on reservoir inflows and selected reservoir outflow. Downstream flows would be maintained by the spillway low level outlets and/or the spillway main gates. As the reservoir level nears the maximum normal reservoir level, the commissioning of the first turbine/generator unit would be completed and a transition to the operational phase would begin.

The duration of Stage 3 filling, may be increased if reservoir inflows are relatively high to enable commissioning of the first unit to be completed prior to the reservoir reaching elevation 461.8 m. Once the first unit is commissioned, TGP levels would only be exceeded with a combined discharge between Unit 1 and the spillway greater than 2100 m³/s. As shown in Table 1, inflows exceeding 2100 m³/s are rare.

3.6 Turbine/Generator Commissioning

After reservoir filling and commissioning of the first turbine/generator unit, commissioning of the second and subsequent units would be completed in sequence, with approximately 4 to 8 weeks in between the completion of each individual unit commissioning process. It is estimated that the commissioning process for all 6 units would take between 6 and 12 months. Following commissioning of the first unit, the reservoir would be maintained within the normal operating range of elevation 460.0 m to 461.8 m for the duration of the commissioning process. As each additional unit is commissioned, the discharge through the spillway would be reduced until the capacity of the commissioned units exceeds the inflows. At this time all spillway gates would be closed and the turbine/generators would maintain downstream flows.

4. Monitoring

During reservoir filling, instrumentation in the dam and reservoir slopes would be monitored to compare observations of actual dam movement and groundwater pressure relative to expected values. Based on the observed performance, it is possible that the duration of the hold points would be extended or the rate of filling may be reduced to closely monitor critical instrumentation if an unexpected trend is observed.

During the detailed design of the dam, generating station and spillway the requirements for monitoring of parameters such as dam movement and groundwater pressures during reservoir filling and operations would be determined. The monitoring program would include the type and locations of all required instrumentation.

As described in the memorandum on Site Instrumentation[1], a Failure Modes and Effects Analysis would be completed to assess measures that may need to be implemented during reservoir filling in response to performance monitoring, in particular with respect to leakage through relaxation joints in the abutments, higher than expected groundwater levels under the RCC buttress and in the left bank. For example, excessive leakage from the left bank drainage gallery would indicate that the relaxation joints had not been completely grouted. This could require holding the reservoir and undertaking additional grouting. Actions need to be pre-planned so that the contractor has the necessary equipment on site when required and the contract includes the provisions required to undertake the work.

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[1] KCB/SNC memorandum INT-1197 dated February 17, 2014

5. Emergency Planning

If an issue similar to the examples described in Section 4 is identified during monitoring of reservoir filling, the following sections include a brief description of drawdown feasibility, potential preventative measures and some potential emergency action processes that could be implemented.

5.1 Drawdown

The potential to draw the reservoir back down in the event of an observed issue differs as the reservoir fills. The following summarizes the potential for draw down:

- Below elevation 425 m (before Tunnel 1 is closed) – Drawdown is possible to as low as elevation 411 m by reducing PCN outflow, depending on local basin inflows.
- Elevation 425 m to Elevation 442 m – No drawdown is possible after Tunnel 1 has been closed, limited control would be available on reservoir rate of rise depending on local basin inflows. Significant changes to the design and significant risks would have to be accepted to allow drawdown in this range. Re-opening the gate on Tunnel 1 would result in a hydraulic jump forming in the tunnel and moving down the tunnel to the outlet structure, with the potential to severely damage or fail the tunnel lining or outlet structure. The tower on Tunnel 1 would also have to be built 14 m taller to allow gate operation up to elevation 442 m. The capacity of the converted Tunnel 2 would only be slightly above the minimum inflow from PCN; therefore, even if PCN flows were reduced to minimum, the rate of filling could be slowed but could not be reversed. At El. 440 m the spillway low level gates can discharge minimum downstream flows; however, the spillway capacity is limited with low flow depths in the approach channel. The minimum emergency drawdown level is assumed to be El. 442 m.
- Elevation 442 m to Elevation 461.8 m – Drawdown is possible to as low as elevation 442 m using the main spillway gates and the spillway low level gates.

The lack of drawdown potential between elevation 425 m and 442 m is not a significant concern from a dam safety perspective. The hydraulic loading on the dam is relatively low compared to maximum normal reservoir level at 461.8 m. There is potential to perform a pre-filling to test the dam at a higher hydraulic loading than experienced during normal diversion, as discussed below.

5.2 Pre-Filling

Reservoir drawdown is not possible once Tunnel 1 is closed and reservoir filling through modified Tunnel 2 has been initiated. The reservoir would fill from elevation 425 m to elevation 442 m with only limited control on the reservoir rate of rise if a problem is identified during monitoring.

An analysis was performed looking at potential failure modes and reservoir filling precedents and it was concluded that drawdown capability was not required during reservoir impoundment up to El. 442 m. The possibility of a pre-filling, to test the dam at an intermediate reservoir level near the end of the diversion window is being considered. Pre-filling may consist of stopping pumping between the upstream cofferdam and the partially completed earthfill dam allowing the area to flood to the average water level of approximately elevation 415 m. The pre-filling level could also be raised slightly higher by pumping additional water, however the details are yet to be determined.

Pre-filling would allow the dam performance to be monitored prior to the start of reservoir filling, when drawdown is still a possibility.

5.3 Orifice Design

Design of the orifices to be placed in Tunnel 2 is based on the successful precedent at the Xiaolangdi Hydroelectric project in China and has been verified by physical hydraulic modeling at the LaSalle lab in Montreal for Site C. It is, therefore, unlikely that a significant issue would be encountered; however, the following methods could be implemented in the event of an emergency to minimize potential consequences.

5.3.1 Gate Regulation

The performance of the orifices in Tunnel 2 is based on the premise that gate regulation is not required. If a significant problem was observed during filling, such as evidence of cavitation damage in the tunnel, the gate on Tunnel 2 could be partially closed to reduce flow through Tunnel 2 and possibly prevent further damage. At higher reservoir levels, the gate could be closed 50% to 60% while still maintaining the minimum downstream flow. Gate closure would cause unsymmetrical flow at the first orifice but would reduce flow velocity and head loss at each of the remaining orifices.

5.3.2 Outlet Channel Headloss

The performance of the orifices is largely dependent on the amount of backpressure on the downstream side of each orifice. Increasing the head loss at the tunnel outlet would serve to increase backpressure and potentially prevent further damage in the event that evidence of cavitation damage is observed.

Rockfill could be dumped in the outlet channel to create a partial blockage and in doing so generate additional headloss. The velocity at the outlet is quite low during filling so the additional headloss generated by a blockage would not be substantial, however, in the event of an emergency a small benefit could be realized.

FIGURES

Figure 1: Construction Headpond Elevation for Tunnel 1 Operation Only

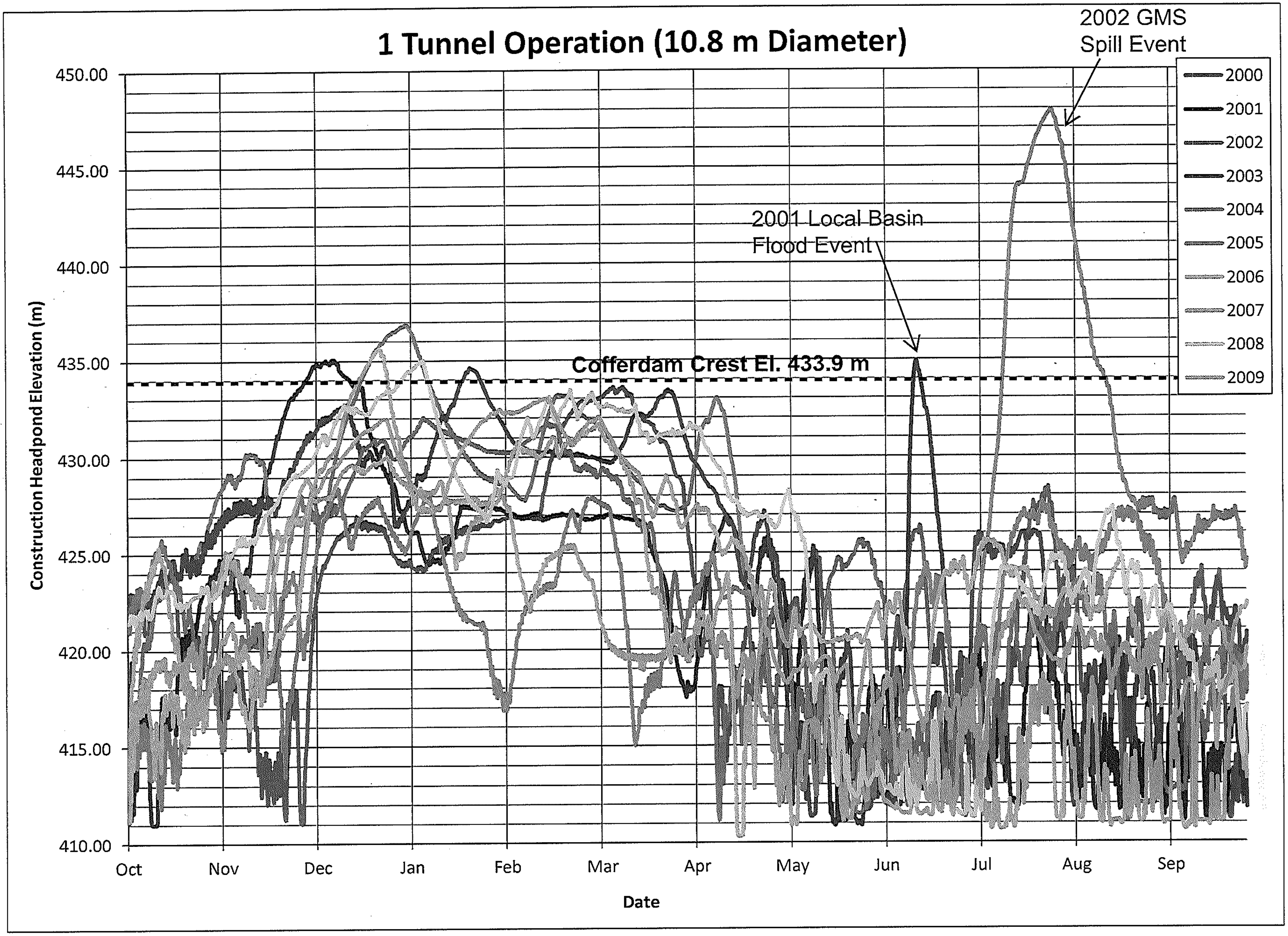


Figure 2: Historic Advancement of Peace River Ice Front

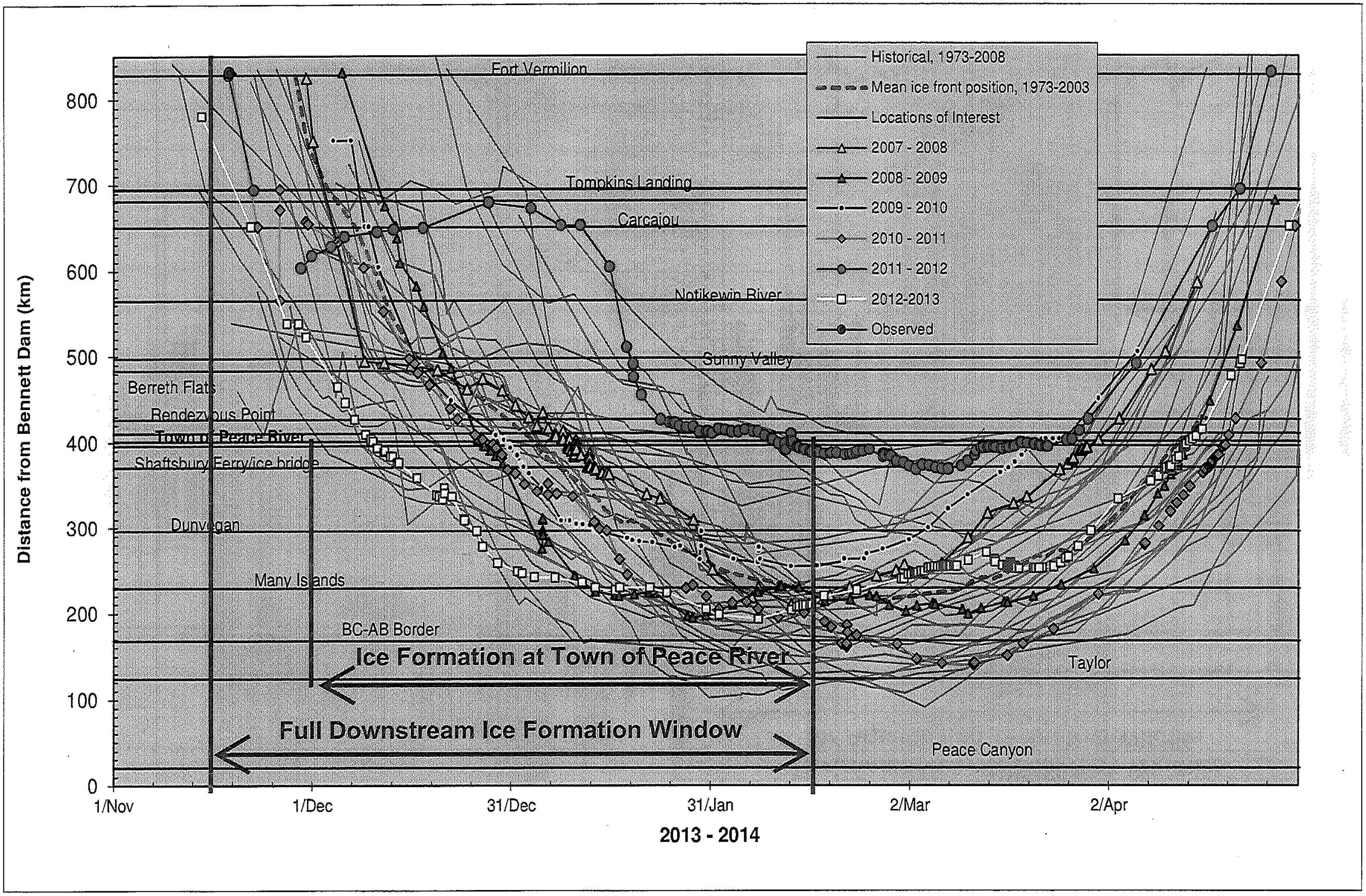


Figure 3: Reservoir Filling and Tunnel Conversion Time Windows (Avg Site C Inflows)

