Nalcor Energy – Lower Churchill DG3 Capital Costs Overview

19-September-2012

Boundless Energy

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Confidential and Commercially Sensitive

Safety Moment

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Purpose / Objectives

- To present the Decision Gate 3 capital cost estimates.
- To review key drivers of Decision Gate 3 capital cost estimate.

Presentation Outline

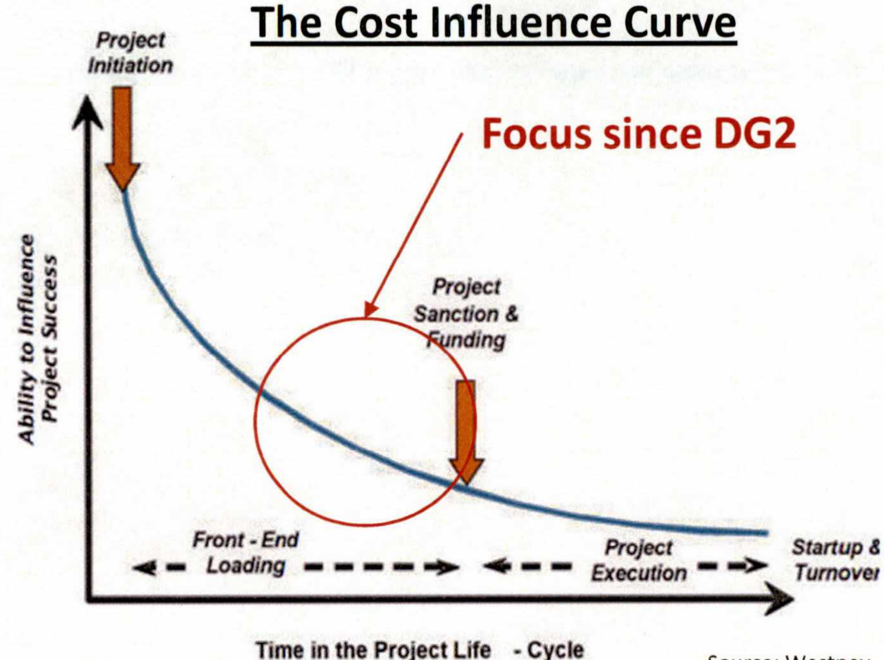
- The Project Today
  - Project Execution Roadmap
  - Project Definition since Decision Gate 2
- Decision Gate 3 Cost Estimate
  - Process and Outcome
  - Review Key Changes since Decision Gate 2

Project Execution Roadmap

Application of Industry Best Practice

- Front-end loading to confirm project scope and align with business objectives
  - Advanced Project Definition through completion of substantial engineering
    - Target engineering completion prior to start of construction
  - Extensive execution and construction planning
  - Adopt contracting strategies that minimizes and optimally allocates risk
  - Firming key prices through bidding before Sanction
- Early and continued focus on de-risking the projects
  - Shaped engineering, execution planning, contracting strategies, and decision to commence Early Infrastructure Works

The Cost Influence Curve



Source: Westney

"... the LCP Gate 3 estimate in its current state is one of the best mega-project "base" estimates that this reviewer has seen in some time."

- John K. Hollmann, PE CCE CEP, Owner – Validation Estimating LLC April 2012

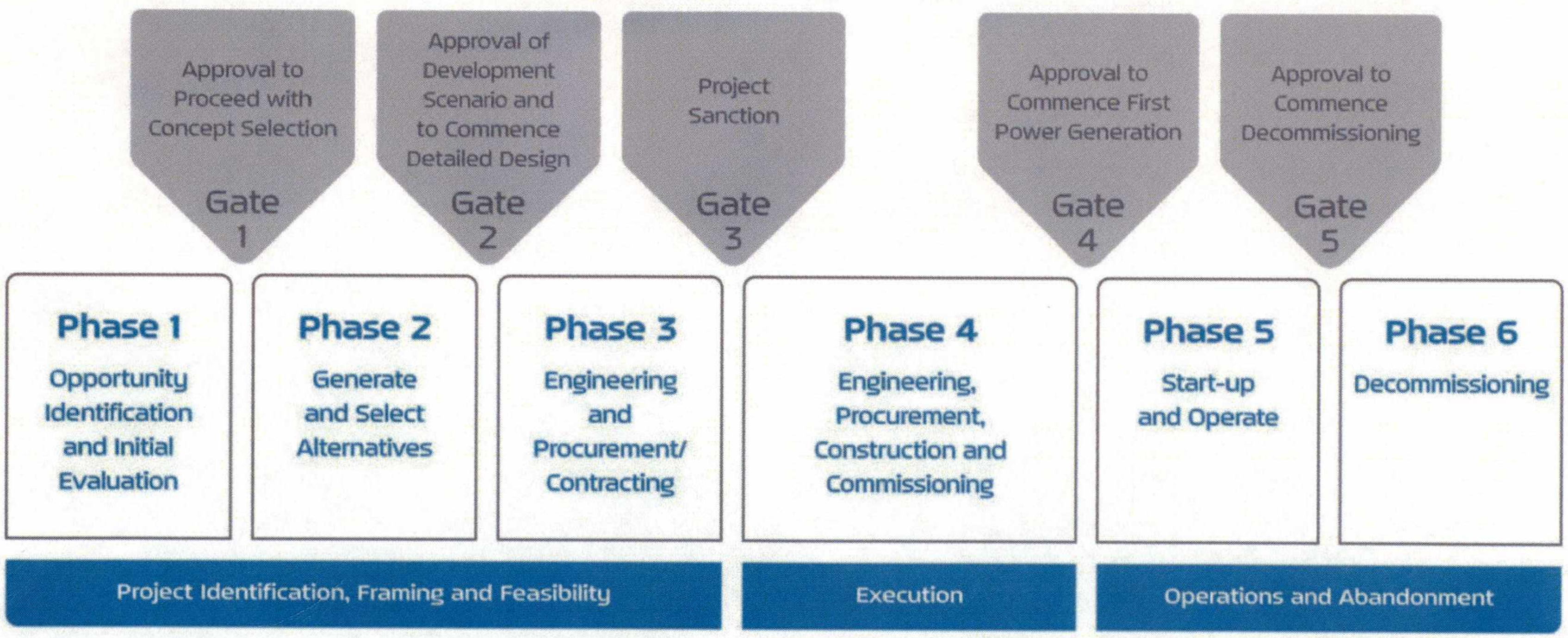
Front-End Loading: *#1 Predictor of Performance*

Site Factors + Engineering Definition + Project Execution Planning → **FEL**

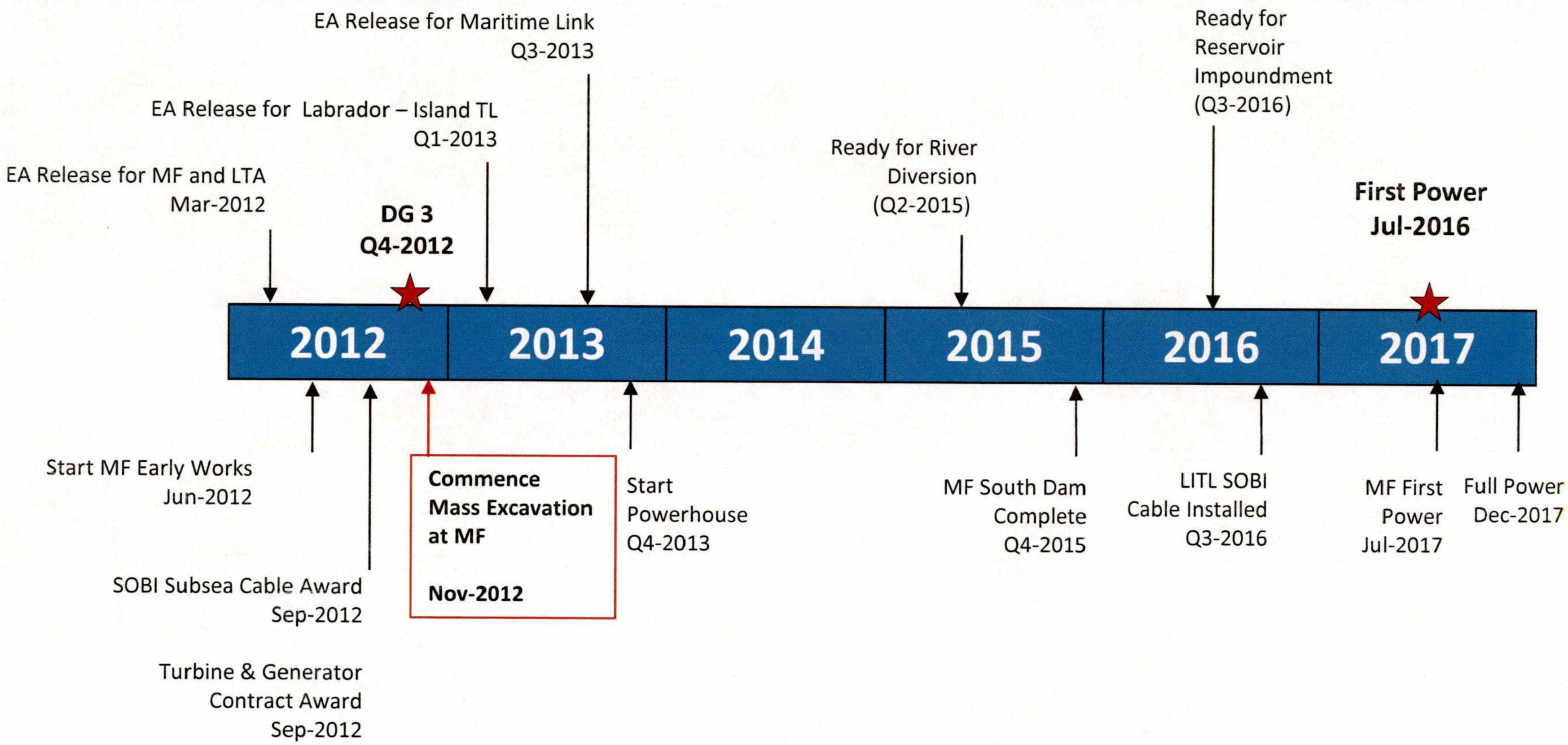
- Gateway Phase 3 focus directed towards completing the level of Front-End Loading to confirm the project definition and a "Sanction-quality" Class 3 cost estimate.
- We are tracking industry best practice which suggest expending 4 – 6% of Total Invested Capital in FEL activities pre-DG3
  - ~$250 million expended to-date
  - Engineering and detailed design well advanced > 45% complete

Nalcor's Stage-Gate Process

Structured, front-end loading process that enables risk-informed decision making at Decision Gates by completing critical analysis in the Phase leading to the Decision Gate, while ensuring a balance of analysis with capital pre-investment .



Project Milestones



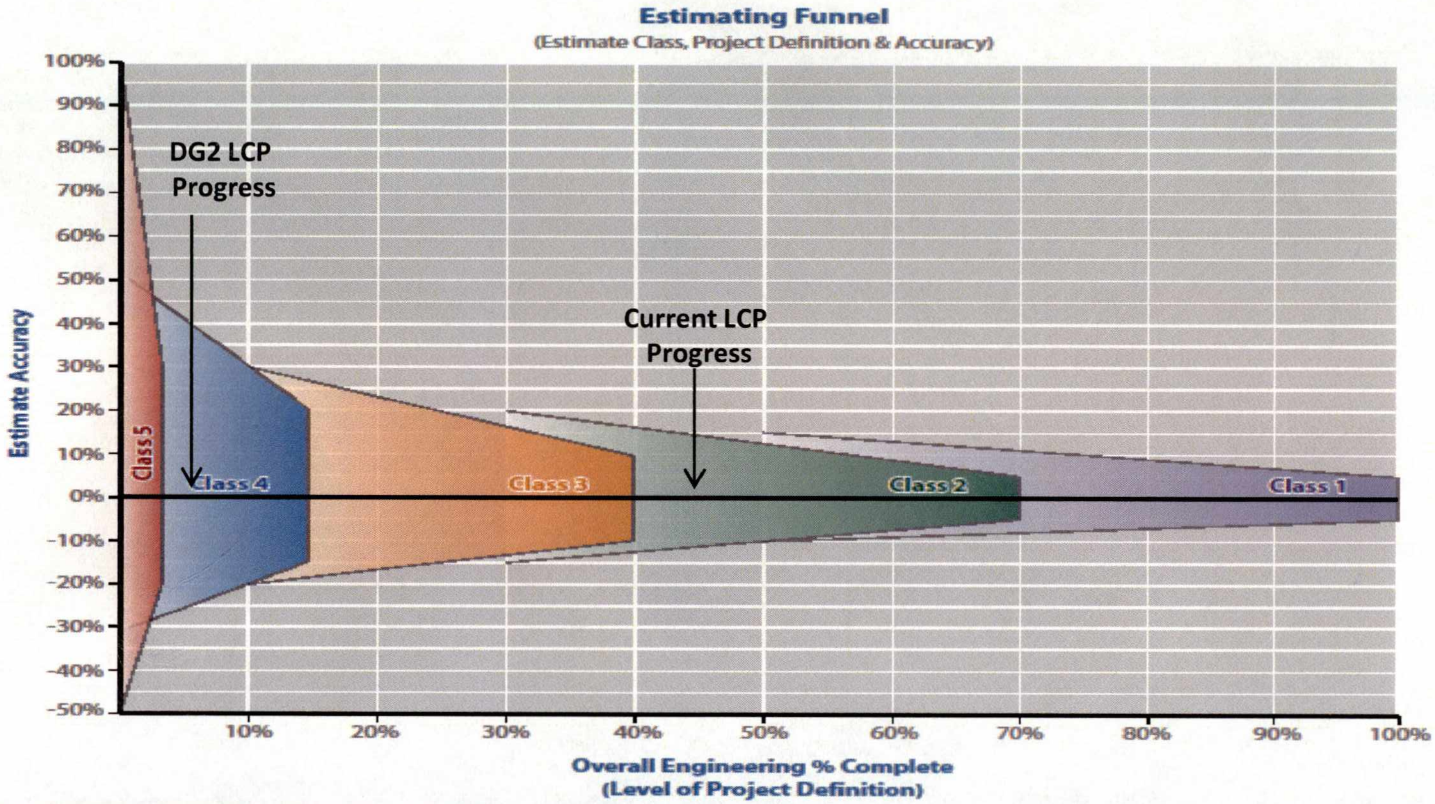
Establishing a High Quality DG3 Cost Estimate

- Estimate accuracy is the degree of confidence that the estimated cost will be close to the final project cost.
- As a project becomes better defined and less likely to change the more confidence there is that the estimate will accurately predict the final project cost.
- The accuracy of a project's cost estimate is a function of the:
  - level of Front-End Loading (i.e. project definition) completed
  - understanding and completion of project's risk exposure

Estimate Accuracy
Shaping Characteristics for Lower Churchill

- Primary Driver:
  - High degree of project definition (i.e. represented by amount of engineering completed)
- Secondary Drivers:
  - Non-technically complex Project
  - Significant amount of effort expended to prepare estimate
  - High quality reference cost data available

Estimate Accuracy Evolution



Required for	Decision Gate 1	Decision Gate 2	Decision Gate 3	Financial Close	Mid-Point Check
Class	AACEI Class 5	AACEI Class 4	AACEI Class 3	AACEI Class 2	AACEI Class 1
Estimate Purpose	Opportunity Screening	Alternative Selection	Sanction / Control	Financing	Check Estimate
Project Definition	0% to 2%	1% to 15%	10% to 40%	30% to 70%	50% to 70%

Project Definition Since DG2

Significant Engineering has been completed since Decision Gate 2

- Followed work plan established at DG2 with early engineering directed towards areas of uncertainty
  - ~400 FTEs employed
  - Currently >45% engineering and detailed design complete – 1000+ document & drawings issued
- Project scope and execution plan have been confirmed, thereby allowing:
  - well-informed decision at DG3
  - more accurate cost estimate
  - matured risk awareness
  - enhanced capital predictability

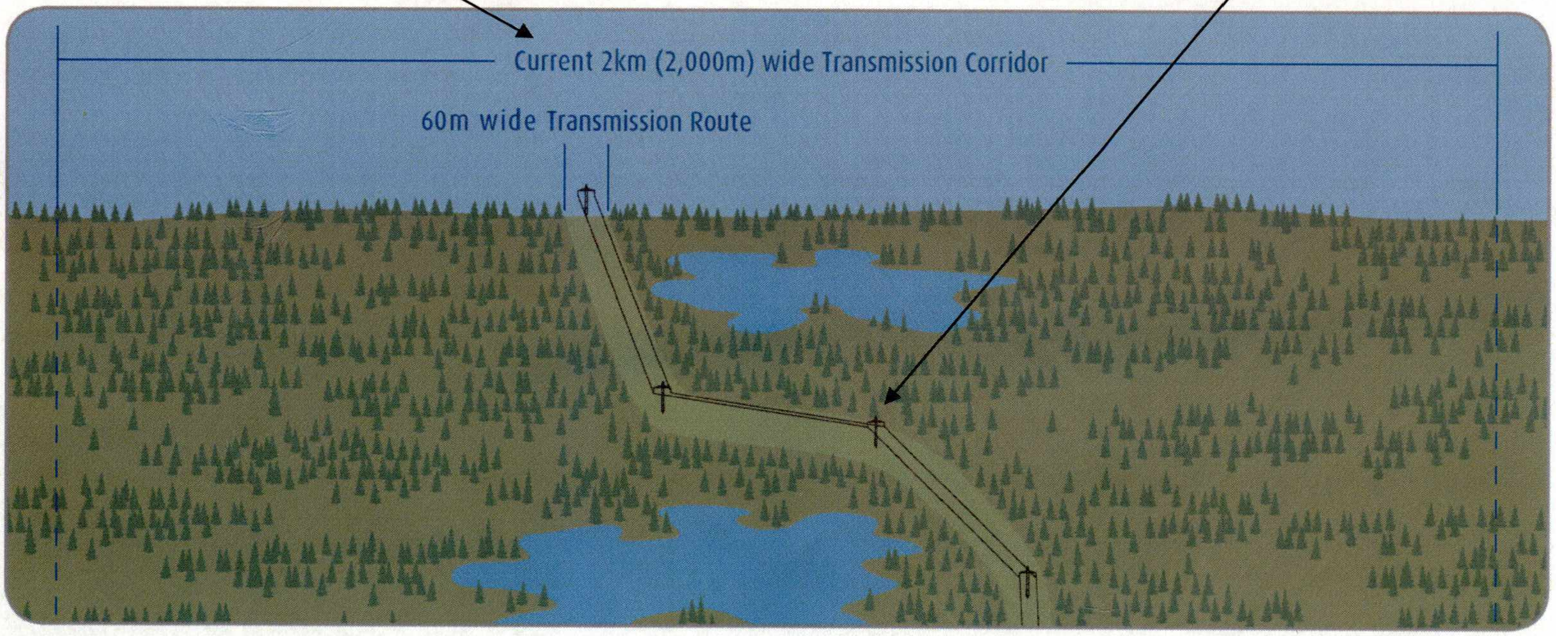
Project Definition – HVdc Transmission

A Closer Look: HVdc Transmission

Significant Engineering Design Development Complete

DG2: Working with general knowledge of Corridor Only

Now: Individual Tower Locations Selected

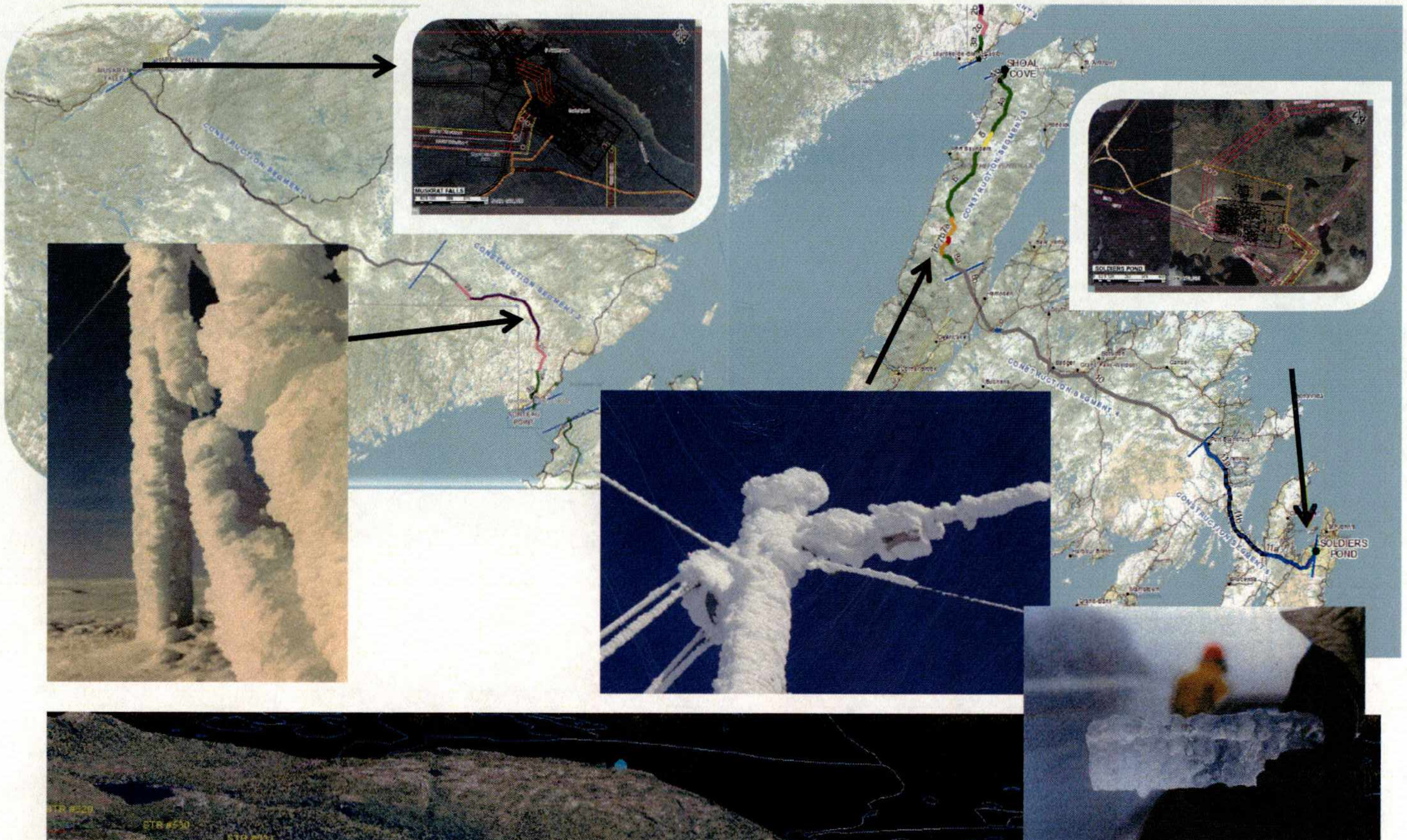


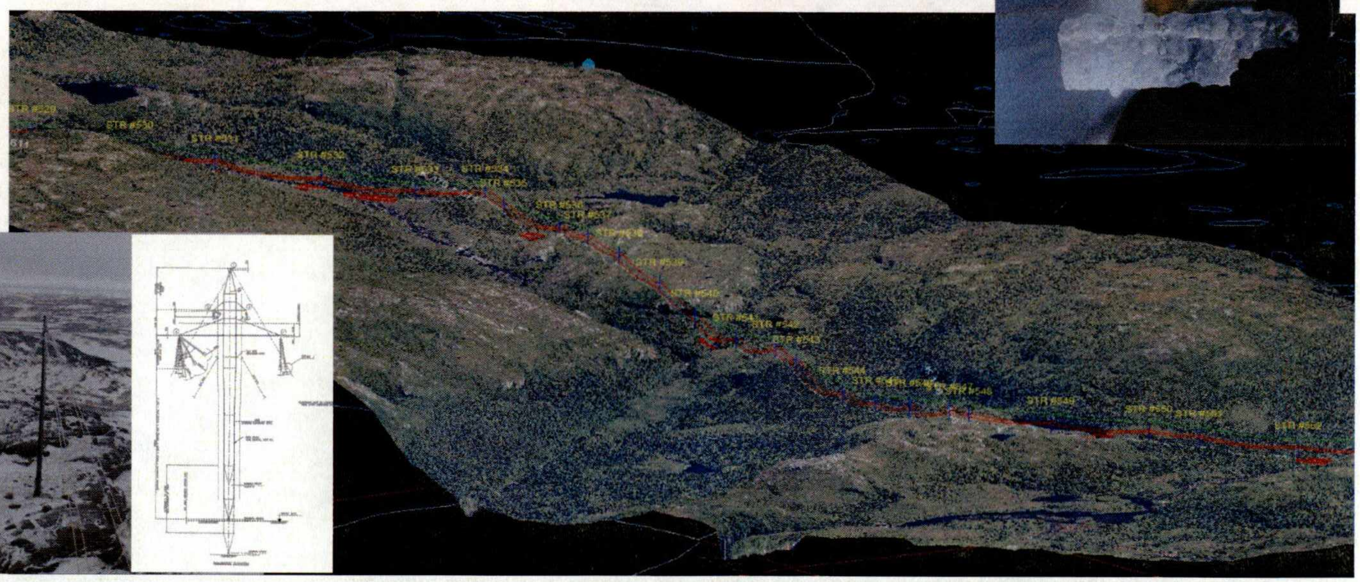
HVdc Engineering & Design Progress

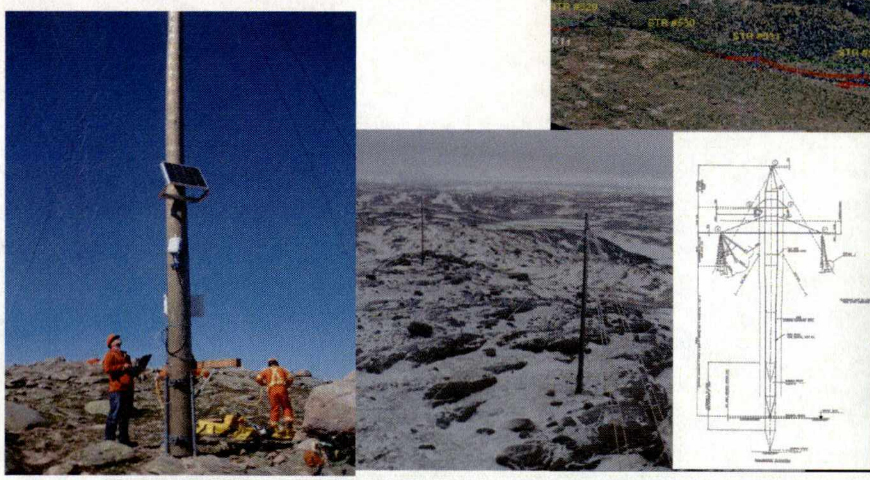
Decision Gate 2	Decision Gate 3
• Preliminary 2km wide Transmission Corridor selected and basic geotechnical data obtained • Generic tower configurations – not specific to our line • Desktop tower loading work underway • Preliminary execution plan • Preliminary conductor selection • Budgetary quotes for tower steel and conductor	• Lidar topography survey complete of Corridor • Line Routing within Corridor complete • Individual tower locations selected • Harsh climatic conditions of southern Labrador and Long Range Mountains confirmed with meteorological data and / or modelling • 13 Tower loading cases identified resulting in significant number of tower designs • Foundation designs in-progress • Conductor Optimization and System Stability studies complete • ROW vegetation and clearing plans in-place • Insulator and tower hardware designs progressing • Budgetary quotes for all material • Detailed construction plan in-place • Acquisition of property for Marshalling Yards underway • All line crossings and property easements identified • Tie-in points being design

Meteorological Conditions

- 3650 towers
- 350,000 Insulators
- 3,000,000 m of Conductor
- 13 distinct wind and ice combination zones developed from multiple desktop report and existing network of test towers/ test spans
- 170 km of High Alpine (Rime) Ice and Wind Loading, 180 km Heavy Glaze Ice
- 250 km of remote inaccessible line in central Labrador



