BCTC VITR CPCN AND SEA BREEZE_VIC CPCN – Exhibit B1-1 (1 of 2)

British Columbia Transmission CORPORATION™

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July 07, 2005

Mr. Robert J. Pellatt
Commission Secretary
British Columbia Utilities Commission
Sixth Floor, 900 Howe Street
Box 250
Vancouver, BC V6Z 2N3

Dear Mr. Pellatt:

Re: British Columbia Transmission Corporation ("BCTC") Application for Certificate of Public Convenience and Necessity ("CPCN") For Vancouver Island Transmission Reinforcement Project ("VITR")

Pursuant to section 45 of the *Utilities Commission Act*, British Columbia Transmission Corporation ("BCTC") applies for a CPCN for a capital project to reinforce the transmission system serving Vancouver Island and the Southern Gulf Islands.

Sincerely,

Original singed by:

Marcel Reghelini
Director, Regulatory Affairs

1.0 PROJECT OVERVIEW AND EXECUTIVE SUMMARY

This is an application by the British Columbia Transmission Corporation (BCTC) for a Certificate of Public Convenience and Necessity pursuant to sections 45 and 46 of the *Utilities Commission Act* for the Vancouver Island Transmission Reinforcement Project (VITR, the “Project”).

1.1 Project Overview

Vancouver Island’s electricity needs are currently met by a combination of on-Island generation and transmission from the Mainland. Existing generation on Vancouver Island provides approximately 30% of the Island’s peak load. The remaining 70% is dependant on transmission capacity from the Mainland.

There are three existing transmission interconnections between Vancouver Island and the Mainland: two 500 kV Alternating Current (AC) circuits commissioned in 1983 and 1985 between Pender Harbour and Qualicum Bay; a bi-pole High Voltage Direct Current (HVDC) system commissioned in 1969 and 1976 between South Delta and North Cowichan; and two 138 kV AC circuits commissioned in 1956 and 1958, roughly paralleling the HVDC system.

The 500 kV transmission circuits are in excellent condition. However, the HVDC system is ageing and will be de-rated to zero (can no longer be relied on to provide firm dependable capacity) in the fall of 2007. While the 138 kV cables remain suitable as local supply circuits to serve the southern Gulf Islands, they are no longer used for bulk power transfers to Vancouver Island.

Based on BC Hydro’s recent electricity load forecasts, there will be a significant shortfall in firm transmission capacity (~300 MW) to Vancouver Island when the HVDC system is de-rated to zero. This shortfall is forecast to grow in subsequent years. BCTC has developed contingency measures to bridge the 2007/08 winter peak. However, these measures do not provide a long-term solution for the Vancouver Island capacity shortfall.

BCTC is proposing the VITR Project to meet this long-term capacity shortfall and to provide reliable capacity to serve existing demand and future load growth on Vancouver Island. It is forecast that the VITR Project will be able to meet these needs from 2008 to approximately 2017 at which time additional transmission capacity will be required.

In general terms, the VITR Project consists of replacing one of the existing 138 kV transmission lines between South Delta and North Cowichan with a new, 67 km 230 kV transmission line. BCTC proposes building the Project entirely within the existing 138 kV right-of-way (ROW). BCTC also proposes to upgrade the second existing 138 kV line, where prudent, to facilitate the installation of a second 230 kV line in the future, when this is necessary.

In more specific terms, the VITR Project will involve the following:

(a) Between Arnott substation in Ladner and Tsawwassen substation, the two existing 138 kV wooden H-frame transmission lines will be removed and replaced by one new 230 kV double-circuit overhead line on single steel poles.

(b) In the now densely-populated community of Tsawwassen, one of the two existing 138 kV wooden H-frame lines will be removed and replaced by an underground 230 kV line between the Tsawwassen substation and English Bluff Terminal in the existing ROW. In certain areas, a second set of underground conduits will also be installed to limit repeated impacts on private property if a second 230 kV circuit is installed in the future. The second 138 kV line will remain in place to continue to serve the southern Gulf Islands.

(c) For the Strait of Georgia and Trincomali Channel submarine crossings, three of the existing single-phase 138 kV cables will be decommissioned and replaced with three new 230 kV submarine cables. The remaining 138 kV submarine cables (three plus one spare) will continue to supply the southern Gulf Islands through existing substations on Galiano and Salt Spring Islands.

(d) For Galiano and Salt Spring Islands, the majority of the two existing 138 kV latticed steel lines will be replaced with one new 230 kV double-circuit overhead line on single steel poles. The existing latticed steel structures on the long spans between Galiano and Parker Islands will be modified to carry the new circuits. One of the new circuits will be operated at 138 kV to supply the southern Gulf Islands load.

(e) A new 230 kV double-circuit will replace the existing conductors at approximately the same height across Sansum Narrows between Salt Spring and Vancouver Island. New structures will be put in place to accommodate the new conductors.

(f) The two existing 138 kV lines on a combination of wooden H-frames and latticed steel structures between Sansum Narrows and the Vancouver Island Terminal in North Cowichan will be replaced by one new 230 kV double-circuit overhead line on single steel poles.

The VITR facilities will be operated and maintained by BCTC and owned by BC Hydro. A more complete Project Description and Project Justification are contained in Sections 3 and 4 respectively.

In addition to providing reliable electricity supply to Vancouver Island, the VITR Project will also reduce expected increases in ongoing operating and maintenance costs associated with the existing system and will reduce exposure to system failures due to seismic events.

The VITR facilities are required to be in place as soon as possible. An in-service date of October 2008, prior to the 2008/2009 winter peak season, is considered reasonably achievable, subject to the Commission's approval of the Project.

1.2 Summary of Costs

The total capital cost of the VITR Project is estimated to be $245 million, including the costs of removal and material disposal for the 138 kV facilities to be decommissioned as part of the Project. Table 1-1 shows a summary of the total estimated capital cost by asset category.

Table 1-1. VITR Project Costs by Asset Category

	Asset	VI230 DEF	VI230 CA	VI230 UG	VI230 OH	VI230 ARN	VI230 SAT	VI230 VIT	VI230 TBY	IDC	OH	Totals
2			Submarine Cable	TSW Cable	OH T/L	Line Pos'	RX	Line Pos' PST	RX			
3	Submarine Cable	$6,125	$132,178	$0	$0	$0	$0	$0	$0	$7,335	$3,825	$149,462
4	Cable terminals	$279	$6,024	$0	$0	$0	$0	$0	$0	$334	$174	$6,812
5	UG Cable	$395	$0	$8,520	$0	$0	$0	$0	$0	$473	$247	$9,634
6	UG Civil Work	$316	$0	$6,816	$0	$0	$0	$0	$0	$378	$197	$7,707
7	OH Lines	$1,882	$0	$0	$40,610	$0	$0	$0	$0	$2,254	$1,175	$45,921
8	Substation Various Equipment	$1,006	$0	$0	$0	$1,561	$2,652	$14,043	$3,454	$1,205	$628	$24,549
9	Telecomm	$18	$0	$0	$0	$64	$78	$147	$99	$22	$11	$440
10	ROW	$19	$0	$0	$407	$0	$0	$0	$0	$23	$12	$460
11	**Total Costs**	**$10,039**	**$138,202**	**$15,336**	**$41,017**	**$1,625**	**$2,730**	**$14,191**	**$3,553**	**$12,023**	**$6,269**	**$244,985**

1.3 Impact on Revenue Requirement and Customer Rates

The Transmission rate impact of the Project is approximately 4.4% of the Total Transmission Revenue Requirement. The average impact as a percentage of BC Hydro's Total F2006 Revenue Requirement is approximately 1%. The rate impact is discussed in more detail in Section 4.5.

1.4 Order Sought

BCTC submits that the VITR Project is in the public convenience and necessity and requests that a CPCN be granted for the construction and operation of the VITR Project, as proposed.

Based on consultation in the community of Tsawwassen, and considering the unique circumstances whereby development of residences has been allowed to enclose a portion of the existing ROW, severely limiting access for maintenance or vegetation management, BCTC proposes underground construction on the existing ROW for a 3.7 km section of the Project. BCTC submits that construction in this manner represents a balanced response to the interests of affected landowners to minimize impacts on their property, the achievement of ready access by BCTC to the ROW, and with the interests of ratepayers seeking service at least cost. BCTC is requesting approval of this balanced approach including acceptance, subject to prudent control of costs through project development and construction, that the estimated $16 million additional cost of underground construction on the 3.7 km section through Tsawwassen is appropriate for recovery in rates once the Project comes into service.

As an outcome of its consultations with the Tsawwassen community, BCTC has also committed that, if alternative (community) sources of funding or financing can be put in place to cover any additional costs associated with alternative means of undertaking the Project in this area (e.g., underground construction in public streets or advancing the underground replacement of the second 138 kV line), BCTC is prepared to undertake the Project in this manner. At this time, there has been no agreement on funding alternative means of carrying out the Project. However, BCTC submits that it has put forward sufficient evidence to allow the approval of these alternatives should this occur. Therefore, in addition to the approval of the Project as proposed, BCTC requests approval, contingent upon confirmation of external funding and upon notice to the Commission, to underground the Project in public streets or to advance the underground replacement of the second 138 kV line in this area.

Finally, as described in more detail in Section 3, the VITR Project is subject to a number of detailed environmental processes, including environmental (and socio-economic) assessment and approval processes under the *British Columbia Environmental Assessment Act* (BCEAA), the *Canadian Environmental Assessment Act* (CEAA), and, because a 12 km portion of the marine section of the Project will take place in US waters, under various US legislation. BCTC has addressed the major socio-economic and environmental issues that arose as part of the VITR public consultation process in this Application. However, given the comprehensive environmental reviews of the VITR Project that BCTC must satisfy, BCTC respectfully submits that it is not necessary, nor would it be appropriate, for the Commission to carry out a detailed review of the potential environmental and socio-economic effects of the Project. In general terms, BCTC anticipates that any CPCN for the VITR Project will be granted subject to receipt of the necessary permits and regulatory approvals to satisfy Canadian and US environmental assessment and protection requirements.

BCTC must have a transmission solution to Vancouver Island in place by the fall of 2008. Accordingly, approval of the Project, subject to those appropriate conditions and routing that the Commission finds in the public interest, is requested so that BCTC has a reasonable opportunity to meet the 2008 in-service date. For greater certainty, BCTC respectfully requests that the Commission approve the Project as proposed, or with modifications considered to be in the public convenience and necessity and supported by the evidence, rather than denying the Project if it finds that the Project, as proposed, is not in the public interest.

1.5 Schedule

Subject to direction from the Commission, BCTC proposes to have the VITR Project in-service by October 2008. BCTC is confident that this schedule is achievable and that the regulatory, technical and construction risks are reasonably manageable. The current schedule still includes 4 to 6 months of float available to accommodate unforeseen delays. Regulatory processes are the most likely source of any Project delay. The following are key milestone dates following submission of this Application:

(a) Call for Tender for submarine cables - Fall 2005;

(b) Complete environmental studies - December 2005;

(c) Commission decision on CPCN Application - late January or early February 2006;

(d) Submit application for Environmental Assessment Certificate (EAC) - February 2006;

(e) Award contract for submarine cables - Spring 2006;

(f) Receive EAC - late summer 2006;

(g) Start land construction - early 2007;

(h) Install submarine cables - Summer 2008; and

(i) Project in-service - October 2008.

The Project schedule is discussed in more detail in Section 3.6.

1.6 Requested Process

The Commission's CPCN Application Guidelines, which are attached to Commission Letter No. L-18-04, contemplate (at page 3) that the filed Application will be reviewed by the Commission for possible deficiencies, and that this will normally generate an Information Request for responses by the Applicant. Once the additional information is received, the Commission will review the Application in the context of Project justification, issues and concerns raised, as well as general Project suitability. The Guidelines further provide that, when necessary, the Commission may then establish a Regulatory Agenda if further review of the Application is required. This will generally consist of one of the following options:

(a) Grant a CPCN without further input from the Applicant or other interested parties;

(b) Require further information from the Applicant;

(c) Set down a written or oral public hearing; or

(d) Deny the Application.

Based on BCTC's public consultation in connection with the Project, while BCTC believes that there are a number of aspects of the Application that may be resolved without a public hearing, it is likely that some form of hearing process will be necessary to resolve portions of the Application. In recognition of this, and the timing and schedule of the VITR Project, BCTC respectfully requests that public notice of this Application and a Pre-hearing Conference to assist in establishing a Regulatory Agenda for the Project take place at as early a date as possible. BCTC also respectfully submits that, if the Commission is prepared to do so, a first round of Information Requests be generated at as early a date as possible including, if necessary, prior to the establishment of a Regulatory Agenda for the Project, would greatly assist the process schedule.

1.7 Structure of the Application

Section 1 provides an overview of the Project and also serves as an Executive Summary. Section 2 discusses the Applicant, Project Team and specialized services that have been contracted for. Section 3 provides a detailed description of the Project including the overhead, underground and submarine portions, schedule, and environmental assessment and approval processes. Section 4 describes the need for the Project, an analysis of alternatives to the Project, alternative means of carrying out the Project, rate impacts, and risk management. Section 5 describes stakeholder and First Nations consultation and responses to issues raised during the public consultation process. Section 6 provides a summary of other approvals, permits and authorizations required for the Project. A detailed Table of Contents is set out on the next page, followed by a list of Abbreviations and a Glossary.