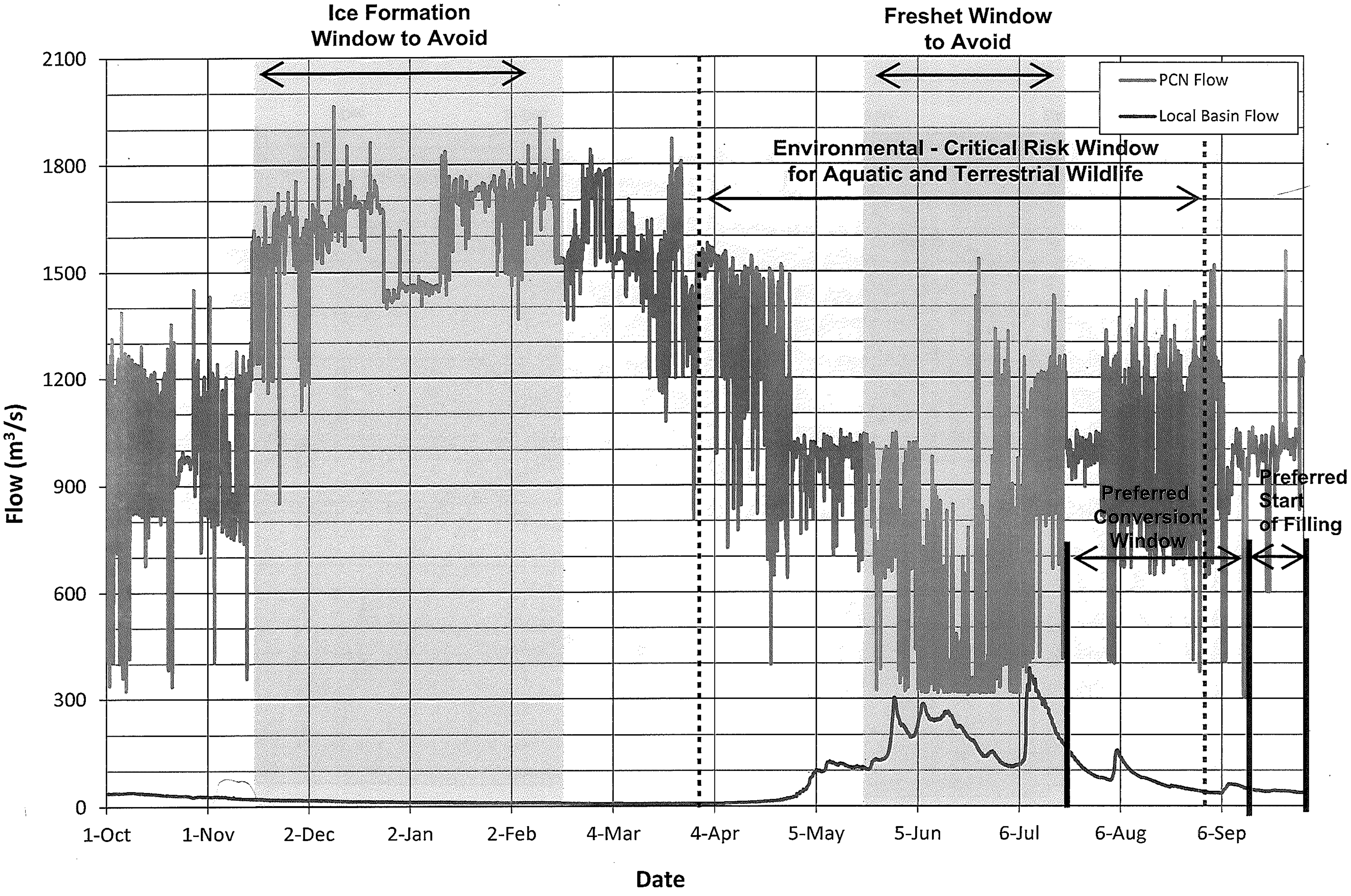


Figure 4: Construction Headpond Elevation for Tunnel 2 and Converted Tunnel 2

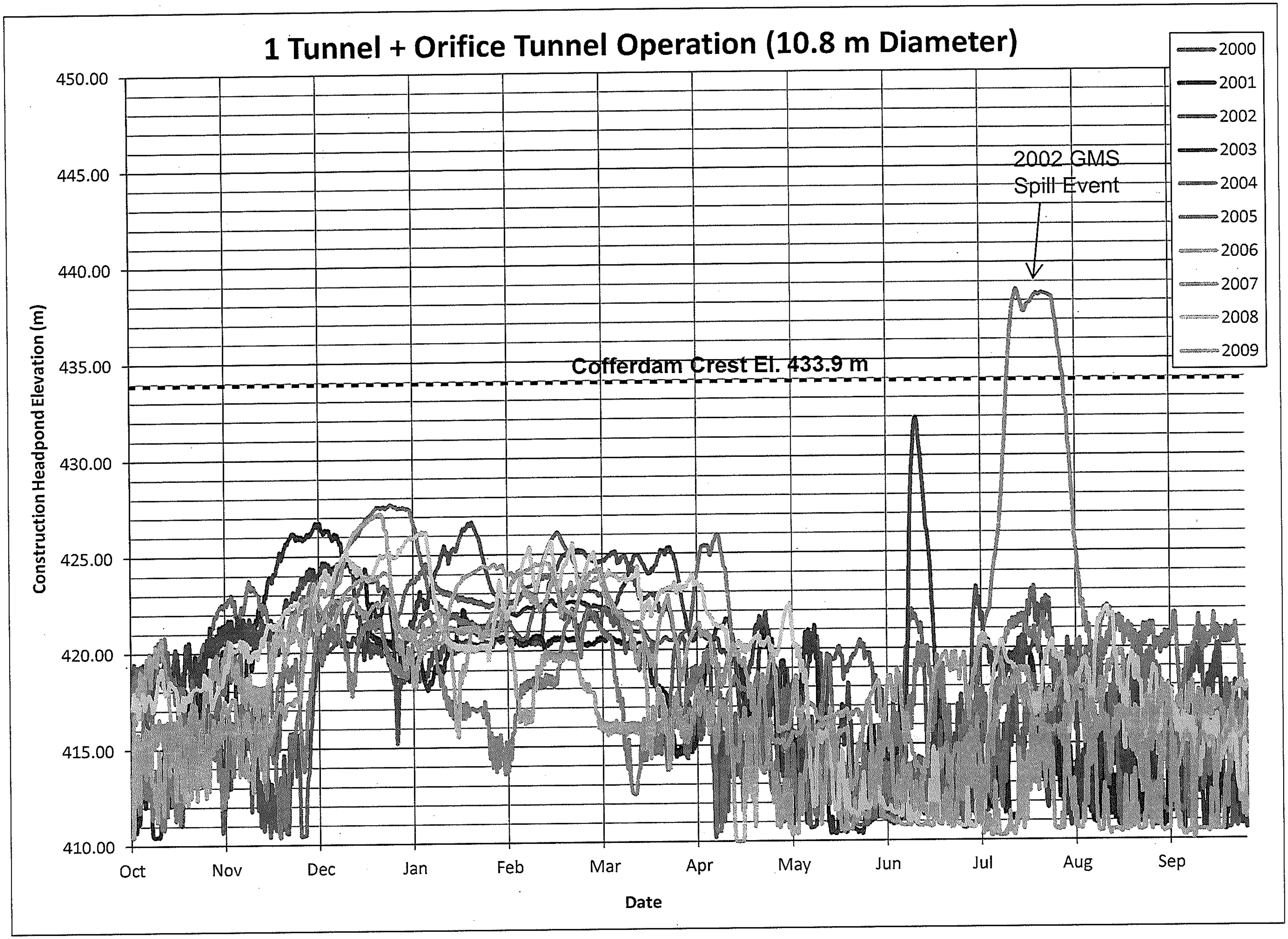
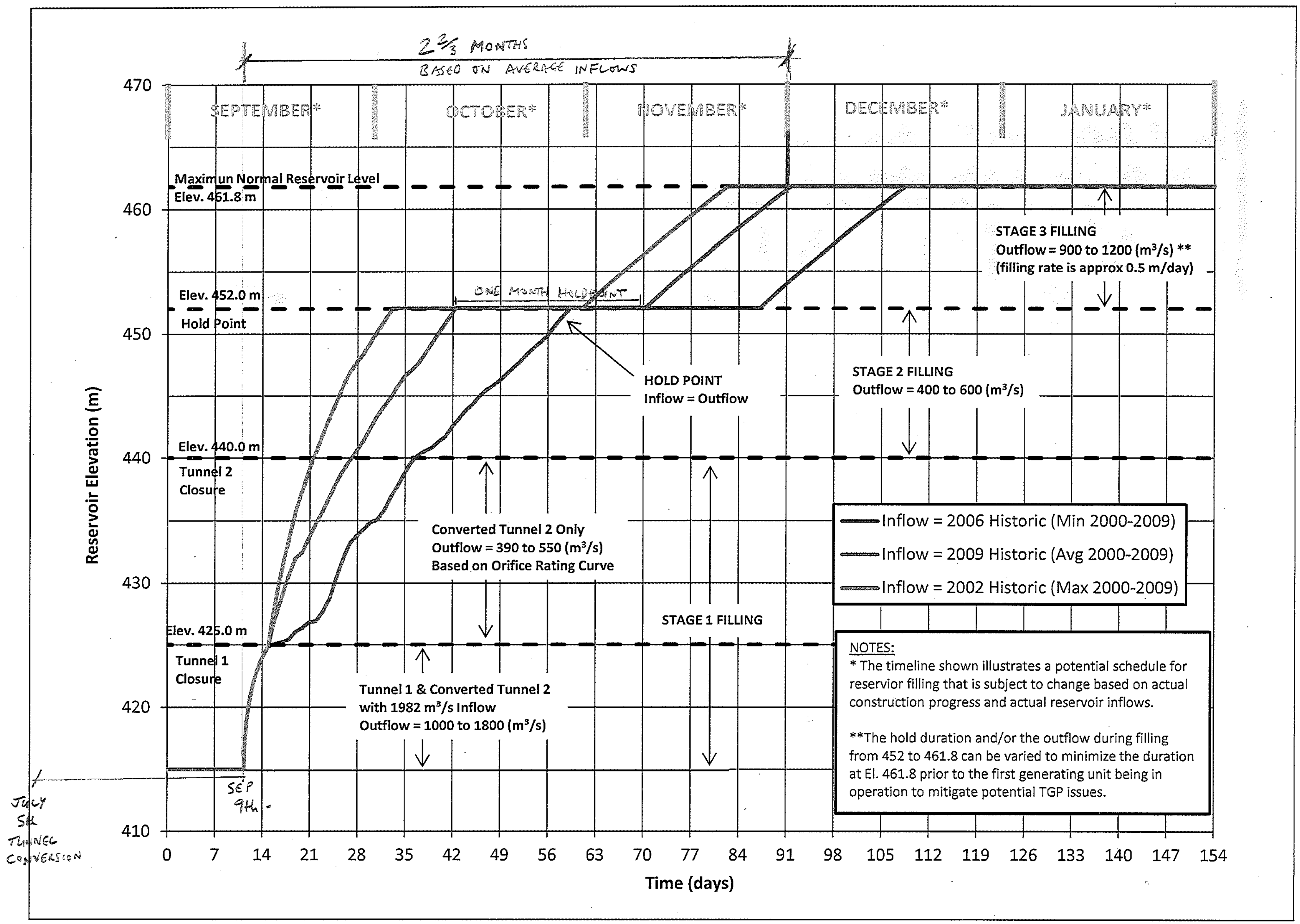


Figure 5: Reservoir Filling Curves for a Range of Historic Inflows



NOTES:

* The timeline shown illustrates a potential schedule for reservoir filling that is subject to change based on actual construction progress and actual reservoir inflows.

**The hold duration and/or the outflow during filling from 452 to 461.8 can be varied to minimize the duration at El. 461.8 prior to the first generating unit being in operation to mitigate potential TGP issues.