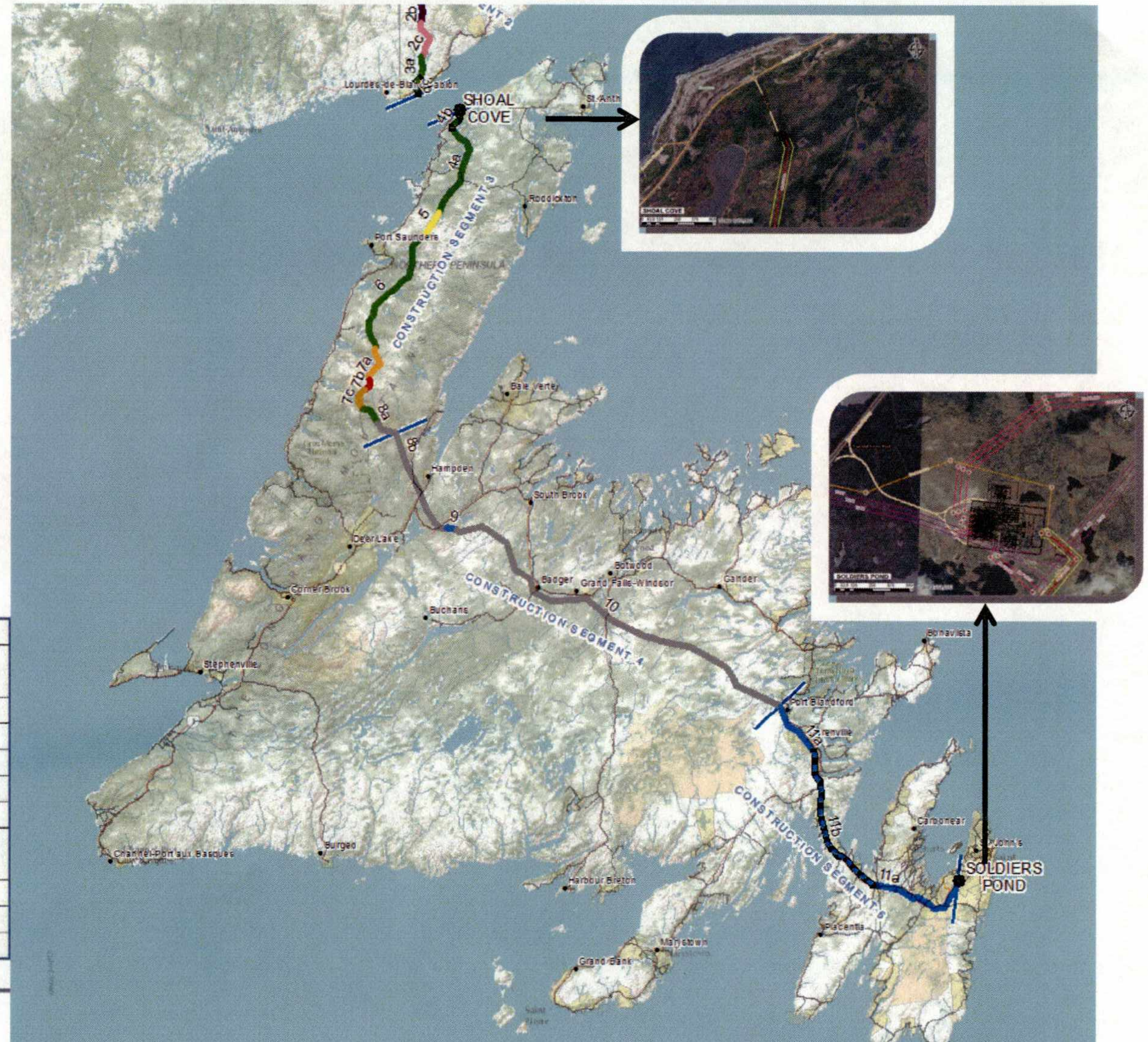




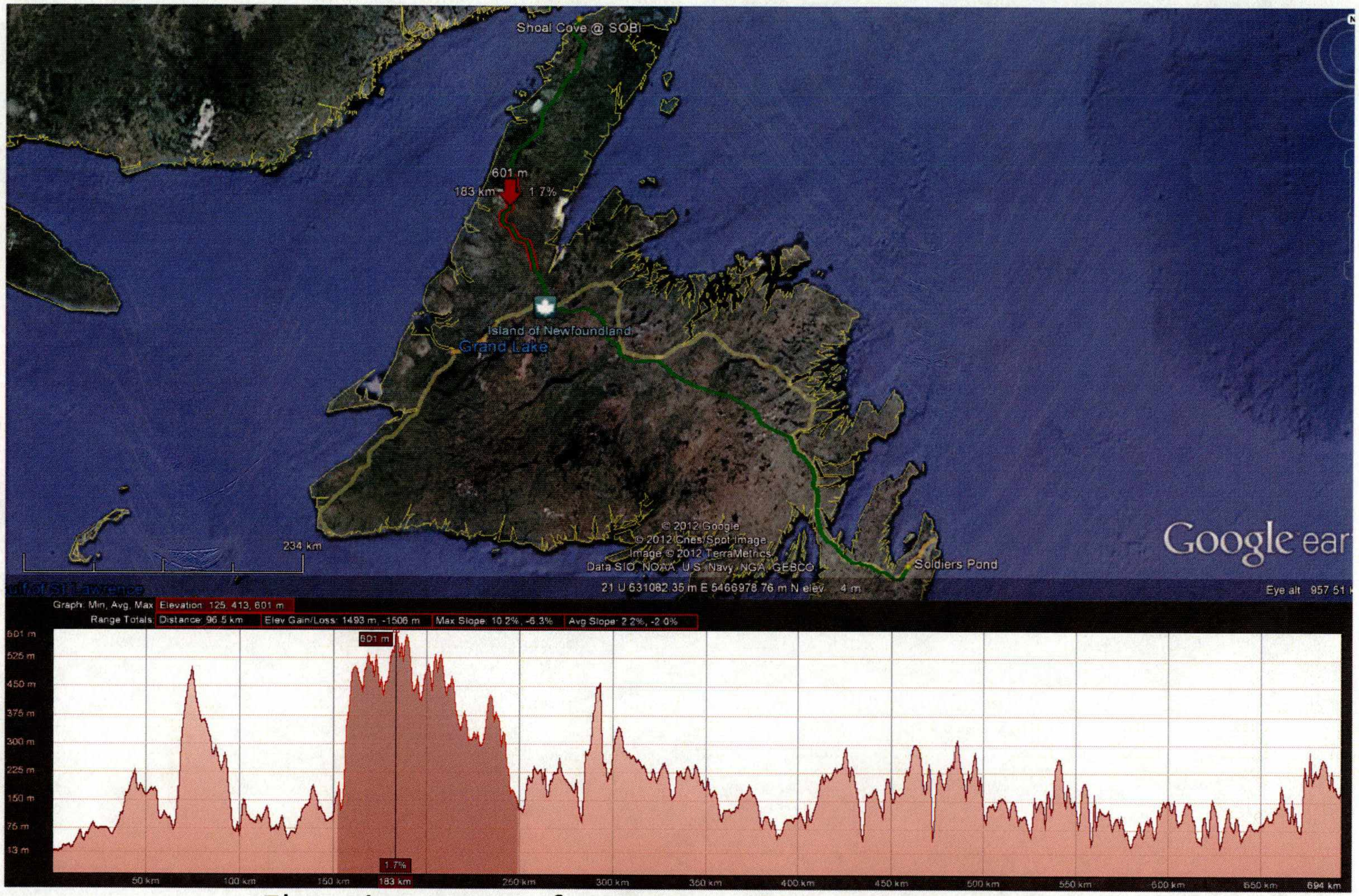
Meteorological Loading Cases Confirmed

- 696 km from Shoal Cove to Soldiers Pond
- Long Range Mountains
- Avalon higher population density, more existing infrastructure
- 13 Meteorological loading cases (135mm Rime Ice and 180 km/h winds)

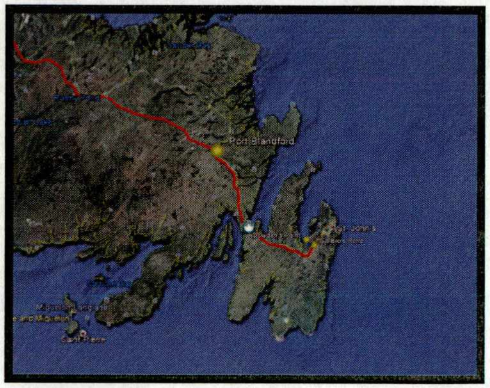
Newfoundland	③	4b	Average Zone 2	12.5	50	Glaze	120	N	Coastal	40	F10
		4a	Average Zone 2	56.4	50	Glaze	120	N	Inland	300	F5
		5	HOSJ High Alpine	18.9	115	Rime	150	N	Inland	500	F12
		6	Average Zone 2	72.6	50	Glaze	120	N	Inland	480	F5
		7a	LRM High Alpine	21.1	115	Rime	180	N	Inland	590	F9
		7b	LRM Extreme Alpine	7.1	135	Rime	180	N	Inland	630	F6
		7c	LRM High Alpine	12.8	115	Rime	180	N	Inland	600	F9
		8a	Average Zone 2	12.9	50	Glaze	120	N	Inland	550	F5
	④	8b	Average Zone 1	74.9	50	Glaze	105	N	Inland	400	F4
		9	Alpine	7.8	75	Glaze	130	N	Inland	430	F7
		10	Average Zone 1	221.0	50	Glaze	105	N	Inland	360	F4
	⑤	11a	Eastern Zone	89.4	75	Glaze	130	N	Inland	280	F7
		11b	Eastern Zone	88.8	75	Glaze	130	N	Coastal	210	F8



Detailed Topography Mapped



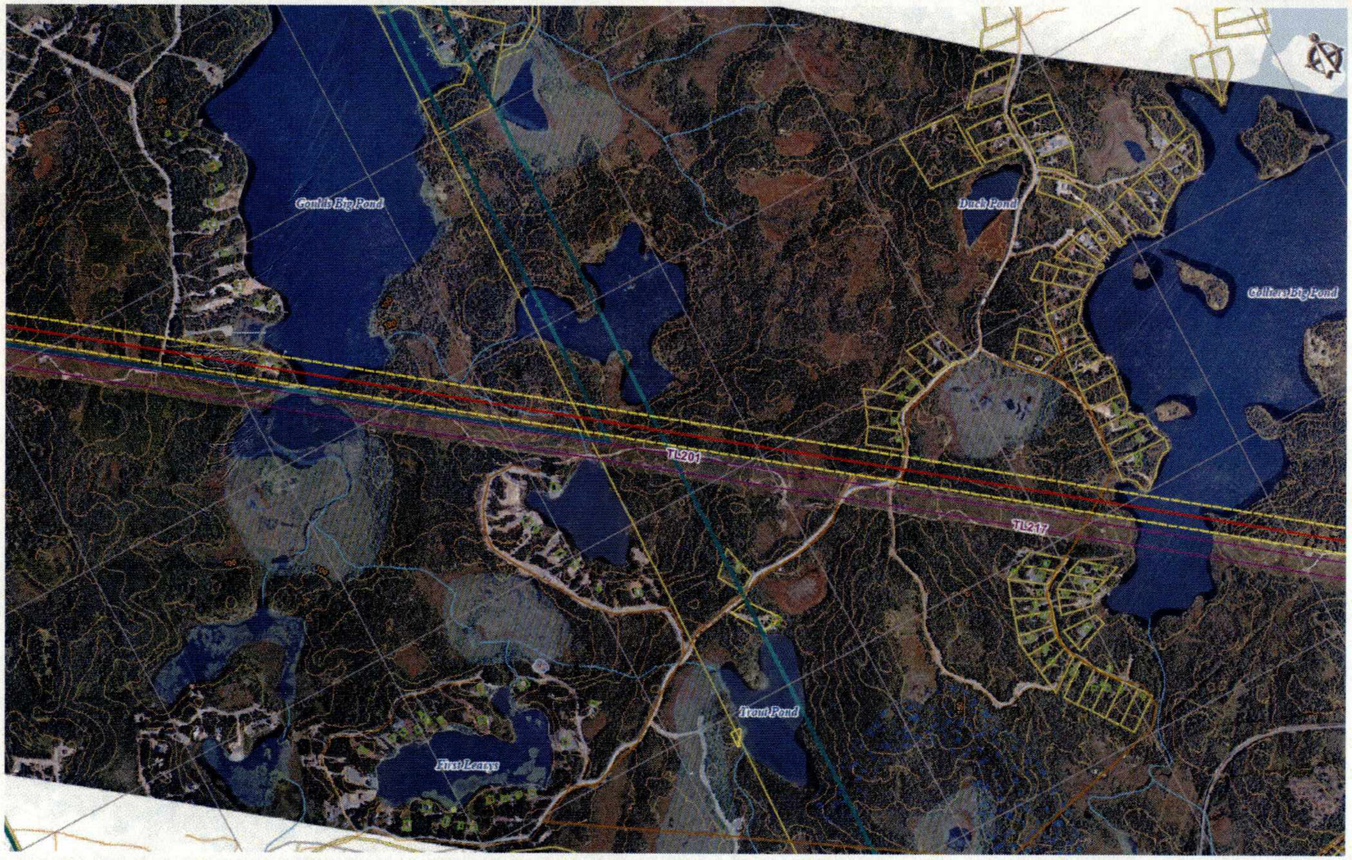
Elevation ranges from 0m to 630m above MSL



Lidar Terrain Mapping

(Lidar = Aircraft based remote sensing technology to detect terrain conditions)

Avalon - Starting at Port Blandford, higher population density, more infrastructure and land use constraints.



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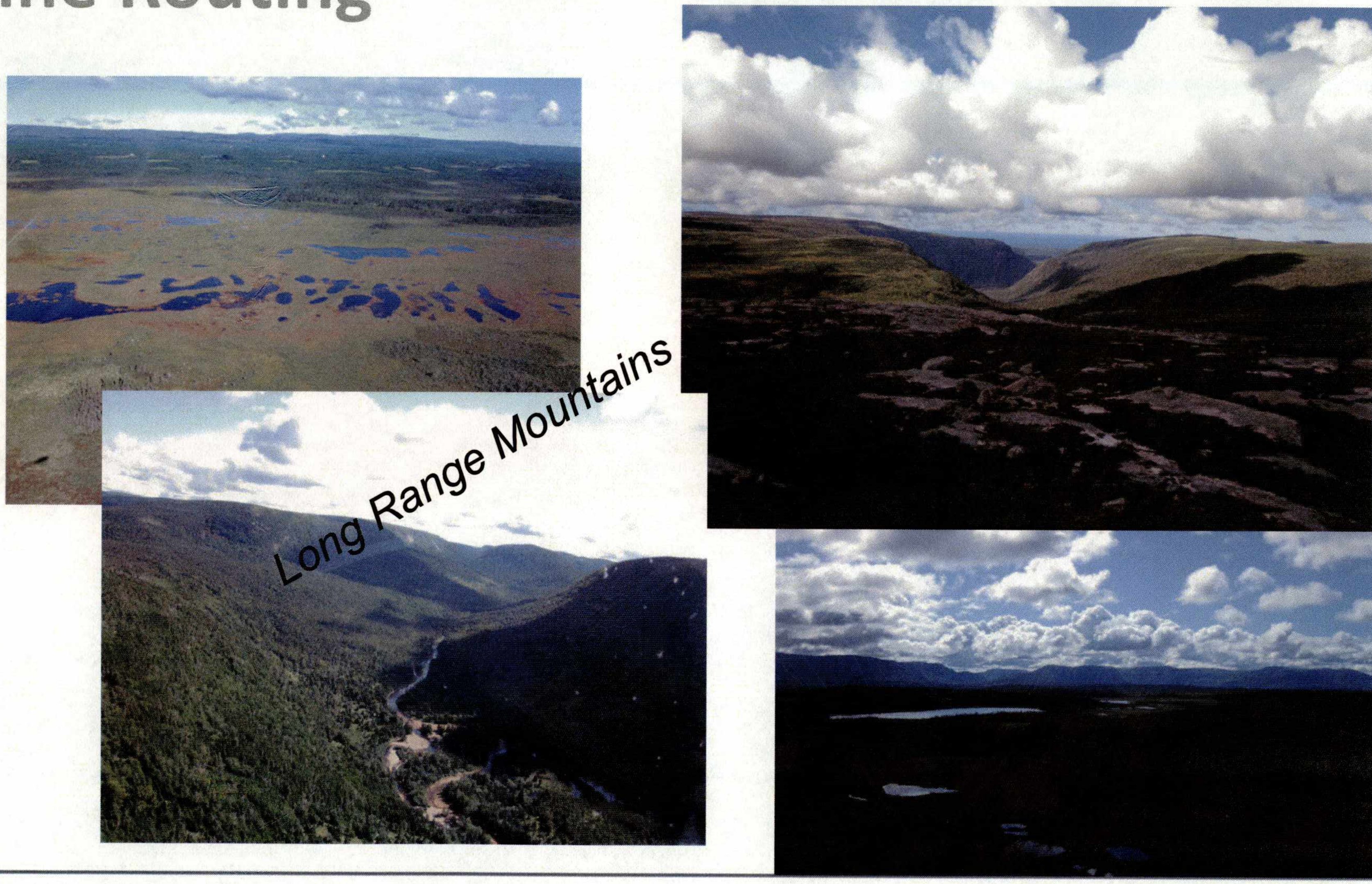
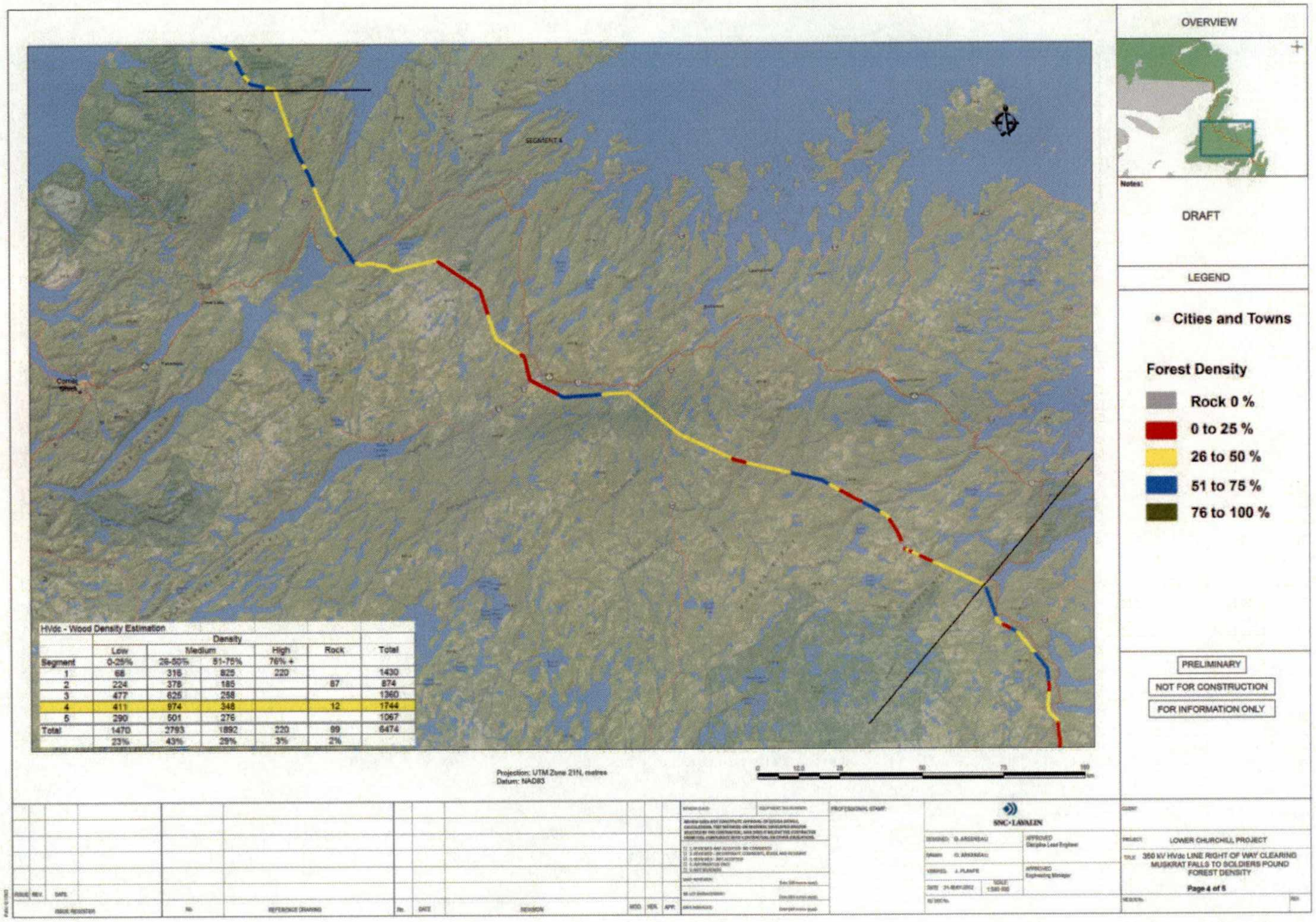
Field Assessment of Terrain to Verify Line Routing



Leveraging Technology to Assist with Wood Density Estimation

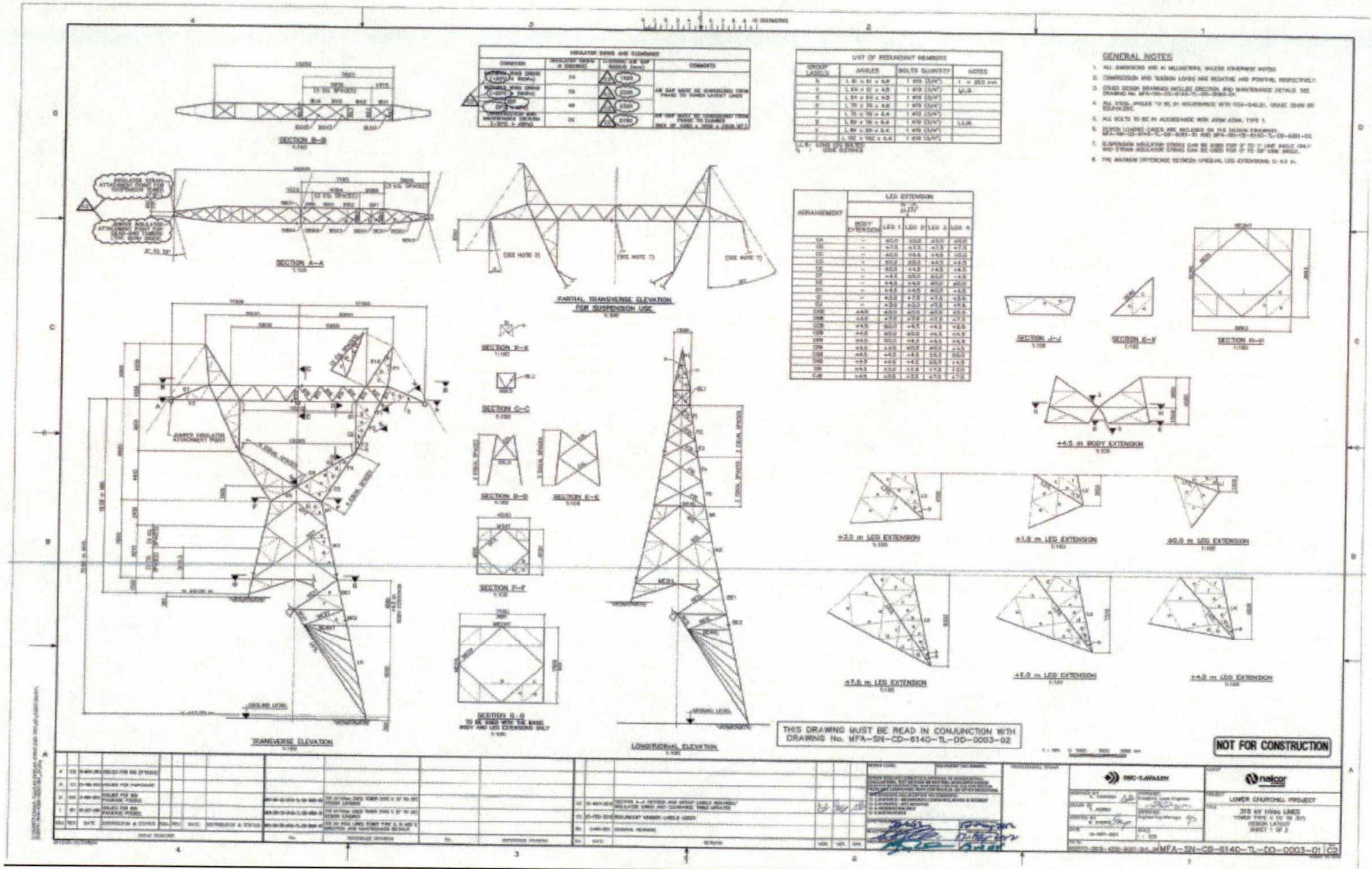


HVdc - Wood Density Estimation

	Density					Total
	Low	Medium		High	Rock	
Segment	0-25%	26-50%	51-75%	76% +		
1	68	316	825	220		1430
2	224	378	185		87	874
3	477	625	258			1360
4	411	974	348		12	1744
5	290	501	276			1067
Total	1470	2793	1892	220	99	6474
	23%	43%	29%	3%	2%	

HVdc Tower Designs In-Place

(315 kV Tower Type C Design Layout)



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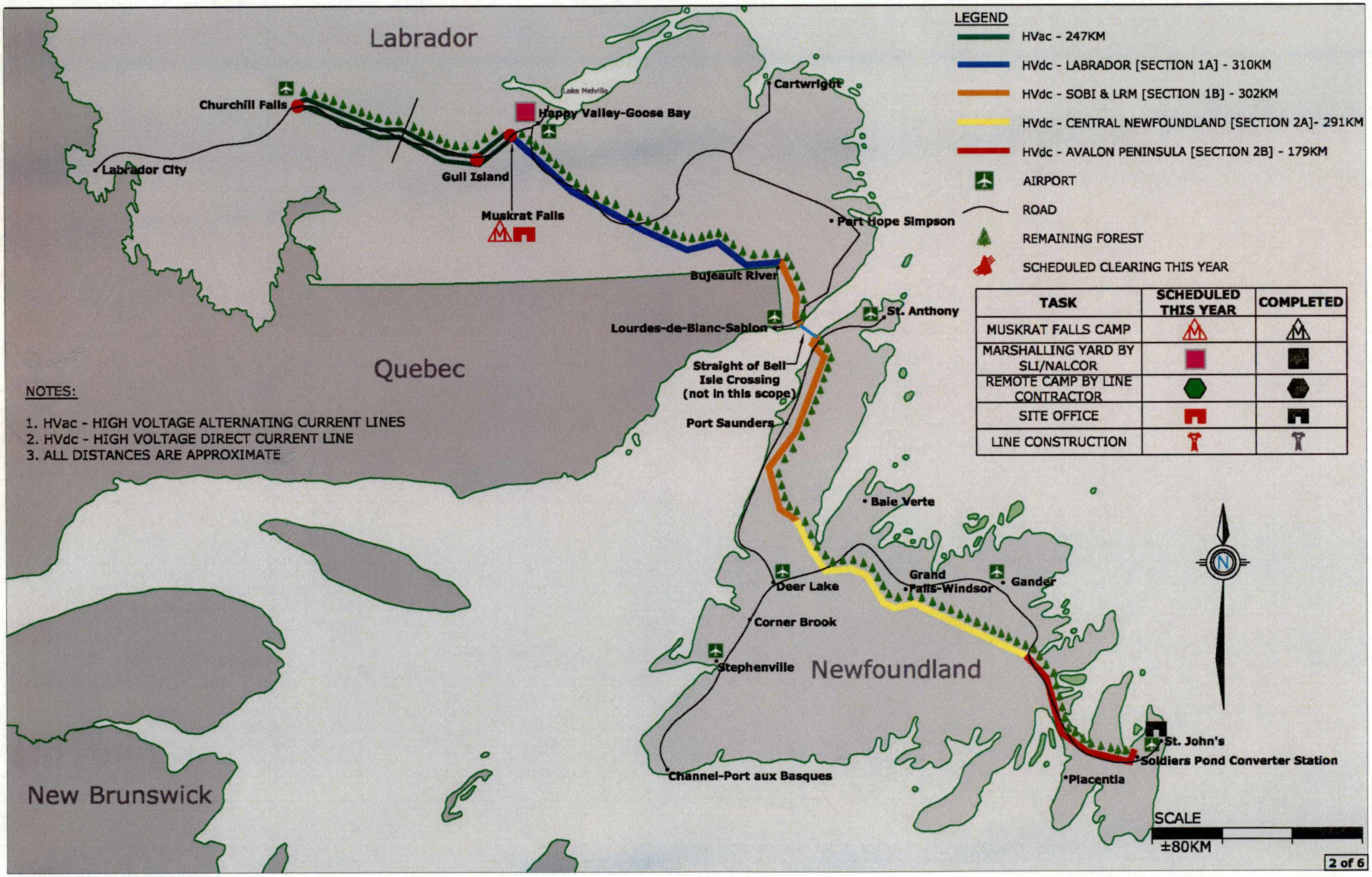
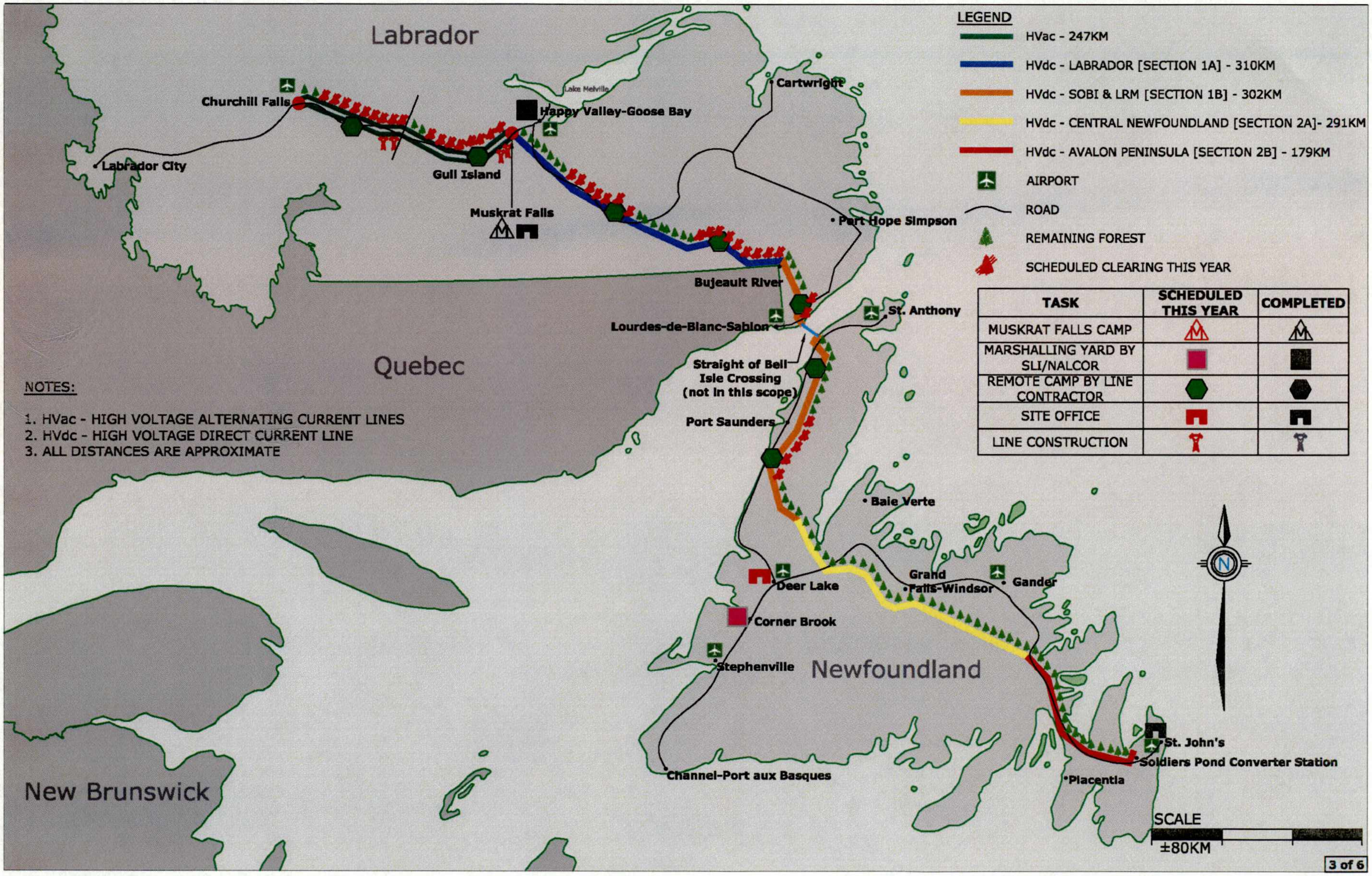
HVdc and HVac Transmission Construction Sequence