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1 LIST OF ABBREVIATIONS

1	**Acronym**	**Definition**
2	EAC Application	Application for an Environmental Assessment Certificate under BCEAA, and for a Screening Level Environmental Assessment under CEAA
3	ARN	Arnott Substation
4	BC Hydro	British Columbia Power and Hydro Authority
5	BCEAA	British Columbia Environmental Assessment Act
6	BCEAO	British Columbia Environmental Assessment Office
7	BCTC	British Columbia Transmission Corporation
8	BCUC	British Columbia Utilities Commission
9	BIL	Basic Insulation Level
10	CEA Agency	Canadian Environmental Assessment Agency
11	CEAA	Canadian Environmental Assessment Act
12	CPCN	Certificate of Public Convenience and Necessity
13	CSMA	Coastal Zone Management Act
14	DFO	Fisheries and Oceans Canada
15	DPP	Duke Point Partnership
16	EA	Environmental Assessment
17	EAC	Environmental Assessment Certificate
18	EBT	English Bluff Terminal
19	EIS	Environmental Impact Statement
20	EMF	Electromagnetic Field Effects
21	EMP	Environmental Management Plan
22	ESA	Endangered Species Act
23	ESAs	Environmentally Sensitive Areas
24	GLS	Galiano Substation
25	GPS	Global Positioning System
26	HADD	Harmful Alteration, Disruption, or Destruction
27	HVDC	High Voltage Direct Current
28	ICG	Island Co-Generation
29	ING	Ingledow Substation
30	JARPA	Joint Aquatic Resources Permit Application
31	LIDAR	Light Detection and Ranging
32	kV	Kilovolt
33	MBO	Maracaibo Terminal
34	MTG	Montague Harbour Terminal

Acronym	Definition
MWLAP	Ministry of Water, Land and Air Protection
RA(s)	Responsible Authority(ies) under CEAA
SAL	Salt Spring Island Substation
SARA	Species at Risk Act
SCFF	Self-Contained, Fluid-Filled
TBY	Taylor Bay Terminal
TEM	Terrestrial Ecosystem Mapping
TGS	TransGrid Solutions
TOR	Terms of Reference
VIGP	Vancouver Island Generation Project
VIT	Vancouver Island Terminal
VITR	Vancouver Island Transmission Reinforcement Project
VSC	Voltage Sourced Converters
WECC	Western Electricity Coordinating Council

GLOSSARY

Term	Definition
Air Lifting	Use of an air compressor to inject air into the bottom end of a 150 - 500 mm diameter vertical tube. The rising air expands, creating a lower pressure area at the bottom opening. Sediments are drawn into the bottom of the tube and ejected from the top. The method is especially useful for light excavation of underwater trenches in gravel and cobble sea bottoms and for uncovering existing buried cables.
Alternating Current (AC) transmission system	Type of electrical power system in which voltage and current reverses direction each half-cycle. Systems in North America operate at 60 cycles per second.
Anchor	For overhead line construction, a device that serves as a reliable support to hold an object firmly in place, usually guy wires.
Armour Wires	Steel, copper or bronze wires or straps around the outside of a submarine cable. Their primary purpose is to help the cable withstand the high tensions developed during cable-laying. The secondary purpose is to provide some protection to the cables from external abrasion, contact by fishing gear, and anchors.
British Columbia Transmission Corporation (BCTC)	A provincial Crown corporation, formed in May 2003, responsible for managing, operating, planning and maintaining most of the provincial electrical power transmission system and its interconnections with the larger North American grid.
British Columbia Utilities Commission (Commission)	The British Columbia Utilities Commission is an independent regulatory agency of the Provincial Government that operates under and administers the *Utilities Commission Act*. The Commission's primary responsibility is the regulation of British Columbia's natural gas and electricity utilities to ensure that the rates charged for energy are fair, just and reasonable, and that utilities provide safe, adequate and secure service to their customers.
Cable	Insulated conductor used for underground or submarine applications.
Cable Terminal(s)	A non-generating electrical power station where a transition is made between overhead transmission lines to underground or submarine cables. Cable Terminals refers to English Bluff Terminal (EBT), Taylor Bay Terminal (TBY), Montague Harbour Terminal (MTG), and Maracaibo Terminal (MBO).
Cable Vault	Underground chamber for cable splicing and maintenance access.
Cathodic protection	The reduction or prevention of corrosion by impressing a low level direct current or installing passive sacrificial anodes.
Circuit	A conductor or a system of conductors through which an electric current flows is intended to flow. In the case of an AC system, it is composed of three conductors and for DC systems, it is composed of two.

Term	Definition
Circuit breaker	A control device for connecting or disconnecting a transmission line under normal load or emergency fault conditions.
Conductor	Wire or group of wires not insulated from each other, suitable for carrying an electrical current.
Construction	Refers to both removal of the existing 138 kV transmission lines and submarine cables, and installation of the new transmission lines and underground and submarine cables, including modifications to the ARN and VIT substations and the Cable Terminals.
Decommissioning	Refers to the eventual removal and dismantling of the proposed new transmission line and submarine cable infrastructure at the end of its useful life (in approximately 60 or more years).
Electromagnetic Fields (EMF)	The electric and magnetic fields that exist wherever energized electrical equipment or appliances are located. The electric fields are associated with voltage; and the magnetic fields are associated with the amount of current being used.
Environmental Management Plan (EMP)	Document prepared prior to construction that identifies environmental aspects and potential effects related to the Project; prescribes suitable mitigation measures to effectively minimize environmental effects during construction; and defines responsibilities for environmental management and external monitoring of contractor activities.
High Voltage Direct Current (HVDC) system	The type of power system in which electric current flows in a single direction and whose voltage magnitude does not vary, or varies only slowly.
HVDC Light®	HVDC Light® is an ABB registered trademark for its product using voltage source converters (VSC) with pulse-width modulation.
Insulator	A device, made of non-conducting material, used to give support to electrical conductors and shield them from ground or other conductors. An insulator inhibits the flow of current from the conductor to the earth or another conductor.
KiloVolt (kV)	One thousand volts.
Linear alkylbenzene (LAB)	Insulating fluid typically used in self contained fluid-filled (SCFF) power cables to control the high electric stresses in the insulation.
Orthophoto	An aerial photograph that has been rectified such that it is equivalent to a map of the same scale. It is a photographic map that can be used to measure true distances, an accurate representation of the Earth's surface.
Phase-shifting transformer (PST)	A large device that controls the voltage phase-angle relationship of one circuit in respect to another. In the case of VITR, the PST will help to balance power flow between the northern and southern transmission corridors connecting to Vancouver Island.

Term	Definition
Pole structure	A column or columns of tapered wood, steel, or concrete, supporting overhead conductors on arms or brackets. In transmission, generally used at voltage levels of 230 kV or lower.
Right-of-way (ROW)	A right-of-way is a right to pass over, on or under the lands of another and is generally understood as the land reserved for placement of a physical improvement such as a railway, transmission line or pipeline. Specifically for the Project, this term is used collectively for all individual rights-of-way.
Shunt Reactor	An electrical device used to control system overvoltages by introducing inductive reactance between a circuit and ground.
Structure	Provides support for the overhead conductor. Structure types include wood pole or several wood poles together (i.e., H frame), steel or concrete poles, or lattice steel tower.
Submarine Cables	Refers to transmission lines which are specifically designed to convey electrical current beneath the ocean. A submarine cable typically has a diameter of approximately 100 to 150 mm.
Substation(s)	A non-generating electrical power station that serves to transform voltages to higher or lower levels. Substations refer to the Arnott Substation (ARN) in Delta, and the Vancouver Island Terminal Substation (VIT) in North Cowichan on Vancouver Island.
Transmission Line	Refers to both existing overhead as well as the proposed overhead transmission lines, underground and submarine transmission cables and structures within the Project area.
Water-jetting	Use of focused high-pressure water-jets to fluidize a narrow trench in the sea bottom for cable burial. Divers can use water-jetting in shallow water, but it is most effectively done using specialized, neutral-buoyancy water-jetting machines.

2.0 APPLICANT

2.1 Name, Address and Nature of Business

BCTC is a provincial Crown corporation that was formed in May 2003, and began operations on August 1, 2003. BCTC's head office is located at 1055 Dunsmuir Street in Vancouver.

Under the *Transmission Corporation Act*, and a number of designated agreements between BCTC and BC Hydro, BCTC has the responsibility to operate and manage BC Hydro's transmission system. BCTC is also responsible for planning, constructing and obtaining all regulatory approvals for enhancements, reinforcement, and sustaining and growth investments to BC Hydro's transmission system, and for entering into commitments and incurring expenditures for capital investments on the transmission system. BC Hydro continues to own the core transmission assets and is required to make capital expenditures to support these investments.

2.2 Financial Capacity

BCTC is incorporated under the *Company Act*. The Minister of Finance is the fiscal agent of BCTC, and BCTC may borrow money with the approval of the Minister.

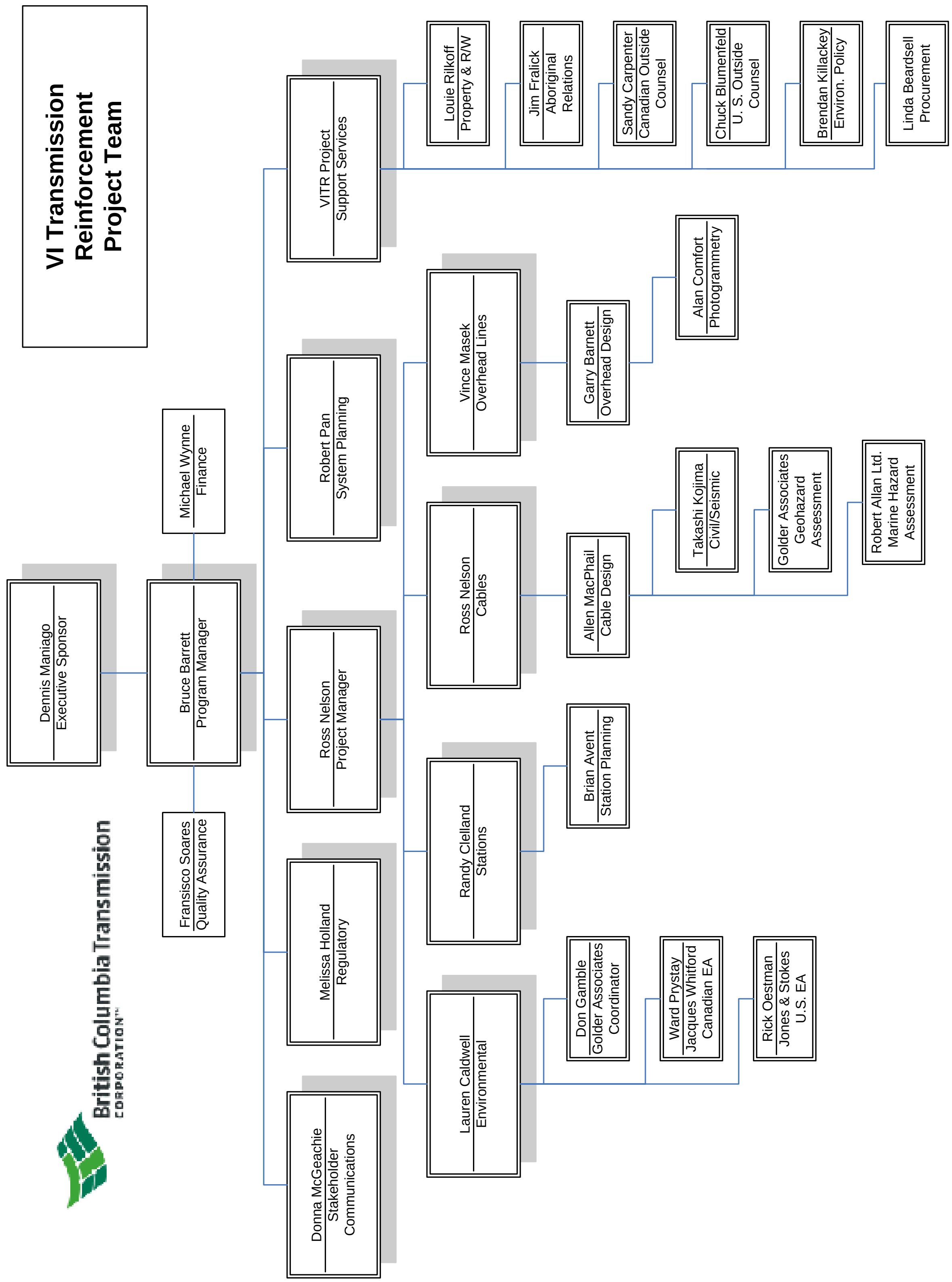
BCTC has the financial capability to undertake the VITR Project by means of borrowing directly from the Province and by funds generated by the operation of its business.

2.3 Technical Capacity

BC Hydro has been responsible for the planning, design and construction of generation, transmission and distribution facilities since 1962. With the formation of BCTC in 2003, employee transfers from BC Hydro's Transmission Line of Business to BCTC ensured the continued technical expertise of the transmission business. In addition, the knowledge, experience and expertise of BC Hydro's Engineering Services unit are available to BCTC under the terms of Support Services Agreements between BCTC and BC Hydro.

BCTC has also retained the services of specialized consultants to advise on various aspects of the Project as required. The VITR Project Team structure, members and roles are identified in the Figure 2-1 below. A description of the services being provided to BCTC for the VITR Project follows.

Figure 2-1. VITR Project Team



2.3.1 Engineering Services and Operations

The transmission system managed by BCTC includes 5,700 km of 500 kV transmission circuits, more than 12,100 km of 69 kV to 360 kV AC transmission circuits, and 125 km of 280 kV DC transmission circuits. The system also includes 196 circuit km of submarine cable and 142 circuit km of underground cable at all system transmission voltages. As a result, BCTC now operates, manages and maintains one of the largest high-voltage overhead, underground and submarine cable systems in North America.

BCTC has retained BC Hydro Engineering Services to provide engineering support for the VITR Project. BC Hydro Engineering Services has been designing and constructing 230 kV and higher overhead, underground and submarine cable transmission systems since 1947 (through the original companies that were joined to form BC Hydro) and have pioneered several overhead and high voltage cable system developments.

BC Hydro Engineering has world-class transmission underground and submarine cable engineering expertise with a combined total of more than 120 person-years of cable design, procurement, installation and project management experience. Their specialist transmission cable engineers have contributed to other transmission cable projects around the world and are significant contributors to international standards development.

BC Hydro Engineering Services Transmission Overhead design engineers have expertise in dealing with some of the most challenging mountainous terrain in the world and areas which are subject to extremes in climatic conditions. Their engineers have used one of the largest conductors in the world to overcome extraordinary loading conditions encountered at a particularly mountainous location about 2000 m above sea level. They have also designed special supporting structures and custom-designed extra-high strength conductors for several long water-crossing spans up to 3500 m in length. The Transmission Overhead engineers have provided consulting services on a number of significant international projects.

2.3.2 Geotechnical Services

For seismic and other geotechnical matters, BC Hydro Engineering Services has been supplemented with further external expertise. Golder Associates Ltd. was selected as geotechnical consultants through an open tendering process. Golder assembled a team of world-class experts in areas of risk assessment (Dr. Farrouk Nadim of Norwegian Geotechnical Institute), seismic and slope stability (Dr. Upal Atukorala, Golder), marine geology (Dr. Brian Bornhold of Coastal and Ocean Resources Inc.), geophysical and marine survey (Harry Olynyk, Terra Remote Systems), and seismic/structural analysis (D.G Honegger).

2.3.3 Environmental Services

BC Hydro Engineering Transmission Division, Environment Contracts and Construction (ECC) is providing environmental management services for the VITR Project.