Figure 6: Reservoir Filling Outflow for a Range of Historic Inflows

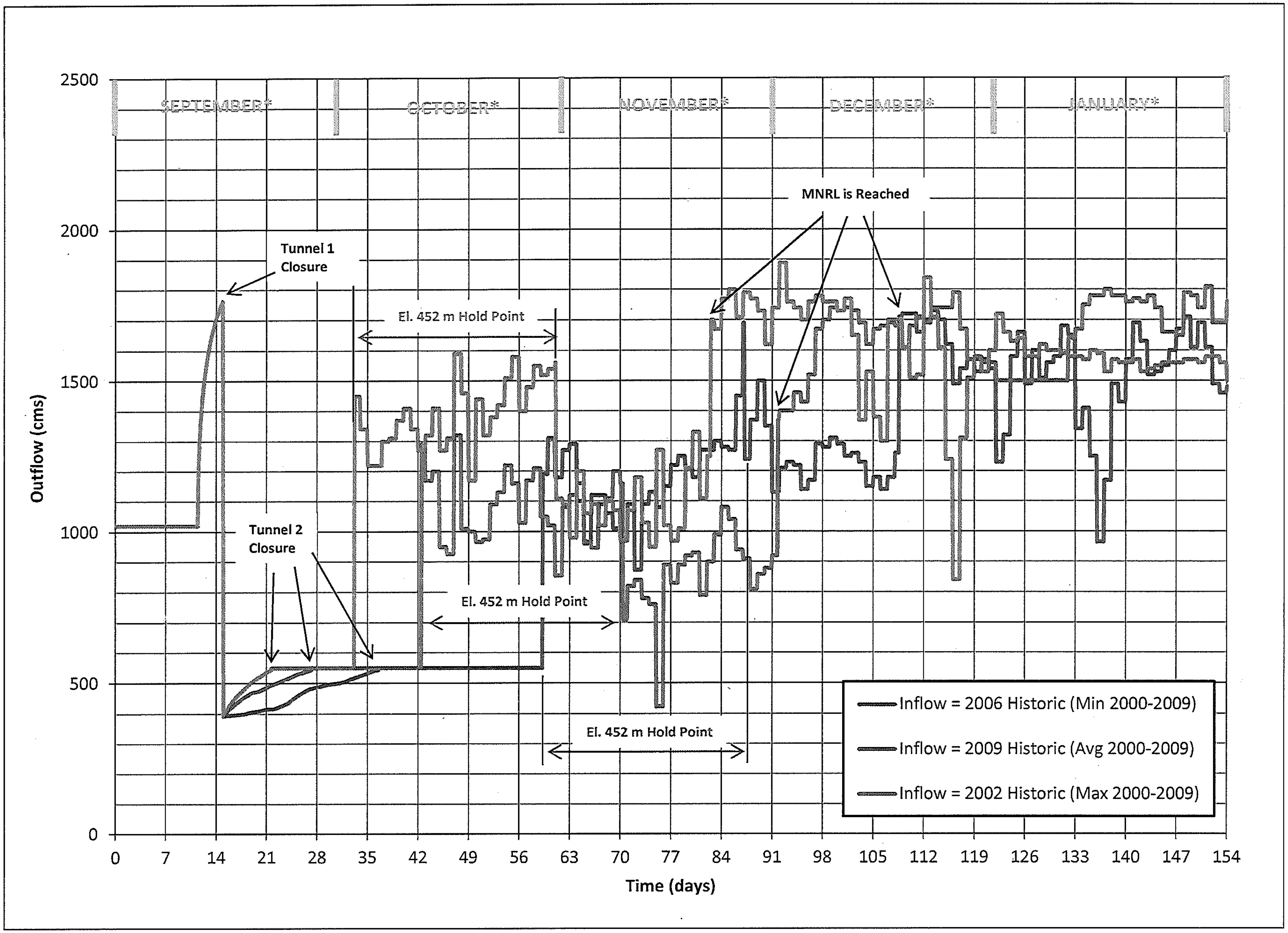
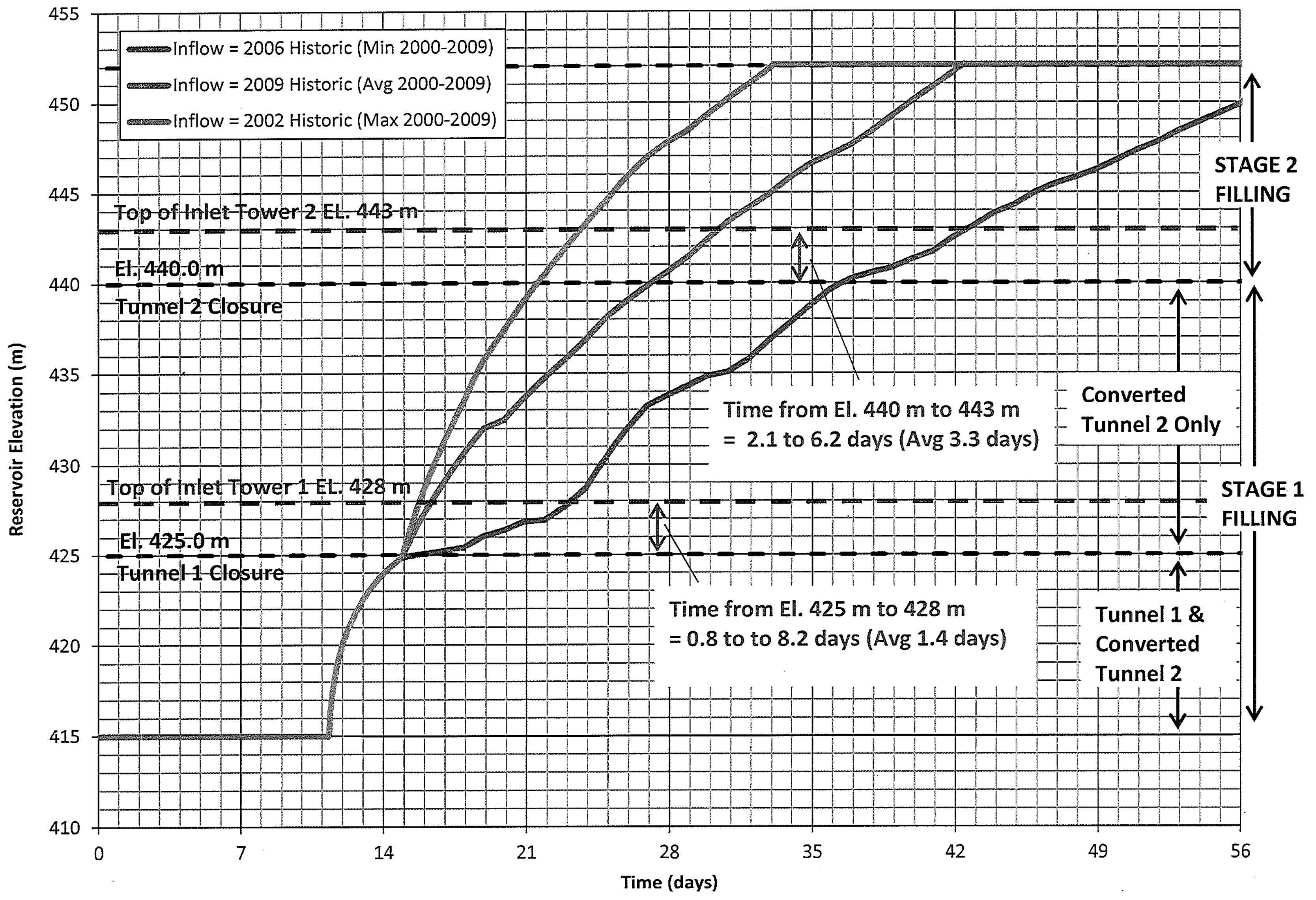


Figure 7: Approximate Time Windows between Tunnel Closure and Tower Overtopping



Appendix 4

SITE C CLEAN ENERGY PROJECT

DIVERSION TUNNEL ORIFICES
SCOPE OF WORK
CONSTRUCTION METHODS

Prepared by
Klohn Crippen Berger Ltd. and SNC-Lavalin Inc.

For

BC Hydro

Klohn Crippen Berger

SNC • LAVALIN

March 2014

SITE C CLEAN ENERGY PROJECT

DIVERSION TUNNEL ORIFICES
SCOPE OF WORK
CONSTRUCTION METHODS

Prepared by: [redacted]
SNC-Lavalin Inc.

Checked by: [redacted]
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Reviewed by: [redacted]
SNC-Lavalin Inc.

[redacted]	[redacted]	[redacted]
BC Hydro	Klohn Crippen Berger Ltd.	SNC-Lavalin Inc.

Klohn Crippen Berger

SNC·LAVALIN

March 2014

SITE C CLEAN ENERGY PROJECT

IMPLEMENTATION DESIGN
TECHNICAL MEMORANDUM
TITLE

CONTENTS

APPENDIX

SITE C – TUNNEL No. 2 INSTALLATION OF ORIFICES

Construction Methods

1 INTRODUCTION

The study objectives are to develop construction methods, construction schedule and order of magnitude estimate to carry out the work described here-in.

The Work environment will be:

- A 10.8 meters diameter concrete-lined tunnel.
- Access will be trough an access shaft at the downstream portal, on which portal runs a 19 meter wide road. Of these 19 meters, 9.5 will be left open to traffic. The rest will be used as working area.
- In the tunnel outlet area a sump-pit will have been constructed, before diversion

The scope of work, as per drawing 1016-C14-05930, will be to install:

- On embedded steel plates, pre-set in concrete before concrete-lining the tunnel, 4 sets of orifices (steel rings) that may or may not be filled with concrete.

This work will have to be carried-out from mid-July to mid-September of the last year of the dam construction, as per the Technical Memorandum chapter 3.2.

2 WORK SEQUENCE

It is assumed that all handling of gate and stop logs is done by a third party before the opening of the downstream access shaft.

2.1 Mobilization

Before opening the access shaft, at the downstream end of tunnel No. 2, the Contractor will prepare the working area for temporary facilities, lay-down/storage area, mobilize all is equipment, temporary facilities and materials required to carry out the works in the required period (62 days from opening to closure of the access shaft), if possible.

The outside equipment required will comprise, but not limited to:

- 50 tons capacity crane to lift equipments and materials in and out of the tunnel
- Generator to provide power to 6 x 400 amps welding machines, ventilation and lighting in the tunnel.
- Stand-by generator that can be used for small tools and emergencies
- Air compressor for small tools such as drills, impact tools, etc.
- Battery chargers for electric equipments
- 2 concrete pumps : one outside in working area near the access shaft and the other in the tunnel
- 1 set of void-grouting equipment. It is anticipated that very little void-grouting will be required
- Exhaust fans and their corresponding generator.
- Office trailer(s)
- Workers changing-room trailer(s)
- Workers lunch-room trailer(s)

2.2 Opening access, dewatering and install services

Once the Contractor has everything ready and planned for, he will open the access shaft and install the tunnel dewatering pumps and empty the tunnel. It is assume that with 4 x 35HP x 6 inches pumps, dewatering can be done within 3 days.

Immediately following this, the contractor installs the drainage pumping system and begins installing the construction services:

- The access ladder c/w cage at the downstream access.
- Extends to the floor of the tunnel the existing ladder c/w cage at the inlet vent shaft.
- Ventilation system: exhaust fan at the inlet vent shaft and fresh air input at the downstream access shaft, thus creating airflow from the access to the vent shaft.
- Electric Power
- Tunnel lighting
- Compressed air piping c/w 2 pressure tanks

- Telephone emergency system
- Main piping for concrete delivery
- Service Water

2.3 Lowering equipment in tunnel

At the same time services are installed, equipment will be lowered in the tunnel. They will be parked in the tunnel outlet zone. When parking space is full, equipment not needed will be lifted out and replaced by required equipment. Planning/sequencing will be very important to successfully carry out this project, due to time and traffic constraints.

2.4 Rings installation

After services are in place, installation of the steel rings starts. The rings will be divided in 8 elements in order to have smaller/lighter pieces, easier to manipulate/handle and set in place (see appendix No. 1, sketch No. 1).

Work will be carried-on on 2 rings at the same time. Ring No. 1 will be completely built in one stage. The other rings will be erected in 2 stages:

- The top part of the ring (75%) will be erected (6 elements).
- The second (bottom) part (2 elements) of the ring (25%) will be constructed only when upstream rings are completely finished, in order to have traffic access.
- When one ring is completed, all unnecessary services are dismantled and carried-out.

3 RING ERECTION – CONCRETE-FILLED ALTERNATIVE

Before diverting the river waters in the tunnel, precise measurements at the location of the ring must be taken. This will allow a specific fabrication for each ring, assuming no deformation will occur during the diversion period: final ring closure accessories will have to be conceived/designed/provided in case proper fit is not achievable.

This will also allow the fabrication of a template or templates for the positioning/drilling of the holes to hold the elements (pieces of the steel ring) in place. During the shop testing of the ring assembly, for each ring, the template must be also tested in order to insure that the holes to be drilled on site will coincide with the ones on the components.

3.1 Required equipment, among others, in tunnel:

- 2 x workers carrying electric truck

- 2 x working platforms allowing passage of the small transport equipment for the erection of the rings
- 1 or 2 templates
- 2 x small transport electric trucks (Type TUG model eTT-8/eTT-12 or something similar) equipped with a loading platform and hydraulic extendable booms with rotating head
- 2 x tower lights at each working area
- Small tools such as drills, impact tools, etc
- Up to 3 welding machines per working area
- Scissors-lifts, small articulated cherry picker
- Miscellaneous small tools, such as chain blocks, scaffolds, planks for walking on working platforms, ladders, etc

3.2 Ring assembly

The ring assembly is a set of activities that are almost all the same for the 4 rings. Ring No. 1 is different: it is built completely with no stoppage, while rings Nos. 2, 3 and 4 are built in 2 stages. The following will describe the 2 stages ring assembly:

3.2.1 Start-up activities (common part) using small truck-boom equipped:

- Move-in with tower lights
- Move-in working platform
- Move-in the template
- Install template to drill the holes, in the existing embedded plates and concrete, required to assembly/align/maintain in place/tack-weld the elements of the ring, with handling equipment and accessories (appendix No. 1, sketches Nos. 1, 2 and 3)
- Drill holes and place/bolt anchors receiving angles/brackets to attach elements of the ring. Meanwhile move-in the elements of the steel ring with the transport truck equipped with handling boom.

Specifications, sizes, lengths, dimensions of anchors, bolts, angles and other accessories will have to be defined and designed.

3.2.2 Stage 1 activities (placing top 6 of 8 elements of the ring):

- With the boom truck and handling equipment, manipulate the pieces into position for the top part of the ring (75% of the circle), excluding the inclined plate which will be set in place after the upstream circumferential weld is finished. Workers on the platform will place the element in position and then align/fix and tack-weld in final position. This placing can start from the top of the crown, coming down on both sides or it can start at the bottom ends and go up to the crown. A space large enough has to be left in the bottom part for traffic to go through until the upstream rings are completed.

  Once the top 2 or 3 elements are in place, longitudinal welding is started to join the components together. It is assumed 3kg per meter of metal is required in this type of welding, at this stage. This will have to be defined at the design stage.

- As soon as possible, with the advancement of the longitudinal welds, the upstream circumferential welding is started. Because of the length (+/- 26 m), 2 welding machine can be used. For this welds, it is assumed that (+/-) 1.5 kg per meter of metal will be required. As mentioned before, this will have to be defined at the design stage.

- When the upstream weld is finished, the downstream weld is started and at the same time the placing of the upstream inclined plate begins. The procedure for placing the upstream plate is similar as the one mentioned above:

  - Handling/placing/aligning/fixing/tack-welding of the elements.
  - Welding longitudinally the pieces together (assuming 3kg per meter of metal) with 1 welding machine.
  - Welding circumferentially (assuming also 3kg per meter of metal) on top and at the bottom with 2 welding machines.

  It is to be noted that at certain times longitudinal welds can be carried-out at the same time or even after the circumferential welds since all elements have been tack-welded in place before, working space permitting. (See sketches 2 and 3)

- Place/weld steel plate caps at the lower extremities and prepare for concreting the top part of the ring. This activity is only required for rings No. 2, No. 3 and No. 4. Ring No. 1 will have only one concrete activity when all the components of the ring are in place.

  Once the concrete pumps and accessories, and the handling equipment are in place, concreting can start.

- Self-leveling and quick-setting concrete will be used. This concrete has the following characteristics:

  - Fluid concrete
  - Easy to put in place without segregation

  - Easily pump able
  - Requires very little vibration if any, due to the fact that there is no reinforcing steel

Concrete will be poured in a first pump outside and then, pumped into a booster pump in the tunnel that will pump the concrete in the ring.

The ring will have shop-pre-drilled holes for concreting. These will come, from the shop, with their screw able caps that will be placed to plug the holes as the concrete is poured in the rings.

The concreting pipes and accessories will be manipulated by the handling equipment.

- After concreting, there is a 3 days wait period before void grouting can be done on top of the ring. Grouting holes will have been prefabricated at shop and come with their screw able caps.
- During this period all unnecessary services for Stage 2 will be dismantled and transported-out of the tunnel and grouting preparation will be carried-out.
- Void-grouting is the last activity of this first phase for ring No. 2 to No. 4.
- Stage 2 can start when the upstream ring is completely finished.

3.2.3 Stage 2 activities (placing bottom 2 of 8 elements of the ring):

These activities are similar and almost in the same sequence as the activities in Stage 1. In summary, they include the following (for detailed description see Stage 1 activities):

- Handle/place/align/fix elements into position for the bottom part (25% of the circle), except the inclined upstream plates
- Do longitudinal welds
- As soon as possible do upstream circumferential weld
- Handle/place/align/fix inclined plate elements, while welding the downstream circumferential
- Weld longitudinal joints of the inclined plates together
- Weld top and bottom circumferential joints.
- Prepare for concreting bottom part of the ring
- During the 3 days waiting period before grouting, dismantle all unnecessary services for grouting and transport-out of the tunnel and carry-out grouting preparation
- Void grouting is carried-out

Once grouting is finished and all materials and equipments are moved downstream to the next ring, the second phase of the next downstream phase can commence.