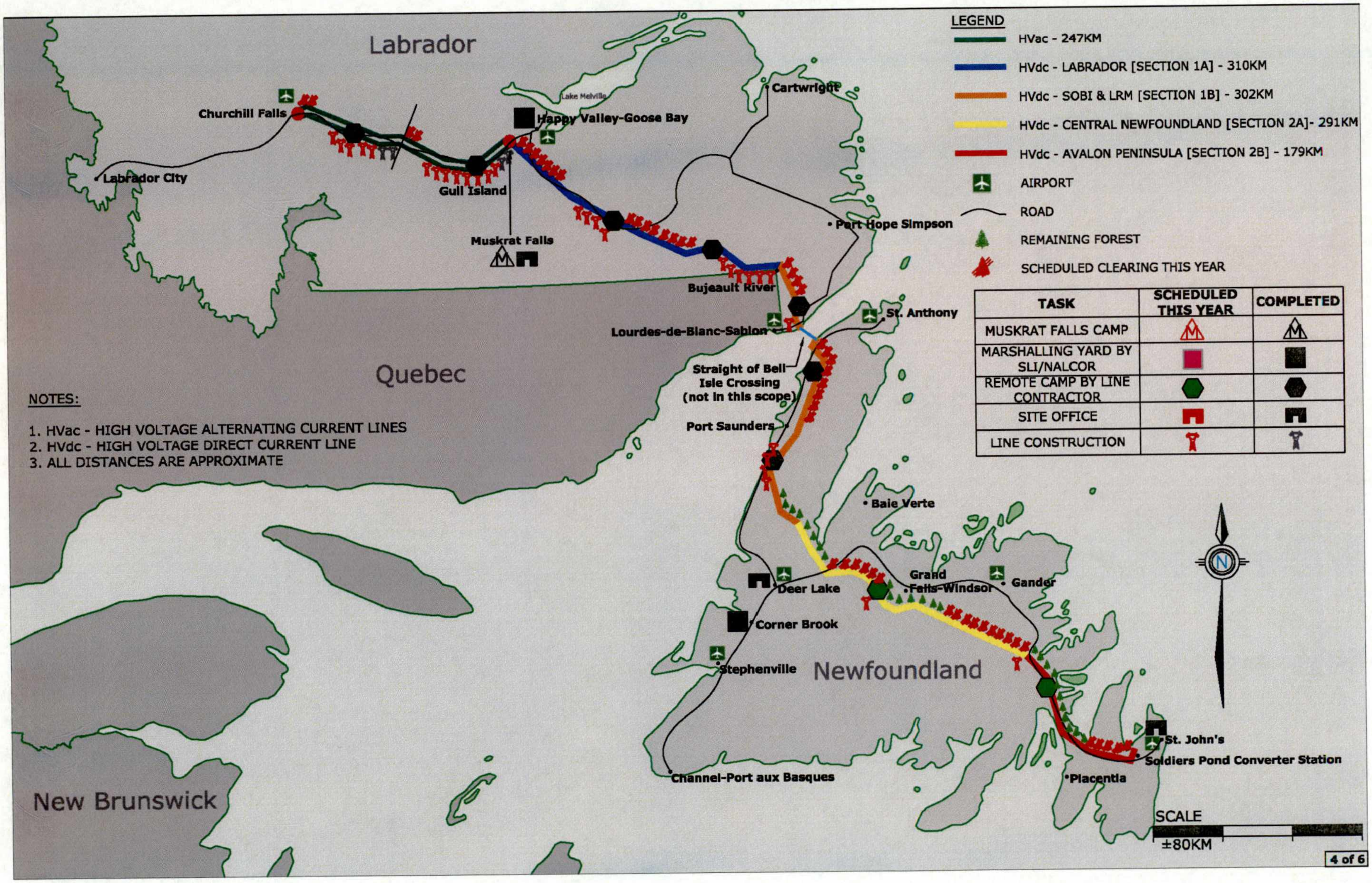
Construction Build Sequence - 2012



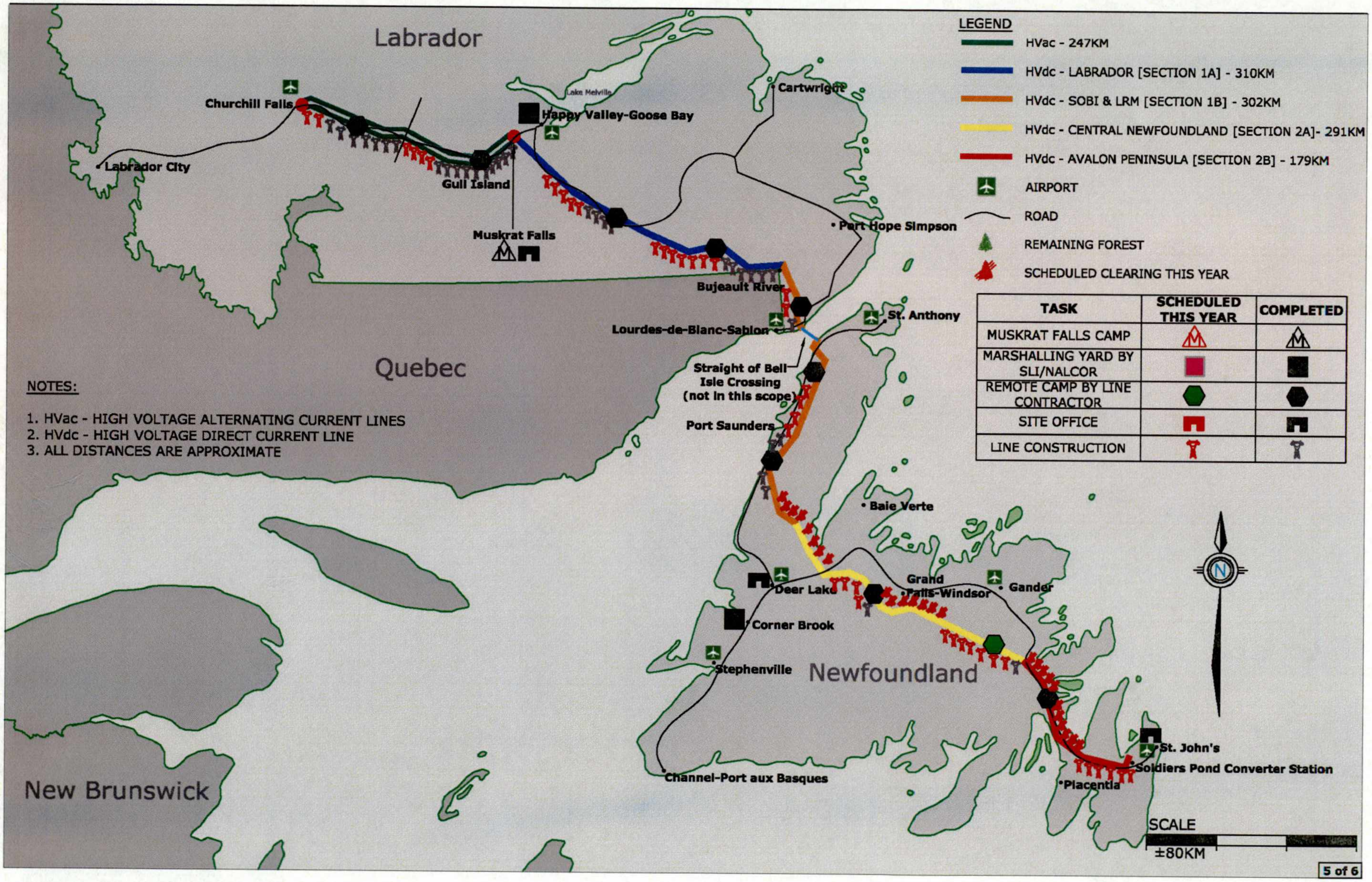
Construction Build Sequence - 2013



Construction Build Sequence - 2014

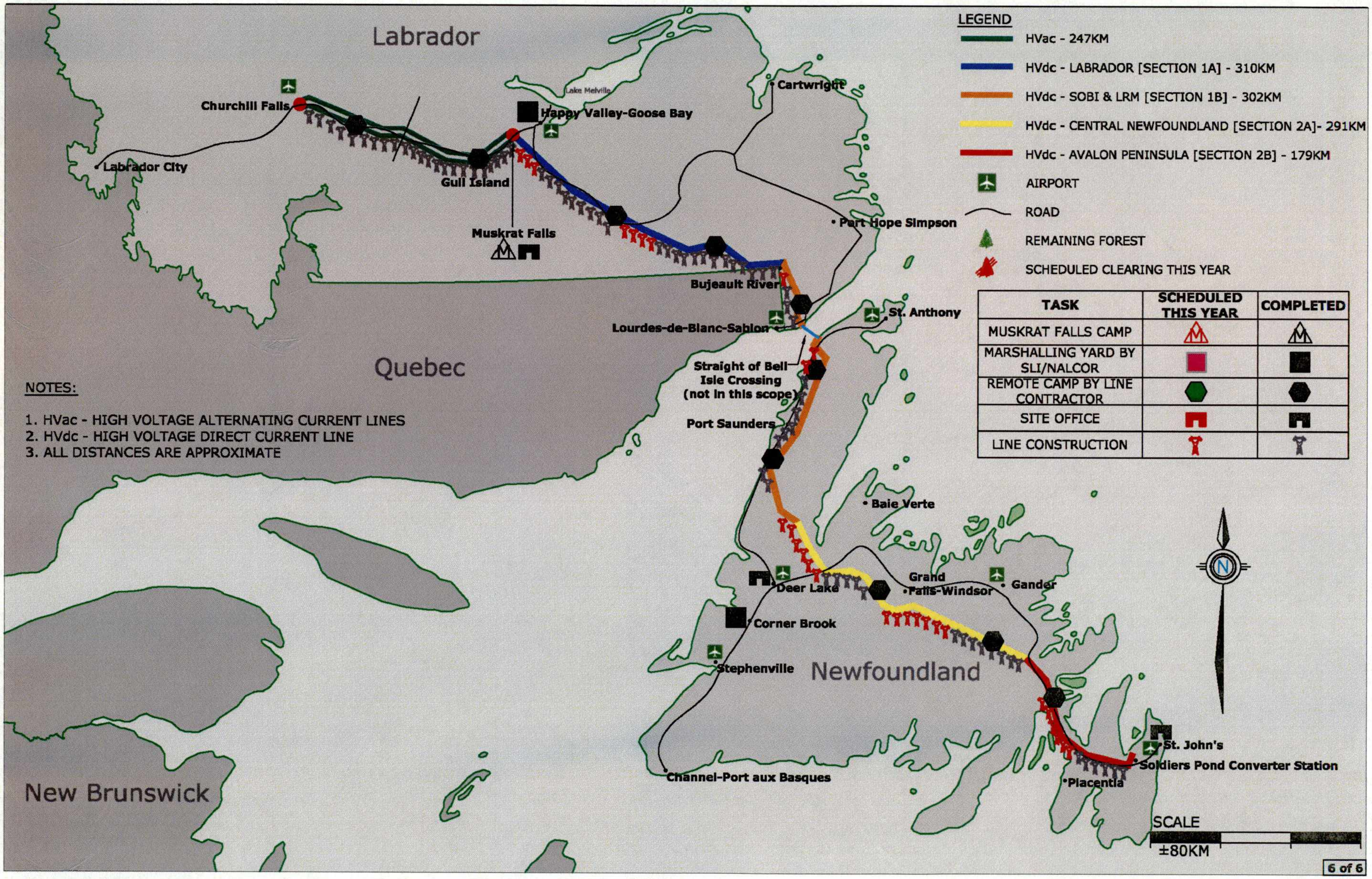


Construction Build Sequence - 2015

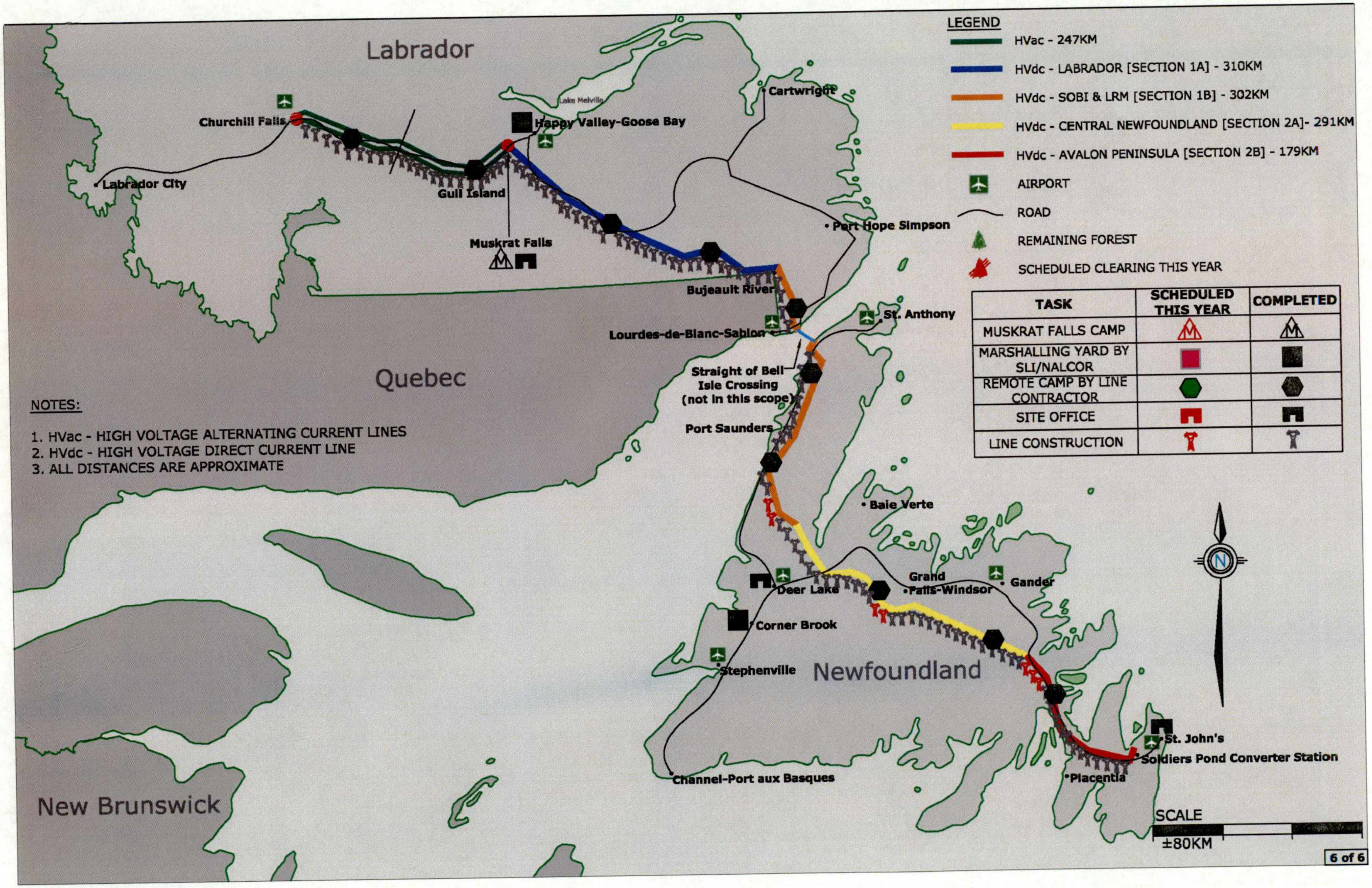


TASK	SCHEDULED THIS YEAR	COMPLETED
MUSKRAT FALLS CAMP		
MARSHALLING YARD BY SLI/NALCOR		
REMOTE CAMP BY LINE CONTRACTOR		
SITE OFFICE		
LINE CONSTRUCTION		

Construction Build Sequence - 2016



Construction Build Sequence - 2017



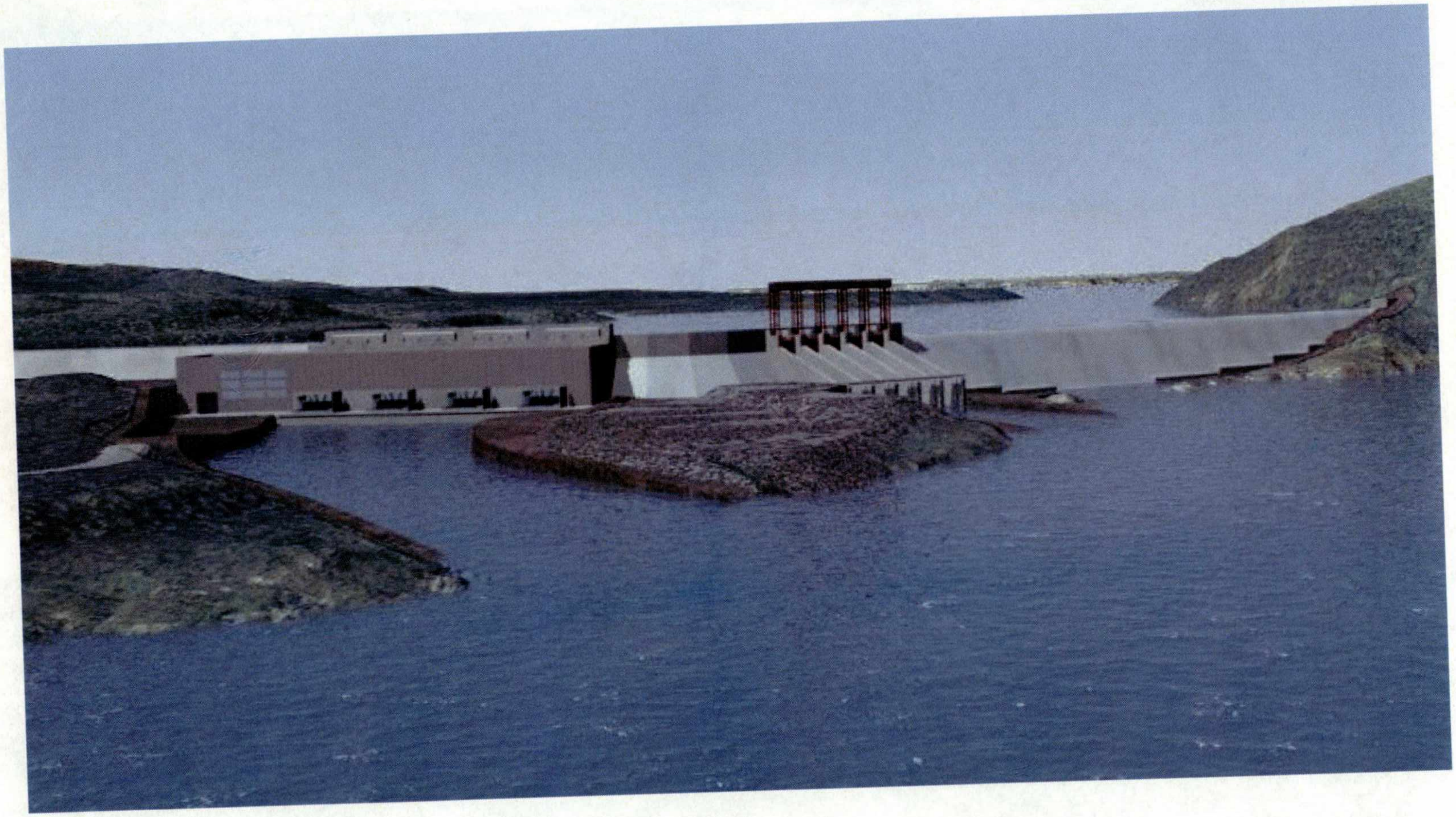
TASK	SCHEDULED THIS YEAR	COMPLETED
MUSKRAT FALLS CAMP		
MARSHALLING YARD BY SLI/NALCOR		
REMOTE CAMP BY LINE CONTRACTOR		
SITE OFFICE		
LINE CONSTRUCTION		

NOTES:

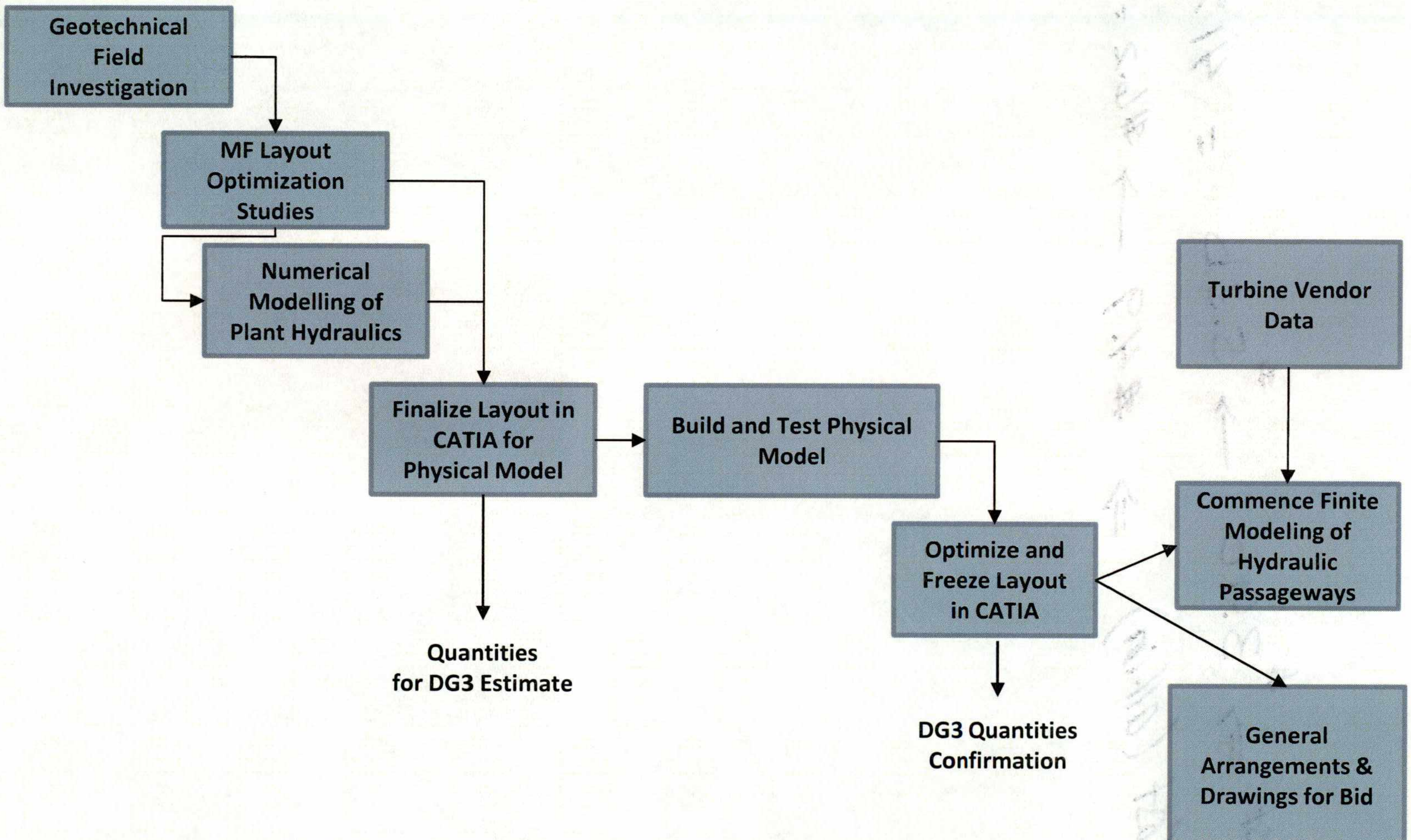
1. HVac - HIGH VOLTAGE ALTERNATING CURRENT LINES
2. HVdc - HIGH VOLTAGE DIRECT CURRENT LINE
3. ALL DISTANCES ARE APPROXIMATE

Project Definition – Muskrat Falls

Muskrat Falls Today



MF Engineering Work Plan from DG2



MF Engineering & Planning Progress

Decision Gate 2

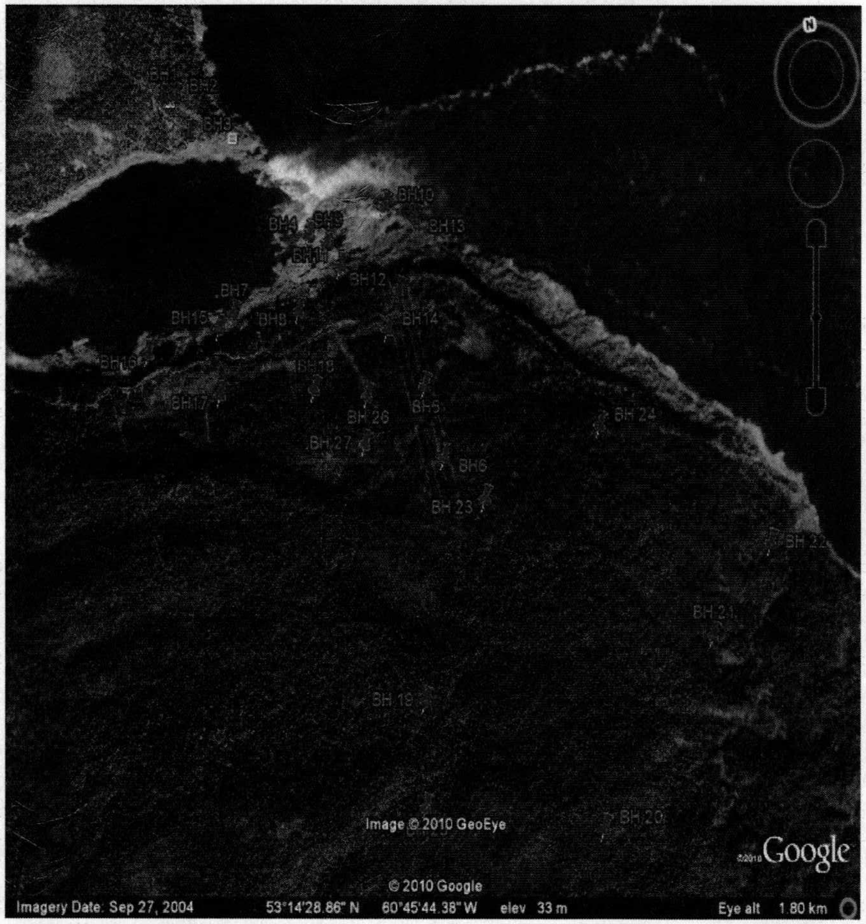
- Desktop studies complete based upon early field work to confirm development Variant
- Quantities calculated using 1998 Feasibility Studies
- River and ice management studies underway
- 1998 geotechnical investigations
- Leverage Gull Island studies for infrastructure works