The environmental consultants retained to undertake the environmental assessments for the VITR Project are Jacques Whitford for the portion of the Project which is within Canadian jurisdiction, and Jones & Stokes for the portion of the Project which is within US jurisdiction. Jacques Whitford is one of the largest and most respected environmental consulting firms in Canada. The firm and staff assigned to the Project have significant environmental assessment experience in BCEAA and CEAA processes for marine and terrestrial environments including Roberts Bank, the Strait of Georgia and the southern Gulf Islands.

Jacques Whitford will be also conducting the biophysical and cultural technical assessments outlined in the Terms of Reference prepared under BCEAA, leading up to the preparation of an Environmental Assessment Certificate Application (the EAC Application) under BCEAA and, concurrently, a Screening Level Report under CEAA. Jacques Whitford will continue to provide technical support during the post-Application phase of the environmental assessment process to respond to agency, public, and First Nations comments on the EAC Application.

Jones & Stokes is a large, nationwide US environmental consulting firm with offices in Seattle and substantial experience in the Pacific Northwest. Jones & Stokes has done NEPA/SEPA Environmental Assessments and Environmental Impact

Statements for many projects in similar marine environments. They recently worked successfully on new power and telecommunications submarine cable projects from the US mainland to the San Juan Islands.

Jones & Stokes will be conducting the environmental assessments for the portion of the submarine cable replacement within US territorial waters, required to satisfy the *Washington State Environmental Policy Act* (SEPA) and the federal *National Environmental Policy Act* (NEPA). The focus of these assessments will primarily be on marine biological and cultural resources and will involve interaction with US regulatory agencies and Tribal governments. Jones & Stokes will also take the lead role in preparing environmental permit applications to obtain federal, state, and local approvals for the portion of the Project within the US.

Golder Associates has been retained to coordinate and provide technical input during the Definition Phase of the Project, including preparation of the Project Description and Terms of Reference; to serve as a liaison between the regulatory agencies, the Project team, and the environmental consulting teams; and to assist in the preparation of the environmental assessments and monitor progress of the environmental consultants to ensure that the deliverables are achieved, and that the Project schedule is maintained.

2.3.4 Properties and First Nations Issues

Under the Master Agreement between BCTC and BC Hydro, BC Hydro retains primary responsibility for properties and property rights and for aboriginal relations with respect to transmission system assets and operations, as well as new capital projects.

BC Hydro specialists in property matters and aboriginal relations work closely with BCTC and the VITR Project Team in planning and carrying through project activities including First Nations consultation, management of existing property rights, and the acquisition of any additional property rights required by the Project.

2.4 Communications

Communications with respect to this Application should be sent to:

British Columbia Transmission Corporation
Suite 1100, Four Bentall Centre
1055 Dunsmuir Street
P.O. Box 49260
Vancouver, BC V7X 1V5

Attention: Marcel Reghelini, Director Regulatory Affairs

Phone: (604) 699-7331
Fax: (604) 699-7537
Email: Marcel.Reghelini@bctc.com

2.5 Legal Counsel for the Applicant

BCTC has retained outside legal counsel to support internal resources for the preparation of this Application and any associated proceeding. Outside legal counsel is also providing support for the BCEAA and CEAA environmental assessment and approval processes.

Fasken Martineau DuMoulin LLP
Suite 2100
1075 West Georgia Street
Vancouver, BC V6E 3G2

Attention: Sandy Carpenter

Phone: (604) 631-3131
Fax: (604) 632-4994
Email: scarpenter@cgy.fasken.com

BCTC has also retained outside legal counsel to support internal resources for the preparation of US permitting applications.

Perkins Coie, Attorneys at Law
1201 Third Avenue
Suite 4800
Seattle, WA 98101-3099

Attention: Charles Blumenfeld

Phone: (206) 359-8000
Fax: (206) 359-9000
Email: CBlumenfeld@perkinscoie.com

3.0 PROJECT DESCRIPTION

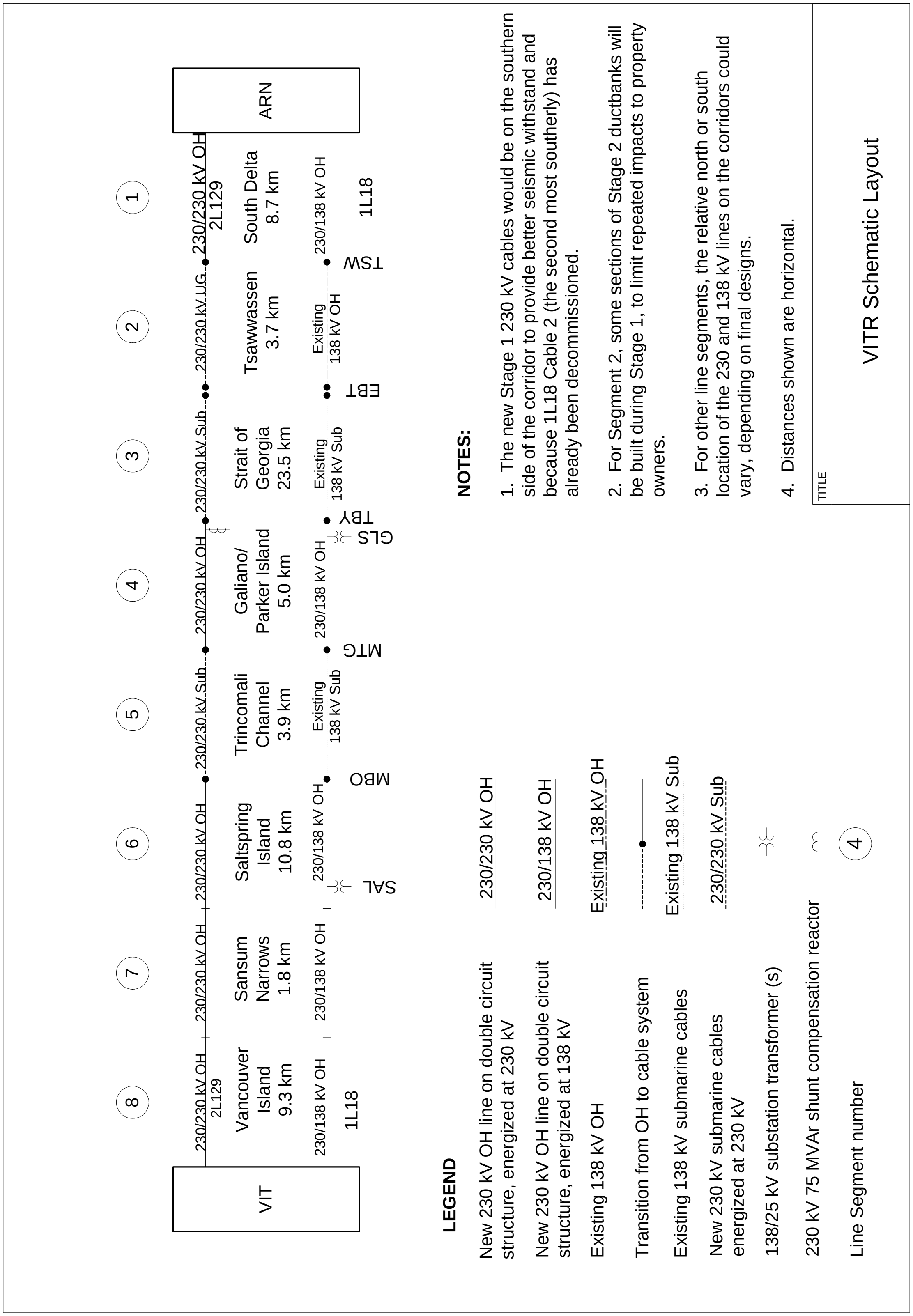
The VITR Project, as proposed, will replace one of the two existing 138 kV transmission circuits (1L17 and 1L18) between Arnott Substation (ARN) in South Delta and Vancouver Island Terminal (VIT) in North Cowichan with a new 230 kV (600 MW) circuit. As part of the Project, BCTC will also make prudent preparations for later construction of a second 230 kV circuit. It has been determined that one new 230 kV circuit is required as soon as possible (see Section 4 – Project Justification). An in-service date of October 2008, prior to the 2008-2009 winter peak season, is considered reasonably achievable subject to the Commission's approval of the Project. The need for the second 230 kV circuit is currently forecast for 2017 and will be the subject of a separate CPCN Application when necessary.

3.1 General Overview

BCTC will initially construct all of the 230 kV overhead line sections for two new 230 kV circuits in the form of one double-circuit line. One of the new circuits would be temporarily connected to one of the existing 138 kV submarine cable circuit and operated at 138 kV until the second set of 230 kV submarine cables is installed at a later date. For underground and submarine portions of the Project, only cables for the single new 230 kV circuit would be initially installed.

BCTC proposes that the Project be constructed entirely within the existing 138 kV corridor. The total length of the Project corridor is approximately 66.7 km. The corridor is divided into 8 segments. A schematic layout of the segments is shown in Figure 3-1. A general description of each segment follows in Section 3.2.

Figure 3-1. VITR Schematic Layout



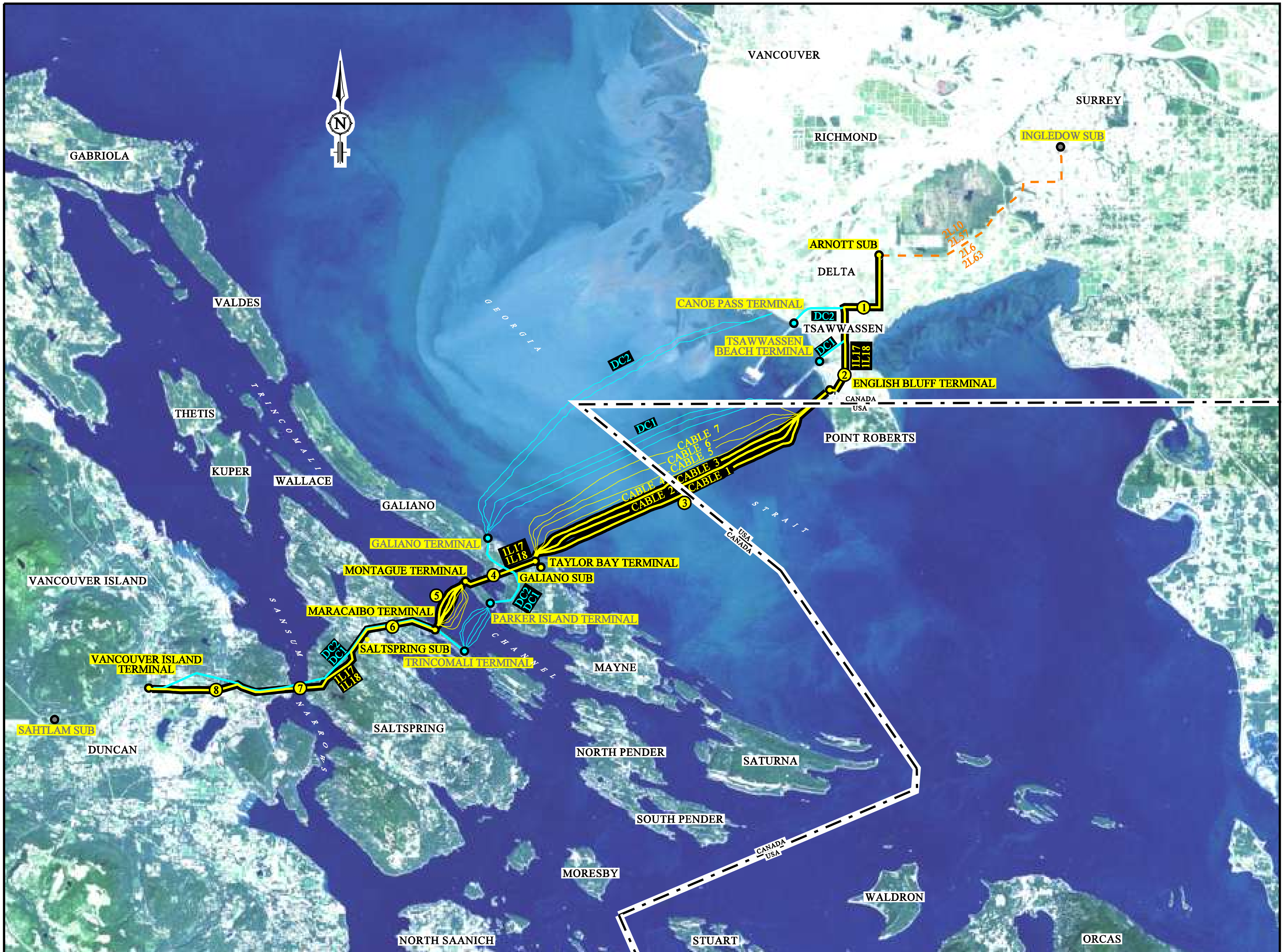


Figure 3-2. VITR Project Overall Route

Vancouver Island Transmission Reinforcement Project
CPCN Application, 7 July 2005

4 0 4 8 Km

DIGITAL MAP	PROJECT No.	British Columbia Transmission Corporation BChydro ENGINEERING PHOTOGRAMMETRY SERVICES
PREPARED BY GJB	PHOTO DATE 1999	VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT ARNOTT SUBSTATION TO VANCOUVER ISLAND TERMINAL
DATE JUN 23, 2005	PHOTO SCALE	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 1 OF 1
N.T.S.	DWG. SCALE AS SHOWN	CONTOUR INT. / DWG. No. / R. 1

3.2 Corridor Segments

Figure 3-2 shows the location of the two existing 138 kV transmission lines and the proposed route of the VITR Project. The transmission line corridor is divided into eight segments, based on existing environmental and land use conditions and proposed construction methods:

Table 3-1. Corridor Segments: Construction Type and Length

Segment Number	Description	Type of Construction (Existing/Proposed)	Length (km)
1	South Delta	Overhead/Overhead	8.7
2	Tsawwassen	Overhead/Underground	3.7
3	Strait of Georgia	Submarine/Submarine	23.5
4	Galiano/Parker Islands	Overhead/Overhead	5.0
5	Trincomali Channel	Submarine/Submarine	3.9
6	Salt Spring Island	Overhead/Overhead	10.8
7	Sansum Narrows	Overhead/Overhead	1.8
8	North Cowichan	Overhead/Overhead	9.3
Total			66.7

A short description of the existing facilities and proposed work in each of these segments is set out below. A more detailed Project Description is set out in Section 3.3.