3.3 Ring No. 1- Particularities

Ring No. 1 is different of all others in the sense that it is built in only one phase. Since there are no other upstream rings, there is no need to leave a passage for equipments and or materials. Hence the ring can be built completely in one phase (appendix No. 1, sketch No. 1):

- Complete erection of the steel ring
- Concreting in one pour of the complete ring
- One only grouting activity.

4 RING ERECTION – WITHOUT CONCRETE ALTERNATIVE

This alternative in similar to the first one mentioned above except in that there is no concrete filling of the rings and thus there is no need for void-grouting.

5 CONSTRUCTION SCHEDULE - CONCRETE FILLED RINGS ALTERNATIVE

The schedule corresponding to this alternative is based on the following constraints:
(See construction schedule with concrete filling in appendix No. 2):

- Gate and stop logs are in place (work done by a third party) before opening the downstream access shaft.
- Work will be carried-out on 2 x 10 hours shifts per day, 7 days a week.
- Opening of the downstream access shaft on July 15th.
- Closing of the downstream access shaft on September 15th, if possible.
- Labor Day has been considered as a holiday.
- Erection of the rings according to the described method above
- Mobilization of required temporary facilities, equipment and material are carried out before July 15th.
- Demobilizing is done after September 15th or after all works including clean-up and repairs are finished in the tunnel.

It is based on 2 crews working at the same time in the tunnel and carrying-out all the activities mentioned above.

The result, as shown on the schedule, is a 7 days delay beyond the allowed time limit of 62 days for this alternative. (See Construction Schedule with concrete filling in appendix 2)

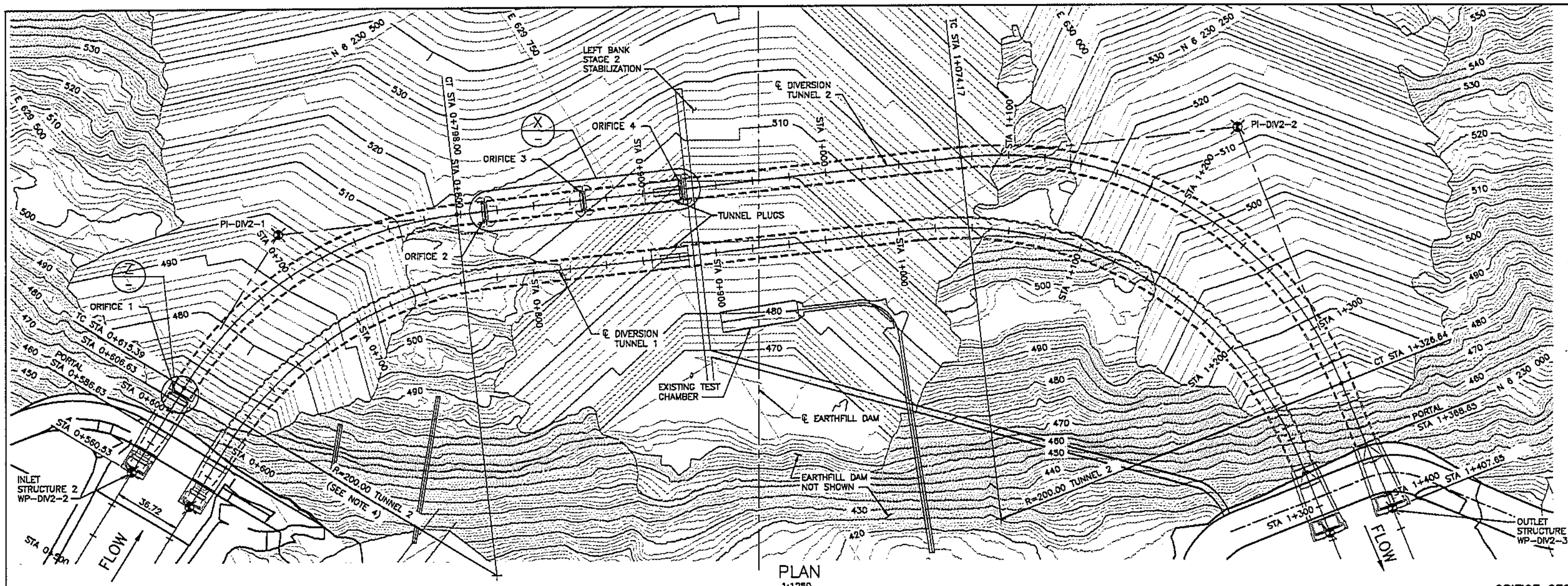
6 CONSTRUCTION SCHEDULE – WITHOUT CONCRETE ALTERNATIVE

Basically this alternative schedule is the same as the one described above, but without the activities required for concreting and void-grouting or the rings. But time is allowed to dismantle services after each ring completion, before starting closure on the next bottom part of the ring

In this alternative, there is no critical path since works ends (closure of the downstream access shaft) 4 days before the end of the allowed time frame. (See Construction Schedule without concrete filling in appendix 3)

7 ORDER OF MAGNITUDE ESTIMATION

To be completed later-on



PLAN
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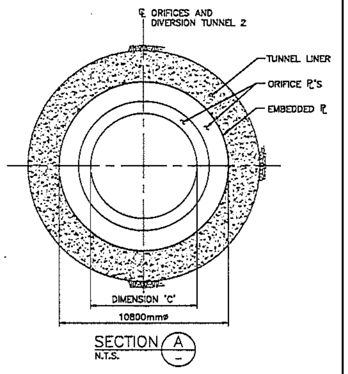
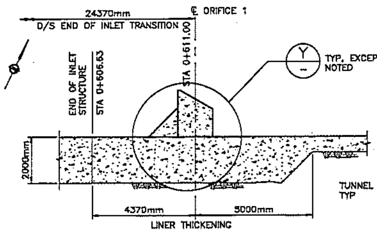
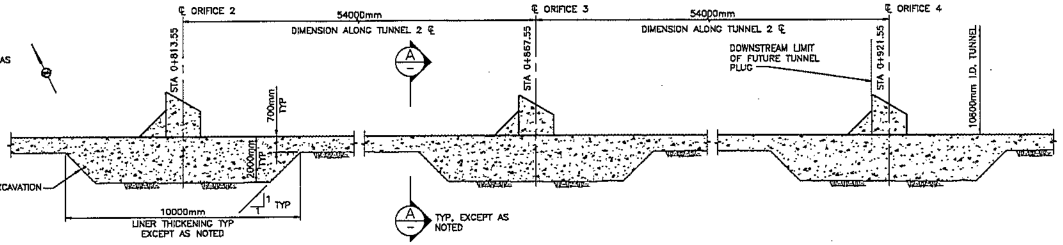


SECTION A
N.T.S.



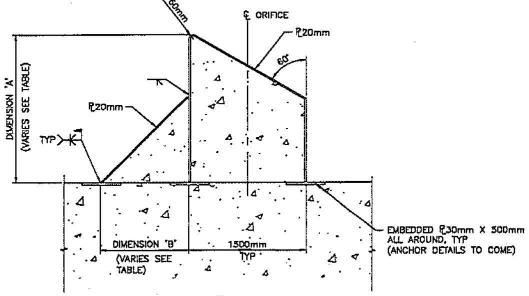
HALF PLAN SHOWING ORIFICE 1 AT TUNNEL 2 CENTERLINE
FOR PROFILE SEE DWG 05931

DETAIL Z
1:100



HALF PLAN SHOWING ORIFICES 2, 3 & 4 AT TUNNEL 2 CENTERLINE
FOR PROFILE SEE DWG 05931

DETAIL X
1:100



DETAIL Y
N.T.S.

ORIFICE GEOMETRY TABLE

	DIMENSION 'A'	DIMENSION 'B'	DIMENSION 'C'
ORIFICE #1	1700mm	1000mm	7400mm
ORIFICE #2	1650mm	1000mm	7500mm
ORIFICE #3	1500mm	900mm	7800mm
ORIFICE #4	1350mm	800mm	8100mm

NOTES:

1. ALL DIMENSIONS, ELEVATIONS AND STATIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. ORIFICES WILL BE INSTALLED IN DIVERSION TUNNEL 2 NEAR THE END OF RIVER DIVERSION TO FACILITATE RESERVOIR FILLING.
3. TUNNEL STATIONING REFLECTS HORIZONTAL DISTANCES ONLY, VERTICAL PROFILE IS IGNORED.
4. BEND RADIUS IS DEFINED ON AN INCLINED PLANE. FOR PROFILE SEE DRAWING 1016–C14–05931.

LEGEND:

⊠ WORKPOINTS AND PI

0 5m
1:100

0 50m
1:1250

ISSUED FOR PHYSICAL MODEL CONSTRUCTION ONLY

	NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
	C	REVISED LOCATIONS OF ORIFICES	31JAN2014	JEREMY BRUCE	BM	WN	STL		JC	JN
	B	ORIFICES RELOCATED TO INLET	07MAY2013	JEREMY BRUCE	KQ	WN	STL		JC	JN
	A	ISSUED FOR PHYSICAL HYDRAULIC MODEL	01MAY2013	JEREMY BRUCE	KQ	WN	STL		JC	JN

REVISIONS

SNC+LAVALIN
Klohn Crippen Berger

DSGN	JB
INDEP CHK	BM
DFTG	WN
DFTG CHK	STL
REPORT NO.	07-02-0121C-00007
DWG. NO.	

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BChydro ENGINEERING

SITE C CLEAN ENERGY PROJECT

PHYSICAL HYDRAULIC MODEL
DIVERSION TUNNELS
RESERVOIR FILLING OPTION IN-LINE ORIFICES
PLAN, SECTIONS AND DETAILS

DATE MAY 2013
DWG NO 1016-C14-05930
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NOT TO BE REPRODUCED WITHOUT THE PERMISSION OF BC HYDRO

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APPENDIX 1

Sketch Ring Installation Methods

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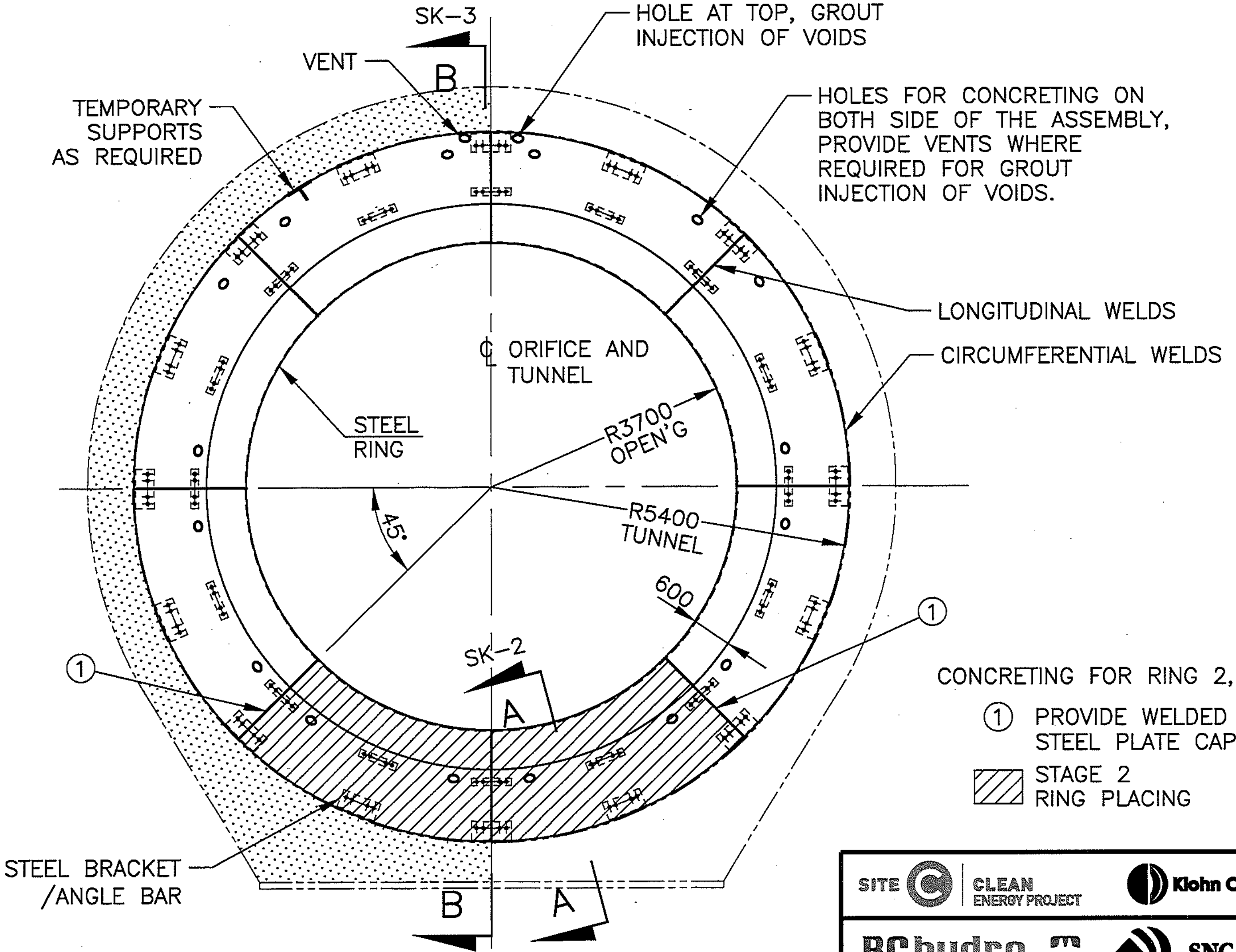

ORIFICE 1 GEOMETRY

NTS

NOTE: ORIFICES 2, 3 AND 4 ARE SIMILAR BUT WITH DIFFERENT DIMENSIONS (SK-1, SK-2 AND SK-3)