Decision Gate 3

- Numerical modeling of hydraulic passages complete
- Geotechnical investigations for powerhouse complete
- Site layout optimized to ensure operational reliability and long-term asset integrity
- All structures modeled in CATIA 3D to produce quantities of rock excavation and concrete
- Scaled physical model testing completed to verify layout and various river management operations (e.g. temporary diversion)
- Turbine efficiency model testing complete and incorporated into contractual commitments
- Detailed constructability optimizations complete / underway
- Turbine & Generator contract ready to award
- Engineering complete for infrastructure works

Geotechnical Investigations Confirm Sub-Surface Conditions

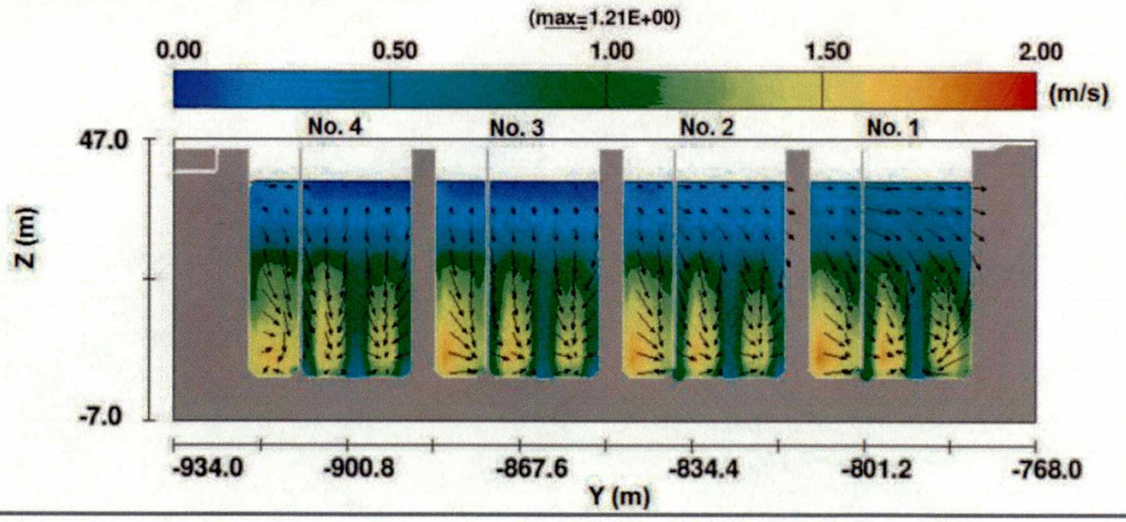
Borehole Locations at Muskrat Falls



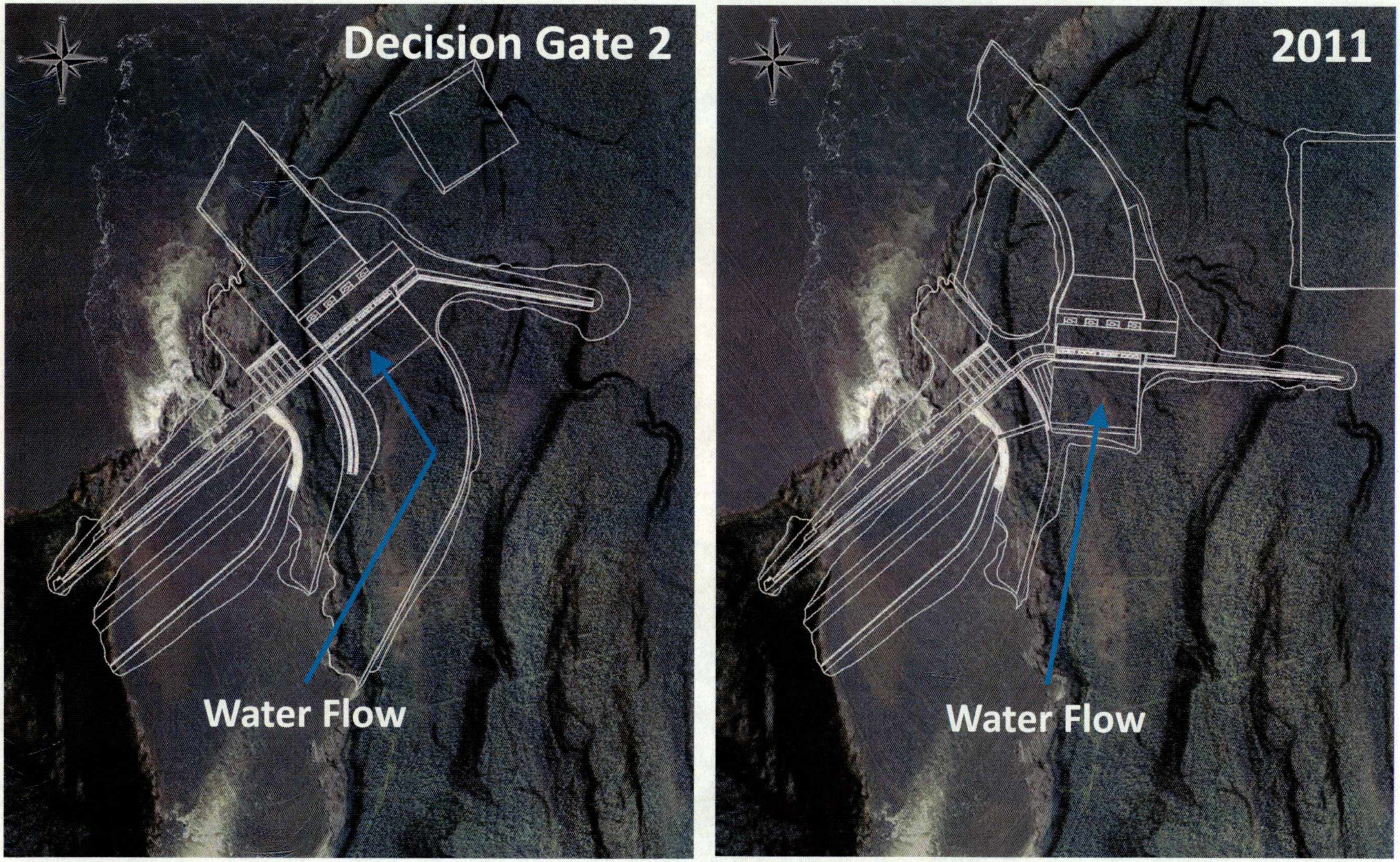
Borehole Operations at Muskrat Falls

Numerical Modeling Identified Potential Operational Integrity Issues

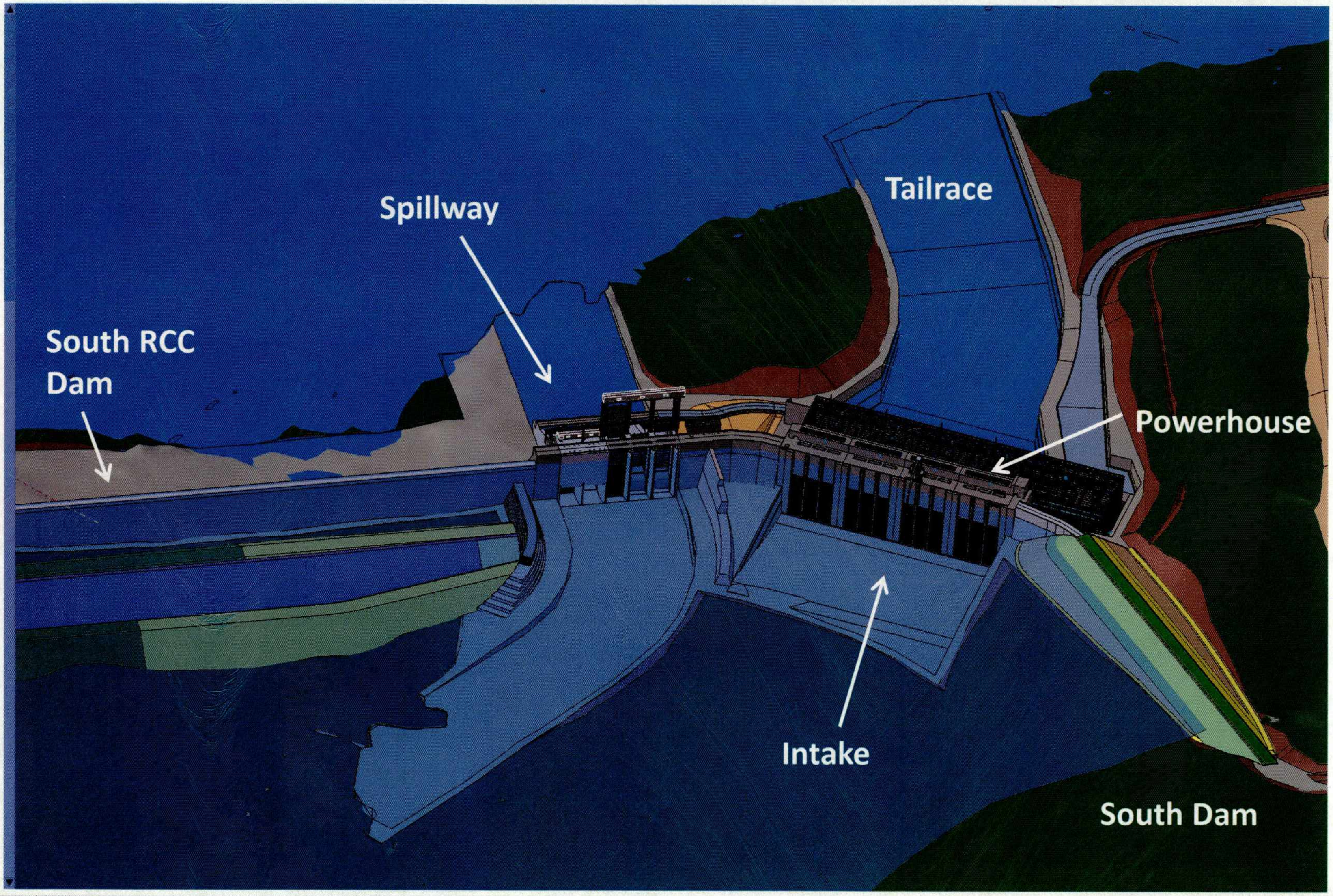
- Hydraulic conditions near the surface upstream of the intake indicated the presence of eddies and flow velocity parallel to the intake at Unit 1 (at the top of the graph).
- These conditions indicate a possible problem at this unit, including the possibility of a vortex, increase of head losses at the intake or non-optimal flow conditions at the unit.



Solution: Plant Reorientation by 30°



Revised Layout Designed in 3D CAD



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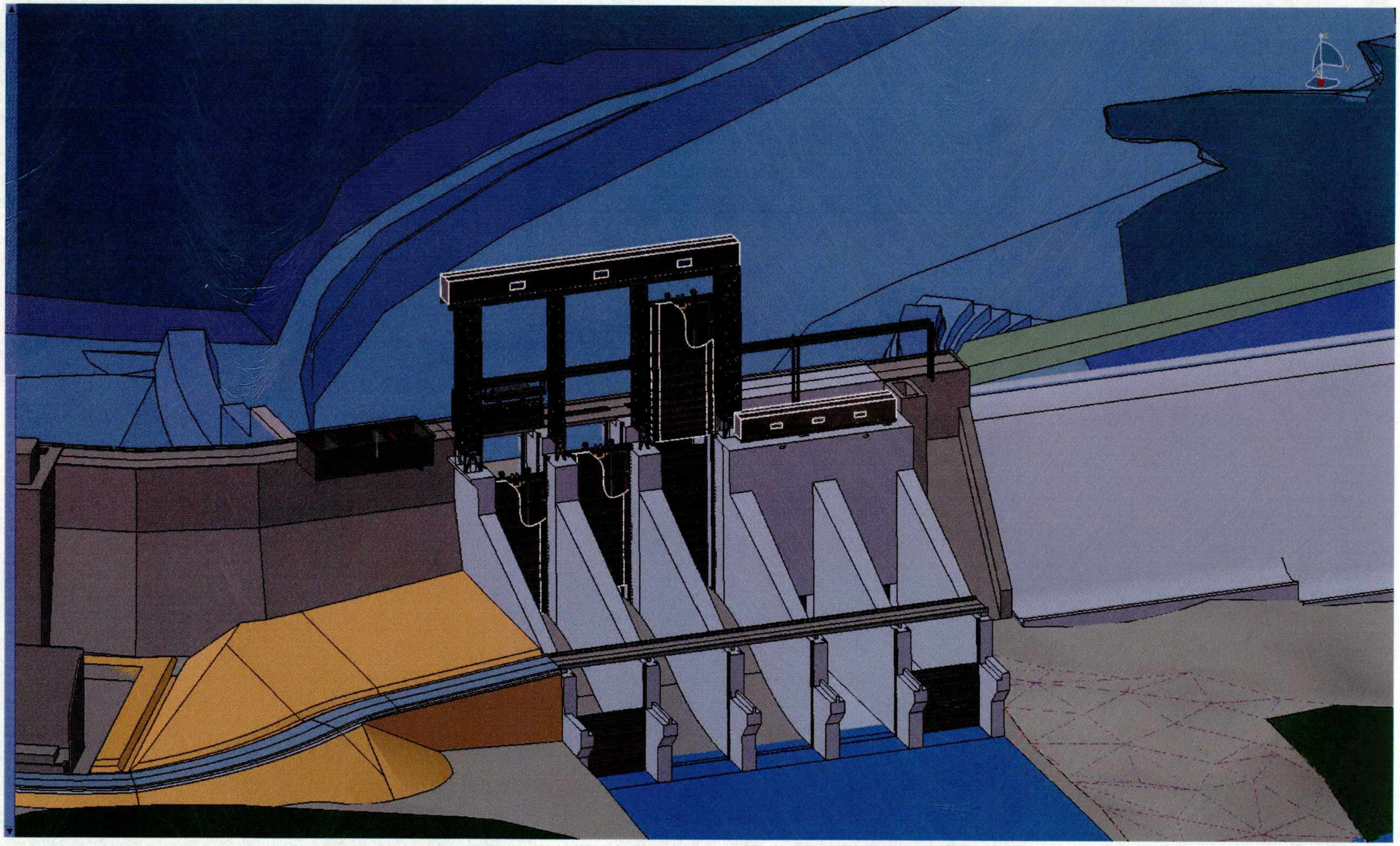
Design Optimization Continued
(Radial versus Vertical Spillway Gates)



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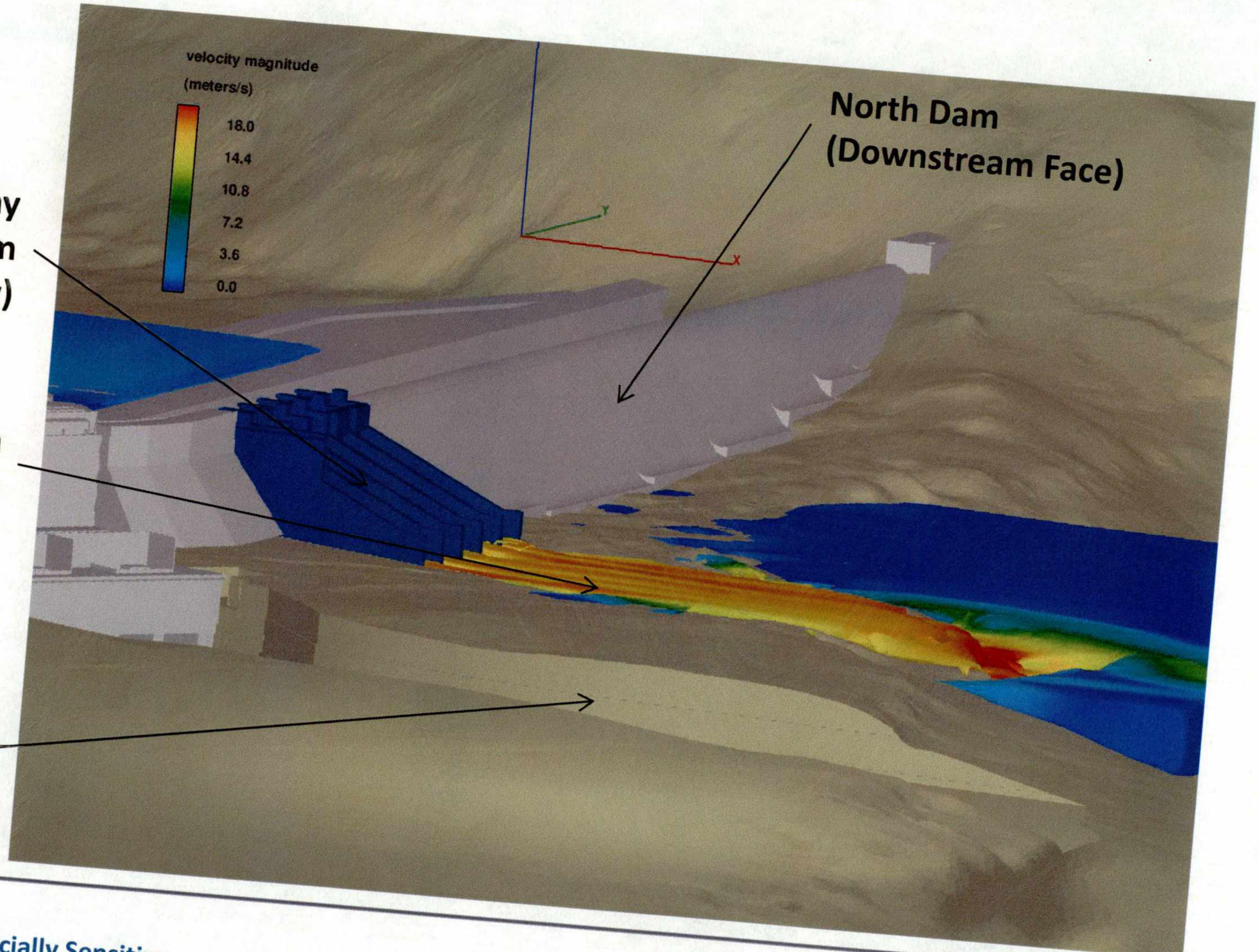
Spillway – Assessing Downstream Erosion

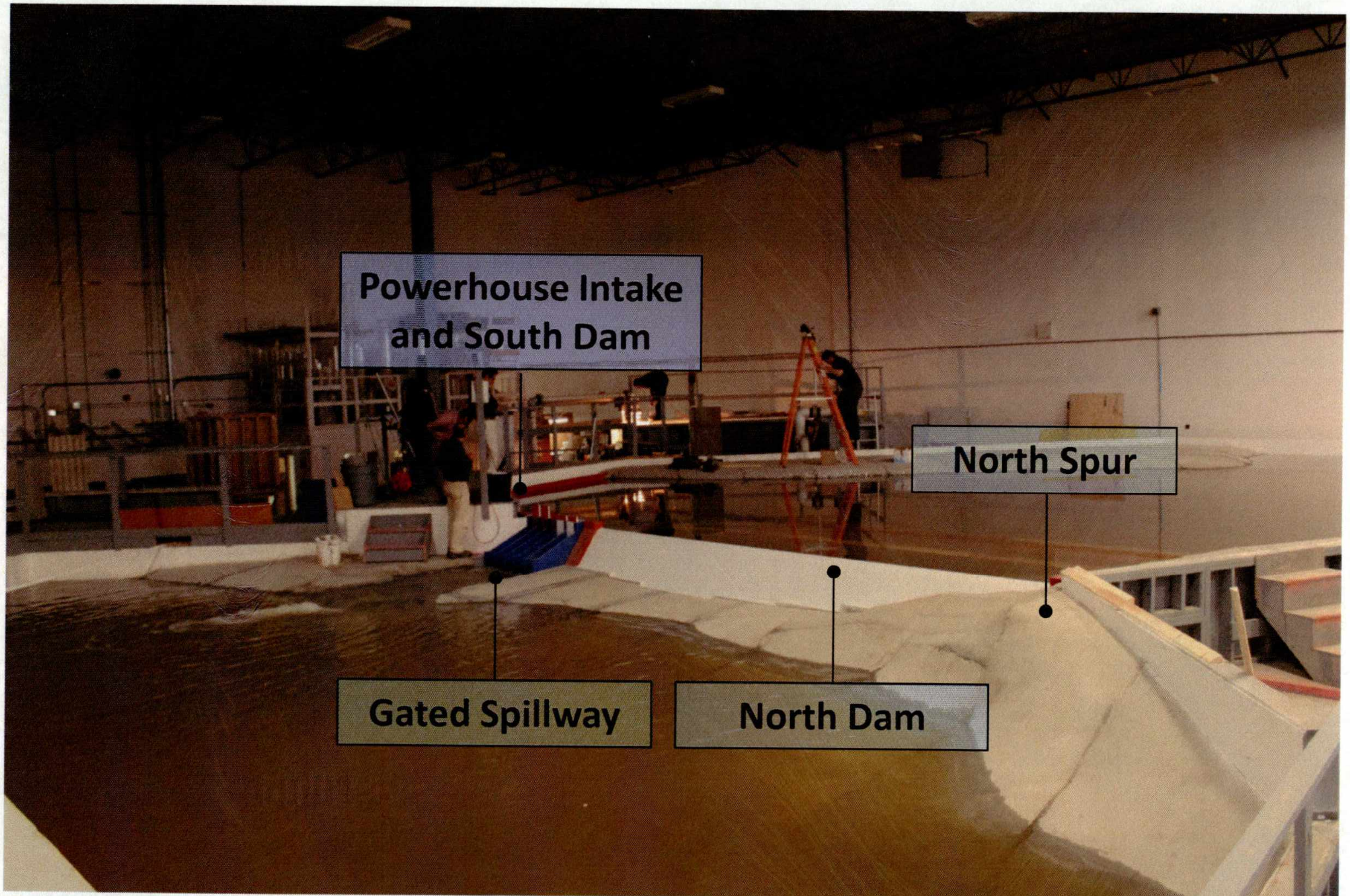


Spillway (Downstream View)

Flow through Spillway

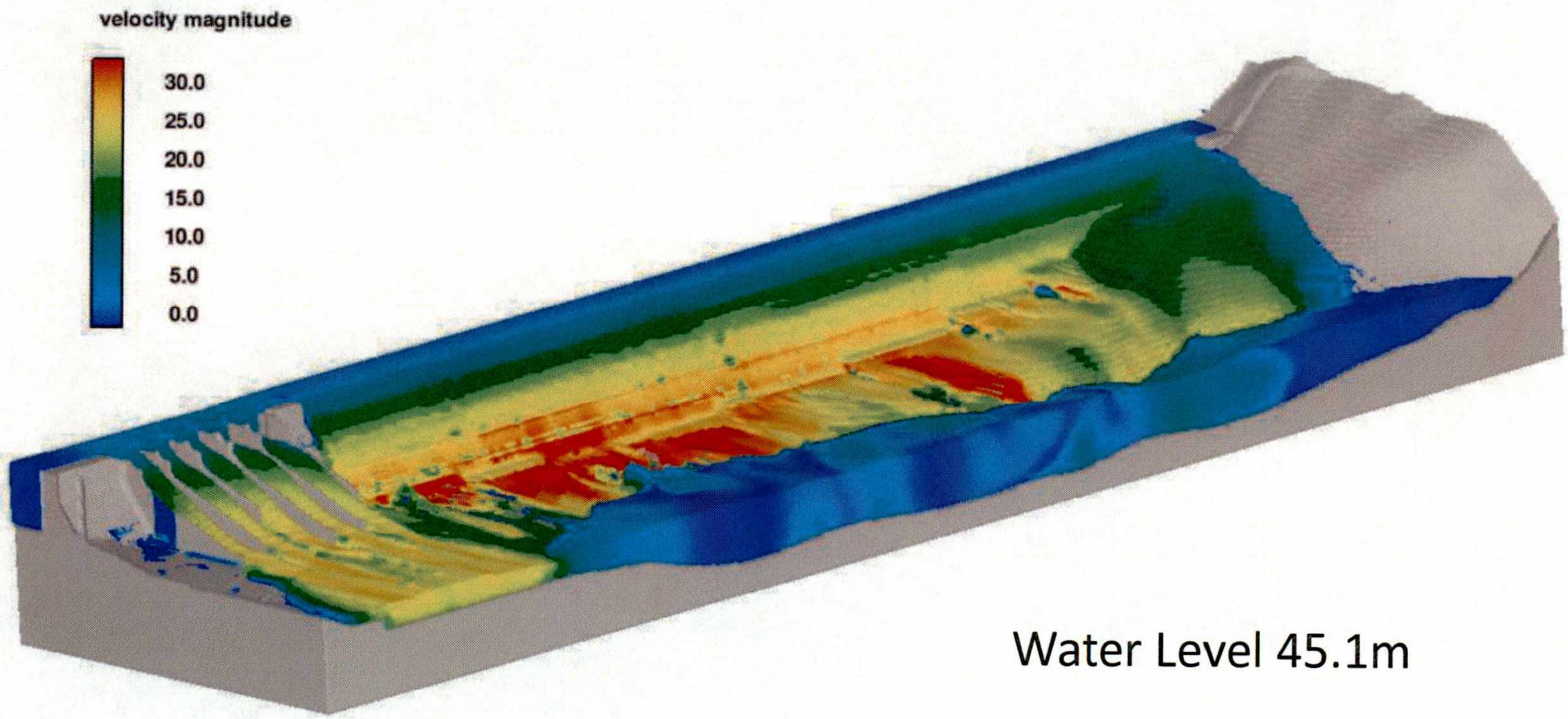
Powerhouse Tailrace Channel

Layout Verified by Scaled Operational Model



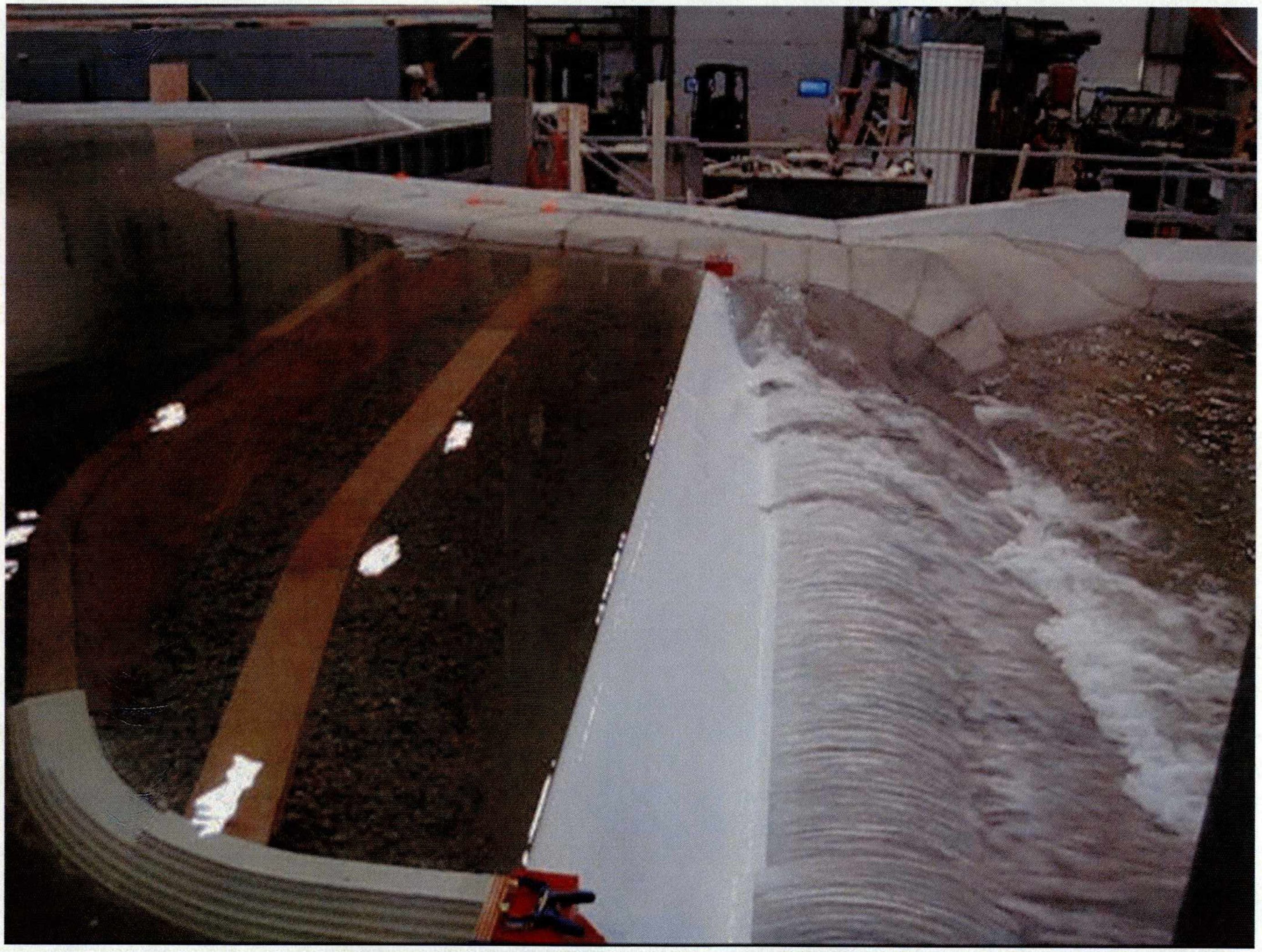
Muskrat Falls Spillway

Numerical Modelling during PMF Event



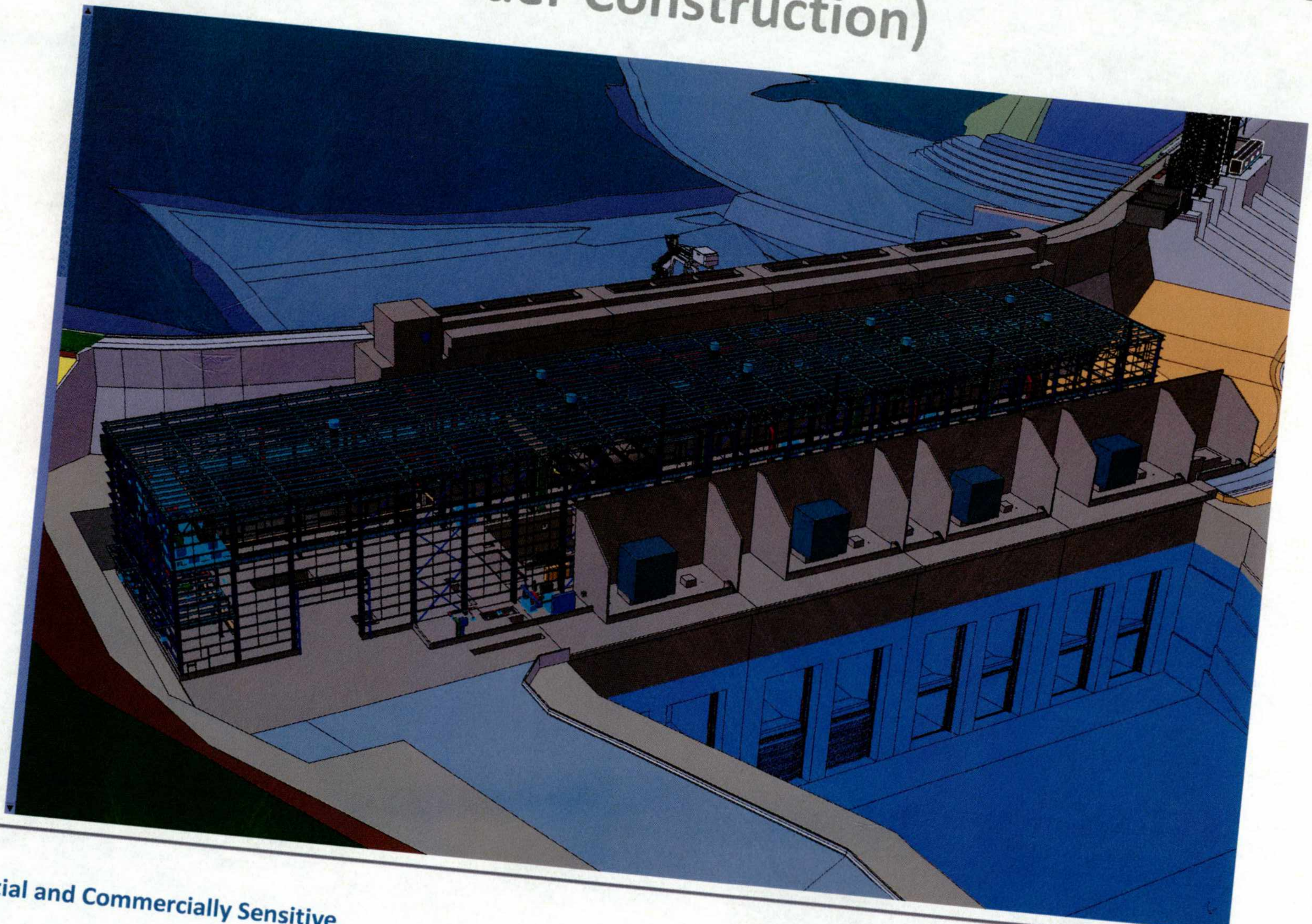
Water Level 45.1m

Rare Operational Events Modelled
(North RCC Dam – Secondary Spillway)