3.2.1 Segment 1 – South Delta

This segment is 8.7 km long, beginning at ARN on Ladner Trunk Road in East Ladner and ending adjacent to the existing Tsawwassen Distribution Substation (TSW) at the northern edge of the Tsawwassen community. A short section of the existing ROW near ARN passes between two residential neighbourhoods. The rest of Segment 1 passes through agricultural land.

The existing ROW in Segment 1 is approximately 140 m (455 ft) wide and presently contains six separate overhead lines including:

(a) One bi-pole HVDC line (DC1 & DC2) on lattice steel structures (installed in 1969 and 1976);

(b) The metallic return for the HVDC system on single wood poles (installed in 1977/78);

(c) Two single-circuit 138 kV lines (1L17 and 1L18) on wood H-frame structures (installed in 1956 and 1958); and

(d) Two 69 kV lines on single wood poles (installed in 1970).

Photographs showing the typical layout and conditions on the existing ROW in Segment 1 are shown in Figures 3-3 and 3-4.

BCTC proposes to remove the two existing 138 kV wood H-frame transmission lines and replace them with one new 230 kV double-circuit line on single steel pole structures.[1] The new steel poles will be entirely within the existing ROW and will be located to minimize impacts to agricultural operations. There will be no changes to any of the other existing lines. Line terminal modifications and other work required at ARN will take place entirely within the existing substation property (see Section 3.4).

3.2.2 Segment 2 – Tsawwassen

This segment is 3.7 km long, between TSW and the existing English Bluff Terminal (EBT). Segment 2 passes through the now densely populated community of Tsawwassen on an existing 53.34 m (175 ft) wide ROW. The existing ROW contains two separate 138 kV transmission lines on wood H-frame structures. The existing lines were built in 1956 and 1958, respectively, prior to the construction of the homes, schools and other improvements that are now adjacent to the ROW. Representative photographs of the existing ROW are shown in Figures 3-5 and 3-6 (the line along the street in Figure 3-5 is a local distribution line).

BCTC proposes to remove one of the two existing 138 kV wood H-frame single-circuit lines and replace this with a new 230 kV cable circuit in underground conduits. A new underground cable terminal station will be installed adjacent to TSW within the existing property (see Section 3.3.3.2). The second existing 138 kV overhead circuit would remain in place to continue to provide service to the southern Gulf Islands (see Section 3.5).

[1] There will be more than one pole to carry the circuits at a few corners and long spans

Figure 3-3. South Delta

Figure 3-4. South Delta

Figure 3-5. Tsawwassen

Figure 3-6. Tsawwassen

In selected areas of Segment 2, a second set of underground conduits will also be installed to facilitate the potential installation of a second 230 kV underground cable circuit in the future and to limit repeated impacts to private properties.

The existing legal rights-of-way on this corridor include the ability to construct and operate 230 kV overhead lines as an upgrade and replacement of the existing 138 kV lines; however, the existing rights do not permit BCTC to install and operate underground cables through most of Segment 2. These underground rights will have to be acquired as part of the Project.

As indicated in Section 5, BCTC has offered to the Tsawwassen community that, if community funding or financing can be arranged to cover the additional costs, the Project could accommodate two potential modifications:

(a) Installing portions of Segment 2 underground in public streets, instead of the existing corridor; and/or

(b) Advancing installation of a second underground circuit to allow removal of both of the two existing 138 kV overhead circuits.

3.2.3 Segment 3 – Strait of Georgia

Segment 3 is 23.5 km long, between EBT in Tsawwassen and Taylor Bay Terminal (TBY) on the eastern shore of Galiano Island. It passes under the Strait of Georgia via submarine cables. Approximately 12 km of this segment passes through US waters.

There are currently seven cables on the existing submarine ROW (two sets of three single-phase 138 kV cables and one spare). BCTC proposes to remove one of the existing sets of 138 kV cables and replace these with a new set of three single-phase 230 kV cables. The new 230 kV cables will be installed underground between EBT and the shore, buried in the seabed to beyond the low tide line, and then laid directly on the seabed in deep water, all within the existing ROW.

Portions of the buried decommissioned 138 kV cables may be abandoned in place, if this is determined to be preferable from an environmental perspective. The remaining set of 138 kV cables will be re-connected to the remaining overhead

138 kV circuit at EBT to continue providing reliable service to the southern Gulf Islands. A spare 138 kV submarine cable will be retained. Required cable terminal modifications at EBT and TBY will take place entirely within the existing property boundaries (see Section 3.4).

3.2.4 Segment 4 – Galiano/Parker Islands

This segment is 5.0 km long, between TBY and Montague Terminal (MTG) on the western shore of Parker Island. It passes through forested land across Galiano Island, over water adjacent to Montague Harbour, and across Parker Island on an existing 53.34 m (175 ft) ROW.

The existing ROW contains two single-circuit 138 kV lines on lattice steel structures and a local distribution line. Typical photos of the existing ROW are shown in Figures 3-7 and 3-8. There are a few residences near the corridor.

BCTC proposes to remove both existing 138 kV lattice steel lines in Segment 4 and replace these with a single new 230 kV double-circuit steel pole line on the existing ROW. The four existing high-strength lattice steel structures on the long spans between Galiano and Parker Island, adjacent to Montague Harbour, will be modified to carry the new circuits. The crossing over Montague Harbour will maintain the existing 38 m of safe navigable clearance.

There will also be terminal modifications at TBY and MTG, including additional shunt compensation devices at TBY. The terminal work at both sites will take place entirely within the existing properties (see Section 3.4).

3.2.5 Segment 5 – Trincomali Channel

This segment is 3.9 km long, between MTG and Maracaibo Terminal (MBO) on the eastern shore of Salt Spring Island. It passes through Trincomali Channel via submarine cables.

As with the portion of the Project under the Strait of Georgia (Segment 3), there are currently seven cables on the existing ROW (two sets of three single-phase 138 kV cables and one spare). Again, BCTC proposes to remove one of the existing sets of 138 kV cables and replace these with a new set of three, single-phase 230 kV cables.

Figure 3-7. Galiano Island

Figure 3-8. Parker Island

As with Segment 3, the new 230 kV cables will be installed underground between the cable terminals and the shore, buried in the seabed to beyond the low tide line, and laid directly on the seabed in deep water within the existing established ROW.

The remaining set of 138 kV cables will be re-connected to one circuit on the new overhead line to maintain reliable service to the southern Gulf Islands. A spare 138 kV cable will be retained. Required terminal modifications at MBO will take place within the existing property boundaries.

3.2.6 Segment 6 – Salt Spring Island

Segment 6 is 10.8 km long between MBO and Sansum Narrows on the western shore of Salt Spring Island. Segment 6 passes through forested and agricultural land across Salt Spring Island, on an existing 115 m (375 ft) ROW from MBO to the slopes of Mt. Sullivan containing two separate 138 kV lines on lattice steel structures and one bi-pole HVDC line on lattice steel structures, and an existing 53.34 m (175 ft) ROW over Mt. Sullivan to Sansum Narrows containing two 138 kV lines on lattice steel structures (the HVDC line follows a separate right-of-way from the slopes of Mt. Sullivan to Sansum Narrows).

There are several areas where residential developments and individual homes are adjacent to the existing ROW. Typical photos of the existing ROW are shown in Figures 3-9 and 3-10.

BCTC proposes to remove both of the existing 138 kV lattice steel lines and replace these with one new 230 kV double-circuit steel pole line near the centreline of the existing ROW throughout Segment 6. There will also be terminal modifications at MBO that will take place entirely within the existing property (see Section 3.4).

3.2.7 Segment 7 – Sansum Narrows

This segment is 1.8 km long across Sansum Narrows between Salt Spring and Vancouver Islands. It consists of two single-circuit spans, approximately 60 m (200 ft) above the navigation channel on an existing ROW (see Figure 3-11 for a photo of the existing crossing).

1 **Figure 3-9. Salt Spring Island, Athol Peninsula**

2 

3 **Figure 3-10. Salt Spring Island**

4 

Figure 3-11. Sansum Narrows

BCTC proposes to remove the existing lattice steel towers and conductors. New conductors will then be installed on new steel pole structures. The new conductors will be in approximately the same location as the existing conductors and meet the 52.5 m safe navigable clearance provided by the adjacent DC crossing over the navigation channel.

3.2.8 Segment 8 – North Cowichan

Segment 8 is 9.3 km long between Sansum Narrows and VIT, adjacent to Highway 1 in North Cowichan on Vancouver Island. The whole of Segment 3 is within the boundaries of the District of North Cowichan. It passes through forested and agricultural land on an existing 53.34 m (175 ft) ROW containing two 138 kV single-circuit lines. On the eastern portion of this segment near Maple Mountain, the existing lines are on lattice steel structures. The western portion is on wood H-frame structures.

There are a few farms and individual homes adjacent to the ROW. Typical photos of the existing ROW are shown in Figures 3-12 and 3-13.

Figure 3-12. North Cowichan

Figure 3-13. North Cowichan

BCTC proposes to remove both existing 138 kV single-circuit lines and install one new 230 kV double-circuit steel pole line on the existing ROW. There will also be line terminal modifications at VIT, including the installation of a phase-shifting transformer to control power flow on the line, and the installation of a shunt compensation device at the neighbouring Sahtlam substation. The terminal and substation work will take place entirely within the existing substation properties (see Section 3.4).

3.3 Detailed Description

Physically, the VITR Project consists of Overhead Lines, Underground Cables, Submarine Cables, one new Cable Terminal, and modifications to two existing Substations and the four existing Cable Terminals. Each of these proposed Project facilities is described in more detail below. See Appendix A (Sheets 1 through 24) for a conceptual layout of the terrestrial portions of the Project including all but the two submarine crossings (Segments 3 and 5) overlaid on aerial orthophotos of the existing corridor.

3.3.1 Overhead Lines

3.3.1.1 Existing 138 kV Overhead System

The existing 138 kV transmission infrastructure between the Lower Mainland of British Columbia and Vancouver Island, including the overhead transmission lines, cable terminal stations and submarine cables, was constructed in the mid-1950s. The overhead portion of the existing 138 kV transmission system is comprised of two single-circuit lines (1L17 and 1L18). The original design transmission capacity was 120 MW for each circuit, but both have been de-rated to 100 MW due to armour wire corrosion on the submarine cables.

There are currently 254 138 kV structures along the overhead sections of this corridor, including 156 wood H-frame structures and 98 lattice steel structures. The wood H-frame structures are located on the 12.4 km segments in South Delta and Tsawwassen (Segments 1 and 2) and a 4.5 km portion of the segment in North Cowichan near VIT (Segment 8). The segments on Galiano and Parker Islands (Segment 4) and Salt Spring Island (Segment 6) and the balance of the Vancouver Island segment (Segment 8) use lattice steel.

The existing structure types and heights along the corridor are summarized below:

Table 3-2. Existing Overhead Structure Types and Heights

Location	Structure Type	Range in Height (m)	Average Height (m)
South Delta (Segment 1)	Wood H-frame	16 to 27	17.5
Tsawwassen (Segment 2)	Wood H-frame	16 to 20	17.5
TBY to Montague Harbour on Galiano Island (portion of Segment 4)	Steel Lattice	19 to 26	22
Across Montague Harbour to MTG on Parker Island (remainder of Segment 4)	Steel Lattice	41	41
Salt Spring Island (Segment 6)	Steel Lattice	19 to 32	22
North Cowichan (first portion of Segment 8)	Steel Lattice	20 to 33	22
North Cowichan (remainder of Segment 8)	Wood H-frame	16 to 21	17.5

3.3.1.2 Proposed Overhead Transmission Lines (Segments 1, 4 ,6, 7 and 8)

The two existing 138 kV overhead lines will be replaced with a single new 230 kV double-circuit line on galvanized steel poles in the existing ROW, except for the portion through Tsawwassen (Segment 2) where new facilities are proposed to be constructed underground (see Section 3.3.3). With the exception of four existing special long-span structures near Montague Harbour, all conductors, insulators, hardware and supporting structures will be of conventional design and new manufacture. The design life of the new overhead lines should exceed 60 years.

While the ultimate configuration of the new infrastructure will allow for two 230 kV circuits, each with a nominal rating of 600 MW, initially only one circuit will be energized at 230 kV. The second overhead 230 kV circuit would be connected to the remaining portions of the existing 138 kV facilities (see Section 3.5) and operated at 138 kV to continue supply to the southern Gulf Islands through existing substations on Galiano Island and Salt Spring Island.

Several technical studies have been performed to investigate alternatives, to validate a conceptual design for the proposed overhead facilities and to support cost estimating activities.

3.3.1.2.1 Structure Design Alternatives

Selection of new transmission support structures and conductor configurations has been based on engineering design requirements (see Appendix B), plus the following objectives:

(a) minimize disruption to the current land uses along the ROW;

(b) minimize construction of new roads and vegetation removal;

(c) reduce electromagnetic fields (EMF), radio frequency (RF) interference and audible noise as much as practical; and

(d) improve aesthetic appearance of the ROW.

As indicated, BCTC proposes to use galvanized steel poles. With the exception of a few special long-span structures, all new structures will be capable of supporting two 230 kV circuits (double-circuit). Narrow configuration single-circuit steel poles may be considered in a few locations as a means of reducing structure heights, where desirable.

In total, approximately 126 new structures will be installed and 4 modified to replace the existing 263 wood H-frame and lattice steel structures (excluding Segment 2 in Tsawwassen). The majority of the new structures would be placed adjacent to existing structure sites in positions that will minimize ROW preparation requirements and site disturbance. In Tsawwassen, 18 of 36 existing wood H-frame structures will be removed and replaced with underground construction.

3.3.1.2.2 Location within Right-of-Way

Minimum separation from ROW edge and existing electrical circuits has been determined on the basis of CAN/CSA Standard C22.3-No.1-01 and past BC Hydro practice. Increments for minimum clearances from existing electrical utilities will be included to facilitate construction and maintenance and to conform to safety standards on “limits of approach” for line workers.

3.3.1.2.3 Preliminary Structure Spotting

To support engineering feasibility studies, public consultation, environmental studies and cost estimating, preliminary structure spotting has been completed for the entire length of the route (see Appendix C). This layout was completed using a digital elevation model of the existing corridor complete with existing structure geometry and location. The preliminary structure spotting allows evaluation of different structure types and configurations. It also allows examination of individual structure loading using the proposed conductors, limiting design conditions, minimum clearances and expected severe weather loading.