CONCRETING FOR RING 2, 3 AND 4

① PROVIDE WELDED STEEL PLATE CAP

▨ STAGE 2 RING PLACING

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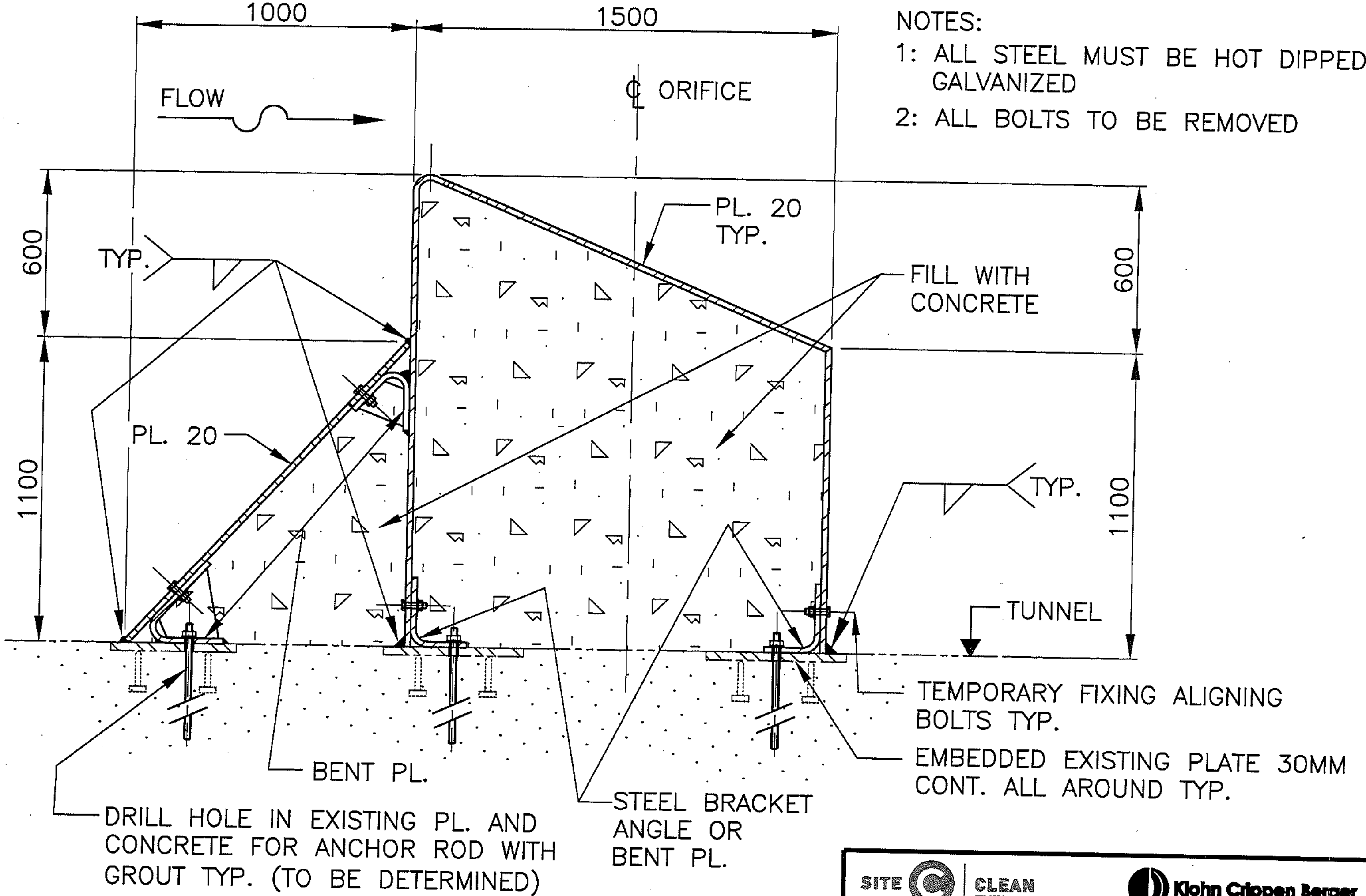
ERECTION OF 8 SECTIONS PER RING
DIVERSION – TYPICAL ARRANGEMENT
ORIFICE 1 TO 4 SK-1

3/26/2014 1:32
W:\01-WORK SPACE\ORIFICE-RINGS SKETCH\SK-site C derivation.dwg

NOTES:

1: ALL STEEL MUST BE HOT DIPPED GALVANIZED

2: ALL BOLTS TO BE REMOVED



ORIFICE 1 GEOMETRY
SECTION A–A

SK–1
NTS

SITE C CLEAN ENERGY PROJECT
Klohn Crippen Berger
BChydro
SNC • LAVALIN

TEMPORARY ATTACHEMENT RING
DIVERSION – TYPICAL ARRANGEMENT
ORIFICE 1 TO 4
SK–2

BC HYDRO

Site C - Install Orifices In Tunnel No. 2
Filled with Concrete

MARCH 2014

ID	Task Name	Duration	Start	Finish
1	**Start Opening Access Shaft (Stoplogs assumed in place)**	0 days	Tue 14-07-15	Tue 14-07-15
2	**Close Access Shaft (Target)**	0 days	Mon 14-09-15	Mon 14-09-15
3	**Close Access Shaft (Real closure)**	0 days	Mon 14-09-22	Mon 14-09-22
4	**Time exceeding target**	7 days	Tue 14-09-16	Mon 14-09-22
5				
6	**Mobilize**	10 days	Fri 14-07-04	Mon 14-07-14
7				
8	**Note : Work in tunnel = 20hrs/day x 7 days/week**	0 days	Wed 14-07-02	Wed 14-07-02
9				
10	**Handling/hoisting system at downstream access shaft**	70 days	Mon 14-07-14	Mon 14-09-22
11	**Remove access shaft panels**	0.15 days	Tue 14-07-15	Tue 14-07-15
12	**Remove tunnel access panels**	0.15 days	Tue 14-07-15	Tue 14-07-15
13	**Install pumping system and drain tunnel**	**3.35 days**	**Tue 14-07-15**	**Fri 14-07-18**
14	Install pumping system	0.2 days	Tue 14-07-15	Tue 14-07-15
15	Dewater tunnel	3 days	Tue 14-07-15	Fri 14-07-18
16	Install infiltration drainage system in sump pit	0.15 days	Fri 14-07-18	Fri 14-07-18
17	**Mobilize equipment in tunnel**	**2 days**	**Fri 14-07-18**	**Sun 14-07-20**
18	Enter transport equipment in Tunnel	1 day	Fri 14-07-18	Sat 14-07-19
19	Enter working equipment in Tunnel	1 day	Sat 14-07-19	Sun 14-07-20
20	**Install services**	**7 days**	**Fri 14-07-18**	**Fri 14-07-25**
21	Access ladder c/w cage at downstream access shaft	0.33 days	Fri 14-07-18	Fri 14-07-18
22	Ventilation	3 days	Sun 14-07-20	Wed 14-07-23
23	Electricity	3 days	Sun 14-07-20	Wed 14-07-23
24	Lighting 750 m	3 days	Sun 14-07-20	Wed 14-07-23
25	Compressed air	3 days	Sun 14-07-20	Wed 14-07-23
26	Emergency phone to access shaft 750m	3 days	Sun 14-07-20	Wed 14-07-23
27	Extend Emergency exit ladder/cage at vent shaft	0.33 days	Fri 14-07-18	Sat 14-07-19
28	Install main concrete delivery piping	5 days	Sun 14-07-20	Fri 14-07-25
29	Service water	3 days	Sun 14-07-20	Wed 14-07-23
30				
31	**Install ring No. 1 (8 sections)**	**23.33 days**	**Wed 14-07-23**	**Fri 14-08-15**
32	**Drilling anchors/attachment holes**	**4.75 days**	**Wed 14-07-23**	**Mon 14-07-28**
33	Move in install working platform and lighting system	0.5 days	Wed 14-07-23	Wed 14-07-23
34	Move in, align and install hole drilling template	0.25 days	Wed 14-07-23	Thu 14-07-24
35	Drill holes, place angles and anchors on embed'd plates	3 days	Thu 14-07-24	Sun 14-07-27
36	Drill and install lifting and holding attachments	1 day	Sun 14-07-27	Mon 14-07-28
37	**Install ring components**	**15 days**	**Sun 14-07-27**	**Mon 14-08-11**
38	Move-in components	0.5 days	Sun 14-07-27	Sun 14-07-27
39	Lift and fix main components in place (75 %)	2.5 days	Mon 14-07-28	Wed 14-07-30
40	Longitudinal welds (75 %)	3 days	Tue 14-07-29	Fri 14-08-01
41	Circumferential welds U/S (75 %)	1.25 days	Wed 14-07-30	Thu 14-07-31
42	Circumferential welds D/S (75 %)	1.25 days	Thu 14-07-31	Sat 14-08-02
43	Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Thu 14-07-31	Sun 14-08-03
44	Longitudinal welds U/S inclined plate (75 %)	1.5 days	Fri 14-08-01	Sun 14-08-03
45	Circumferential welds inclined plate top and bottom (75 %)	4 days	Sat 14-08-02	Wed 14-08-06
46	Move platform	0.15 days	Wed 14-08-06	Wed 14-08-06
47	Lift and fix main components in place (25 %)	0.75 days	Wed 14-08-06	Thu 14-08-07
48	Longitudinal welds (25 %)	0.9 days	Thu 14-08-07	Fri 14-08-08
49	Circumferential welds U/S (25 %)	0.35 days	Thu 14-08-07	Thu 14-08-07
50	Circumferential welds D/S (25 %)	0.35 days	Fri 14-08-08	Fri 14-08-08
51	Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Thu 14-08-07	Fri 14-08-08
52	Longitudinal welds U/S inclined plate (25 %)	0.45 days	Fri 14-08-08	Fri 14-08-08
53	Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Fri 14-08-08	Sat 14-08-09
54	Inspection and testing of welds	10 days	Fri 14-08-01	Mon 14-08-11
55	**Concrete & Grout ring No.1**	**6 days**	**Sat 14-08-09**	**Fri 14-08-15**
56	Ring No.1 concrete preparation - Move-in platform	2 days	Sat 14-08-09	Mon 14-08-11
57	Pour concrete No. 1	0.5 days	Mon 14-08-11	Tue 14-08-12
58	Remove services & patch holes - Move platform	3 days	Tue 14-08-12	Fri 14-08-15
59	Void Grouting preparation	1 day	Thu 14-08-14	Fri 14-08-15
60	Void grouting	0.5 days	Fri 14-08-15	Fri 14-08-15
61	**Install ring No. 2 (8 sections)**	**29.76 days**	**Thu 14-07-24**	**Fri 14-08-22**
62	**Drilling anchors/attachment holes**	**4.75 days**	**Thu 14-07-24**	**Mon 14-07-28**
63	Move in install working platform and lighting system	0.5 days	Thu 14-07-24	Thu 14-07-24
64	Move in, align and install hole drilling template	0.25 days	Thu 14-07-24	Thu 14-07-24
65	Drill holes in embedded plates and place anchors	3 days	Thu 14-07-24	Sun 14-07-27
66	Drill and install lifting and holding attachments	1 day	Sun 14-07-27	Mon 14-07-28
67	**Install ring components**	**26.01 days**	**Sun 14-07-27**	**Fri 14-08-22**
68	**Install top 75% ring components (6 sections)**	**10.5 days**	**Sun 14-07-27**	**Thu 14-08-07**
69	Move-in components	0.5 days	Sun 14-07-27	Mon 14-07-28
70	Lift and fix main components in place (75 %)	2.5 days	Mon 14-07-28	Thu 14-07-31
71	Longitudinal welds (75 %)	3 days	Tue 14-07-29	Fri 14-08-01

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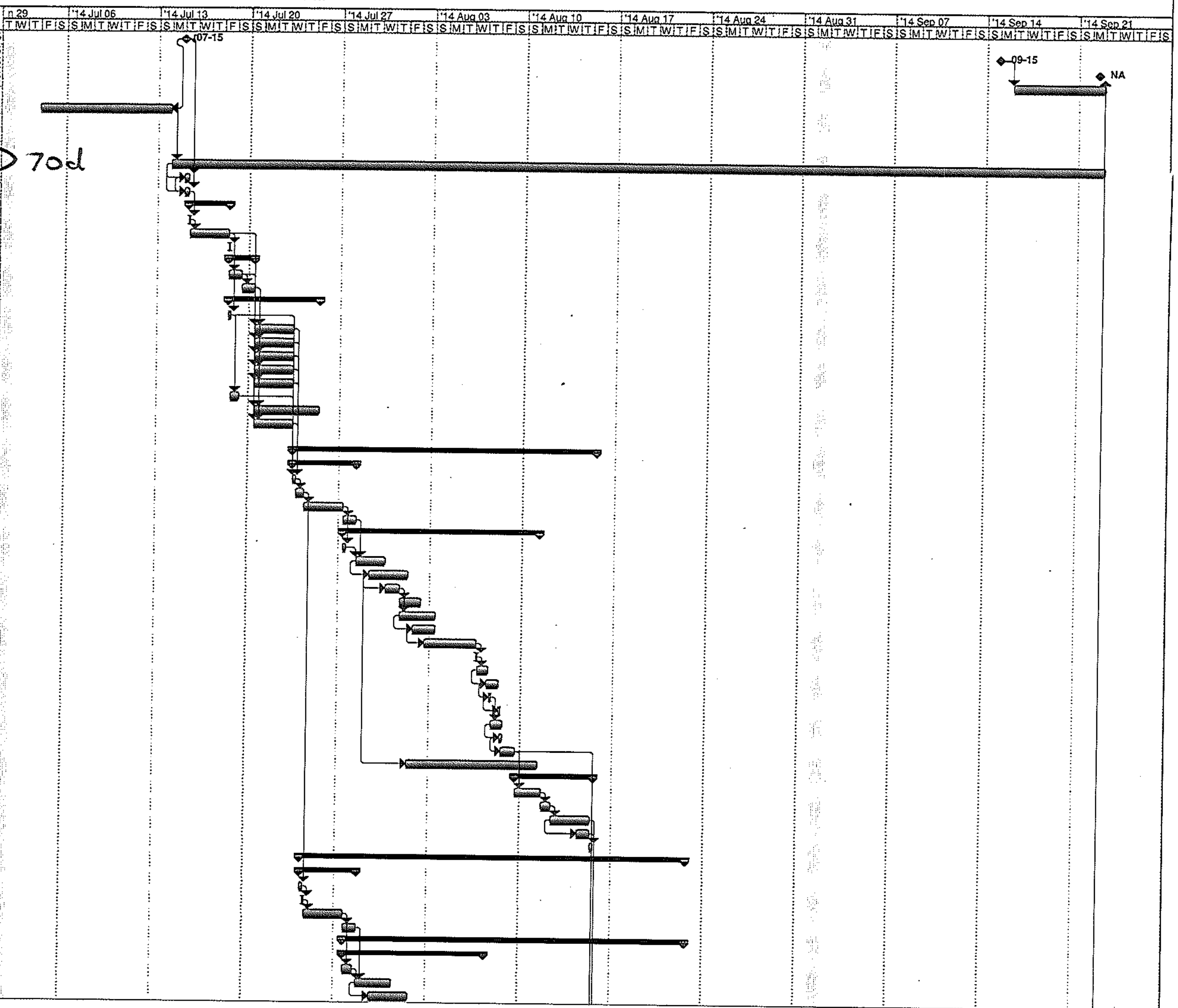