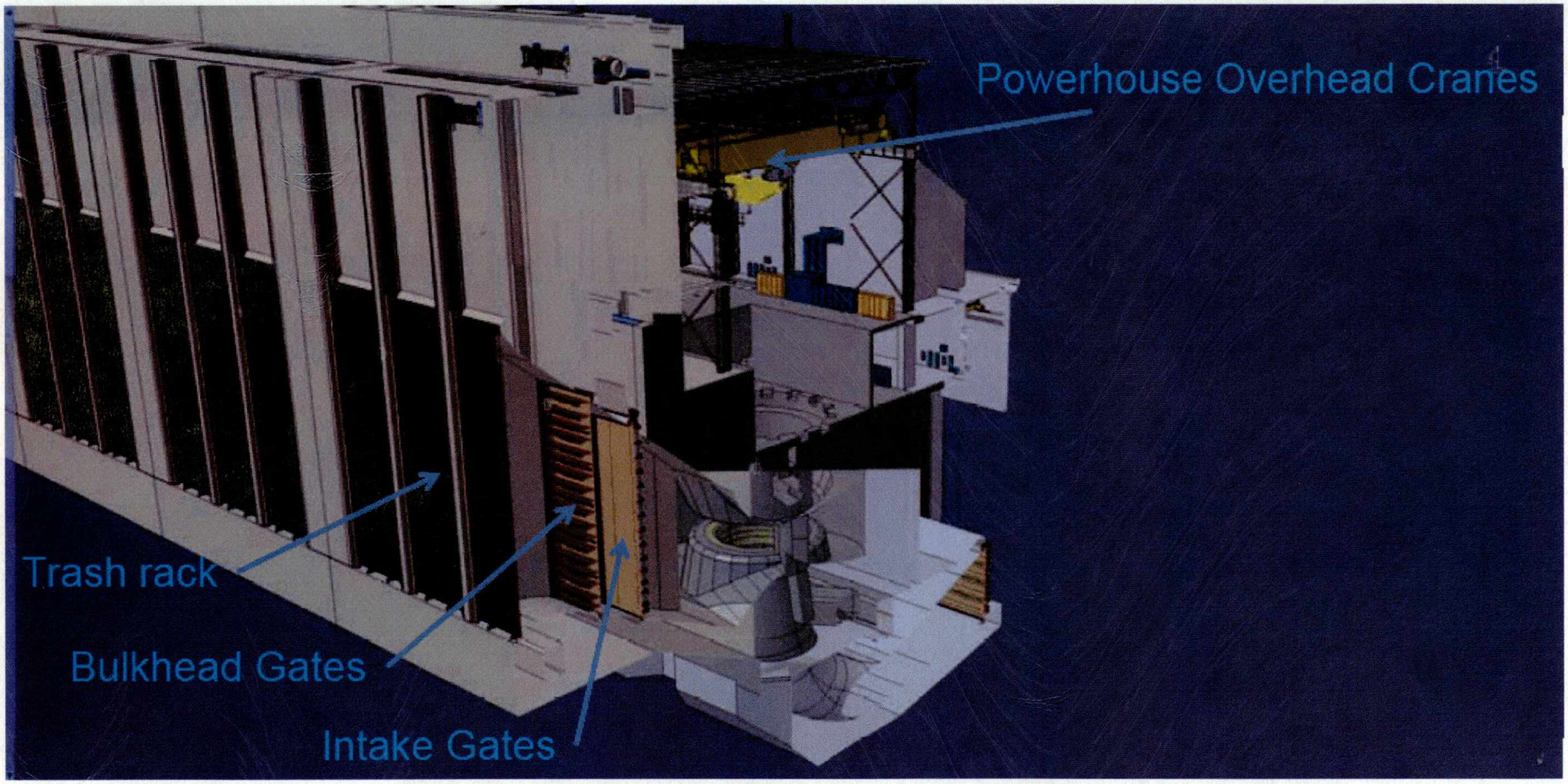


Video

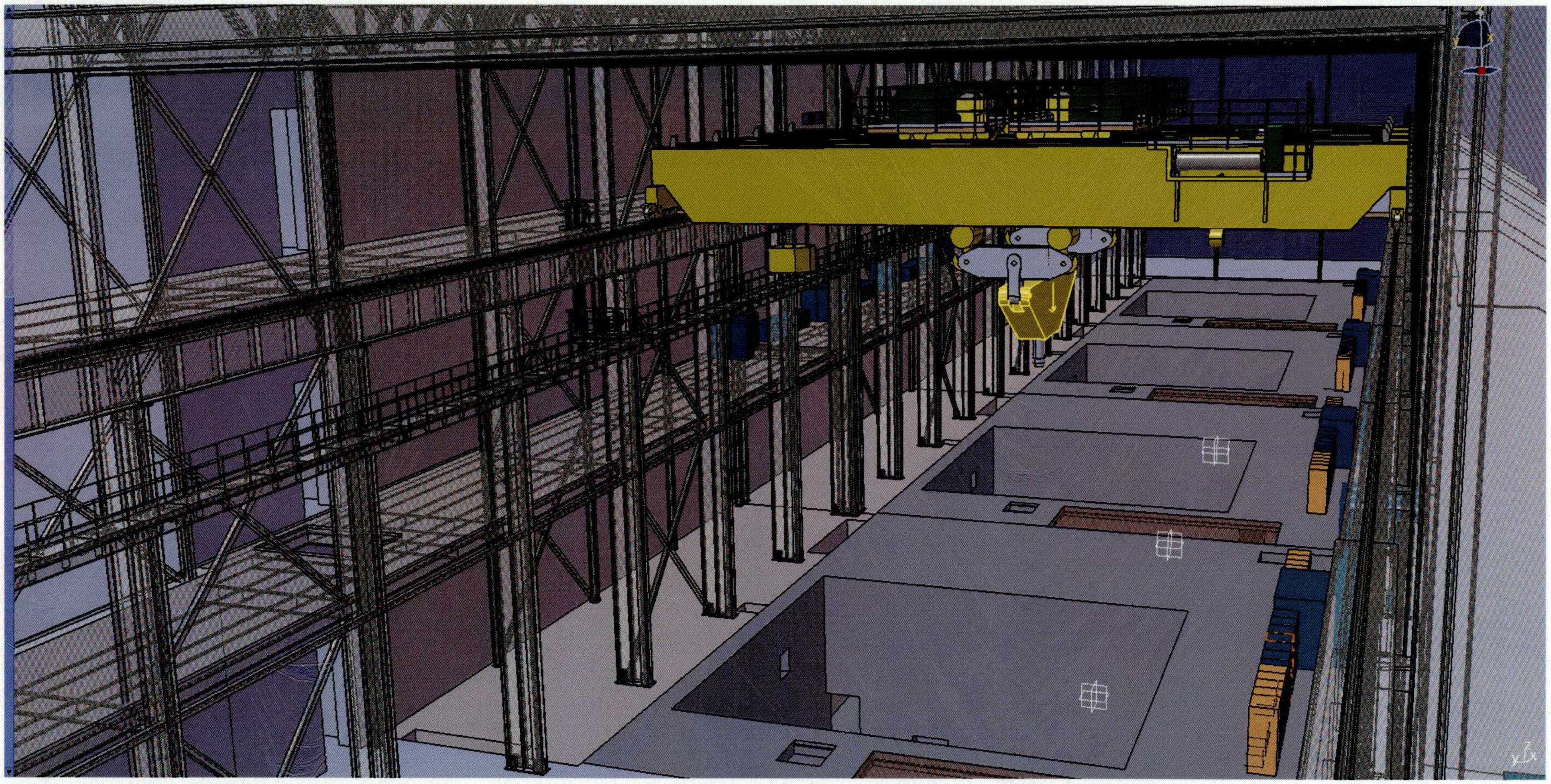
3D Model used for Construction Planning (Superstructure under Construction)



Powerhouse Cross-Section

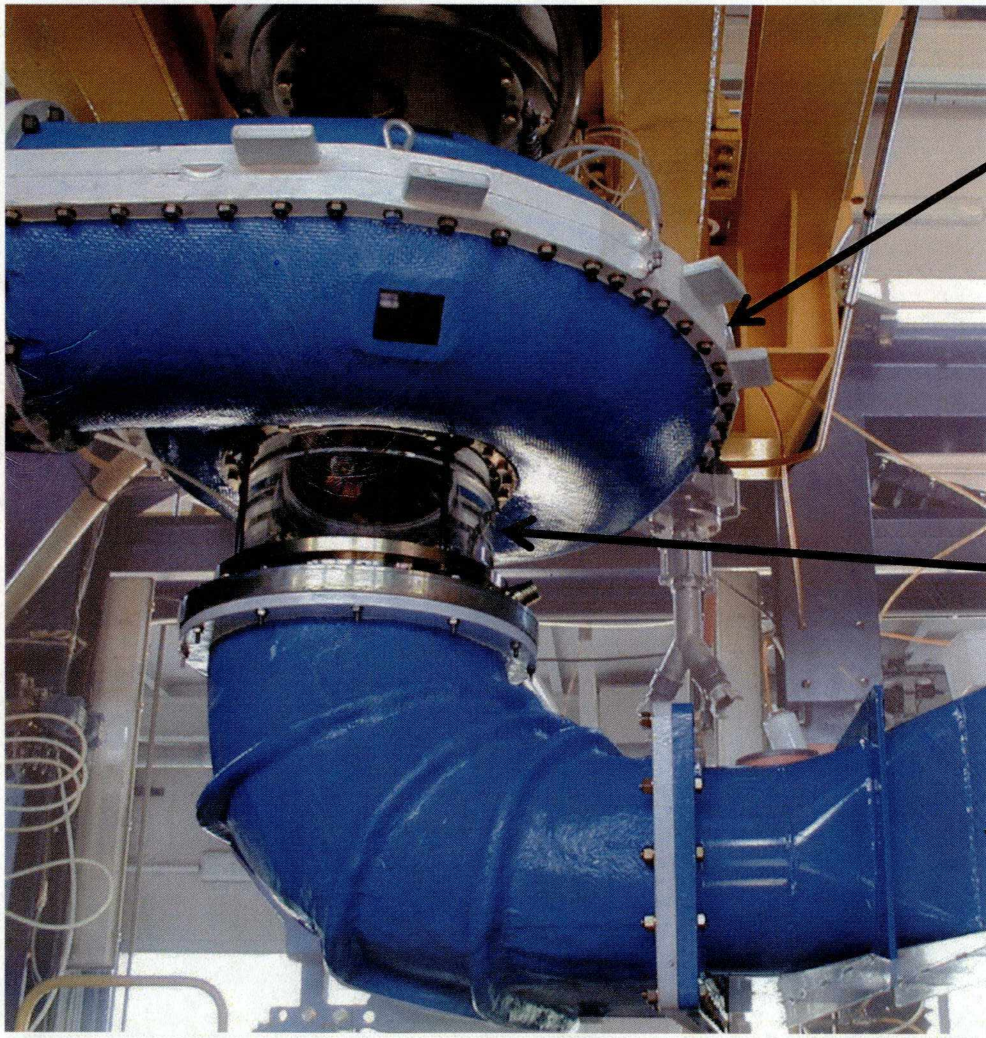


Powerhouse Cranes
(2 x 350 tons Working in Tandem)

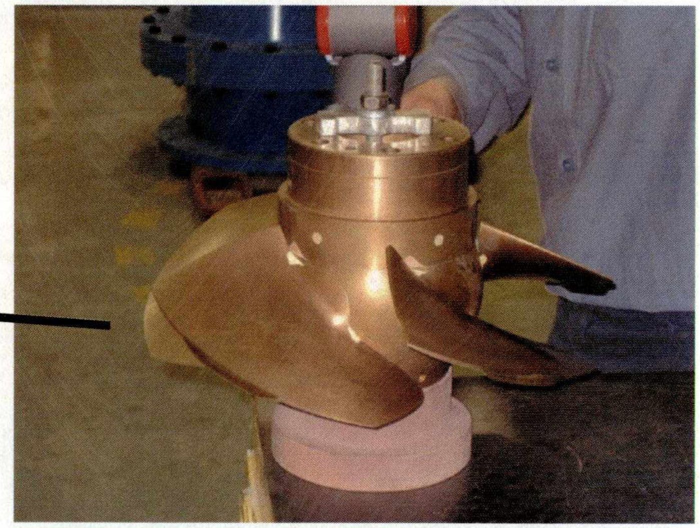


Operational and Schedule Risk Reduction

Turbine Model Testing



Scroll Case



Runner Model (Diameter = 0.380m)

Draft Tube

Early Infrastructure Works
(As of August 13, 2012)

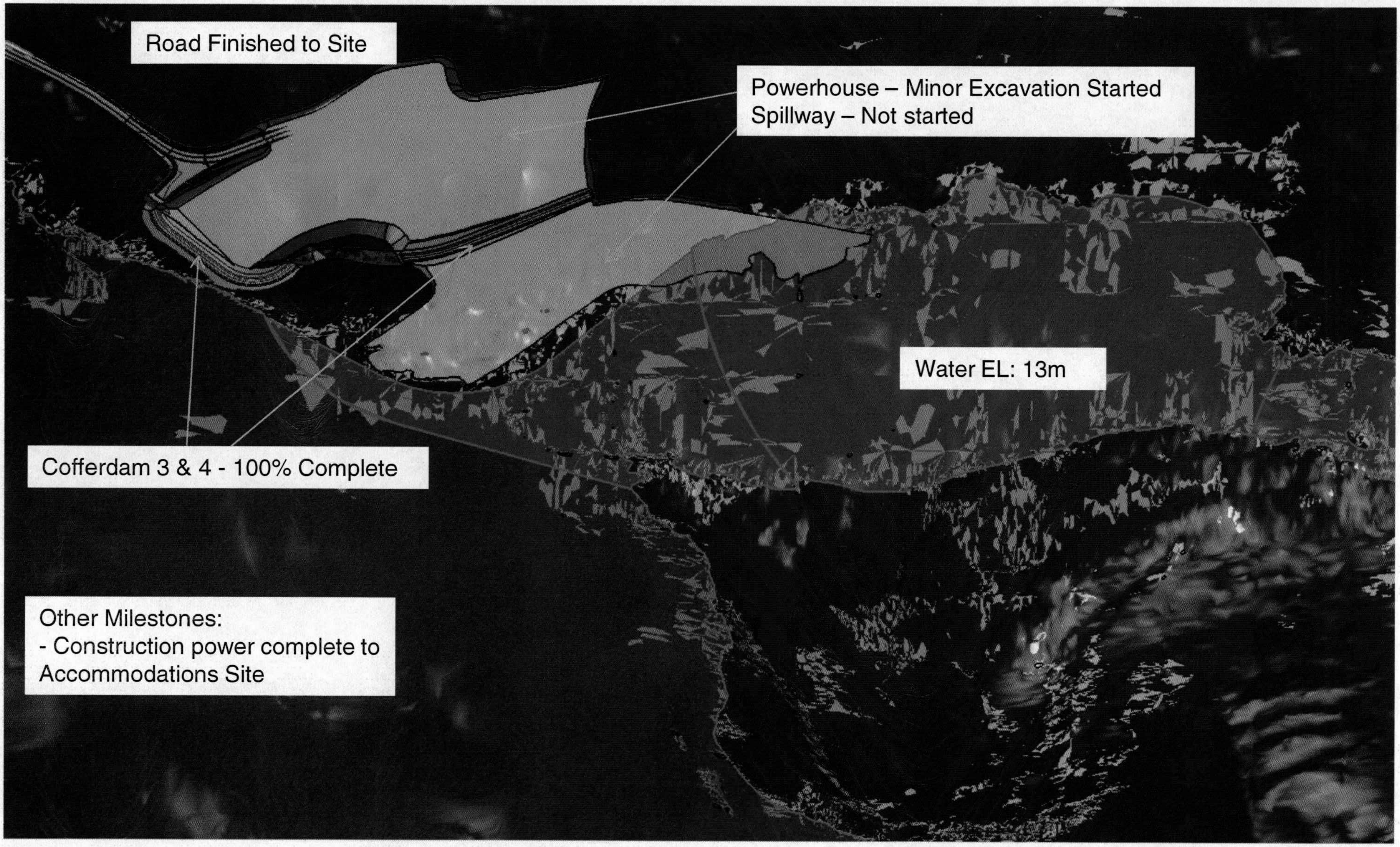
MF Access Road Construction

Placing poles on 25 kV Line

Muskrat Falls Construction Sequence

2012 – December

Note: All Progress % are approximate



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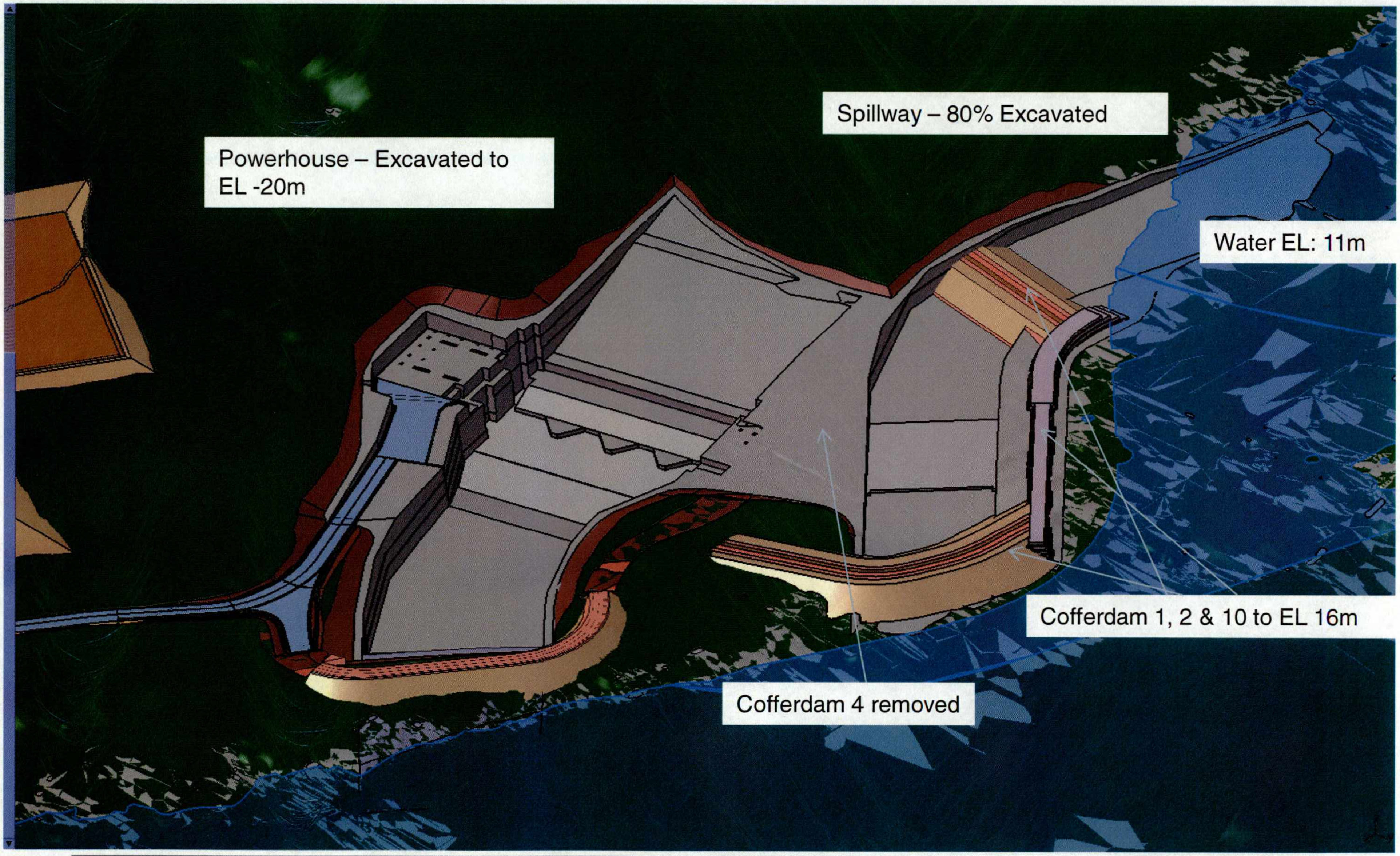
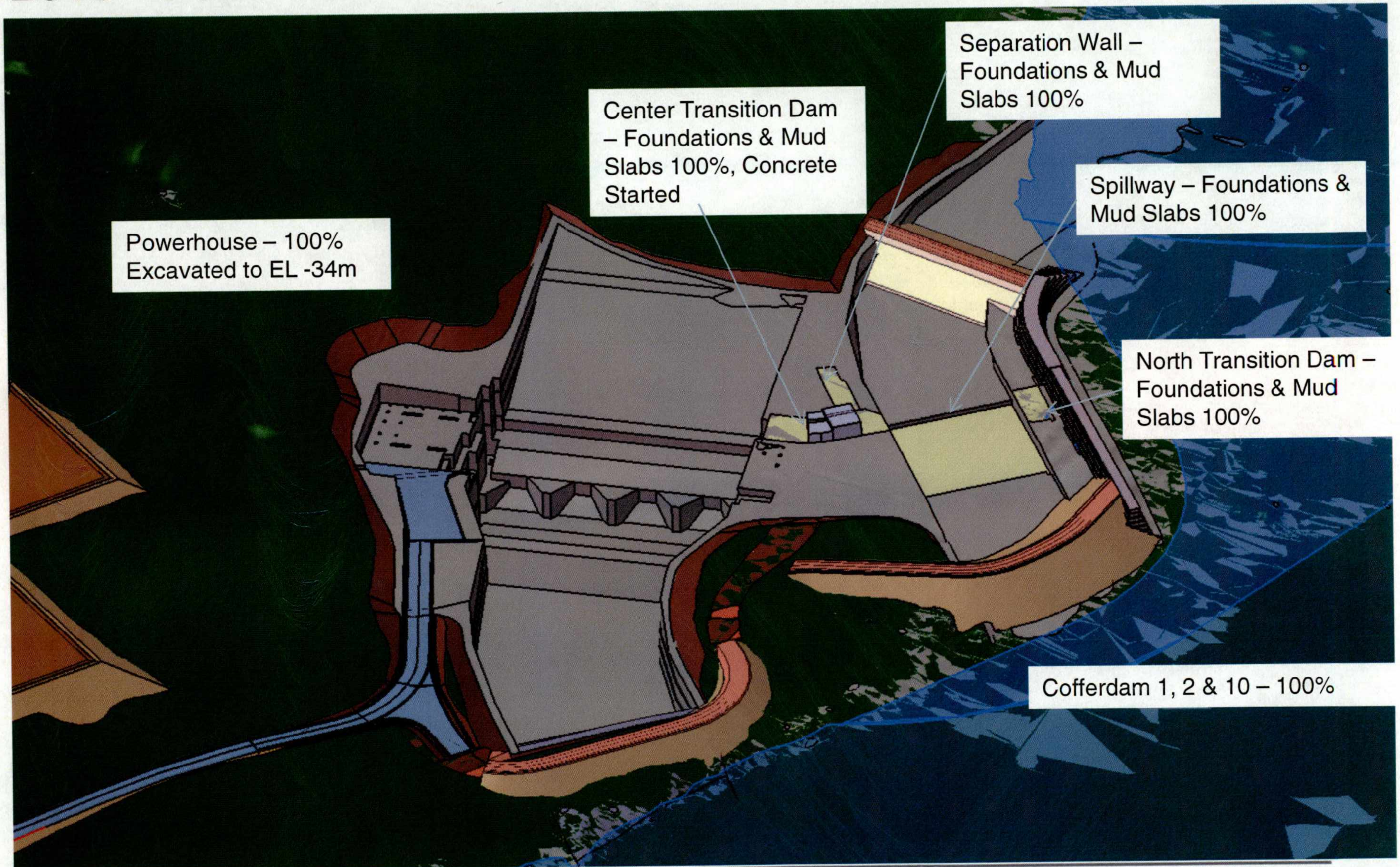
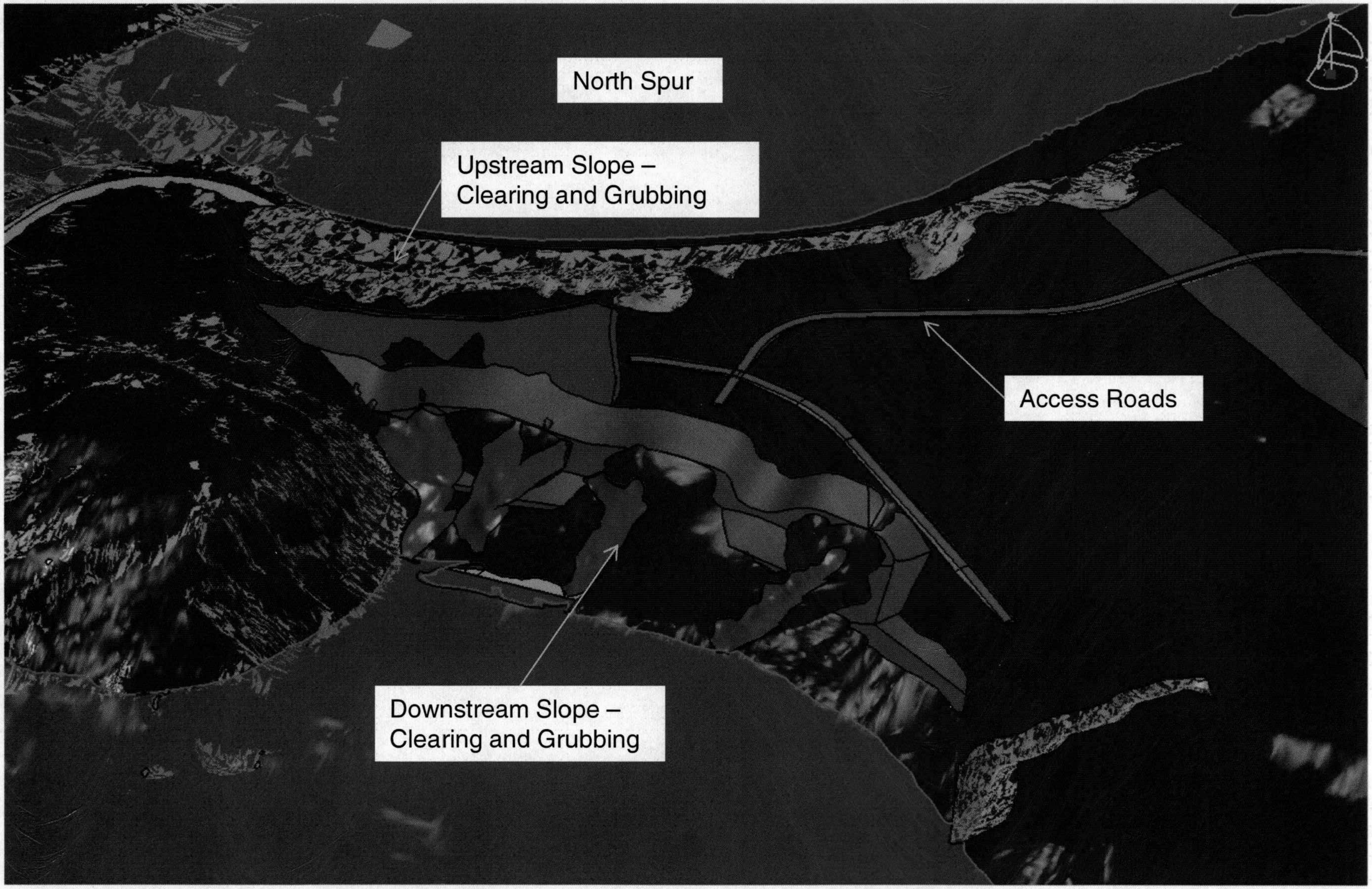
2013 – September