Although the final results will depend on detailed line design, the conceptual layout shown would result in the following structure placements and approximate heights:

Table 3-3. Proposed Structure Type, Placement and Height

Segment	Existing 138 kV Structure Type and Placement	Proposed 230 kV Structure Placement	Typical 230 kV Height
1 – South Delta	Wood H-frame structures, 230 m span, not matched to adjacent to HVDC lattice steel structures	Match step with HVDC towers plus additional mid-span structures	30 m
2 – Tsawwassen	Wood H-frame structures, 230 m span, match stepped for each circuit	None – remove one of two existing 138 kV lines	None
4 – Galiano Island	Lattice steel structures, 350 m span, match stepped for each circuit	For the majority of sites the proposed structures will be generally match stepped with the existing structure locations. Terrain and increased sag of the new conductor will require at least two additional structure locations. The cross under of the HVDC transmission lines at the summit of Galiano Island will require lower, flat single-circuit construction	30 m

Segment	Existing 138 kV Structure Type and Placement	Proposed 230 kV Structure Placement	Typical 230 kV Height
4 – Montague Harbour, Parker Island	Lattice steel structures, match stepped for each circuit	New single-phase steel pole structures will be located at the same sites as the existing structures. The bases of the four taller lattice steel structures adjacent to Montague Harbour will be modified to support new heads and height extensions necessary to maintain safe navigation clearances	Increase height of four existing lattice steel structures by 8 m
6 – Salt Spring Island	Lattice steel structures, 350 m span, match stepped for each circuit	On the Athol Peninsula (Nose Pt.) and the western half of the Island, the proposed structures have been placed where terrain and clearances dictate. This will result in a few additional mid span structures. Within the central portion of the island where the terrain is more favourable, the proposed 230 kV structures will be generally match stepped with the existing 138 kV lattice steel structures	30 m
7 – Sansum Narrows	Single-phase lattice steel structures	New single-phase steel pole structures will be located at the same sites as the existing towers	25 m
8 – Vancouver Island, Lattice Steel Section	Lattice steel structures, 350 m span, match stepped for each circuit	Due to the rugged terrain and the shorter allowable spans for the new structures, the structures have been placed where terrain and clearances dictate. A few additional mid-span structures are required.	30 m
8 – Vancouver Island, Wood H-frame Section	Wood poles, 230 m span, match stepped for each circuit	Match step with existing 138 kV wood pole structure locations	30 m

3.3.1.2.4 Weather Loading

Structural loading criteria have been established to meet established design standards and expected weather loading due to ice and wind.

3.3.1.2.5 External Hazard Assessment

BCTC's evaluation of the existing 138 kV corridor did not identify any significant natural terrain hazards or non-natural hazards that could affect the security of the proposed overhead facilities. While the entire Project area is in a seismically active zone, overhead structures and systems, as proposed, are not especially vulnerable to seismic events.

3.3.1.2.6 Foundations

Sub-surface soil investigation has been done as part of the preliminary technical studies. To assist in preliminary layout and cost estimating, conceptual foundation designs have been prepared for representative structure types under the differing site conditions encountered. The foundation types include:

(a) Steel caisson foundations in the Fraser River delta (South Delta – Segment 1);

(b) Concrete foundations in locations with shallow soft soils overlaying rock or more competent soils such as in North Cowichan (Segment 8), west of Maple Bay;

(c) Direct burial of pole ends in some areas with good granular soils; and

(d) Rock anchor foundations in certain areas on Galiano and Salt Spring Islands and the eastern half of the North Cowichan portion (Segments 4, 6, 7 and 8).

3.3.1.2.7 Conductor Design

It is proposed that each of the new overhead circuits, except long spans at Montague Harbour and Sansum Narrows, use single 1590 MCM ACSR conductor for each of the three phase wires. For standard summer conditions, conductors will be rated for 1626 amps for a conductor temperature of 100°C.

BC Hydro Transmission Engineering Technical Standards, Procedures and Guidelines for vertical and operating clearance criteria will be applied to the conductor sag and swings. These criteria meet or exceed CAN/CSA Standard C22.3-No. 1-01. All other clearances not covered by BC Hydro Transmission Standards will conform to CAN/CSA Standard C22.3-No. 1-01.

Over Montague Harbour and Sansum Narrows, it is proposed that a double-bundled conductor be installed for each phase wire, using the same type of high-strength conductor (238.3 mm^2 54/37 ACSR "Special") as the existing lines. Due to the existing conductor's age, and the need to match sag profiles, the existing conductor will not be re-used at these locations.

3.3.1.2.8 Insulation

Insulation for all 230 kV facilities will provide a minimum basic insulation level equivalent to 12 standard suspension insulator units. This includes the second circuit, which under the current design will be operated at 138 kV. The proposed design will use a composite polymer braced post assembly on typical tangent structures. Insulators for special long spans, heavy angles and dead-end structures will be a glass suspension type. The use of composite insulators for 230 kV construction, other than braced post type or for horizontal posts for jumpers on dead-ends, has not been accepted as a standard by BCTC or BC Hydro.

All temporary 138 kV connections to substation structures at ARN, Galiano, Salt Spring and VIT will conform to 138 kV transmission line standards.

3.3.1.2.9 Grounding and Lightning Protection

Standard design practice for 230 kV transmission lines in BC includes an overhead groundwire for 500 m or three line structures, whichever is greater, beyond the terminal substation (ARN and VIT in this case). There will be similar requirements for the underground or submarine cable terminal stations. Structures connected to the overhead groundwire are required to be fully grounded with a ground resistance less than 10 ohms. Structures outside of the overhead groundwire section shall have a ground resistance not in excess of 250 ohms.

To aid in conceptual design and cost estimating, ground resistivity measurements were taken at several locations. Generally these measurements indicated relatively high ground resistivities; therefore, additional buried grounding conductors will be required at some of the structures closest to ARN and VIT.

3.3.1.2.10 Corridor Access Assessment

An access assessment was conducted for the entire terrestrial corridor except for the Tsawwassen section between TSW and EBT. The assessment reviewed the condition and suitability of access to and along the corridor for right-of-way preparation and structure installation. The assessment covered the terrain, identified access to and along the right-of-way where new accesses are required, and observed restrictions, requirements and ground and vegetation conditions at existing and proposed structure sites.

3.3.1.2.11 Vegetation Analysis

A vegetation analysis of the impact the proposed 230 kV double-circuit line will have on vegetation, both on and adjacent to the existing corridor between ARN and VIT, has been prepared. The analysis was based on DEM ground data, a fall 2004 and spring 2005 LIDAR survey of the Tsawwassen, Galiano, Salt Spring and Vancouver Island areas and a conceptual conductor profile for the proposed 230 kV double-circuit construction and a field assessment of the identified locations.

3.3.2 Overhead Construction Methods and Procedures

Construction activities associated with the VITR Project include:

(a) Site preparation along the ROW, required vegetation clearing and access improvements will be limited since it is an existing transmission corridor;

(b) Removal of the existing 138 kV conductors and structures (removal of only one set of structures in Tsawwassen);

(c) Installation of foundations and anchors;

(d) Installation of new steel support structures;

(e) Installation of conductors, overhead ground wires, and counterpoise (buried ground wires); and

(f) Site restoration along the ROW, including decommissioning of any temporary construction access roads.

The following is a brief summary of construction activities and potential temporary effects during overhead line construction. All construction activities are routine in nature.

(a) For Segments 1 and 8 – South Delta and the western portion of the North Cowichan segment, both existing wood H-frame 138 kV lines will be removed, beginning in Delta. Gulf Island loads will be served from Vancouver Island until the new 230 kV overhead line is complete on the Mainland and one circuit reconnected to the 1L17 submarine cables.

(b) For Segments 4, 6, 7 and 8 - Galiano, Salt Spring, Sansum Narrows and the eastern portion of North Cowichan, both existing lattice steel 138 kV lines will be removed. Gulf Island loads will be served from the Lower Mainland during overhead line construction between Salt Spring Substation and VIT.

(c) The existing conductor will be spooled on reels for recycling. Wood poles and cross-arms, steel structures, insulators and other hardware and materials will be removed and properly recycled or disposed of. Concrete foundations and anchors will be removed.

(d) Holes remaining after removing the wood poles and lattice steel foundations will be filled with suitable local or offsite material.

(e) Construction in the soft soils in Delta will require excavating for caisson foundations, in a manner similar to that used previously for the HVDC line. In better soils, directly-embedded poles and concrete spread footings may be used. In some areas on the islands, rock anchor foundations will require drilling and grouting.

(f) Transmission structures will be simple, galvanized steel poles. Structures will be located to reduce impacts on agricultural operations. Lower sections will likely be installed using construction cranes. Upper sections may be lifted and mounted using helicopters. See Figures 3-14 through 3-21 for typical before and after simulations on the existing ROW.

(g) The new conductor will be installed using reels and tensioning equipment at a limited number of locations for each segment.

(h) Access to the ROW will be timed to avoid conflicts with agricultural and recreational activities; and to minimize impacts to surface soils, vegetation and site drainage due to vehicles and construction operations. Work at road and rail crossings will be carefully scheduled to insure public and worker safety and to minimize any disruption to traffic.

Figure 3-14. Garden Centre, South Delta (Before)

Figure 3-15. Garden Centre, South Delta (After)

Figure 3-16. Athol Peninsula, Salt Spring Island (Before)

Figure 3-17. Athol Peninsula, Salt Spring Island (After)

Figure 3-18. Okana Creek, Salt Spring Island (Before)

Figure 3-19. Okana Creek, Salt Spring Island (Before)

Figure 3-20. Vancouver Island (Before)

Figure 3-21. Vancouver Island (After)

(i) An Environmental Management Plan (EMP) will be prepared detailing measures to be taken during removal and reconstruction to avoid, where possible, and mitigate, where practical, any environmental effects. A draft EMP will form part of BCTC's EAC Application under BCEAA and will be reviewed as part of the environmental assessment and approval process. A final EMP will be issued prior to construction. BCTC does not expect any significant adverse environmental effects from overhead construction-related activities.

(j) All lands and conforming improvements will be restored to previous condition following construction.

3.3.3 Underground Cables – Segment 2

During alternatives analysis and public consultation for the VITR Project, it became apparent that the existing corridor through the densely developed residential area in Tsawwassen would pose considerable challenges for community acceptance and future operation of any new overhead line. Consequently, on March 17, 2005, BCTC made a public commitment to not recommend construction of a new overhead 230 kV line on the existing ROW in Tsawwassen (see Appendix D). A detailed discussion of the alternatives considered is found in Section 4.3.

After considerable evaluation of available alternatives, BCTC has determined that it is the best balance of all stakeholders interests to retain the existing corridor through Tsawwassen and BCTC proposes underground construction on the existing 175 ft ROW for Segment 2 in Tsawwassen. One of the two existing 138 kV wood H-frame single-circuit lines will be removed and replaced with a 230 kV underground cable circuit in underground conduits. In selected areas of Segment 2, a second set of underground conduits will also be installed to facilitate the potential installation of a second 230 kV underground cable circuit in the future and to limit repeated impacts to private properties. The second existing 138 kV overhead circuit would remain in place to continue to provide service to the southern Gulf Islands until the second 230 kV underground circuit is in service.

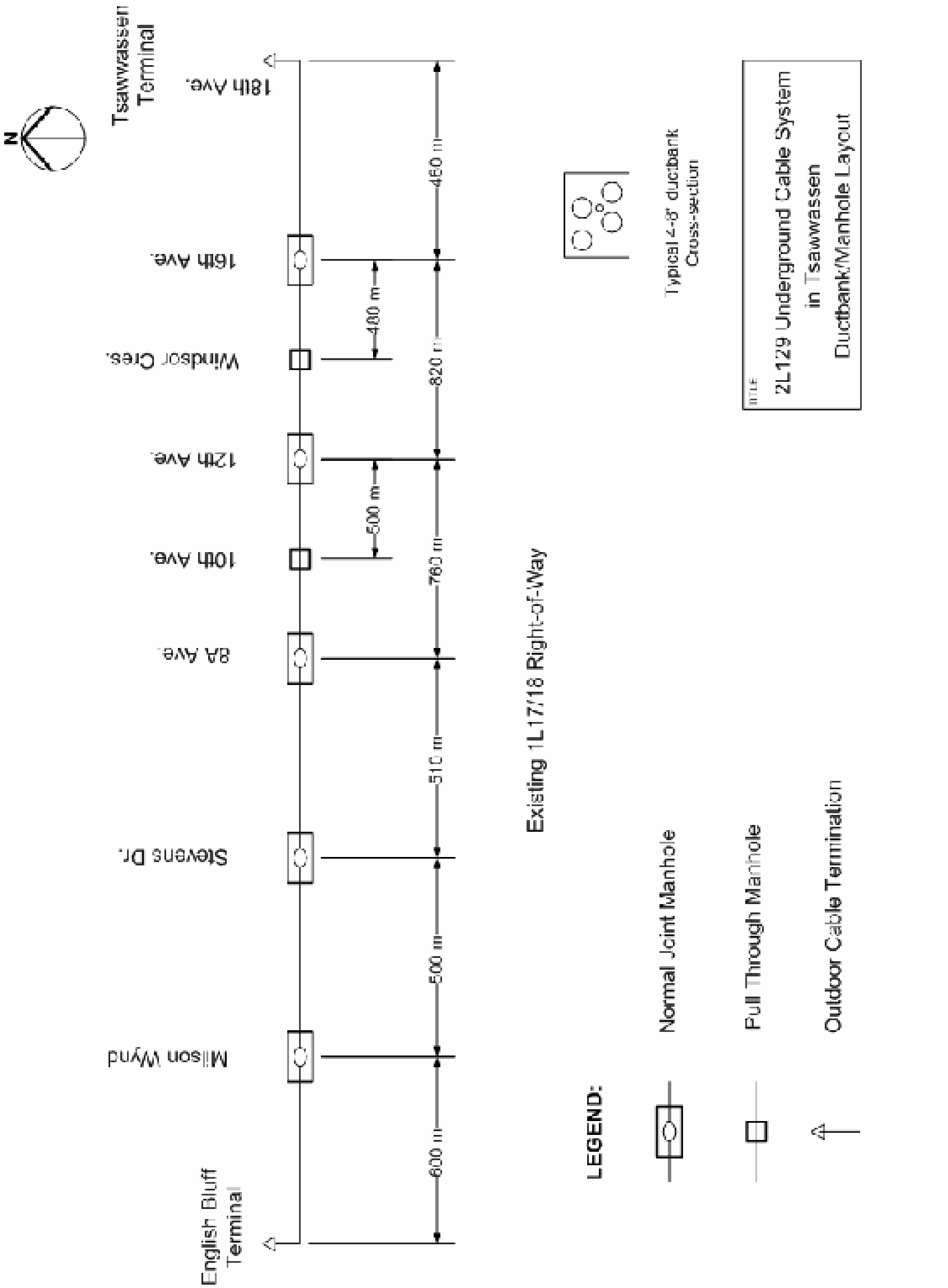
BCTC has also committed that, if alternative sources of funding or financing can be put in place to cover the additional costs associated with the alternative means of undertaking the Project in Tsawwassen (such as underground construction in public streets or advancing the underground replacement of the second 138 kV line), BCTC is prepared to undertake the Project in this manner.