Project: Site C - Tunnel No. 2 Install
Date: Fri 14-03-28
Project:506139-BL-2-20-3130-3600-32

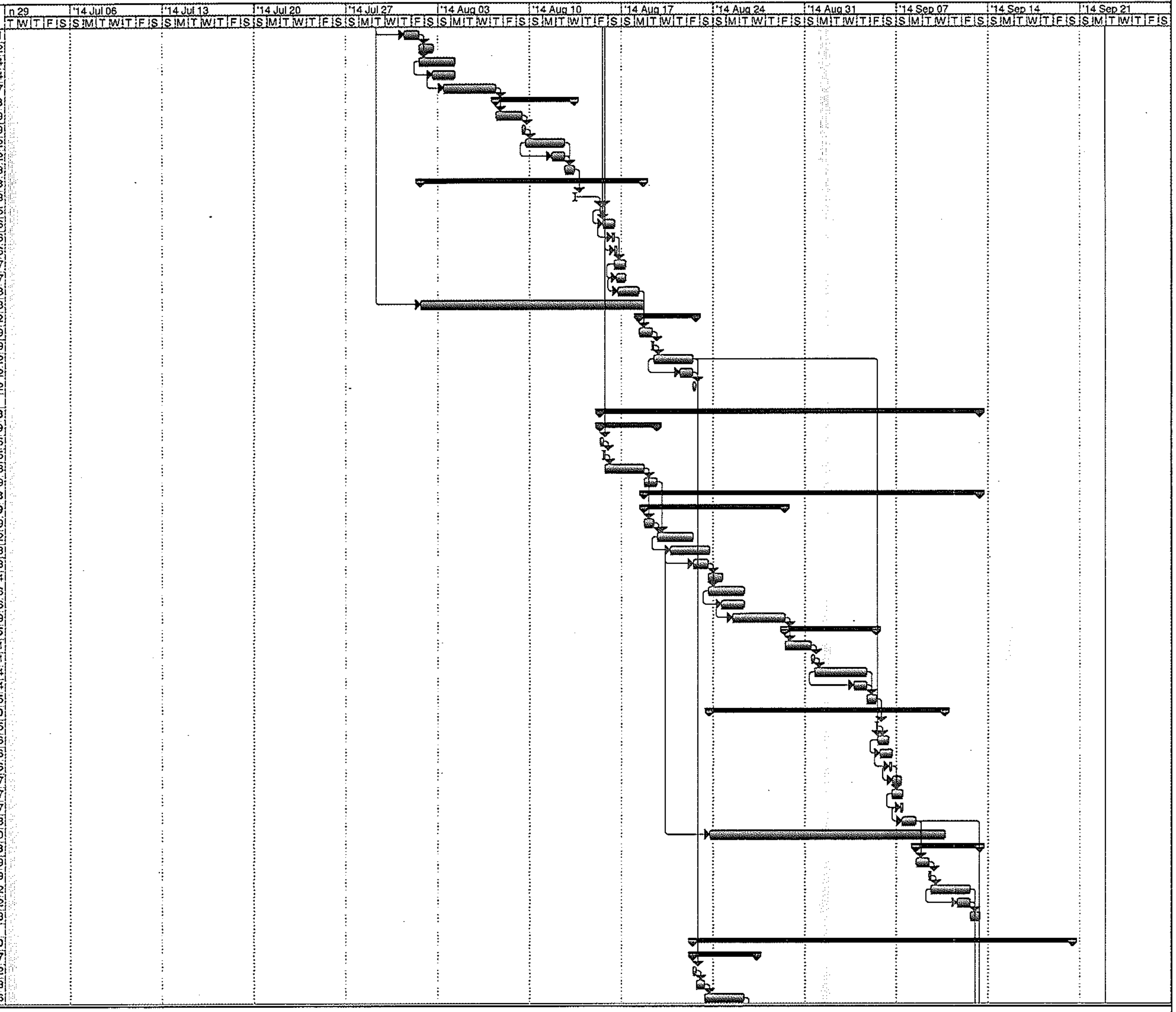
Task	▬	Progress	▬	Summary	▬	Rolled Up Critical Task	▬	Rolled Up Progress	▬	External Tasks	▬	Group By Summary	▬
Critical Task	▬	Milestone	◆	Rolled Up Task	▬	Rolled Up Milestone	◇	Split	⋯⋯	Project Summary	▬	Deadline	⇩

BC HYDRO

Site C - Install Orifices in Tunnel No. 2
Filled with Concrete

MARCH 2014

ID	Task Name	Duration	Start	Finish
72	Circumferential welds U/S (75 %)	1.25 days	Thu 14-07-31	Fri 14-08-01
73	Circumferential welds D/S (75 %)	1.25 days	Fri 14-08-01	Sat 14-08-02
74	Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Fri 14-08-01	Mon 14-08-04
75	Longitudinal welds U/S inclined plate (75 %)	1.5 days	Sat 14-08-02	Mon 14-08-04
76	Circumferential welds inclined plate top and bottom (75 %)	4 days	Sun 14-08-03	Thu 14-08-07
77	**Concrete & grout top 75% ring components**	**6 days**	**Thu 14-08-07**	**Wed 14-08-13**
78	Ring No.2 concrete preparation	2 days	Thu 14-08-07	Sat 14-08-09
79	Pour concrete No. 2	0.5 days	Sat 14-08-09	Sat 14-08-09
80	3 days waiting period	3 days	Sat 14-08-09	Tue 14-08-12
81	Void Grouting preparation	1 day	Mon 14-08-11	Tue 14-08-12
82	Void grouting	0.5 days	Tue 14-08-12	Wed 14-08-13
83	**Install bottom 25% ring components (2 sections)**	**17 days**	**Fri 14-08-01**	**Mon 14-08-18**
84	Move out platform	0.1 days	Wed 14-08-13	Wed 14-08-13
85	Lift and fix main components in place (25 %)	0.75 days	Fri 14-08-15	Fri 14-08-15
86	Longitudinal welds (25 %)	0.9 days	Fri 14-08-15	Sat 14-08-16
87	Circumferential welds U/S (25 %)	0.35 days	Sat 14-08-16	Sat 14-08-16
88	Circumferential welds D/S (25 %)	0.35 days	Sat 14-08-16	Sat 14-08-16
89	Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Sat 14-08-16	Sun 14-08-17
90	Longitudinal welds U/S inclined plate (25 %)	0.45 days	Sat 14-08-16	Sun 14-08-17
91	Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Sat 14-08-16	Mon 14-08-18
92	Inspection and testing of welds	17 days	Fri 14-08-01	Mon 14-08-18
93	**Concrete & grout bottom 25% ring components**	**4.75 days**	**Mon 14-08-18**	Fri 14-08-22
94	Ring No.2 concrete preparation - Move-in platform	1 day	Mon 14-08-18	Tue 14-08-19
95	Pour concrete No. 2	0.25 days	Tue 14-08-19	Tue 14-08-19
96	Remove services & patch holes - Move platform	3 days	Tue 14-08-19	Fri 14-08-22
97	Void Grouting preparation	1 day	Thu 14-08-21	Fri 14-08-22
98	Void grouting	0.5 days	Fri 14-08-22	Fri 14-08-22
99				
100	**Install ring No. 3 (8 sections)**	**28.03 days**	**Fri 14-08-15**	**Sat 14-09-13**
101	**Drilling anchors/attachment holes**	**4.75 days**	**Fri 14-08-15**	**Tue 14-08-19**
102	Move in install working platform and lighting system	0.5 days	Fri 14-08-15	Fri 14-08-15
103	Move in, align and install hole drilling template	0.25 days	Fri 14-08-15	Fri 14-08-15
104	Drill holes in embedded plates and place anchors	3 days	Fri 14-08-15	Mon 14-08-18
105	Drill and install lifting and holding attachments	1 day	Mon 14-08-18	Tue 14-08-19
106	**Install ring components**	**24.28 days**	**Mon 14-08-18**	**Sat 14-09-13**
107	**Install top 75% ring components (6 sections)**	**10.5 days**	**Mon 14-08-18**	**Fri 14-08-29**
108	Move-in components	0.5 days	Mon 14-08-18	Tue 14-08-19
109	Lift and fix main components in place (75 %)	2.5 days	Tue 14-08-19	Fri 14-08-22
110	Longitudinal welds (75 %)	3 days	Wed 14-08-20	Sat 14-08-23
111	Circumferential welds U/S (75 %)	1.25 days	Fri 14-08-22	Sat 14-08-23
112	Circumferential welds D/S (75 %)	1.25 days	Sat 14-08-23	Sun 14-08-24
113	Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Sat 14-08-23	Tue 14-08-26
114	Longitudinal welds U/S inclined plate (75 %)	1.5 days	Sun 14-08-24	Tue 14-08-26
115	Circumferential welds inclined plate top and bottom (75 %)	4 days	Mon 14-08-25	Fri 14-08-29
116	**Concrete & grout top 75% ring components**	**6 days**	**Fri 14-08-29**	**Fri 14-09-05**
117	Ring No.3 concrete preparation	2 days	Fri 14-08-29	Sun 14-08-31
118	Pour concrete No. 3	0.5 days	Sun 14-08-31	Sun 14-08-31
119	3 days waiting period	3 days	Sun 14-08-31	Thu 14-09-04
120	Void Grouting preparation	1 day	Wed 14-09-03	Thu 14-09-04
121	Void grouting	0.5 days	Thu 14-09-04	Fri 14-09-05
122	**Install bottom 25% ring components (2 sections)**	**17 days**	**Sat 14-08-23**	**Wed 14-09-10**
123	Move out platform	0.1 days	Fri 14-09-05	Fri 14-09-05
124	Lift and fix main components in place (25 %)	0.75 days	Fri 14-09-05	Sat 14-09-06
125	Longitudinal welds (25 %)	0.9 days	Fri 14-09-05	Sat 14-09-06
126	Circumferential welds U/S (25 %)	0.35 days	Sat 14-09-06	Sat 14-09-06
127	Circumferential welds D/S (25 %)	0.35 days	Sat 14-09-06	Sun 14-09-07
128	Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Sat 14-09-06	Sun 14-09-07
129	Longitudinal welds U/S inclined plate (25 %)	0.45 days	Sun 14-09-07	Sun 14-09-07
130	Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Sun 14-09-07	Mon 14-09-08
131	Inspection and testing of welds	17 days	Sat 14-08-23	Wed 14-09-10
132	**Concrete & grout bottom 25% ring components**	**4.75 days**	**Mon 14-09-08**	**Sat 14-09-13**
133	Ring No.2 concrete preparation - Move-in platform	1 day	Mon 14-09-08	Tue 14-09-09
134	Pour concrete No. 2	0.25 days	Tue 14-09-09	Tue 14-09-09
135	Remove services & patch holes - Move platform	3 days	Tue 14-09-09	Fri 14-09-12
136	Void Grouting preparation	1 day	Thu 14-09-11	Fri 14-09-12
137	Void grouting	0.5 days	Fri 14-09-12	Sat 14-09-13
138				
139	**Install ring No. 4 (8 sections)**	**28.03 days**	**Fri 14-08-22**	**Sat 14-09-20**
140	**Drilling anchors/attachment holes**	**4.75 days**	**Fri 14-08-22**	**Wed 14-08-27**
141	Move in install working platform and lighting system	0.5 days	Fri 14-08-22	Fri 14-08-22
142	Move in, align and install hole drilling template	0.25 days	Fri 14-08-22	Sat 14-08-23
143	Drill holes in embedded plates and place anchors	3 days	Sat 14-08-23	Tue 14-08-26



Project: Site C - Tunnel No. 2 Install
Date: Fri 14-03-28
Project:506139-BL-2-20-3130-3600-32

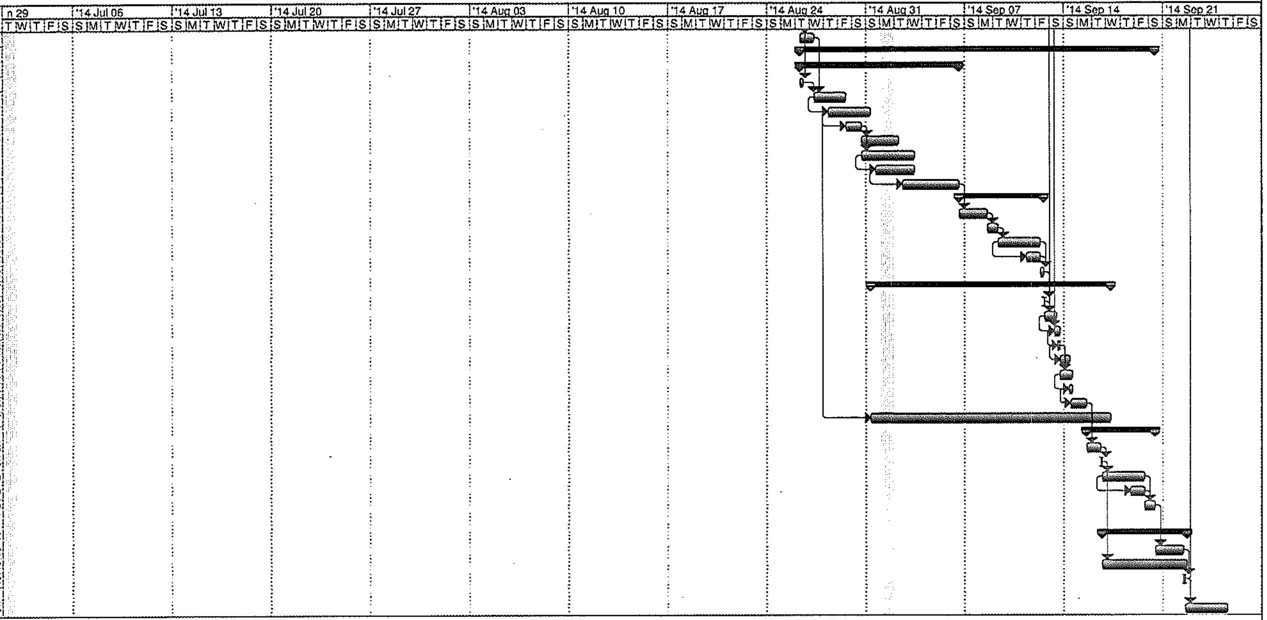
Task	▨	Progress	▬	Summary	▬	Rolled Up Critical Task	▨	Rolled Up Progress	▬	External Tasks	▨
Critical Task	▨	Milestone	◆	Rolled Up Task	▨	Rolled Up Milestone	◇	Split	....	Project Summary	▭
Group By Summary	▬	Deadline	⇩								