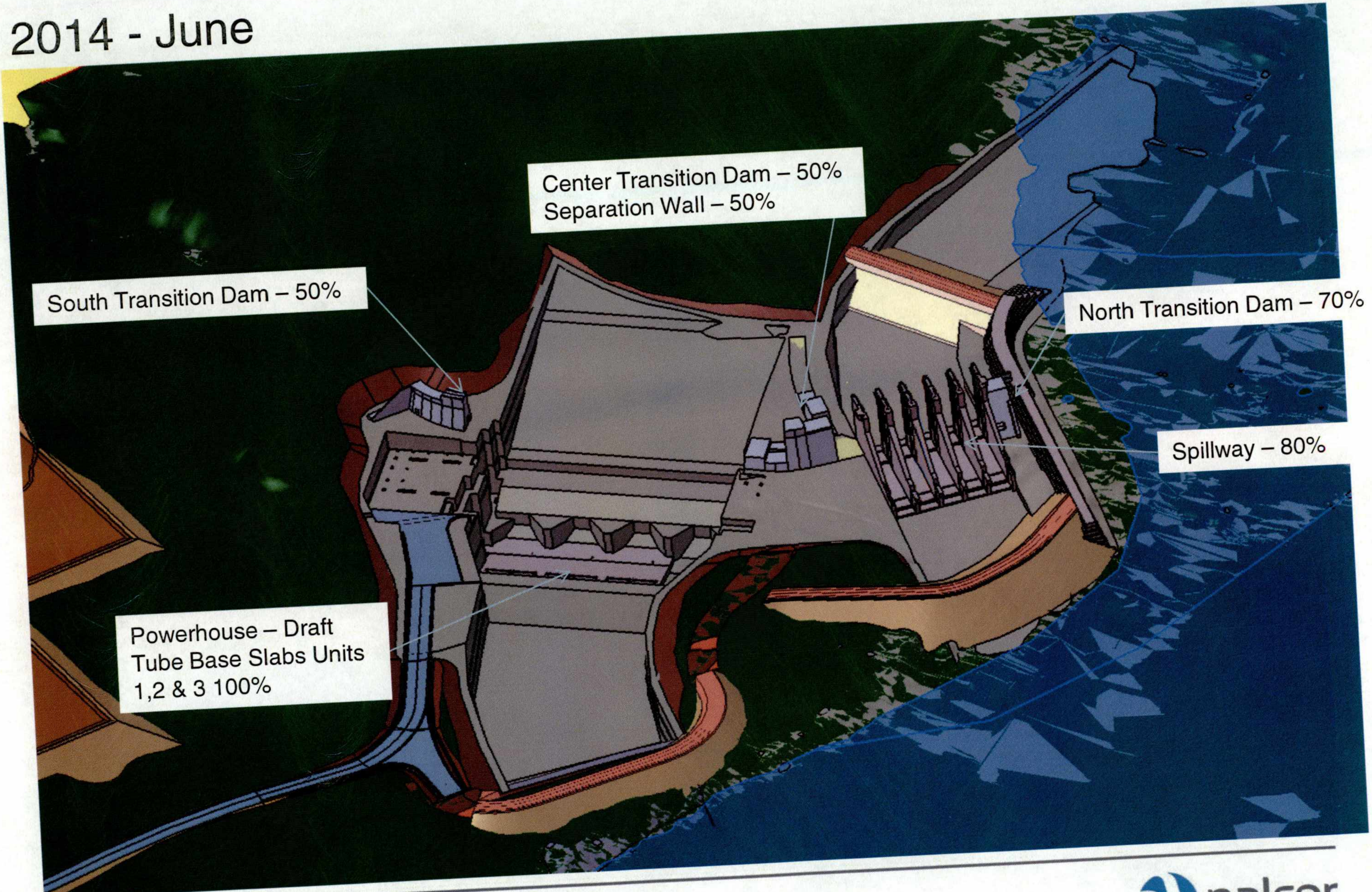
2013 - December



2013 – December (Continued)



2014 - June



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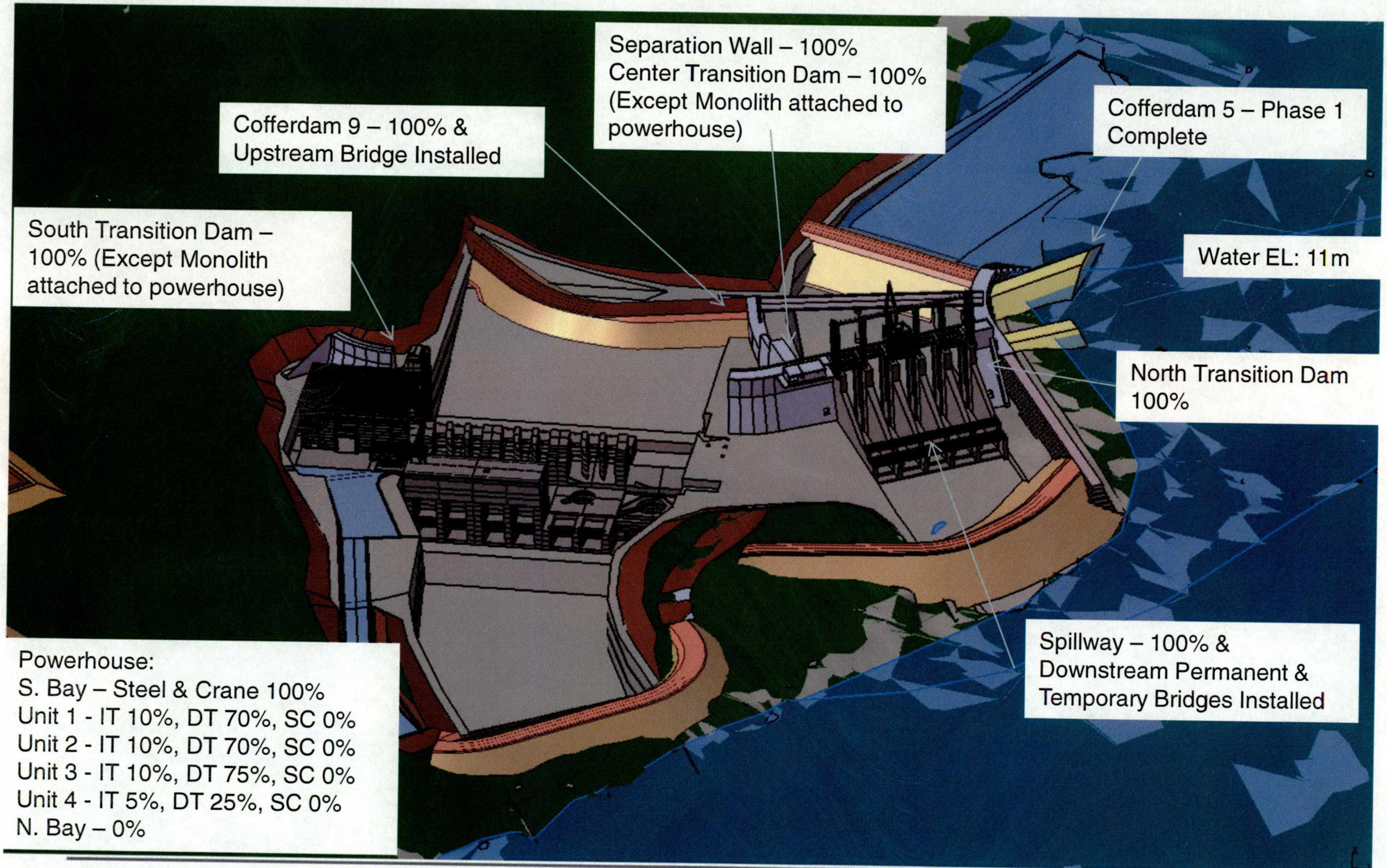
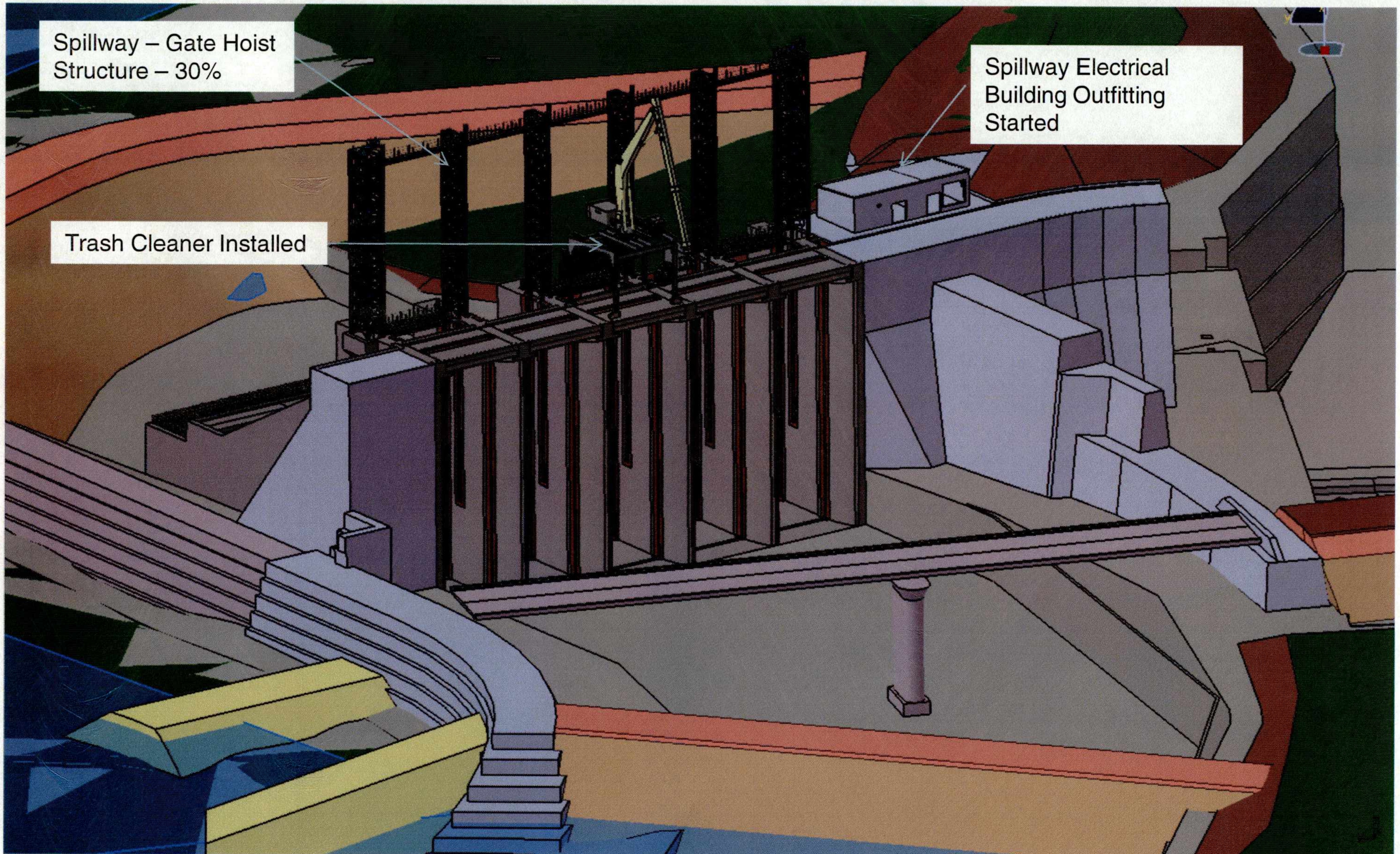
2014 - December



2014 – December (Continued)



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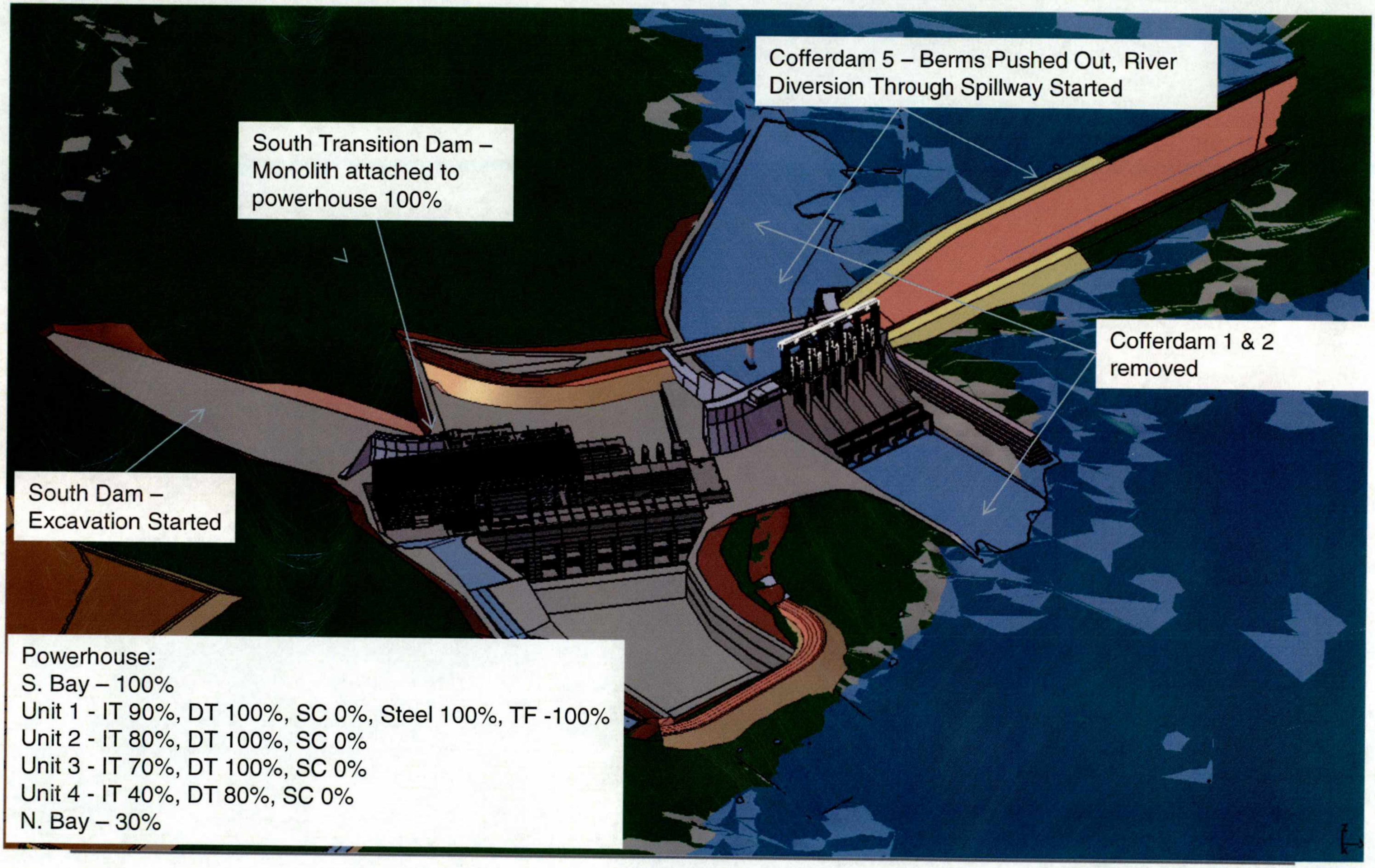
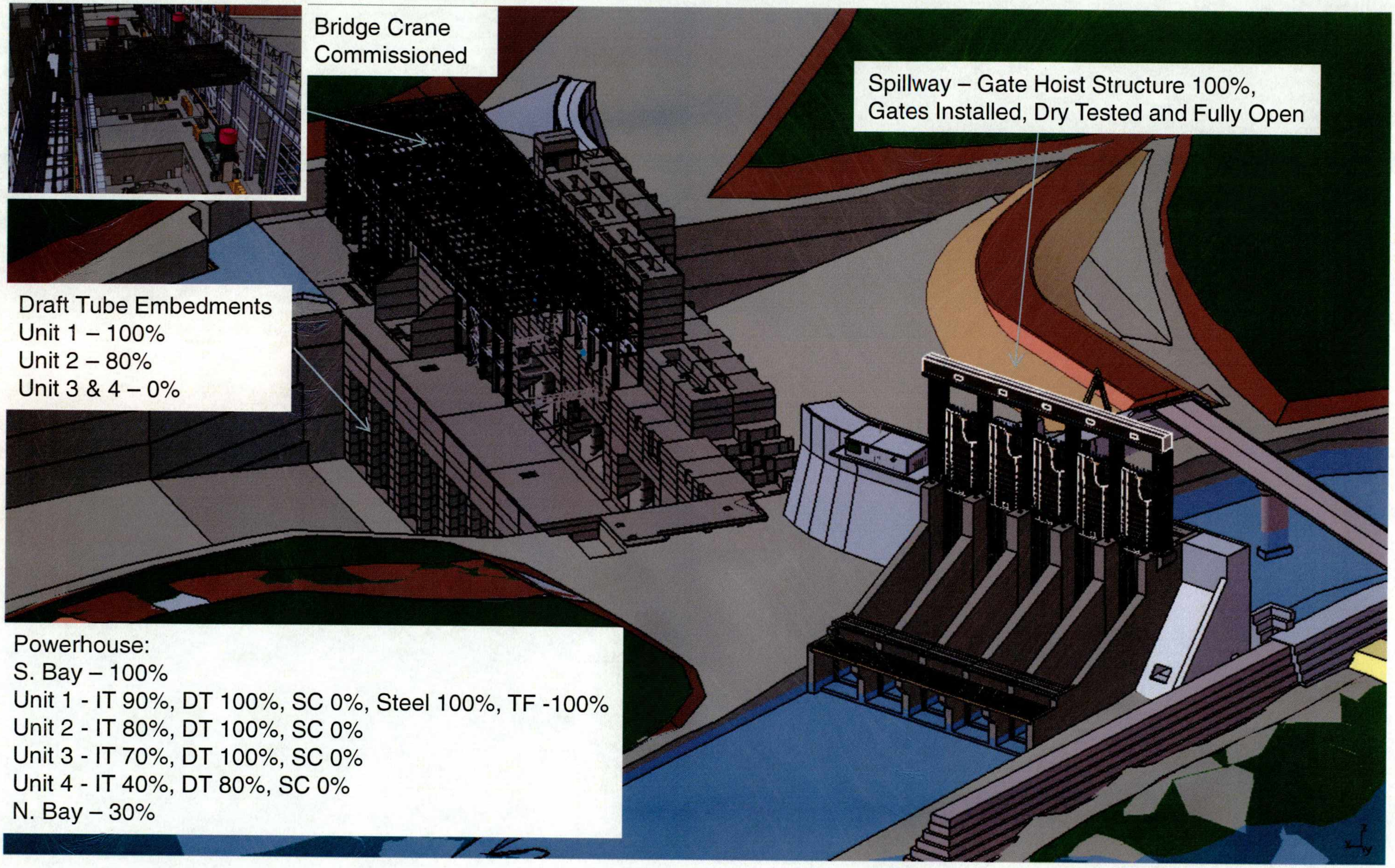
2015 - June


South Transition Dam – Monolith attached to powerhouse 100%
Cofferdam 5 – Berms Pushed Out, River Diversion Through Spillway Started
Cofferdam 1 & 2 removed
South Dam – Excavation Started
Powerhouse:
S. Bay – 100%
Unit 1 - IT 90%, DT 100%, SC 0%, Steel 100%, TF -100%
Unit 2 - IT 80%, DT 100%, SC 0%
Unit 3 - IT 70%, DT 100%, SC 0%
Unit 4 - IT 40%, DT 80%, SC 0%
N. Bay – 30%

2015 – June (Continued)



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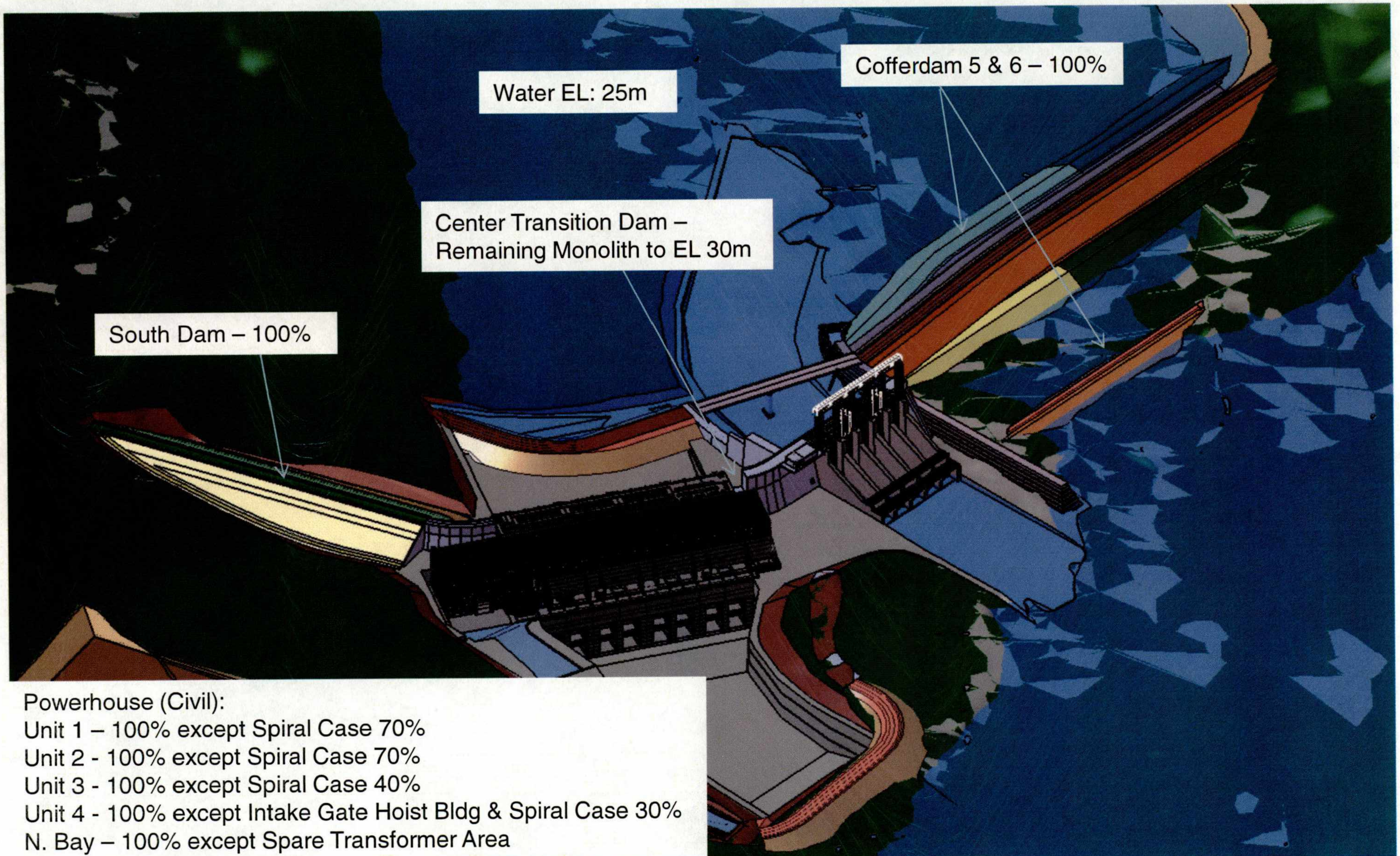
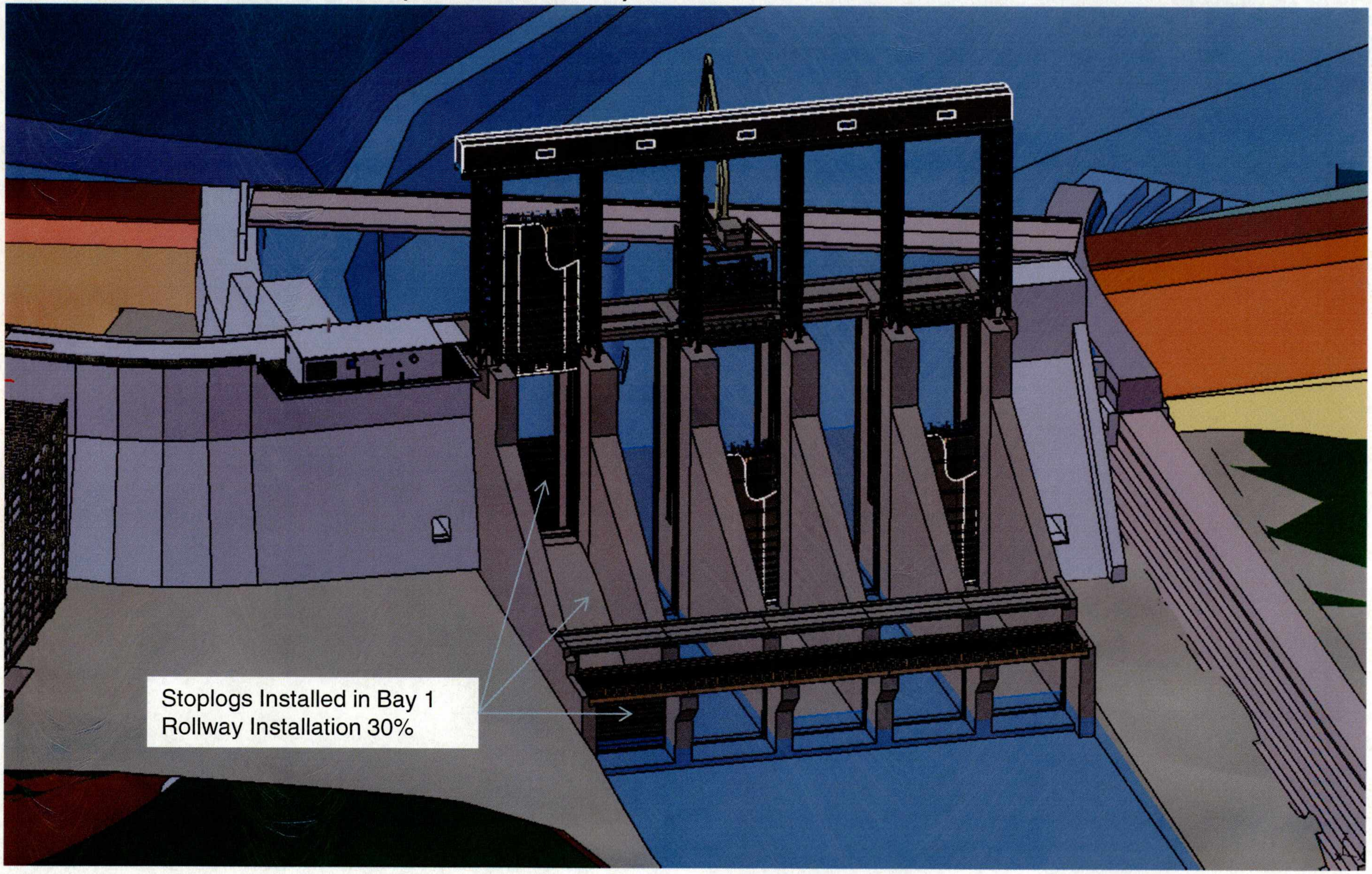
2015 – June (Continued)