3.3.3.1 Underground Cable Facilities

BCTC will employ conventional underground cable design and construction for the VITR Project. The underground portion will begin adjacent to TSW, continue for a distance of approximately 3.7 km, and terminate at EBT. There will be three separate cables installed in a single concrete-encased ductbank. Four to five underground chambers, located near cross-streets, will be required for construction and maintenance activities. These will be accessed by manholes. Smaller supplementary manholes may be required between the larger manholes to facilitate duct cleaning and cable pulling (see Figure 3-22). Once the cables are installed, later access will be very infrequent.

Sheets 5, 6 and 7 of Appendix A show a conceptual layout of the new concrete ductbanks and underground manholes in comparison to the existing overhead lines and ROW boundaries. The ductbank location will be 5 m from the existing right-of-way centreline. A portion of a second ductbank and manholes will also be installed during the initial construction to avoid future disruption to private property if a second 230 kV circuit is installed in the future. The second ductbank will be located 5 m on the opposite side of the ROW centreline, providing a total 10 m circuit separation distance. This distance is needed to minimize mutual heating effects between the two circuits, which would otherwise result in a loss of transmission capacity. It will also help to minimize induced currents and voltages in the parallel buried cable system's conductor and sheaths, which can be a hazard to workers doing maintenance on de-energized circuits. In openly accessible areas or properties not requiring excavation for the first ductbank, future ductbanks and access manholes for the potential second circuit will not be installed at this time.

Figure 3-22. Manhole/Ductbank Layout in Tsawwassen



Configuration of the buried cable system will be approximately as shown in Figure 3-23. Cables used for the underground sections will be self contained fluid-filled; similar to those used for the submarine cable sections (see Section 3.3.4); except that they will not be armoured, and the conductor size will be larger to compensate for their closer proximity and warmer soil ambient temperatures. A typical cable cross-section is shown in Figure 3-24.

The transition from the underground cable system to the submarine cable system will be made at EBT. This can be done via back-to-back cable terminations, which will facilitate complete electrical and hydraulic separation between the two systems, if needed for operations reasons. Alternatively, transition joints can be provided eliminating the need for above ground cable terminals at EBT. This cannot be determined until the public tendering process has been completed and cable supplier's costs and proven capabilities have been evaluated.

Figure 3-23. Configuration of the Buried Cable System in Tsawwassen

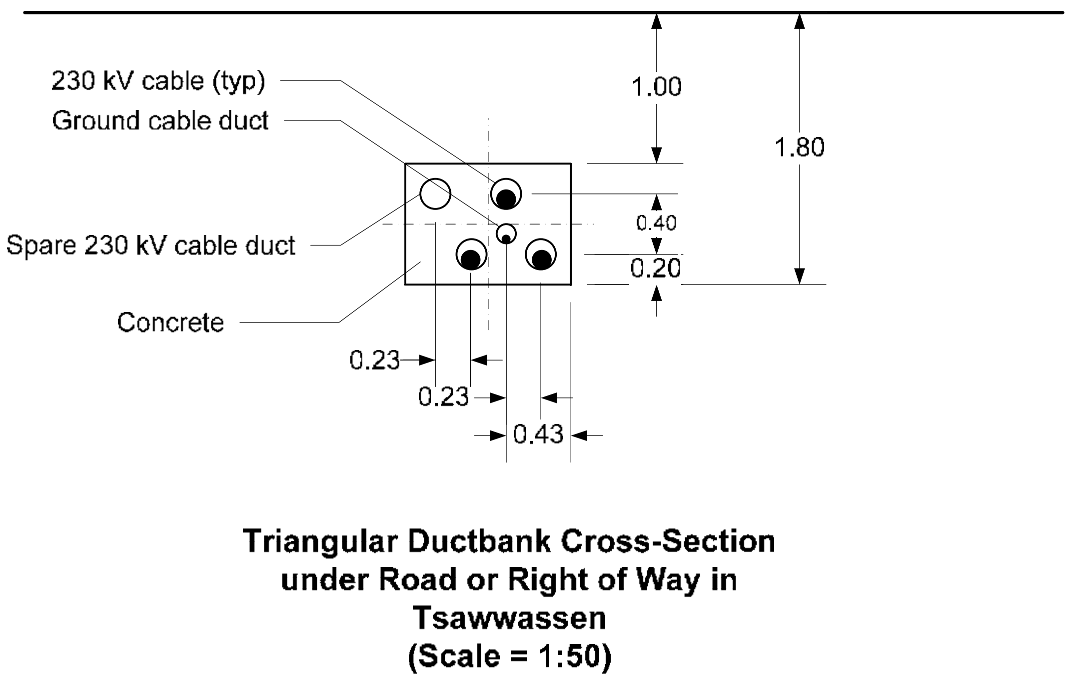
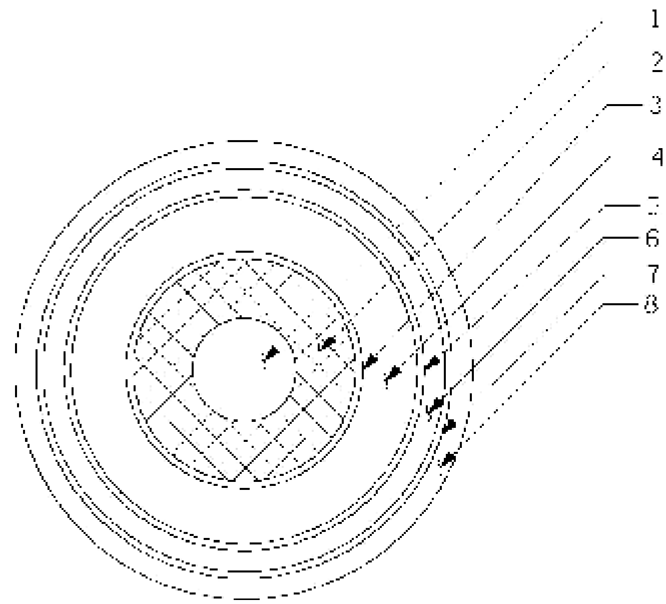


Figure 3-24. Underground Transmission Cable Cross Section



CROSS SECTION OF TYPICAL HIGH VOLTAGE UNDERGROUND TRANSMISSION CABLE

ITEM	COMPONENT	DESCRIPTION
1	INSULATING FLUID DUCT	
2	CONDUCTOR	CROSS SECTION SELF SUPPORTING SHOWN AS STRIPS OF COPPER
3	CONDUCTOR SCREEN	CARBON BLACK PAPERS
4	INSULATION	IMPREGNATED OIL PAPER TAPES
5	CORE SCREEN	CARBON BLACK PAPERS COPPER WOVEN FABRIC TAPE
6	LEAD OR ALUMINUM SHEATH	EXTRUDED LEAD ALLOY OR ALUMINUM
7	REINFORCEMENT (LEAD ONLY)	BRONZE, COPPER OR STAINLESS STEEL TAPES
8	ANTI-CORROSION JACKET	EXTRUDED POLYETHYLENE SHEATH

3.3.3.2 Underground Cable Construction

Construction on this segment will require the select removal of fences, vegetation and other barriers for a width of approximately 20 m on those properties where construction of two ductbanks will occur. The width could be less where only one ductbank is to be installed. This space will be required for excavating equipment and construction vehicles. Linear access for the entire corridor will be required but can be completed in stages. Work will be planned to minimize, to the extent practical, the disruption and time span for overhead line removal, new underground construction, and site restoration on individual properties.

As indicated, one of the existing 138 kV wood pole lines will be removed prior to installation of the underground facilities. The second existing overhead line will remain in place to provide service to the southern Gulf Islands.

Excavation for each ductbank will be approximately 1.5 m wide and 2 to 3 m deep. Most excavated material will be removed from site, unless high re-compaction densities of native material can be proven. Otherwise, select imported backfill materials will be used.

Topsoil will be retained and vegetation restored. Minimum cover over the concrete encased ductbank will be 1 m. Surface improvements will also be restored, except for non-conforming structures or deep-rooted trees located within 5 m of the ductbank centreline.

The three to five underground chambers required for cable splicing and worker access are quite large and will be located near street crossings to facilitate maintenance. These chambers are normally precast in two segments to reduce installation time and disruption. After the ductbank is complete, cable installation can proceed from the access manholes in or near streets without further disruption at other locations. Cables will be installed from reels using specialized equipment. Cable splicing will be done in the underground chambers beneath the access manhole covers.

A new cable terminal, adjacent to TSW, will be constructed entirely on the existing property. Overhead deadend structures will be installed for both new 230 kV overhead circuits from ARN. One new circuit will be connected through to the one existing 138 kV overhead remaining in Segment 2. The other 230 kV circuit will connect to the new 230 kV underground cable terminals above ground.

3.3.4 Submarine Cables – Segments 3 and 5

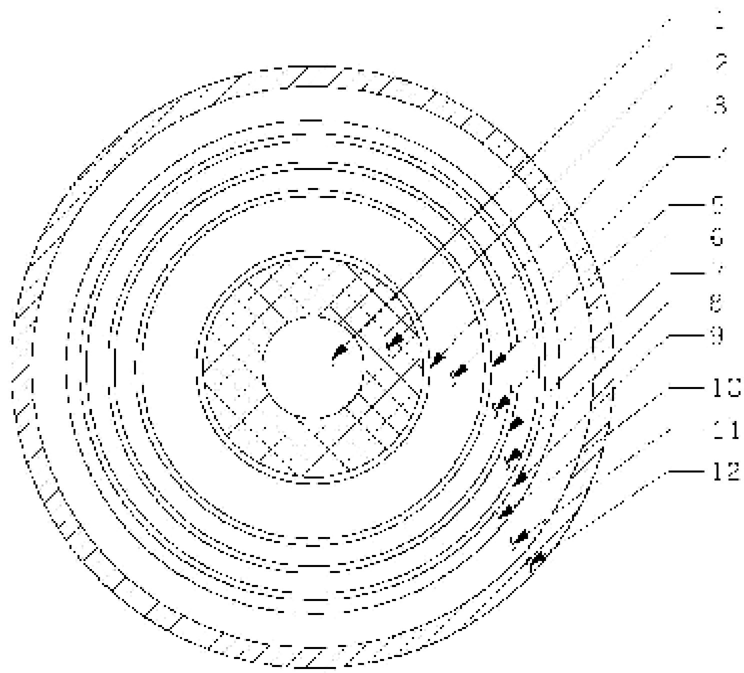
As indicated, as part of the VITR Project, three of the existing 138 kV submarine cables will be removed and replaced with three new 230 kV cables within the Strait of Georgia and Trincomali Channel. The expected life of the new 230 kV submarine cables is approximately 50 years. The remaining 138 kV submarine cable circuit, comprised of three operating cables and one spare, will remain in place to supply Salt Spring and Galiano substations from either ARN or VIT.

3.3.4.1 Cable Design

The new submarine cables will be a self-contained, fluid-filled (SCFF) design, in which the cable insulation is pressurized with insulating fluid supplied from the cable terminals. The outside cable diameter will be approximately 125 mm (5 inches). This is currently the only cable type with proven reliability, suitable for the long distance, deep water, and high-voltage AC installation; however, BCTC is continuously monitoring technological developments and will consider any new proven technologies during final design and contract tendering.

A cross section of a typical SCFF submarine cable is shown in Figure 3-25. The central stranded-copper conductor is the current carrying component. Its hollow core provides a passageway for insulating fluid under static pressure provided by equipment at the cable terminals. The insulating fluid saturates the cable insulation, maintaining the electrical integrity of the cable, and prevents damaging ingress of water in the unlikely event of an underwater leak.

Figure 3-25. Submarine Transmission Cable



CROSS SECTION OF TYPICAL HIGH VOLTAGE SUBMARINE TRANSMISSION CABLE

ITEM	COMPONENT	DESCRIPTION
1	INSULATING FLUID DUCT	
2	CONDUCTOR	CROSS SECTION SELF SUPPORTING SEGMENTAL STRIPS OF COPPER
3	CONDUCTOR SCREEN	CARBON BLACK PAPERS
4	INSULATION	[illegible] PP [illegible] PAPER TAPES
5	CORE SCREEN	CARBON BLACK PAPERS COPPER WOVEN FABRIC TAPE
6	LEAD SHEATH	EXTRUDED LEAD ALLOY
7	REINFORCEMENT	BRONZE, COPPER OR STAINLESS STEEL TAPES
8	ANTI CORROSION JACKET	EXTRUDED POLYETHYLENE SHEATH
9	ANTI TEREDO PROTECTION	
10	BEDDING	POLYPROPYLENE YARN
11	ARMOUR	METAL WIRE ARMOUR (SINGLE OR DOUBLE LAYERS)
12	SERVING	POLYPROPYLENE YARN APPROX MAX OUTSIDE DIAMETER RANGE = 120-145 mm

The proposed insulating fluid is linear alkylbenzene (LAB), which provides optimal electrical, thermal, hydraulic and biodegradability characteristics. The fluid functions to control the high electric stresses in the insulation, which is important in this higher voltage (230 kV) application. The fluid's low viscosity aids in maintaining internal cable pressure requirements when the electrical load changes rapidly. It also evaporates relatively quickly from the water surface, in the unlikely event of a leak. LAB is widely used in similar applications and is superior to refined mineral oil, from a biodegradability perspective. Further details regarding the cable design are provided in Appendix E.

3.3.4.2 Cable Removal

The three most southerly 138 kV cables in the Strait of Georgia and the three most northerly cables in Trincomali Channel will be decommissioned before installation of the new 230 kV cables commences. It is currently expected that this will be done via a separate removal and disposal contract beginning in 2007. It may be necessary to use air-lifting and water jetting equipment to uncover the cables where they are currently buried from shore to below the lowest tide line. Metal components of the recovered cable will be recycled.

It may be determined as a result of the environmental assessment and approval process that it is beneficial to abandon sections of existing buried cable off-shore from EBT in place to reduce effects on water quality and near shore aquatic habitats. If sections of the cables are to be left in place, these cables will be cut and capped.