BC HYDRO

Site C - Install Orifices in Tunnel No. 2 Filled with Concrete

MARCH 2014

ID	Task Name	Duration	Start	Finish
144	Drill and install lifting and holding attachments	1 day	Tue 14-08-26	Wed 14-08-27
145	**Install ring components**	**24.28 days**	**Tue 14-08-26**	**Sat 14-09-20**
146	**Install top 75% ring components (6 sections)**	**10.5 days**	**Tue 14-08-26**	**Sat 14-09-06**
147	Move-in components	0.5 days	Tue 14-08-26	Tue 14-08-26
148	Lift and fix main components in place (75 %)	2.5 days	Wed 14-08-27	Fri 14-08-29
149	Longitudinal welds (75 %)	3 days	Thu 14-08-28	Sun 14-08-31
150	Circumferential welds U/S (75 %)	1.25 days	Fri 14-08-29	Sat 14-08-30
151	Circumferential welds D/S (75 %)	1.25 days	Sat 14-08-30	Tue 14-09-02
152	Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Sat 14-08-30	Wed 14-09-03
153	Longitudinal welds U/S inclined plate (75 %)	1.5 days	Sun 14-08-31	Wed 14-09-03
154	Circumferential welds inclined plate top and bottom (75 %)	4 days	Tue 14-09-02	Sat 14-09-06
155	**Concrete & grout top 75% ring components**	**6 days**	**Sat 14-09-06**	**Fri 14-09-12**
156	Ring No.4 concrete preparation	2 days	Sat 14-09-06	Mon 14-09-08
157	Pour concrete No. 4	0.5 days	Mon 14-09-08	Tue 14-09-09
158	3 days waiting period	3 days	Tue 14-09-09	Fri 14-09-12
159	Void Grouting preparation	1 day	Thu 14-09-11	Fri 14-09-12
160	Void grouting	0.5 days	Fri 14-09-12	Fri 14-09-12
161	**Install bottom 25% ring components (2 sections)**	**16 days**	**Sun 14-08-31**	**Wed 14-09-17**
162	Move out platform	0.1 days	Fri 14-09-12	Fri 14-09-12
163	Lift and fix main components in place (25 %)	0.75 days	Fri 14-09-12	Sat 14-09-13
164	Longitudinal welds (25 %)	0.9 days	Sat 14-09-13	Sat 14-09-13
165	Circumferential welds U/S (25 %)	0.35 days	Sat 14-09-13	Sat 14-09-13
166	Circumferential welds D/S (25 %)	0.35 days	Sat 14-09-13	Sun 14-09-14
167	Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Sat 14-09-13	Sun 14-09-14
168	Longitudinal welds U/S inclined plate (25 %)	0.45 days	Sun 14-09-14	Sun 14-09-14
169	Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Sun 14-09-14	Mon 14-09-15
170	Inspection and testing of welds	16 days	Sun 14-08-31	Wed 14-09-17
171	**Concrete & grout bottom 25% ring components**	**4.75 days**	**Mon 14-09-15**	**Sat 14-09-20**
172	Ring No.4 concrete preparation - Move-in platform	1 day	Mon 14-09-15	Tue 14-09-16
173	Pour concrete No. 4	0.25 days	Tue 14-09-16	Tue 14-09-16
174	Remove services & patch holes - Move out platform	3 days	Tue 14-09-16	Fri 14-09-19
175	Void Grouting preparation	1 day	Thu 14-09-18	Fri 14-09-19
176	Void grouting	0.5 days	Fri 14-09-19	Sat 14-09-20
177				
178	**Tunnel Closure**	**6 days**	**Tue 14-09-16**	**Mon 14-09-22**
179	Remove Balance of services and holes patching	2 days	Sat 14-09-20	Mon 14-09-22
180	Clean-Up & Remove equipments	6 days	Tue 14-09-16	Mon 14-09-22
181	Close hatch	0.15 days	Mon 14-09-22	Mon 14-09-22
182				
183	**Demobilize**	3 days	Mon 14-09-22	Thu 14-09-25



Project: Site C - Tunnel No. 2 Install
Date: Fri 14-03-28
Project:506139-BL-2-20-3130-3600-32

Task	▨	Progress	▬	Summary	▬	Rolled Up Critical Task	▨	Rolled Up Progress	▬	External Tasks	▨	Group By Summary	▬
Critical Task	▨	Milestone	◆	Rolled Up Task	▨	Rolled Up Milestone	◇	Split	......	Project Summary	▭	Deadline	⇩

APPENDIX 3

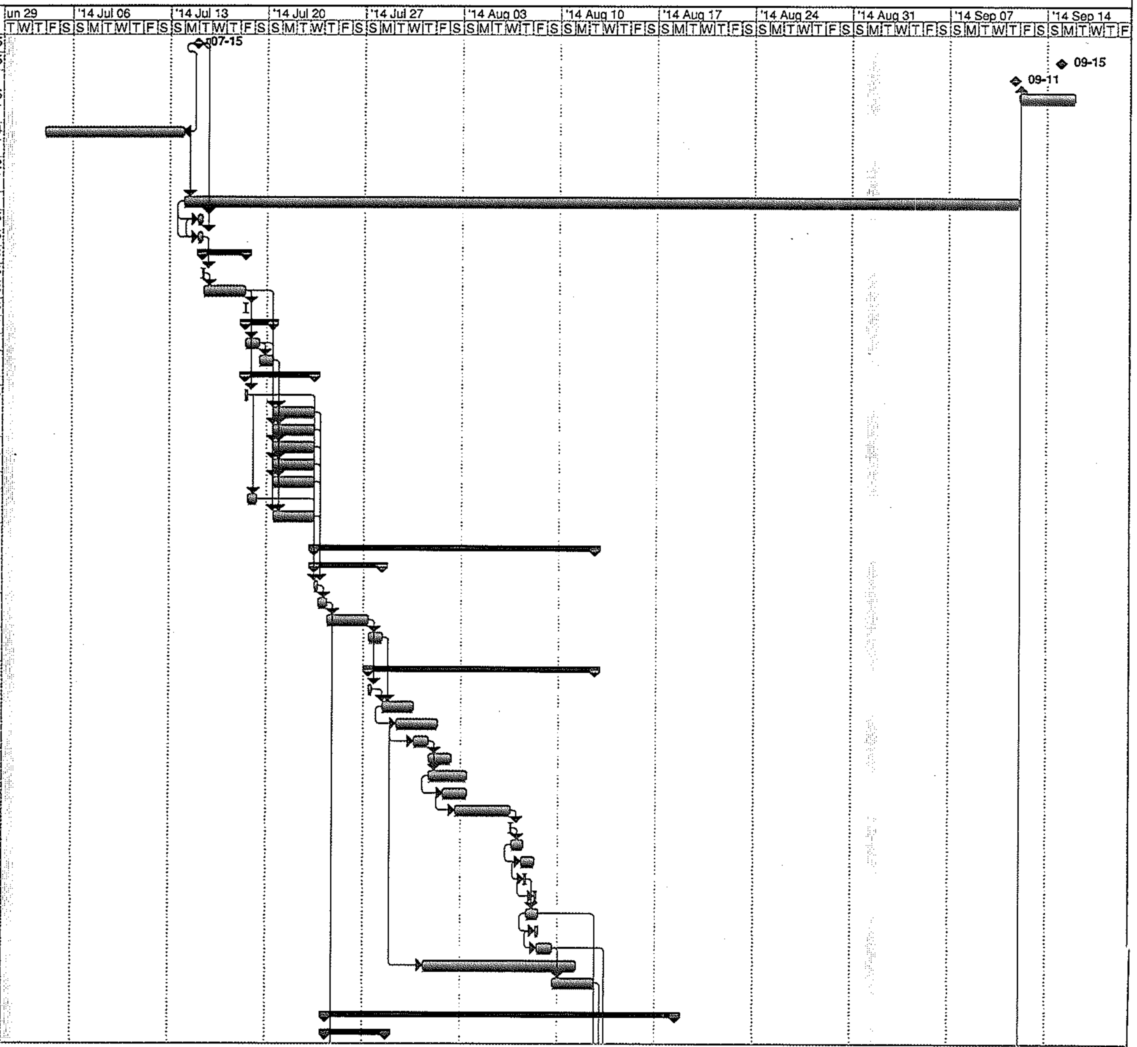
Construction Schedule: alternative without concrete filling

BC HYDRO

Site C - Install Orifices in Tunnel No. 2
No concrete Poured in Rings

MARCH 2014

ID	Task Name	Duration	Start	Finish
1	**Start Opening Access Shaft (Stoplogs assumed in place)**	0 days	Tue 14-07-15	Tue 14-07-15
2	**Close Access Shaft (Target)**	0 days	Mon 14-09-15	Mon 14-09-15
3	**Close Access Shaft (Real closure)**	0 days	Thu 14-09-11	Thu 14-09-11
4	**Time left in allowed time frame**	4 days	Fri 14-09-12	Mon 14-09-15
5				
6	**Mobilize**	10 days	Fri 14-07-04	Mon 14-07-14
7				
8	**Note : Work in tunnel = 20hrs/day x 7 days/week**	0 days	Wed 14-07-02	Wed 14-07-02
9				
10	**Handling/hoisting system at downstream access shaft**	59 days	Mon 14-07-14	Thu 14-09-11
11	**Remove access shaft panels**	0.15 days	Tue 14-07-15	Tue 14-07-15
12	**Remove tunnel access panels**	0.15 days	Tue 14-07-15	Tue 14-07-15
13	**Install pumping system and drain tunnel**	**3.35 days**	**Tue 14-07-15**	**Fri 14-07-18**
14	Install pumping system	0.2 days	Tue 14-07-15	Tue 14-07-15
15	Dewater tunnel	3 days	Tue 14-07-15	Fri 14-07-18
16	Install infiltration drainage system in sump pit	0.15 days	Fri 14-07-18	Fri 14-07-18
17	**Mobilize equipment in tunnel**	**2 days**	**Fri 14-07-18**	**Sun 14-07-20**
18	Enter transport equipment in Tunnel	1 day	Fri 14-07-18	Sat 14-07-19
19	Enter working equipment in Tunnel	1 day	Sat 14-07-19	Sun 14-07-20
20	**Install services**	**5 days**	**Fri 14-07-18**	**Wed 14-07-23**
21	Access ladder c/w cage at downstream access shaft	0.33 days	Fri 14-07-18	Fri 14-07-18
22	Ventilation	3 days	Sun 14-07-20	Wed 14-07-23
23	Electricity	3 days	Sun 14-07-20	Wed 14-07-23
24	Lighting 750 m	3 days	Sun 14-07-20	Wed 14-07-23
25	Compressed air	3 days	Sun 14-07-20	Wed 14-07-23
26	Emergency phone to access shaft 750m	3 days	Sun 14-07-20	Wed 14-07-23
27	Extend Emergency exit ladder/cage at vent shaft	0.33 days	Fri 14-07-18	Sat 14-07-19
28	Service water	3 days	Sun 14-07-20	Wed 14-07-23
29				
30	**Install ring No. 1 (8 sections)**	**20.33 days**	**Wed 14-07-23**	**Tue 14-08-12**
31	**Drilling anchors/attachment holes**	**4.75 days**	**Wed 14-07-23**	**Mon 14-07-28**
32	Move in install working platform and lighting system	0.5 days	Wed 14-07-23	Wed 14-07-23
33	Move in, align and install hole drilling template	0.25 days	Wed 14-07-23	Thu 14-07-24
34	Drill holes, place angles and anchors on embed'd plates	3 days	Thu 14-07-24	Sun 14-07-27
35	Drill and install lifting and holding attachments	1 day	Sun 14-07-27	Mon 14-07-28
36				
37	**Install ring components**	**16.58 days**	**Sun 14-07-27**	**Tue 14-08-12**
38	Move-in components	0.5 days	Sun 14-07-27	Sun 14-07-27
39	Lift and fix main components in place (75 %)	2.5 days	Mon 14-07-28	Wed 14-07-30
40	Longitudinal welds (75 %)	3 days	Tue 14-07-29	Fri 14-08-01
41	Circumferential welds U/S (75 %)	1.25 days	Wed 14-07-30	Thu 14-07-31
42	Circumferential welds D/S (75 %)	1.25 days	Thu 14-07-31	Sat 14-08-02
43	Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Thu 14-07-31	Sun 14-08-03
44	Longitudinal welds U/S inclined plate (75 %)	1.5 days	Fri 14-08-01	Sun 14-08-03
45	Circumferential welds inclined plate top and bottom (75 %)	4 days	Sat 14-08-02	Wed 14-08-06
46	Move platform	0.15 days	Wed 14-08-06	Wed 14-08-06
47	Lift and fix main components in place (25 %)	0.75 days	Wed 14-08-06	Thu 14-08-07
48	Longitudinal welds (25 %)	0.9 days	Thu 14-08-07	Fri 14-08-08
49	Circumferential welds U/S (25 %)	0.35 days	Thu 14-08-07	Thu 14-08-07
50	Circumferential welds D/S (25 %)	0.35 days	Fri 14-08-08	Fri 14-08-08
51	Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Thu 14-08-07	Fri 14-08-08
52	Longitudinal welds U/S inclined plate (25 %)	0.45 days	Fri 14-08-08	Fri 14-08-08
53	Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Fri 14-08-08	Sat 14-08-09
54	Inspection and testing of welds	11 days	Thu 14-07-31	Mon 14-08-11
55	Remove services & patch holes - Move platform	3 days	Sat 14-08-09	Tue 14-08-12
56				
57	**Install ring No. 2 (8 sections)**	**25.36 days**	**Thu 14-07-24**	**Mon 14-08-18**
58	**Drilling anchors/attachment holes**	**4.75 days**	**Thu 14-07-24**	**Mon 14-07-28**



Project: Site C - Tunnel No. 2 Install
Date: Fri 14-03-28
Project:506139-BL-2-20-3130-3600-32