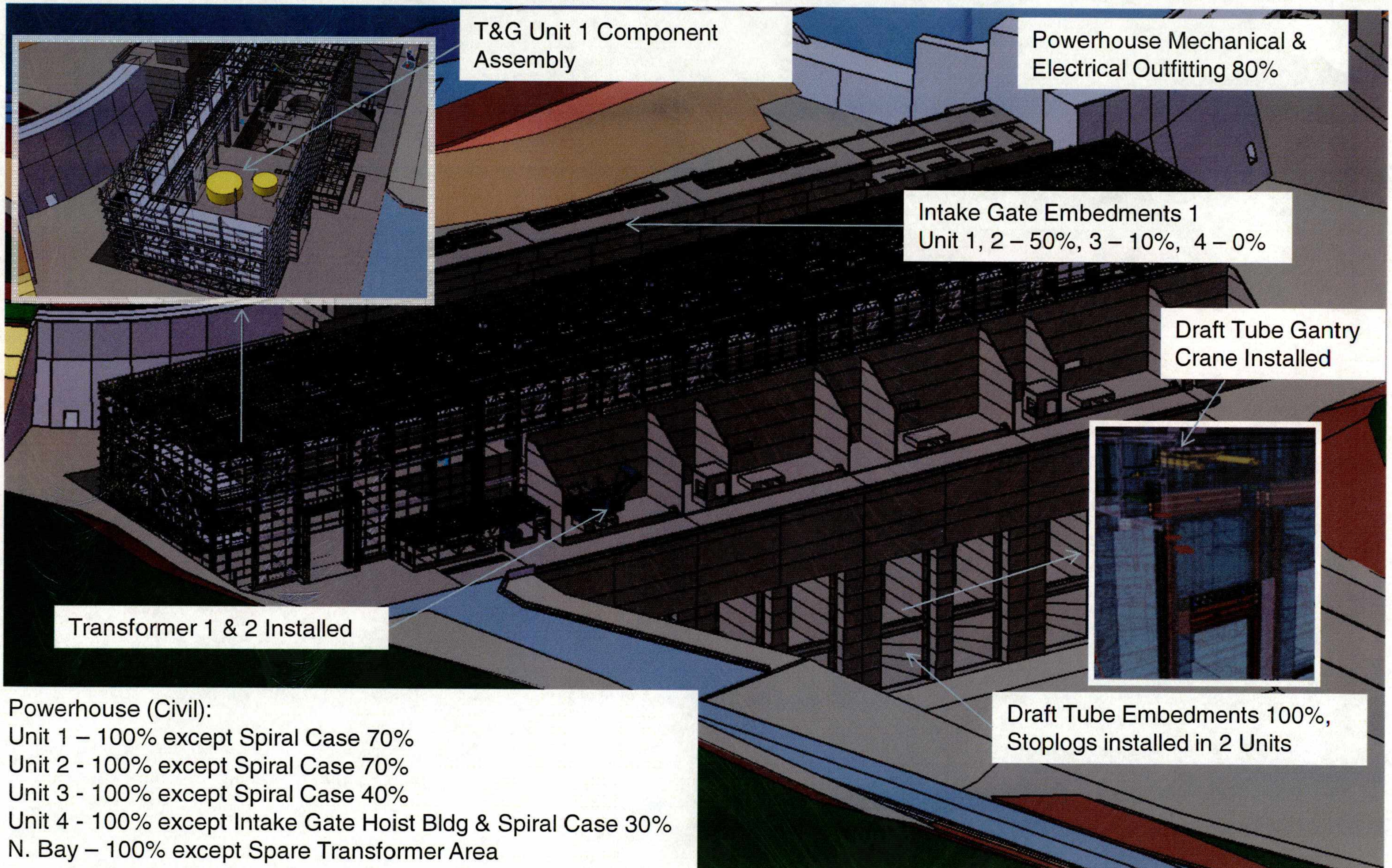
2015 - December



2015 – December (Continued)

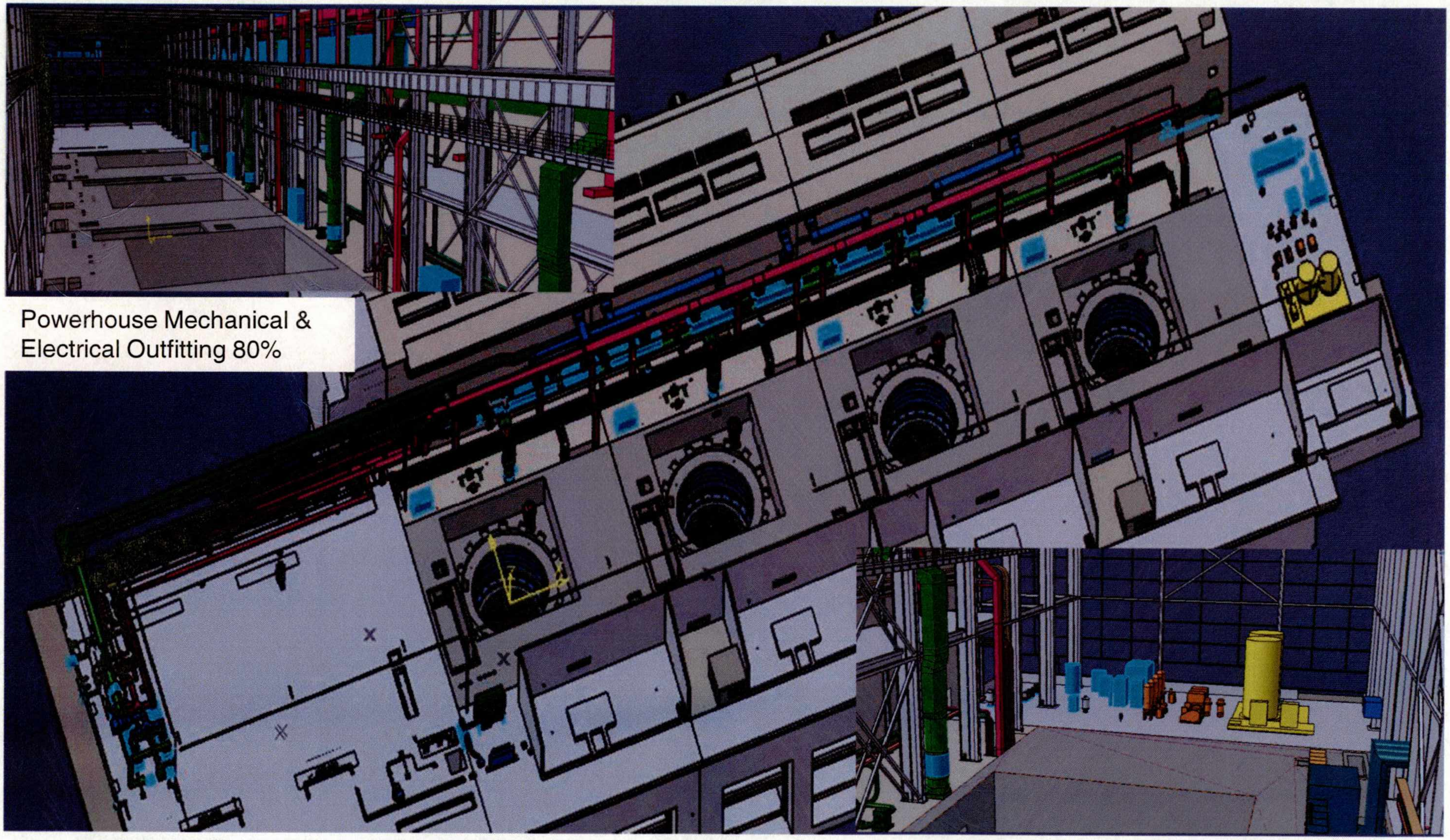


2015 – December (Continued)



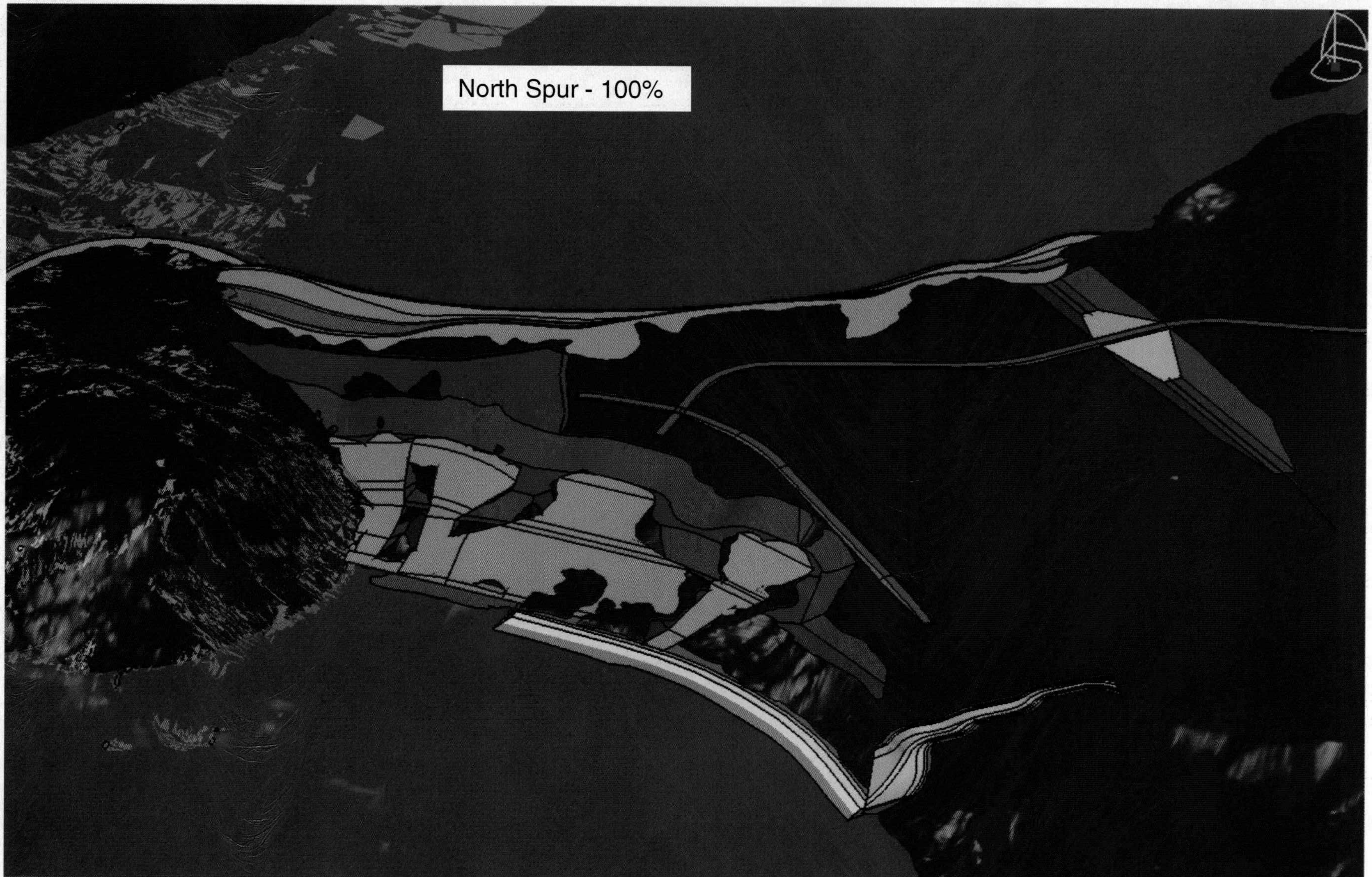
Powerhouse (Civil):
Unit 1 – 100% except Spiral Case 70%
Unit 2 - 100% except Spiral Case 70%
Unit 3 - 100% except Spiral Case 40%
Unit 4 - 100% except Intake Gate Hoist Bldg & Spiral Case 30%
N. Bay – 100% except Spare Transformer Area

2015 – December (Continued)

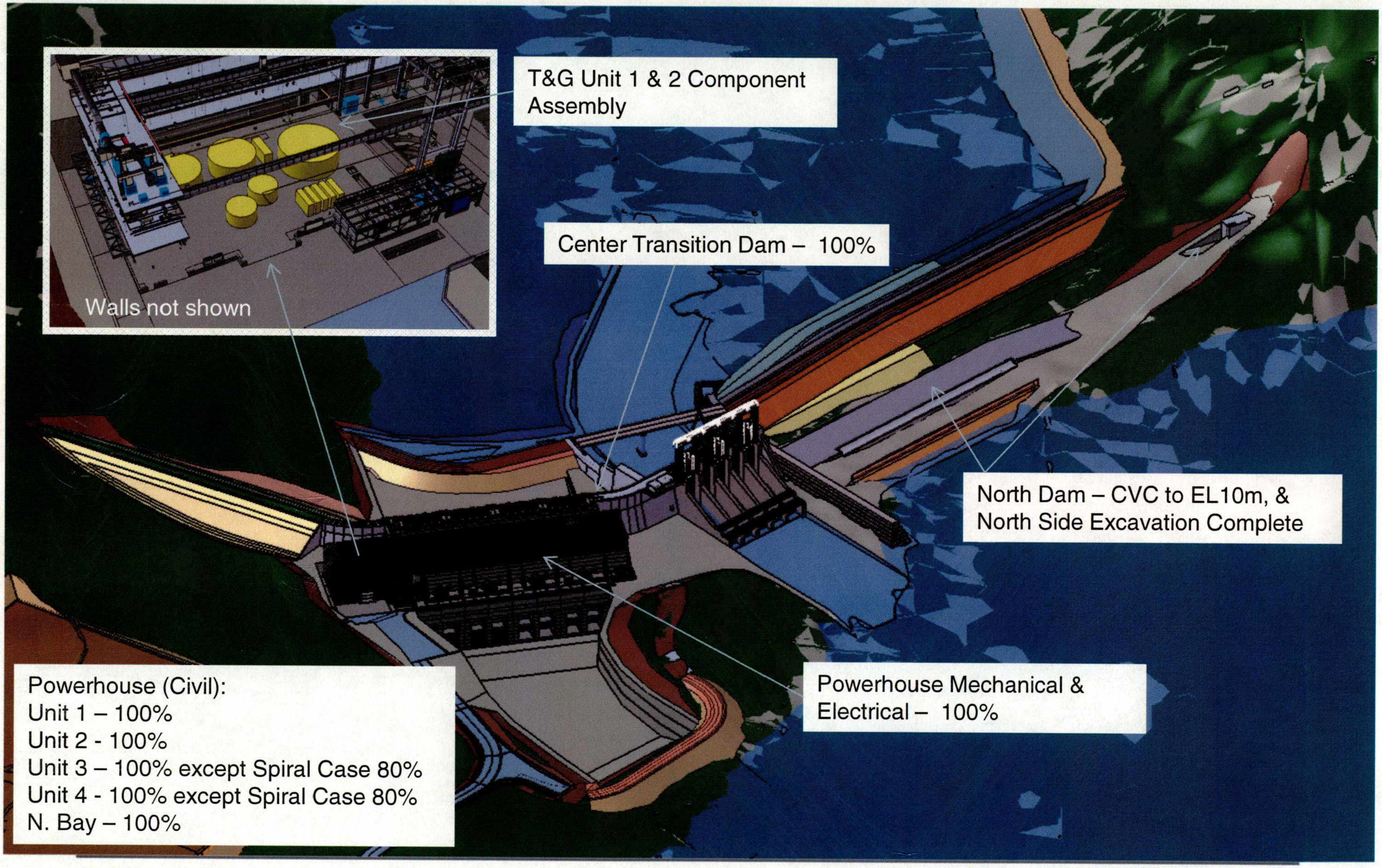


Powerhouse Mechanical & Electrical Outfitting 80%

2015 – December (Continued)

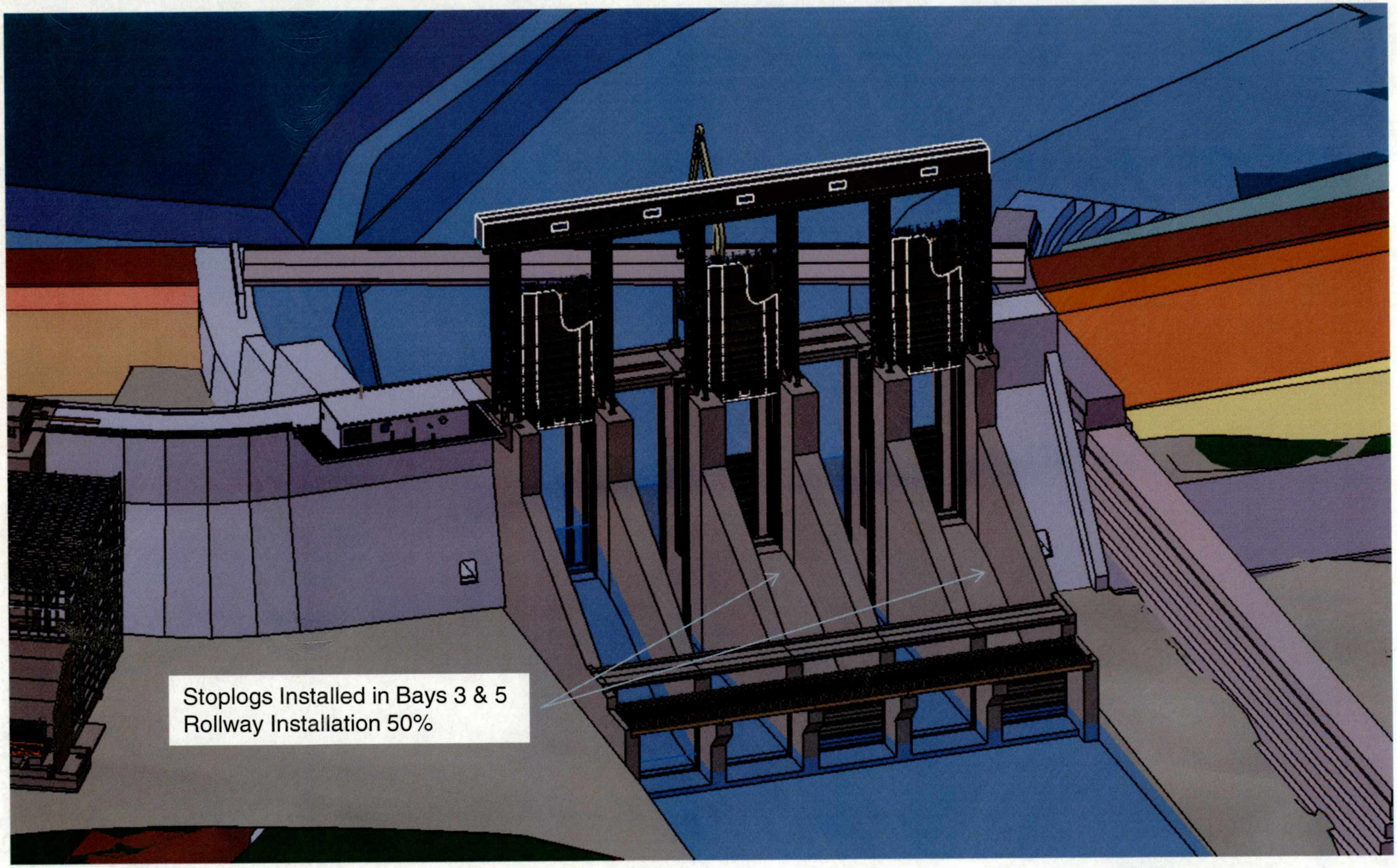


2016 – June

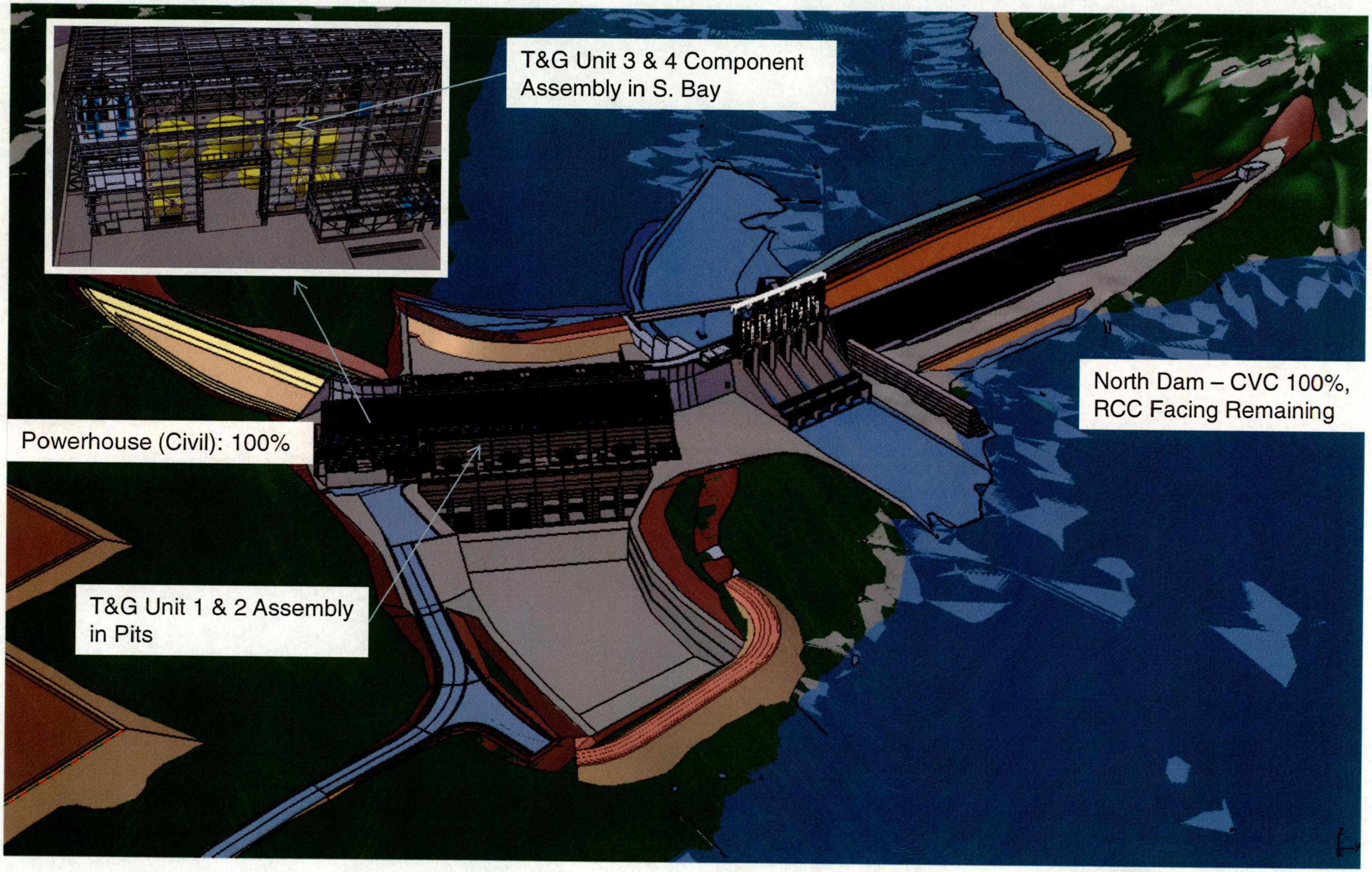

T&G Unit 1 & 2 Component Assembly
Walls not shown
Center Transition Dam – 100%
North Dam – CVC to EL10m, & North Side Excavation Complete
Powerhouse Mechanical & Electrical – 100%
Powerhouse (Civil):
Unit 1 – 100%
Unit 2 - 100%
Unit 3 – 100% except Spiral Case 80%
Unit 4 - 100% except Spiral Case 80%
N. Bay – 100%

2016 – June (Continued)

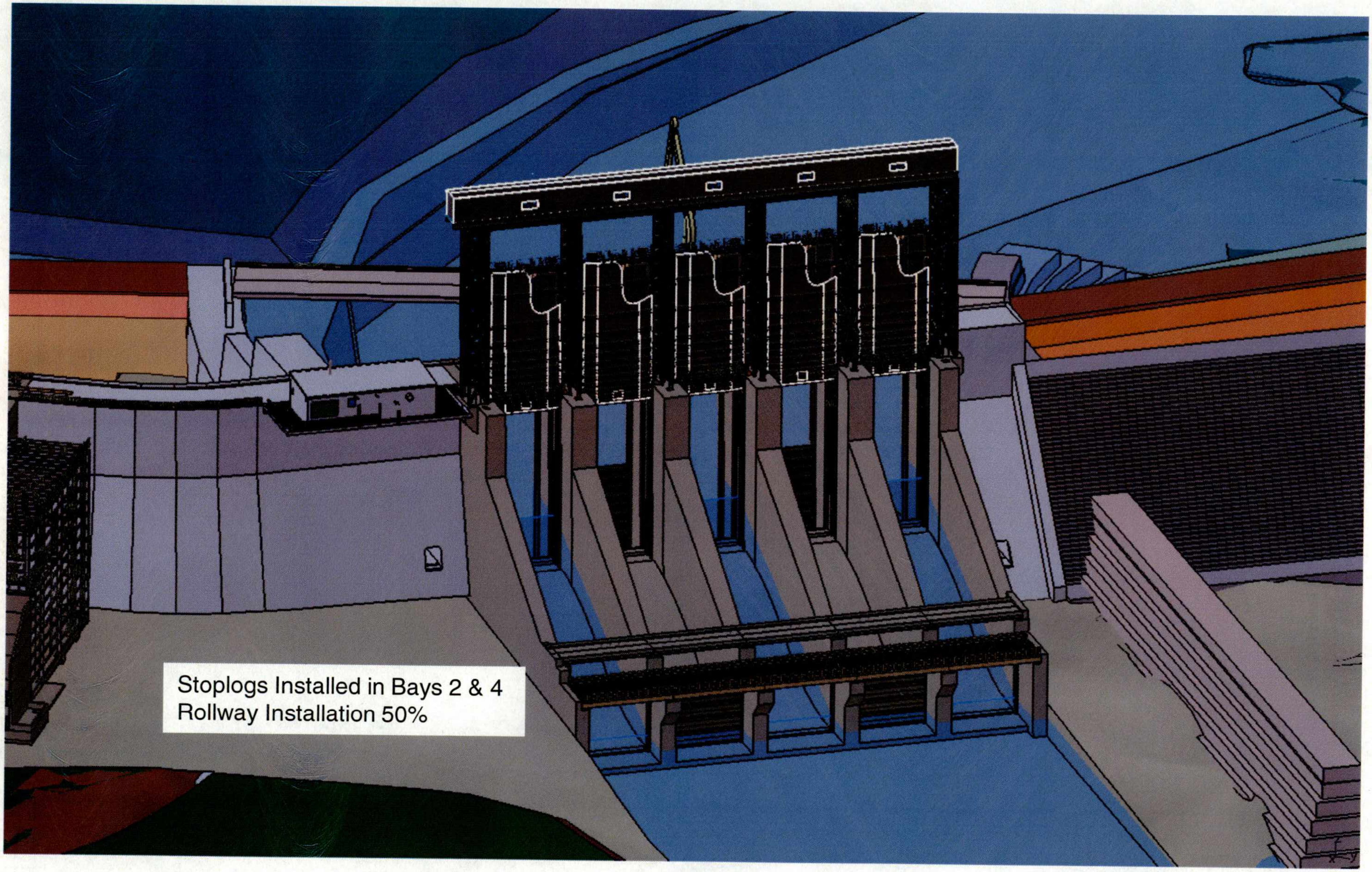
2016 – June (Continued)



2016 – December

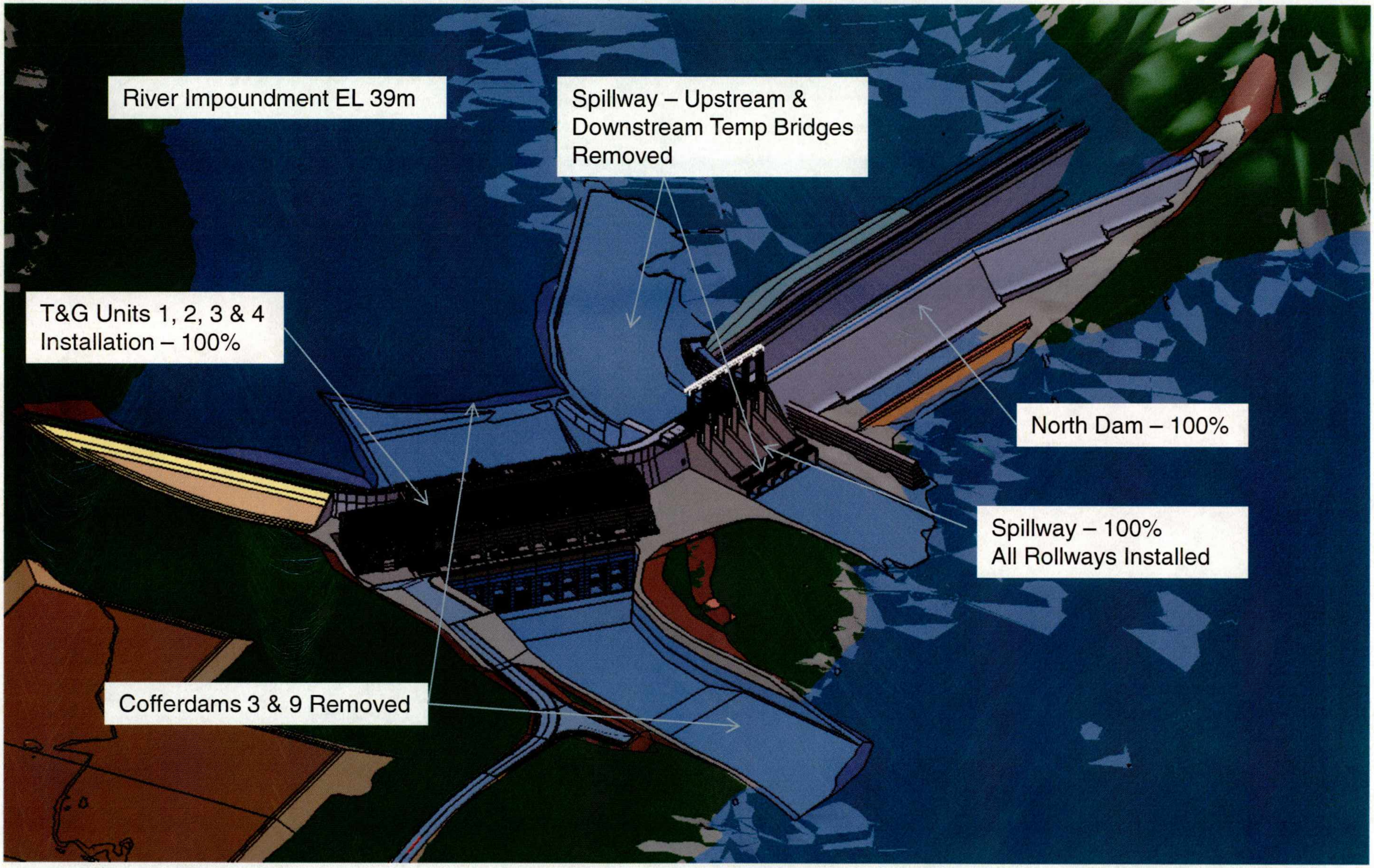


2016 – December (Continued)