3.3.4.3 Cable Installation

Installation of submarine cables will require a dedicated cable-laying vessel, with dynamic positioning capabilities and touchdown monitoring using an underwater remotely operated vehicle (ROV). It is proposed that each cable will be installed in one continuous length between cable terminal landings, except for potential sea/land splices within the intertidal and subtidal zones, as described below.

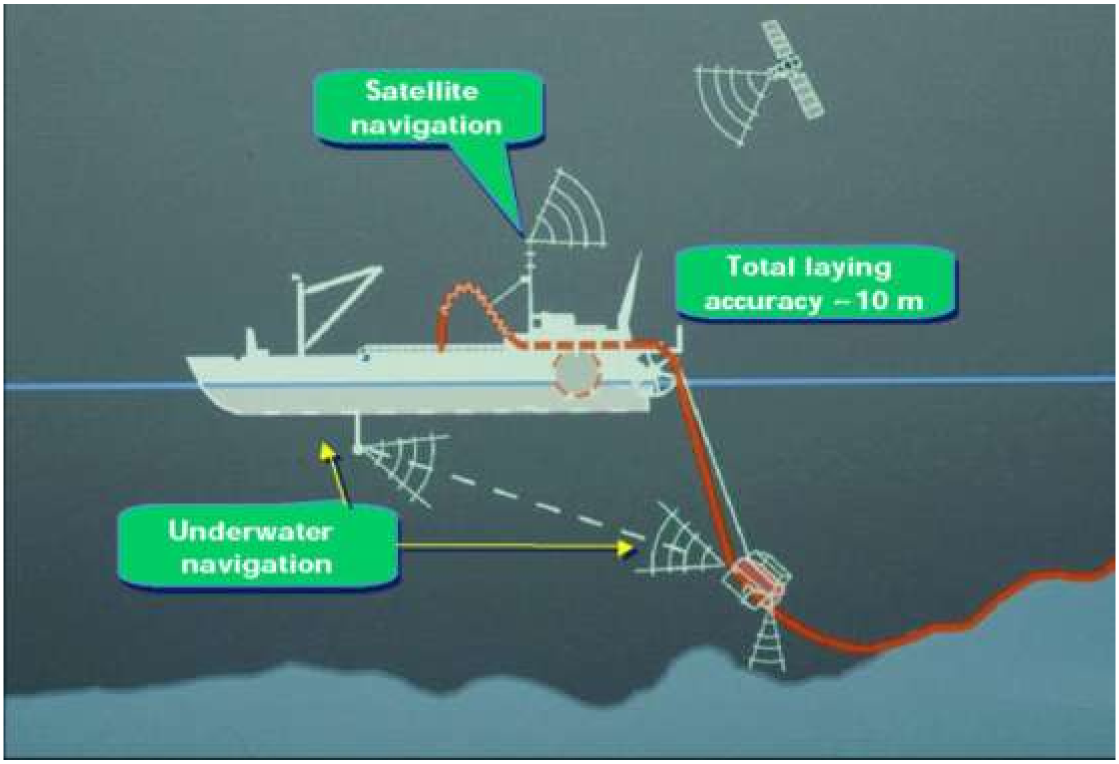
Figures 3-26 through 3-28 provide views of typical cable installation practices proposed for the VITR Project.

The new 230 kV cables will be installed in the existing ROW. Their final position will be controlled and final locations known with precision, using modern navigation and cable-laying equipment. The sequence of activities for cable removal and new cable installation remain to be determined during detailed design and construction tendering. Cable manufacturers, submitting competitive tenders, will often propose

Figure 3-26. Pirelli Cable Laying Ship C/S Giulio Verne During Installation of New DC5 Cable

Figure 3-27. Typical Cable Laying Turntable and Gantry

Figure 3-28. Cable Laying with ROV for Touchdown Monitoring



innovative solutions to help expedite installation or to reduce costs based on their specific designs and installation equipment or their experience on recent projects.

The new submarine cables will be installed to ensure that the new circuit meets seismic performance requirements. Marine-based geotechnical and geophysical investigations have been done to evaluate seismic risks of various alternatives. These studies provided recommendations for optimum routing of the proposed 230 kV submarine cables, and identified possible risk mitigation measures. The area of greatest potential challenge for installation of the new cables is within the intertidal and shallow, steep-slope subtidal areas west of EBT and Point Roberts. This area is at the southern edge of the Fraser River delta. Geotechnical investigations have characterized the marine geology and geophysics in this area, particularly with respect to stability during a seismic event (see Appendix F).

It is proposed that the new submarine cables be located south of the existing cable locations for approximately the first 4 km west of EBT. Based on geophysical analysis, this routing would minimize potential risk of damage to the cables during seismically induced underwater slides along the edge of the Fraser River delta.

A separate Non-Natural Marine Hazards Assessment has been completed examining potential hazards from anchors, fishing gear, or tug tow-lines (see Appendix G). Results indicate no excessive risks to the cables from marine activities in the area.

For entry of the cables into the water from EBT, the new 230 kV cables will use the existing concrete chaseways from their new termination positions, located at approximately the same locations as the existing 138 kV terminations, under English Bluff Road to the upper entrance to the existing cable tunnel near the centre of the city park on BCTC/BC Hydro property, immediately west of English Bluff Road. From there, the cables would be routed through the existing cable tunnel to the lower tunnel entrance at the high water level.

To reach the tunnel entrance, the cable end would be floated ashore across the intertidal mud flats guided by shallow draft workboats during favourable weather conditions. Once the cables are safely pulled ashore and laid on the bottom, they will be water jetted to a vertical depth of approximately 1.0 m beneath the sea bottom, out to –3 m below the low tide line. Protective split pipe covers will be placed around the cables in the upper intertidal zone to provide additional protection against high wave energy and seasonal sediment transport.

For the TBY, MTG and MBO terminal installations, similar methods will be used to float the cables ashore and bury them, except where the sea bottom may be composed of gravel and cobbles. In this case, it may be necessary to use diver-operated air lifting equipment, to ‘vacuum’ open trenches on the sea bottom before cable laying.

At TBY, MTG and MBO, the existing chaseways will be modified and reused from the high water level to the new 230 kV cable termination footings in each terminal station. Figures 3-29 through 3-32 show the existing cable chaseways at EBT, TBY, MTG, and MBO. New sunshades will be installed over the existing exposed chaseways to reduce solar heating effects.

Figure 3-29. Cable Chaseway at English Bluff Terminal (EBT)

Figure 3-30. Cable Chaseway at Taylor Bay Terminal (TBY)

Figure 3-31. Cable Chaseway at Montague Terminal (MTG)

Figure 3-32. Cable Chaseway at Maracaibo Terminal (MBO)

At all terminal approaches, it may be necessary to make a transition from the submarine cables to larger size land cables. This will be done using special sea/land transition joints, located in the intertidal zone.

An Environmental Management Plan (EMP) will be prepared detailing measures to be taken during removal and reconstruction to avoid, where possible, and mitigate, where practical, any environmental effects. A draft EMP will form part of BCTC's EAC Application under BCEAA and will be reviewed as part of the environmental assessment and approval process. A final EMP will be issued prior to construction. BCTC does not expect any significant adverse environmental effects from marine construction-related activities.

3.3.4.4 Cathodic Protection Systems

To avoid the potential for corrosion of cable armour, cathodic protection systems may be installed for the intertidal and subtidal areas near EBT or areas of potential cable abrasion from underwater features such as the Galiano Ridge.

3.4 Substations and Cable Terminals

The VITR Project will require modifications at ARN and VIT substations, a new underground cable terminal adjacent to TSW and modifications to each of the four existing submarine cable terminals (EBT, TBY, MTG and MBO).

The EMP will also consider the impacts of substation and cable terminal construction and facilities. BCTC does not expect any significant adverse environmental effects from construction-related activities at the substation and cable terminal sites.

3.4.1 Modifications at ARN and VIT

The ARN and VIT substations will be modified to accommodate the additional 230 kV line positions. This is routine work and will take place entirely within the existing property.

In addition to the line position modifications at VIT, a phase-shifting transformer (PST) will also be installed at VIT. A PST is a relatively large, fluid-filled device similar to a conventional high-voltage transformer. It will be installed within a secondary fluid containment basin of sufficient capacity, consistent with the requirements of the National Fire Code of Canada and with the British Columbia Fire Code. Installation of the PST may require expansion of the fenced enclosure at VIT but would still take place within the existing property. Details on the configuration and specifications for the PST will be determined during the detailed engineering phase. In addition, noise abatement measures will be incorporated into the modifications at the VIT to minimize potential disturbances to surrounding landowners associated with operation of the PST.

Please see Appendix H for a more detailed description of the required modification at ARN and VIT.

3.4.2 Shunt Compensation Equipment

System studies show that it is necessary to install shunt compensation equipment at TBY and Sahtlam Substation. The purpose of the shunt compensation equipment is to reduce over-voltages on the 230 kV system during light loading conditions, and to compensate for the cable insulation charging current, which reduces real power transmission capacity. Plans are to install a new 75 Mvar device at each location with concrete footings, disconnect switches, fluid containment systems and auxiliary equipment. This will require expanding the fenced enclosure at TBY within the existing property, and a westerly relocation of the existing access road to the Galiano Substation (GLS), again within the existing property. Some tree clearing and site grading will be required. Installation at Sahtlam can be done within the existing site.

3.4.3 Cable Terminals

Modifications and improvements to the four existing cable terminal sites (EBT, TBY, MTG and MBO) will include removal of existing concrete footings for the 138 kV cable terminations and overhead line deadend structures. Except for EBT, which will serve as a transition point between the submarine and underground sections, new installations will include new cable termination footings and support structures, new overhead line deadend footings and structures, lightning arrestors and footings, insulating fluid pressurizing and containment systems, cable chase modifications, grounding systems, site resurfacing and other miscellaneous improvements, such as relocating the access road at TBY. Some tree trimming and clearing may also be required at TBY, MTG and MBO. A new cable terminal station, similar to EBT, TBY, MTG and MBO, will be constructed adjacent to TSW within the existing property.

The cable insulation fluid will be pressurized by systems located at each of the four cable terminal sites. For the Strait of Georgia crossing, ‘pumping plant’ systems will be used to maintain predetermined pressures within the cables. For the shorter and shallower Trincomali Channel crossing, cable insulation fluid will be pressurized either through a conventional pumping plant at MBO and a ‘crossover’ at MTG, or alternatively, via a passive pressure tank system at each terminal. Both of these options would be effective at maintaining required pressure of the insulating fluid during normal operations and automatically reducing pressure under abnormal conditions.

A new storage facility for spare cable will be constructed within the existing MBO property. The storage facility would consist of a revolving steel turntable mounted on a concrete footing. An insulating fluid containment and monitoring system will also be provided.

3.5 Service to the Southern Gulf Islands

The two existing 138 kV circuits (1L17 and 1L18) are currently used to supply the southern Gulf Island loads from ARN with lines normally open at VIT due to supply limitations on Vancouver Island. Two 138 kV distribution substations located on Salt Spring Island and Galiano Island, respectively, are fed from the two circuits.

The installation of one 230 kV circuit will provide sufficient capacity to supply the forecast Vancouver Island shortfall for approximately 10 years. Since the southern Gulf Islands are currently served through existing 138 kV substations, upgrading both existing 138 kV circuits would involve costly, and unnecessary, modifications to these substations for conversion to 230 kV. Accordingly, notwithstanding the VITR Project will provide increased capacity to Vancouver Island, it is necessary to continue to be in a position to supply the southern Gulf Islands at 138 kV.

To accomplish this, under VITR, one of the new 230 kV overhead circuits connected to the 230 kV submarine cables will supply Vancouver Island directly. The other new 230 kV overhead circuit will be connected to the remaining set of 138 kV submarine cables and will be operated at 138 kV to supply Salt Spring and Galiano substations from either ARN or VIT.

This mode of operation will continue until it is necessary to complete the installation of the second 230 kV circuit. At that time, both 230 kV overhead circuits will operate at 230 kV and be configured to supply Vancouver Island and the southern Gulf Islands. Salt Spring substation will be converted to 230 kV and connected to the 230 kV circuits. Galiano Island may be fed from the converted 230 kV Salt Spring substation at distribution voltage or directly supplied from a converted 230 kV Galiano substation. The second 138 kV submarine cable circuit will be decommissioned and removed prior to installation of the second set of submarine cables.

As previously indicated, BCTC is not applying for a CPCN for any of this future work to complete the second 230 kV circuit or to convert the Salt Spring substation at this time. The project will be the subject of a separate CPCN Application when those facilities are needed.