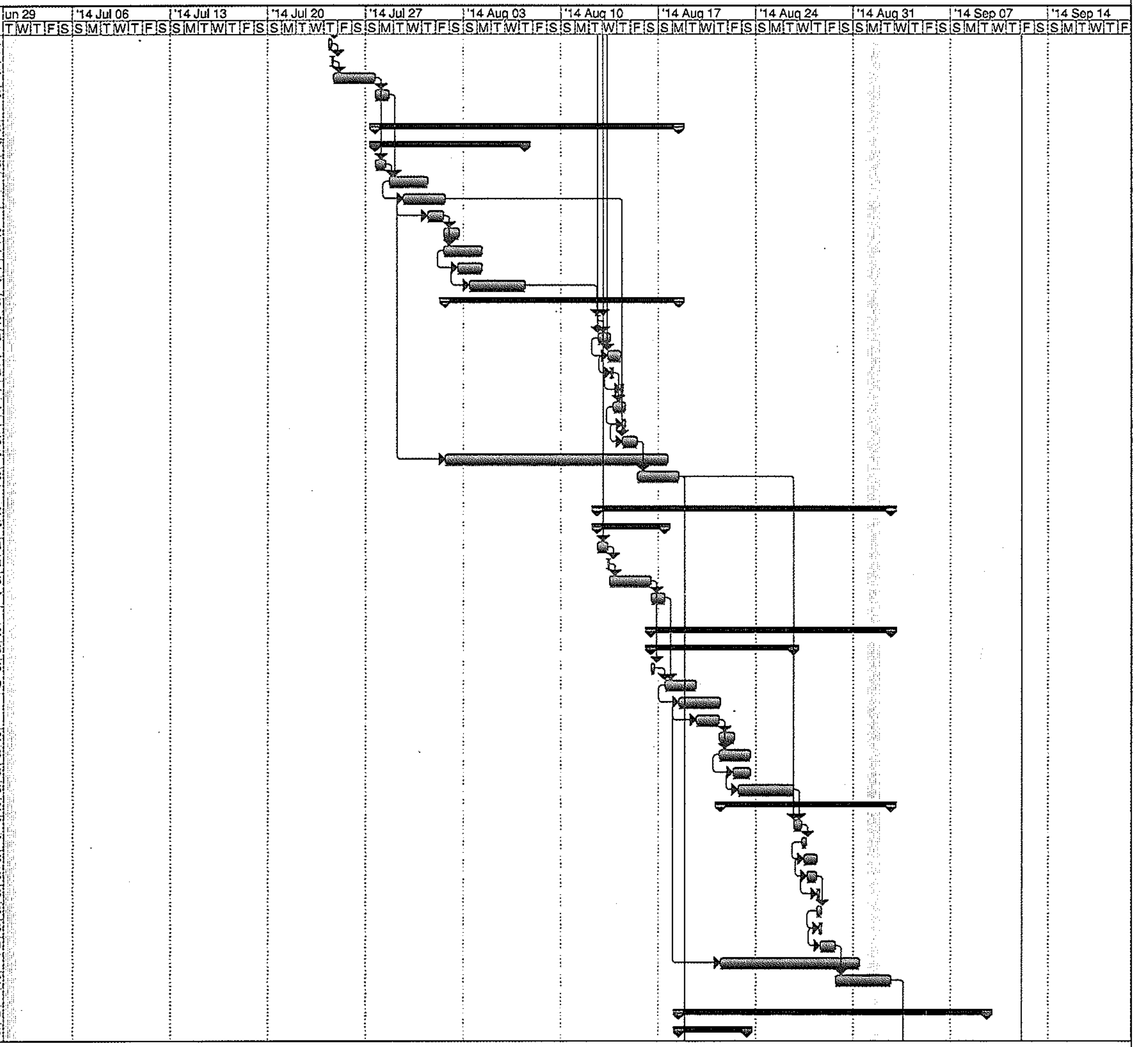
Task
Critical Task
Progress
Milestone ◆
Summary
Rolled Up Task
Rolled Up Critical Task
Rolled Up Milestone ◇
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline ⇩

BC HYDRO

Site C - Install Orifices in Tunnel No. 2
No concrete Poured In Rings

MARCH 2014

ID		Task Name	Duration	Start	Finish
59		Move in Install working platform and lighting system	0.5 days	Thu 14-07-24	Thu 14-07-24
60		Move in, align and install hole drilling template	0.25 days	Thu 14-07-24	Thu 14-07-24
61		Drill holes in embedded plates and place anchors	3 days	Thu 14-07-24	Sun 14-07-27
62		Drill and install lifting and holding attachments	1 day	Sun 14-07-27	Mon 14-07-28
63					
64		**Install ring components**	**21.61 days**	**Sun 14-07-27**	**Mon 14-08-18**
65		**Install top 75% ring components (6 sections)**	**10.5 days**	**Sun 14-07-27**	**Thu 14-08-07**
66		Move-in components	0.5 days	Sun 14-07-27	Mon 14-07-28
67		Lift and fix main components in place (75 %)	2.5 days	Mon 14-07-28	Thu 14-07-31
68		Longitudinal welds (75 %)	3 days	Tue 14-07-29	Fri 14-08-01
69		Circumferential welds U/S (75 %)	1.25 days	Thu 14-07-31	Fri 14-08-01
70		Circumferential welds D/S (75 %)	1.25 days	Fri 14-08-01	Sat 14-08-02
71		Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Fri 14-08-01	Mon 14-08-04
72		Longitudinal welds U/S inclined plate (75 %)	1.5 days	Sat 14-08-02	Mon 14-08-04
73		Circumferential welds inclined plate top and bottom (75 %)	4 days	Sun 14-08-03	Thu 14-08-07
74		**Install bottom 25% ring components (2 sections)**	**16.61 days**	**Fri 14-08-01**	**Mon 14-08-18**
75		Move out platform	0.1 days	Tue 14-08-12	Tue 14-08-12
76		Lift and fix main components in place (25 %)	0.75 days	Tue 14-08-12	Wed 14-08-13
77		Longitudinal welds (25 %)	0.9 days	Wed 14-08-13	Thu 14-08-14
78		Circumferential welds U/S (25 %)	0.35 days	Wed 14-08-13	Wed 14-08-13
79		Circumferential welds D/S (25 %)	0.35 days	Thu 14-08-14	Thu 14-08-14
80		Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Wed 14-08-13	Thu 14-08-14
81		Longitudinal welds U/S inclined plate (25 %)	0.45 days	Thu 14-08-14	Thu 14-08-14
82		Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Thu 14-08-14	Fri 14-08-15
83		Inspection and testing of welds	16 days	Fri 14-08-01	Sun 14-08-17
84		Remove services & patch holes - Move platform	3 days	Fri 14-08-15	Mon 14-08-18
85					
86		**Install ring No. 3 (8 sections)**	**20.28 days**	**Tue 14-08-12**	**Tue 14-09-02**
87		**Drilling anchors/attachment holes**	**4.75 days**	**Tue 14-08-12**	**Sun 14-08-17**
88		Move in install working platform and lighting system	0.5 days	Tue 14-08-12	Wed 14-08-13
89		Move in, align and install hole drilling template	0.25 days	Wed 14-08-13	Wed 14-08-13
90		Drill holes in embedded plates and place anchors	3 days	Wed 14-08-13	Sat 14-08-16
91		Drill and install lifting and holding attachments	1 day	Sat 14-08-16	Sun 14-08-17
92					
93		**Install ring components**	**16.53 days**	**Sat 14-08-16**	**Tue 14-09-02**
94		**Install top 75% ring components (6 sections)**	**10.5 days**	**Sat 14-08-16**	**Tue 14-08-26**
95		Move-in components	0.5 days	Sat 14-08-16	Sat 14-08-16
96		Lift and fix main components in place (75 %)	2.5 days	Sun 14-08-17	Tue 14-08-19
97		Longitudinal welds (75 %)	3 days	Mon 14-08-18	Thu 14-08-21
98		Circumferential welds U/S (75 %)	1.25 days	Tue 14-08-19	Thu 14-08-21
99		Circumferential welds D/S (75 %)	1.25 days	Thu 14-08-21	Fri 14-08-22
100		Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Thu 14-08-21	Sat 14-08-23
101		Longitudinal welds U/S inclined plate (75 %)	1.5 days	Fri 14-08-22	Sat 14-08-23
102		Circumferential welds inclined plate top and bottom (75 %)	4 days	Fri 14-08-22	Tue 14-08-26
103		**Install bottom 25% ring components (2 sections)**	**11.53 days**	**Thu 14-08-21**	**Tue 14-09-02**
104		Move out platform	0.1 days	Tue 14-08-26	Wed 14-08-27
105		Lift and fix main components in place (25 %)	0.75 days	Wed 14-08-27	Wed 14-08-27
106		Longitudinal welds (25 %)	0.9 days	Wed 14-08-27	Thu 14-08-28
107		Circumferential welds U/S (25 %)	0.35 days	Wed 14-08-27	Thu 14-08-28
108		Circumferential welds D/S (25 %)	0.35 days	Thu 14-08-28	Thu 14-08-28
109		Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Thu 14-08-28	Thu 14-08-28
110		Longitudinal welds U/S inclined plate (25 %)	0.45 days	Thu 14-08-28	Thu 14-08-28
111		Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Thu 14-08-28	Fri 14-08-29
112		Inspection and testing of welds	10 days	Thu 14-08-21	Sun 14-08-31
113		Remove services & patch holes - Move platform	3 days	Fri 14-08-29	Tue 14-09-02
114					
115		**Install ring No. 4 (8 sections)**	**21.28 days**	**Mon 14-08-18**	**Tue 14-09-09**
116		**Drilling anchors/attachment holes**	**4.75 days**	**Mon 14-08-18**	**Sat 14-08-23**

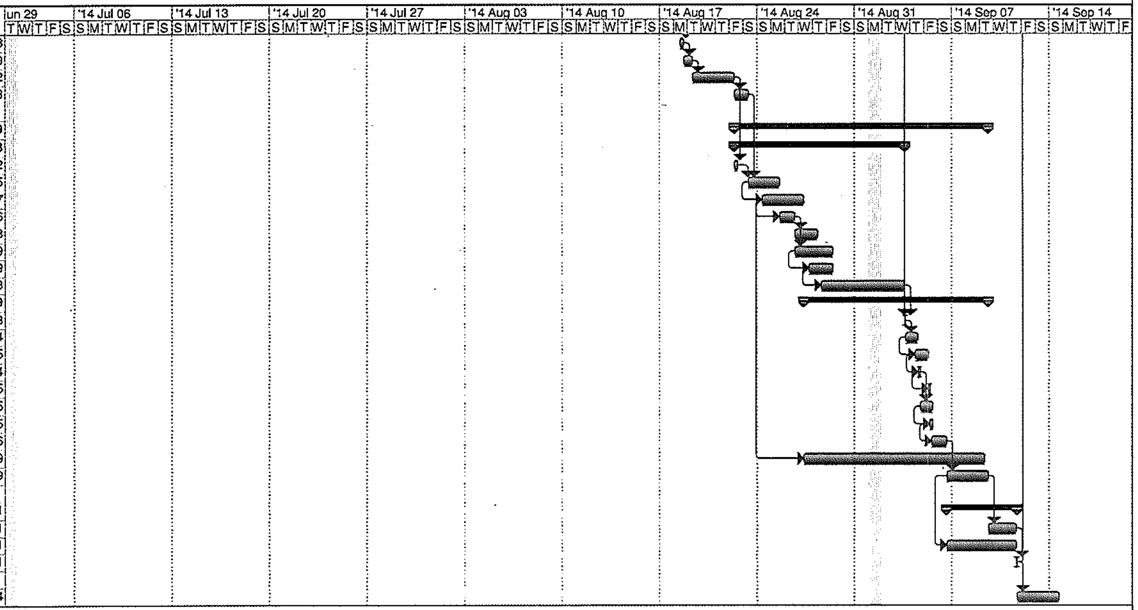


Project: Site C - Tunnel No. 2 Install
Date: Fri 14-03-28
Project:506139-BL-2-20-3130-3600-32

Task
Critical Task
Progress
Milestone ◆
Summary
Rolled Up Task
Rolled Up Critical Task
Rolled Up Milestone ◇
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline ⇩

Site C - Install Orifices in Tunnel No. 2
No concrete Poured in Rings

ID	ⓘ	Task Name	Duration	Start	Finish
117		Move in install working platform and lighting system	0.5 days	Mon 14-08-18	Mon 14-08-18
118		Move in, align and install hole drilling template	0.25 days	Mon 14-08-18	Tue 14-08-19
119		Drill holes in embedded plates and place anchors	3 days	Tue 14-08-19	Fri 14-08-22
120		Drill and install lifting and holding attachments	1 day	Fri 14-08-22	Sat 14-08-23
121					
122		**Install ring components**	**17.53 days**	**Fri 14-08-22**	**Tue 14-09-09**
123		**Install top 75% ring components (6 sections)**	**11.5 days**	**Fri 14-08-22**	**Wed 14-09-03**
124		Move-in components	0.5 days	Fri 14-08-22	Fri 14-08-22
125		Lift and fix main components in place (75 %)	2.5 days	Sat 14-08-23	Mon 14-08-25
126		Longitudinal welds (75 %)	3 days	Sun 14-08-24	Wed 14-08-27
127		Circumferential welds U/S (75 %)	1.25 days	Mon 14-08-25	Tue 14-08-26
128		Circumferential welds D/S (75 %)	1.25 days	Tue 14-08-26	Thu 14-08-28
129		Lift/fix small inclined U/S plate in place (75 %)	2.5 days	Tue 14-08-26	Fri 14-08-29
130		Longitudinal welds U/S inclined plate (75 %)	1.5 days	Wed 14-08-27	Fri 14-08-29
131		Circumferential welds inclined plate top and bottom (75 %)	5 days	Thu 14-08-28	Wed 14-09-03
132		**Install bottom 25% ring components (2 sections)**	**12.53 days**	**Wed 14-08-27**	**Tue 14-09-09**
133		Move out platform	0.1 days	Wed 14-09-03	Wed 14-09-03
134		Lift and fix main components in place (25 %)	0.75 days	Wed 14-09-03	Thu 14-09-04
135		Longitudinal welds (25 %)	0.9 days	Thu 14-09-04	Fri 14-09-05
136		Circumferential welds U/S (25 %)	0.35 days	Thu 14-09-04	Thu 14-09-04
137		Circumferential welds D/S (25 %)	0.35 days	Fri 14-09-05	Fri 14-09-05
138		Lift/fix small inclined U/S plate in place (25 %)	0.75 days	Thu 14-09-04	Fri 14-09-05
139		Longitudinal welds U/S inclined plate (25 %)	0.45 days	Fri 14-09-05	Fri 14-09-05
140		Circumferential welds inclined plate top and bottom (25 %)	1.2 days	Fri 14-09-05	Sat 14-09-06
141		Inspection and testing of welds	12 days	Wed 14-08-27	Tue 14-09-09
142		Remove services & patch holes - Move platform	3 days	Sat 14-09-06	Tue 14-09-09
143					
144		**Tunnel Closure**	**5.15 days**	**Sat 14-09-06**	**Thu 14-09-11**
145		Remove Balance of services and holes patching	2 days	Tue 14-09-09	Thu 14-09-11
146		Clean-Up & Remove equipments	5 days	Sat 14-09-06	Thu 14-09-11
147		Close hatch	0.15 days	Thu 14-09-11	Thu 14-09-11
148					
149		**Demobilize**	3 days	Thu 14-09-11	Sun 14-09-14



Task	▬	Milestone	◆	Rolled Up Critical Task	▬	Split	……………	Group By Summary	▬
Critical Task	▬	Summary	▬	Rolled Up Milestone	◇	External Tasks	▬	Deadline	⇩
Progress	▬	Rolled Up Task	▬	Rolled Up Progress	▬	Project Summary	▭		

Appendix 5

Peace River - Site C Project
Construction - All Person Months - For Camp