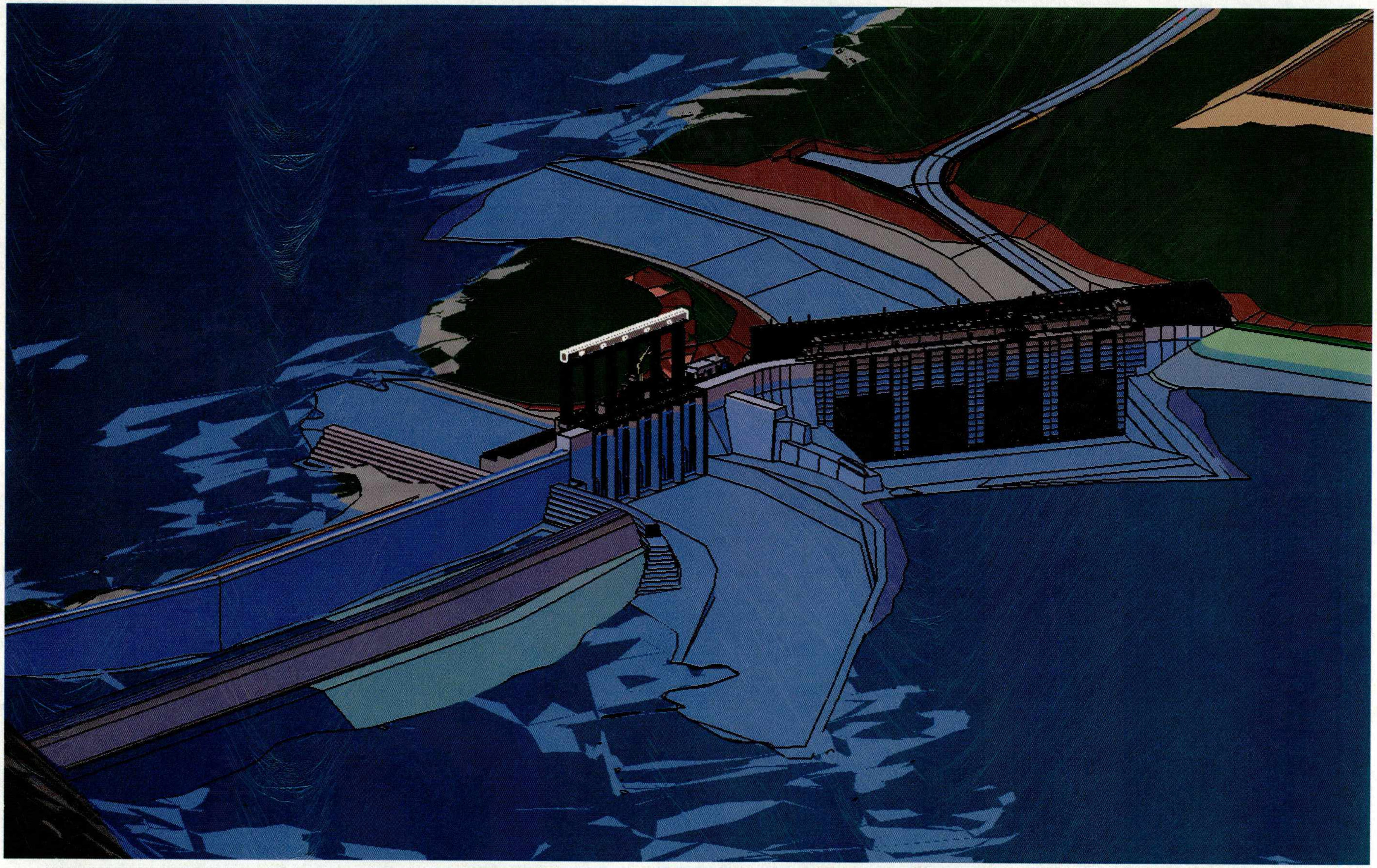


nalcor energy

2017 – June (Continued)



2017 – June – First Power

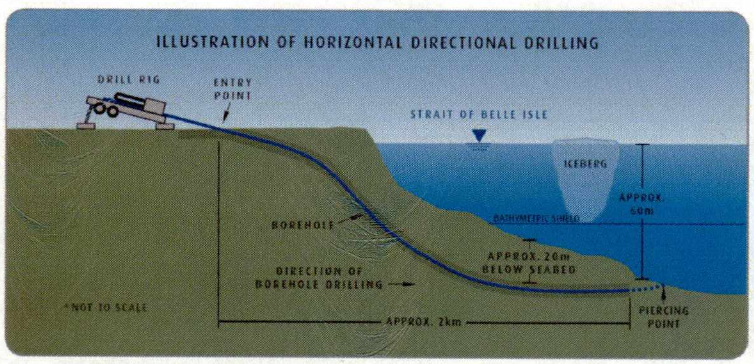


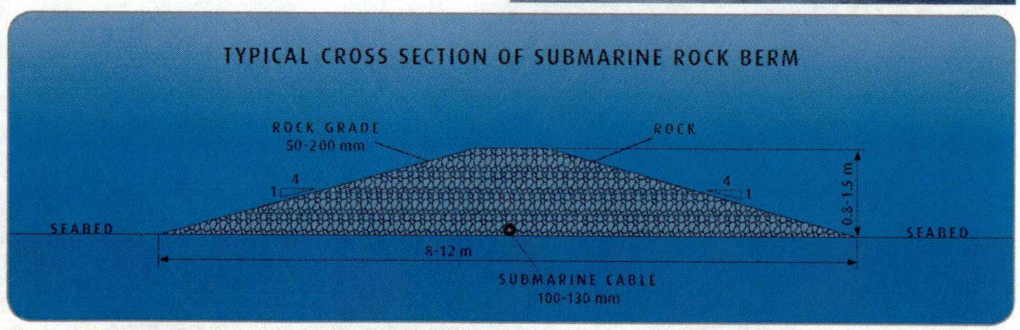
Project Definition – SOBI Crossing

SOBI Crossing: A "deeper" look

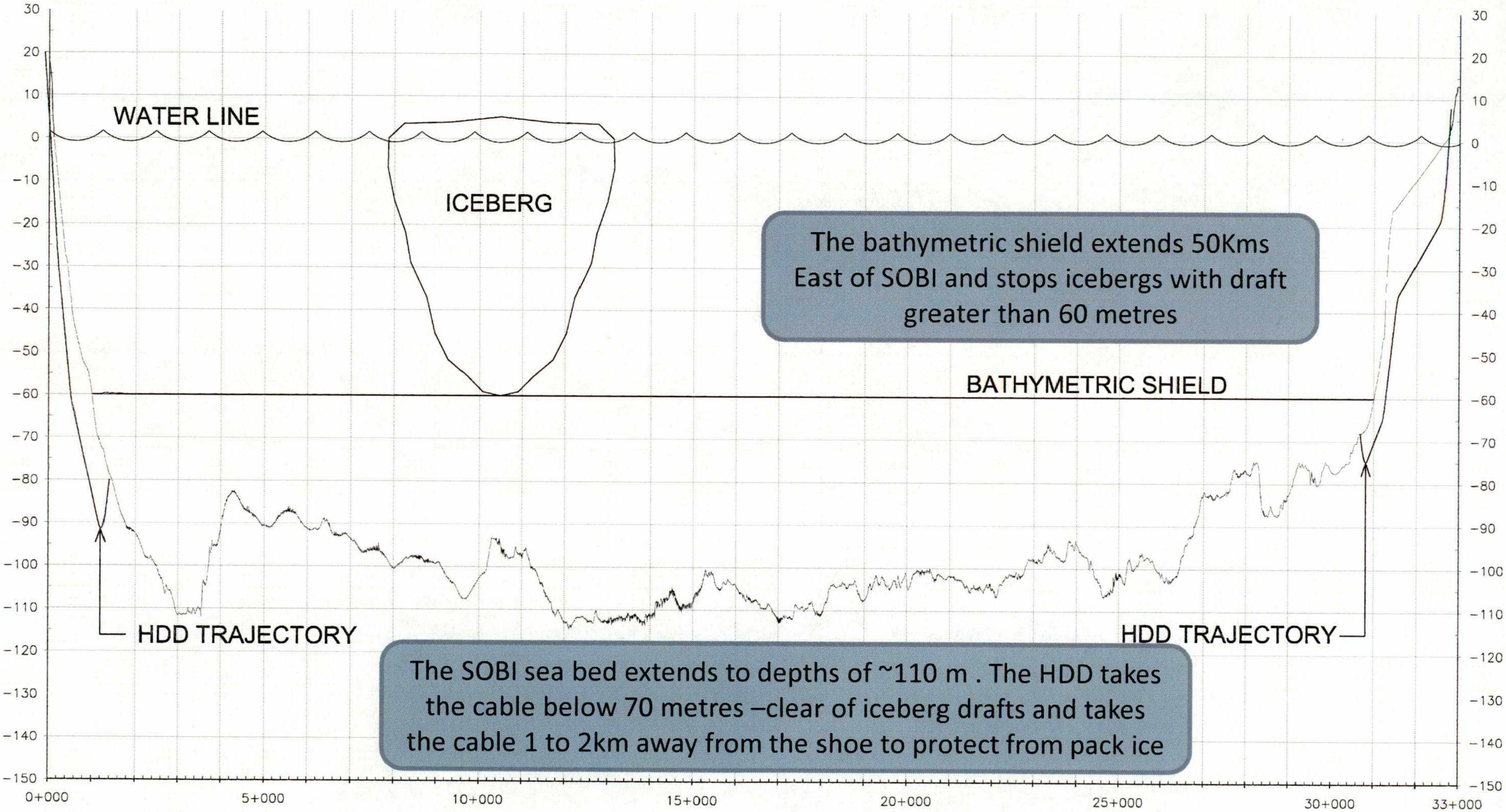
Selected solution for the SOBI cable crossing builds upon team's extensive experience in the design and installation of subsea infrastructure in harsh environments combined with learnings from global cable projects.

- Each of the 3 submarine cables will each have a dedicated horizontally directionally drilled (HDD) conduit to protect the cable from shore and pack ice at the landfall points.
- The conduits will take each cable to a water depth of between 60 to 80m, thus avoiding iceberg scour.
- The cables will then be laid on the sea bed and each protected with a separate rock berm which will protect against fishing gear and dropped objects

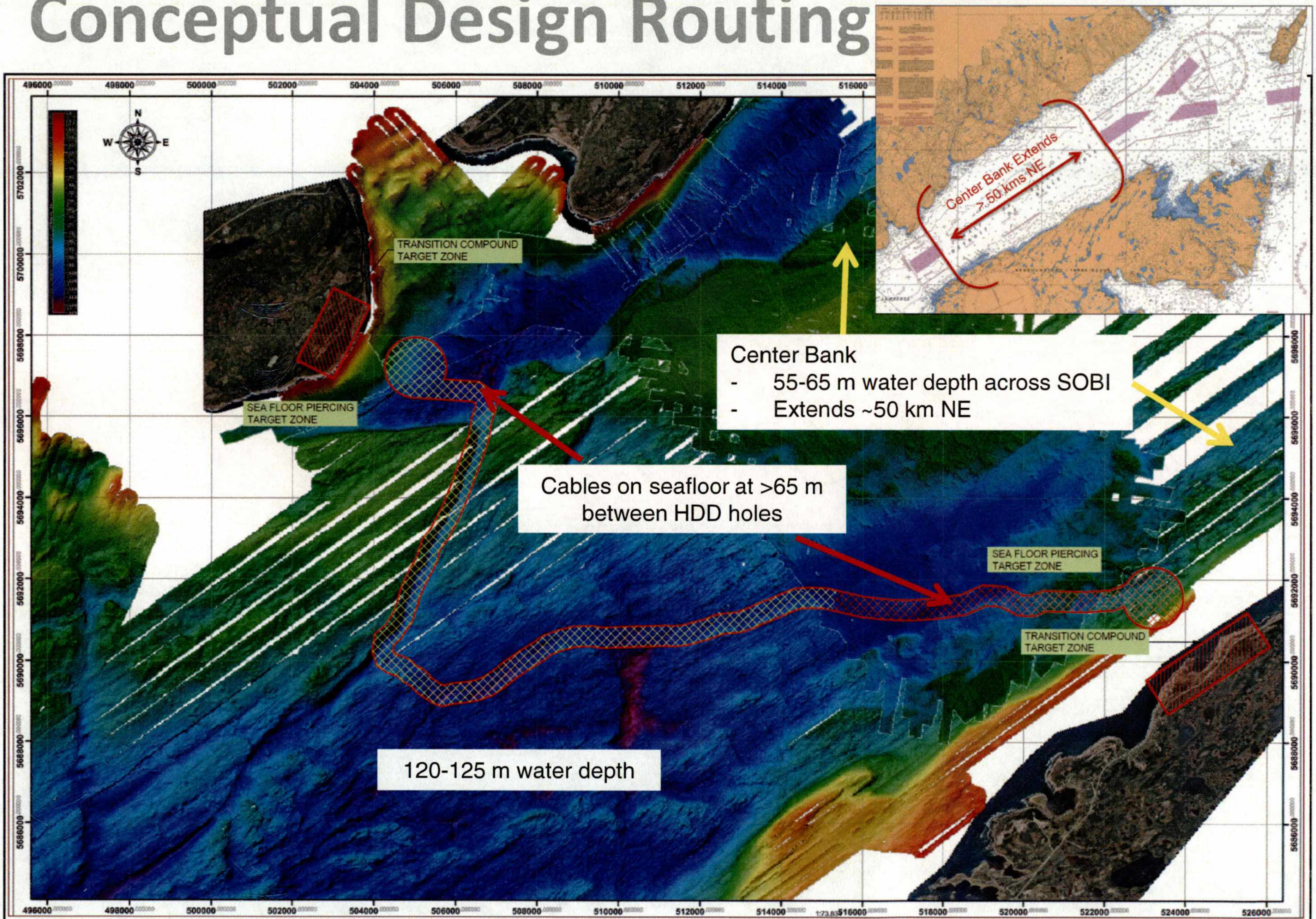




SOBI Iceberg and Pack Ice Protection



Conceptual Design Routing



Center Bank Extent

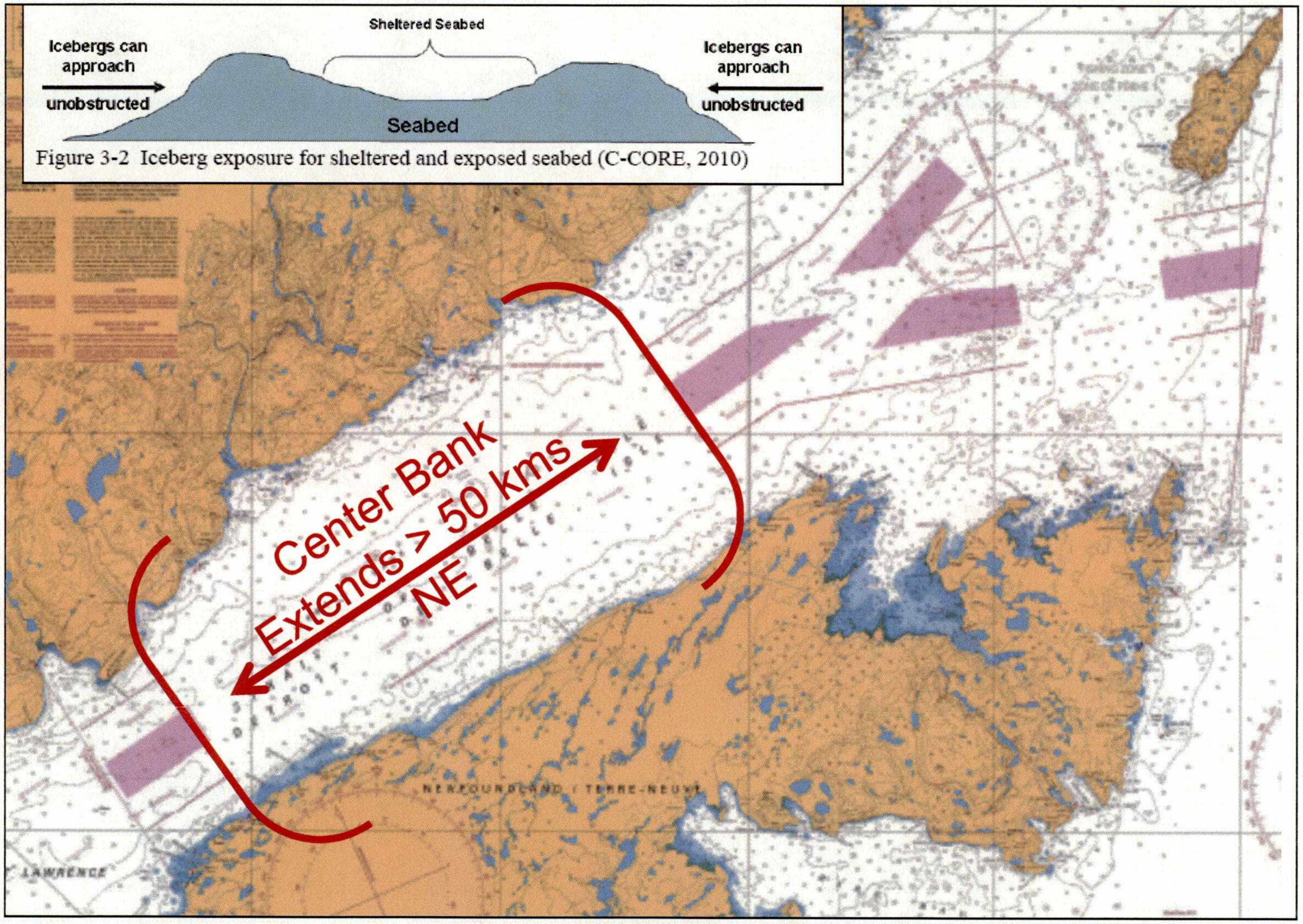


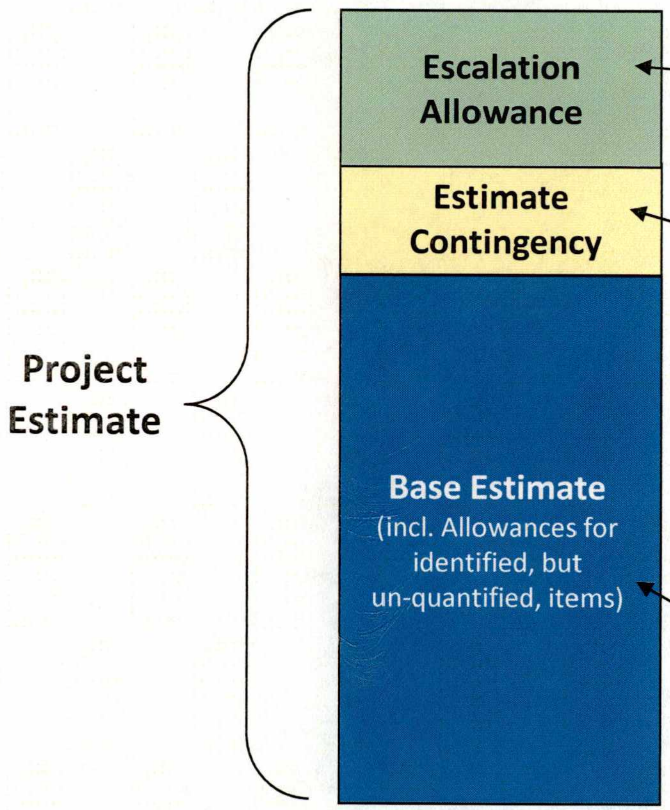
Figure 3-2 Iceberg exposure for sheltered and exposed seabed (C-CORE, 2010)

Nalcor's Estimating Approach

Nalcor's Estimating Approach

- Adopt industry recommended practice
  - Association for Advancement of Cost Engineering (AACE) International
- Focus on key cost drivers
- Fully engage project team
  - Combined Nalcor / SNC-Lavalin >400 FTEs
- Understand and apply lessons learnt from other projects
- Gather external and independent input

Cost Estimate Components



Escalation Allowance
Provision for changes in price levels driven by economic conditions. Includes inflation. Estimated using economic indices weighted against base estimate components.

Estimate Contingency
Provision made for variations to the basis of an estimate of time or cost that are likely to occur, that cannot be specifically identified at the time the estimate is prepared but, experience shows, will likely occur. It is not meant to cover scope changes outside the Project's parameters, events such as strikes or natural disasters, escalation or foreign currency impact, or changes that alter the basis upon which the control point for management of change as been established as captured in key project documents (e.g. basis of design, project execution plan).

Base Estimate
Reflects most likely costs for known and defined scope associated with project's specifications and execution plan as produced by the estimator.

DG3 Estimate – How it was produced

- Owner-led estimate team comprised of SNC-Lavalin and various 3rd parties
- Developed over a 12-month period
- Leveraged extensive historical data for Hydro and Transmission projects developed in Canada
- Reflects what a construction contractor would need to do to evaluate project costs for which a bid is being prepared
  - This approach could be best described as a bottom-up first principle estimate as opposed to a parametric or stochastic method
- Concurrent "Check" or validation estimates and Estimate Process Check completed by expert consultants

Establishing the Cost Estimate

The accuracy of the cost estimate is a function of the engineering, procurement and contracting carried out as shown below

- AACEI* Class 4 Estimate
- Some site investigation work
- Concept selected and feasibility work complete
- Project scope defined
- Quantities estimated based on previous studies
- Estimate based on earlier feasibility studies escalated and updated with latest data
- The estimate reflects the Basis of Design approved at DG2

- AACEI* Class 3 Estimate
- Includes latest geotechnical analysis
- Quantities based on 3D model and detailed engineering work
- Includes actual bid costs for SOBI cable contract, TG sets, tower steel, early infrastructure works plus updated market intelligence and quotes
- Labour rates will be updated based on Labour Agreement
- The estimate reflects the Basis of Design at DG3

- AACEI* Class 2 Estimate
- Includes 100% of all critical / complex PO's and contracts which amount to 80% of all contracts
- Firm quantities with EPC, Lump sum and fixed unit price contracts as appropriate
- The estimate reflects the DG3 Basis of Design plus any approved project changes as per Management of Change process

* *Association for the Advancement of Cost Engineering International*

The Estimators Consider 4 Elements

Definition Factors (Scope) — What is to be built

Construction Methodology & Timeline Factors — How it will be done

Price Factors — Per Unit material / labor cost

Performance Factors — Time to complete each work activity

Estimate Leverages Extensive Information

Definition Factors (Scope) + **Construction Methodology & Timeline Factors** + **Price Factors** + **Performance Factors** = **Base Estimate**

Definition Factors (Scope)

- Design Criteria & Specifications
- General Arrangements & Layouts
- Design Drawings for major components – towers and hardware
- MF rock and concrete quantities from 3D CAD
- Master Equipment List
- Cable List
- Material Take-offs for Construction Bulks
- Equipment Specifications
- Geotech surveys
- WBS & Cost Codes

Construction Methodology & Timeline Factors

- Construction Philosophies
- Construction Execution Plan
- Constructability Reviews
- Construction Schedule
- Logistics and Access, incl. freight forwarding & marshaling yards
- Contract Package Dictionary
- Org. Design and Staff Plans
- Construction Equip. Types
- Labor Demand
- Labor Demarcation
- In-directs Strategies
- Site Services
- Pre-Fabrication Plans
- Crane & Access Studies
- Support Facilities
- Material Sourcing Strategies
- Seasonality Constraints
- Permit Register

Price Factors

- Labor Agreement
- Construction Equip. Rates
- Bid Analysis – T/G, SOBI Cable, Tower Steel, Accommodations, Road
- Budgetary Quotes – various equipment
- Site Services Costs – catering, air transport
- Construction Bulks Prices – Rebar, Cement, Diesel, etc.
- Helicopters and Aircrane
- Contracting Market Intelligence – overhead and profit
- Foreign Exchange Rates

Performance Factors

- Crew Make-up and Assignments
- Task durations
- Workface Restrictions
- Labor Productivity & Benchmarks
- Mobilization Constraints
- Work Front Stacking
- Seasonality Impacts
- Equipment Productivity
- In-Directs Usage
- Offsite Fabrication

Base Estimate

- Estimate organized by Project, Physical Component and by Contract Package
- Documented Basis of Estimate
- Foreign Currency Demand
- Person hours
- Trade demands
- Cash flows

Key Quantities

- Powerhouse, Intake and Spillway
  - Mass Excavation of 2.5M m3
  - 390,000 m3 of concrete
  - 200,000 m2 of formwork
  - 57,000 tonnes of rebar
  - 88m high and 225m wide (the Peace Tower is 92.2m high)
- Dams and Cofferdams
  - 895,000 m3 material
- Roller Compacted Concrete:
  - 226,000 m3 RCC
- North Spur:
  - Overburden and rock excavation of 700,00 m3
  - Rockfill of 1M m3
- HVac LTA Transmission
  - 490 km in length
  - 1280 towers
- HVdc LITL Transmission
  - 1079 km in length
  - 3642 towers
- MF Reservoir
  - 1,800 hectares
  - 157kms of roads
  - 390,000 m3 of merchantable wood

Third Party Validation

"… the LCP Gate 3 estimate in its current state is one of the best mega-project "base" estimates that this reviewer has seen in some time. My conclusion is that this is in large part due to the active involvement of the owner leads in striving for best practices and quality."

John K. Hollmann, PE CCE CEP, Owner – Validation Estimating LLC

(Recipient of AACE's highest honor, the Award of Merit, for editing/authoring the Total Cost Management Framework and authoring or assisting in developing many of AACE's Recommended Practices)

Questions

Back-up Material

Wuskwatim Comparison

Year	2003	2004	2005	2006	2007	2008	2009	2011
				EA Release Aboriginal Agreement signed Start of Construction				The forecast cost is 16% greater than the 2006 estimate
Estimated Cost	$0.99 B	$1.04 B	$1.14 B	$1.35 B	$1.59 B	$1.59 B	$1.59 B	$1.57 B

- The 16% cost increase since start of construction is primarily driven by labor rates – Manitoba has a Province wide agreement on rates rather than Project specific labor agreements. The rates established had to be increased to attract and retain the trades required.

- Both Lower Mattagami (OPG Project) and Lower Churchill Project have learned from this and have estimated labor rates and site conditions which mitigate this risk.

Muskrat Falls Capital Cost is Driven by favorable Site Characteristics

Key Element	Muskrat Falls Site Characteristics
Geotechnical Conditions	• Competent bedrock (Canadian Shield) exposed / near surface • Minimal overburden to remove and dispose • Conditions validated by comprehensive site investigations, thus limited exposure with respect to quantity growth

Physical Layout	• No peripheral structures (i.e. dykes) required to create the Reservoir– basically "filling up the river valley", leveraging Churchill Falls reservoir – no land purchase issues
	• Reliable and predictable flows leading to smaller variations in operating water levels
	• All power structures located at one main site
	• Simple / robust / conventional designs for major permanent structures (Intake , Powerhouse, Spillway, Aux. Dams)
	    • Conventional or roller-compacted concrete founded on bedrock
	    • Generally low-profile dam structures (30 to 40 m high)
	• No underground works (MF has surface powerhouse)
	• No temporary spillway facilities to be constructed
	• Diversion uses existing topography and permanent structures (i.e. Spillway) rather than expensive temporary structures (e.g. Diversion Tunnels)
	• Conventional equipment (T&G sets, gates, cranes)
	• Access by road from Trans-Labrador Highway

Constructability	• All construction materials primarily sourced from site excavations • Very good material balance leading to minimal excess material / spoils • Mostly conventional concreting methods and equipment, in dry conditions