3.6 Schedule and Implementation

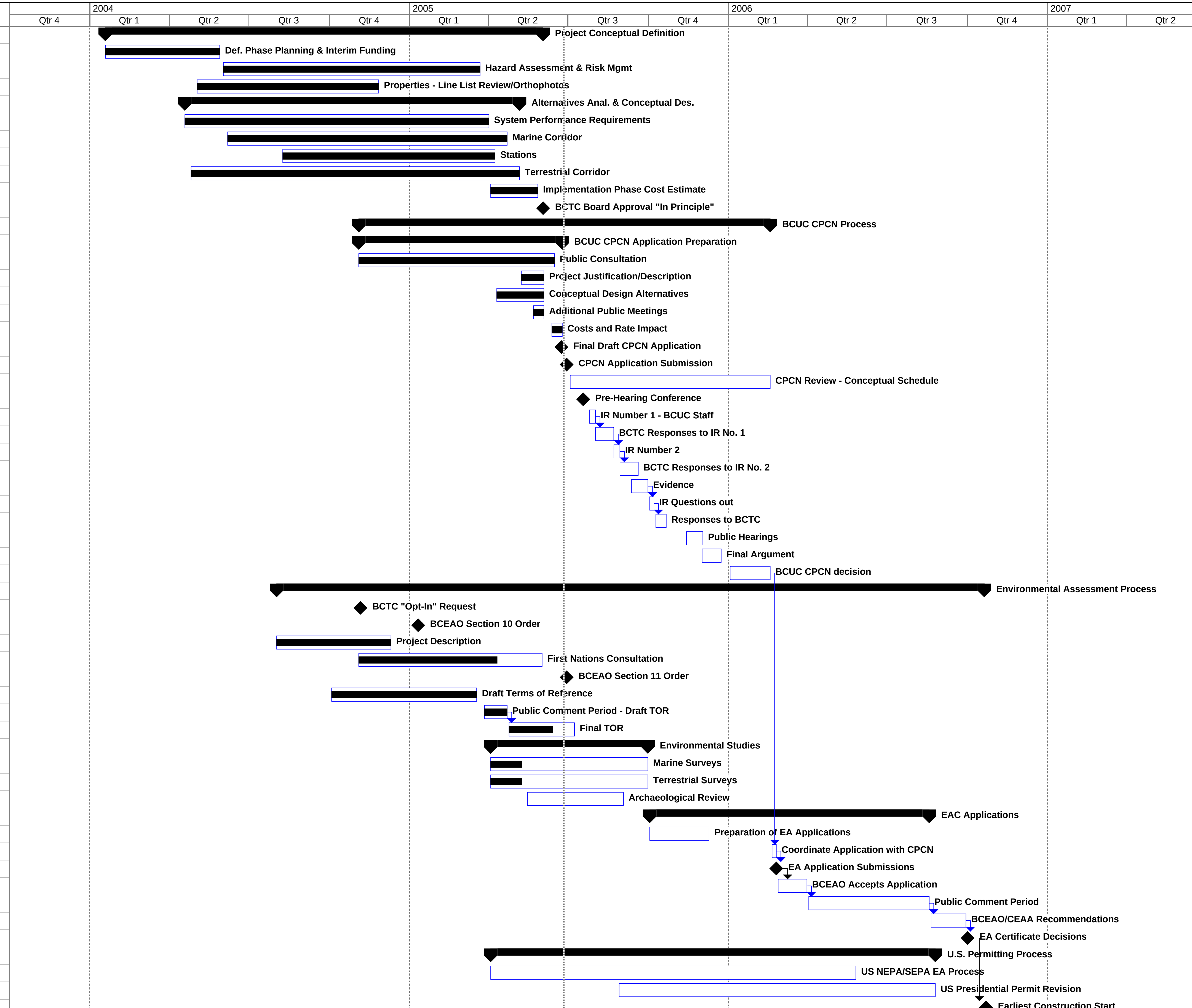
3.6.1 Project Plan with Milestones

Figure 3-33 shows a proposed schedule for the Definition Phase of the VITR Project concluding with the receipt of a CPCN, provincial and federal environmental approvals, successful completion of the required US environmental assessment process, and receipt of ancillary Canadian and US permits. The proposed schedule includes a conceptual schedule for the Commission’s review of this Application, although the actual schedule of activities in the review process will be determined by the Commission.

Figure 3-34 represents a conceptual summary-level schedule for the Implementation Phase concluding with commissioning the Project in October 2008.

Figure 3-33. VITR Project Definition Phase Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Project Conceptual Definition**	**71.8 w**	**Mon 1/19/04**	**Fri 6/3/05**	
2	Def. Phase Planning & Interim Funding	19 w	Mon 1/19/04	Fri 5/28/04	
3	Hazard Assessment & Risk Mgmt	42 w	Wed 6/2/04	Tue 3/22/05	
4	Properties - Line List Review/Orthophotos	30 w	Mon 5/3/04	Fri 11/26/04	
5	Alternatives Anal. & Conceptual Des.	55 w	Mon 4/19/04	Fri 5/6/05	
6	System Performance Requirements	50 w	Mon 4/19/04	Fri 4/1/05	
7	Marine Corridor	46 w	Mon 6/7/04	Fri 4/22/05	
8	Stations	35 w	Mon 8/9/04	Fri 4/8/05	
9	Terrestrial Corridor	54 w	Mon 4/26/04	Fri 5/6/05	
10	Implementation Phase Cost Estimate	8 w	Mon 4/4/05	Fri 5/27/05	
11	**BCTC Board Approval "In Principle"**	0 w	Fri 6/3/05	**Fri 6/3/05**	
12	**BCUC CPCN Process**	67.4 w	Thu 11/4/04	Fri 2/17/06	
13	BCUC CPCN Application Preparation	33.4 w	Thu 11/4/04	Fri 6/24/05	
14	Public Consultation	32 w	Thu 11/4/04	Wed 6/15/05	
15	Project Justification/Description	4 w	Mon 5/9/05	Fri 6/3/05	
16	Conceptual Design Alternatives	8 w	Mon 4/11/05	Fri 6/3/05	
17	Additional Public Meetings	2 w	Mon 5/23/05	Fri 6/3/05	
18	Costs and Rate Impact	2 w	Mon 6/13/05	Fri 6/24/05	
19	Final Draft CPCN Application	0 w	Fri 6/24/05	Fri 6/24/05	
20	**CPCN Application Submission**	0 w	Thu 6/30/05	**Thu 6/30/05**	
21	**CPCN Review - Conceptual Schedule**	33 w	Mon 7/4/05	**Fri 2/17/06**	
22	Pre-Hearing Conference	0 w	Tue 7/19/05	Tue 7/19/05	
23	IR Number 1 - BCUC Staff	1 w	Tue 7/26/05	Mon 8/1/05	
24	BCTC Responses to IR No. 1	3 w	Tue 8/2/05	Mon 8/22/05	23
25	IR Number 2	1 w	Tue 8/23/05	Mon 8/29/05	24
26	BCTC Responses to IR No. 2	3 w	Tue 8/30/05	Mon 9/19/05	25
27	Evidence	3 w	Mon 9/12/05	Fri 9/30/05	
28	IR Questions out	1 w	Mon 10/3/05	Fri 10/7/05	27
29	Responses to BCTC	2 w	Mon 10/10/05	Fri 10/21/05	28
30	Public Hearings	3 w	Mon 11/14/05	Fri 12/2/05	
31	Final Argument	3.2 w	Fri 12/2/05	Fri 12/23/05	
32	**BCUC CPCN decision**	6.8 w	Tue 1/3/06	**Fri 2/17/06**	
33	**Environmental Assessment Process**	**116 w**	**Mon 8/2/04**	**Fri 10/20/06**	
34	BCTC "Opt-In" Request	0 w	Fri 11/5/04	Fri 11/5/04	
35	BCEAO Section 10 Order	0 w	Tue 1/11/05	Tue 1/11/05	
36	Project Description	19 w	Mon 8/2/04	Fri 12/10/04	
37	First Nations Consultation	30 w	Thu 11/4/04	Wed 6/1/05	
38	BCEAO Section 11 Order	0 w	Thu 6/30/05	Thu 6/30/05	
39	Draft Terms of Reference	24 w	Mon 10/4/04	Fri 3/18/05	
40	Public Comment Period - Draft TOR	4 w	Mon 3/28/05	Fri 4/22/05	
41	**Final TOR**	11 w	Mon 4/25/05	**Fri 7/8/05**	40
42	Environmental Studies	26 w	Mon 4/4/05	Fri 9/30/05	
43	Marine Surveys	26 w	Mon 4/4/05	Fri 9/30/05	
44	Terrestrial Surveys	26 w	Mon 4/4/05	Fri 9/30/05	
45	Archaeological Review	16 w	Mon 5/16/05	Fri 9/2/05	
46	EAC Applications	**46 w**	**Mon 10/3/05**	**Fri 8/18/06**	
47	Preparation of EA Applications	10 w	Mon 10/3/05	Fri 12/9/05	
48	Coordinate Application with CPCN	1 w	Mon 2/20/06	Fri 2/24/06	32
49	**EA Application Submissions**	0 w	Fri 2/24/06	**Fri 2/24/06**	48
50	BCEAO Accepts Application	5 w	Mon 2/27/06	Fri 3/31/06	49
51	Public Comment Period	20 w	Mon 4/3/06	Fri 8/18/06	50
52	BCEAO/CEAA Recommendations	6 w	Mon 8/21/06	Fri 9/29/06	51
53	**EA Certificate Decisions**	3 w	Mon 10/2/06	**Fri 10/20/06**	52
54	**U.S. Permitting Process**	**73 w**	**Mon 4/4/05**	**Fri 8/25/06**	
55	US NEPA/SEPA EA Process	60 w	Mon 4/4/05	Fri 5/26/06	
56	US Presidential Permit Revision	52 w	Mon 8/29/05	Fri 8/25/06	
57	**Earliest Construction Start**	0 w	Mon 10/23/06	**Mon 10/23/06**	53

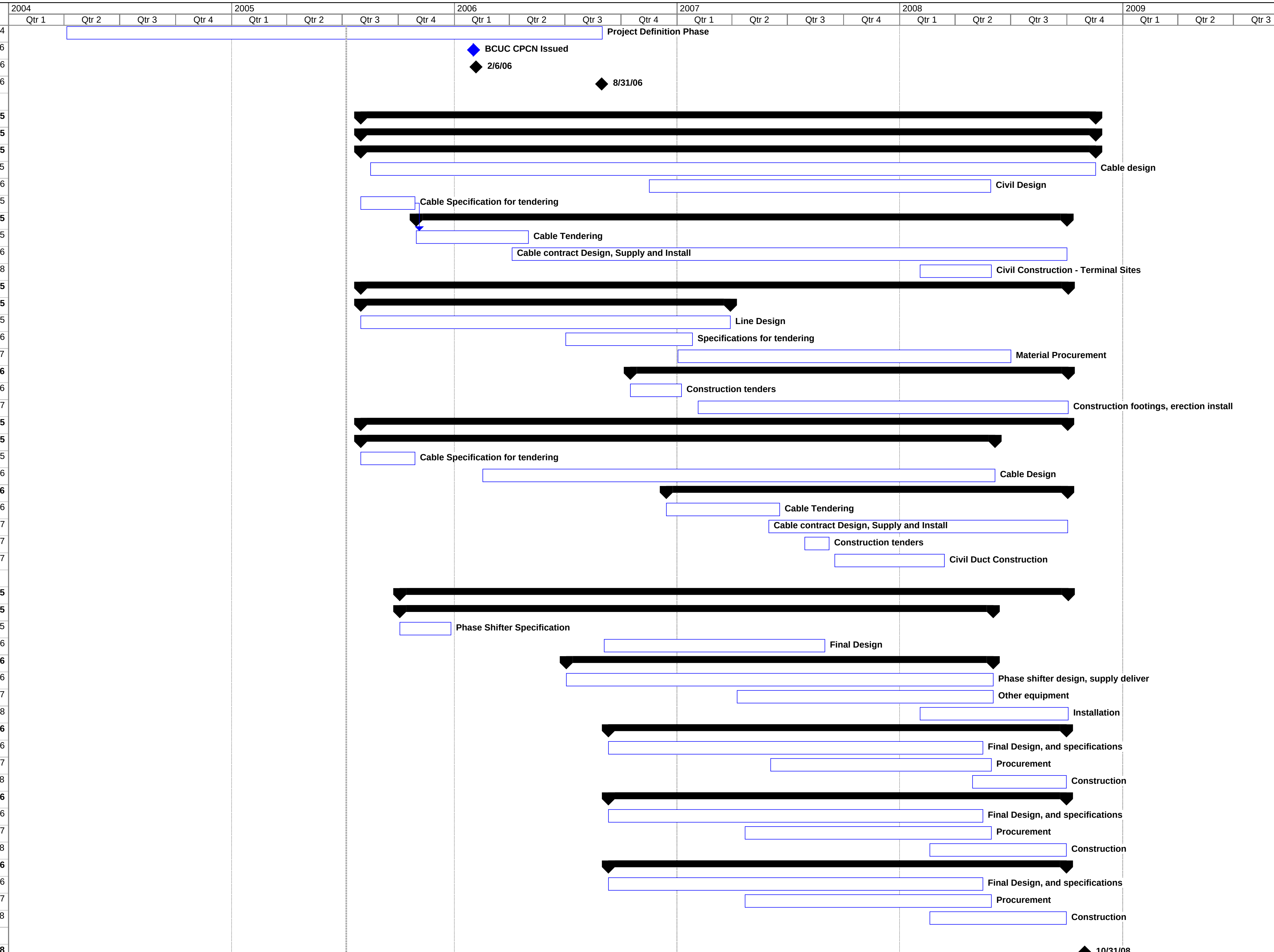


British Columbia Transmission CORPORATION™

Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	

Figure 3-34. VITR Project Implementation Phase Schedule

ID	Task Name	Duration	Start
1	Project Definition Phase	629 days	Tue 4/6/04
2	**BCUC CPCN Issued**	1 day	Wed 2/1/06
3	BCTC Funding Approval	4 wks	Mon 2/6/06
4	**Environmental Assessment Certificate Issued**	1 day	Thu 8/31/06
5			
6	**Project Implementation Phase**	**862 days**	**Mon 8/1/05**
7	**Submarine Cable system**	**862 days**	**Mon 8/1/05**
8	**Final Design**	**862 days**	**Mon 8/1/05**
9	Cable design	170 wks	Wed 8/17/05
10	Civil Design	80 wks	Fri 11/17/06
11	Cable Specification for tendering	66 days	Mon 8/1/05
12	**Procurement**	**763 days**	**Mon 10/31/05**
13	Cable Tendering	132 days	Mon 10/31/05
14	**Cable contract Design, Supply anc**	130 wks	Thu 4/6/06
15	Civil Construction - Terminal Sites	17 wks	Mon 2/4/08
16	**Overhead Transmission**	**831 days**	**Mon 8/1/05**
17	**Final Design**	**435 days**	**Mon 8/1/05**
18	Line Design	87 wks	Mon 8/1/05
19	Specifications for tendering	30 wks	Mon 7/3/06
20	**Material Procurement**	78 wks	Wed 1/3/07
21	**Installation**	**514 days**	**Tue 10/17/06**
22	Construction tenders	12 wks	Tue 10/17/06
23	Construction footings, erection install	87 wks	Mon 2/5/07
24	**Underground Cable system**	**830 days**	**Mon 8/1/05**
25	**Final Design**	**745 days**	**Mon 8/1/05**
26	Cable Specification for tendering	66 days	Mon 8/1/05
27	Cable Design	120 wks	Fri 2/17/06
28	**Procurement**	**470 days**	**Fri 12/15/06**
29	Cable Tendering	132 days	Fri 12/15/06
30	Cable contract Design, Supply and Install	70 wks	Fri 6/1/07
31	Construction tenders	6 wks	Mon 7/30/07
32	Civil Duct Construction	26 wks	Mon 9/17/07
33			
34	**Substations**	**784 days**	**Tue 10/4/05**
35	**VIT**	**695 days**	**Tue 10/4/05**
36	Phase Shifter Specification	12 wks	Tue 10/4/05
37	Final Design	52 wks	Mon 9/4/06
38	**Equipment Procurement**	**500 days**	**Tue 7/4/06**
39	Phase shifter design, supply deliver	100 wks	Tue 7/4/06
40	Other equipment	300 days	Tue 4/10/07
41	**Installation**	175 days	Mon 2/4/08
42	**Arnott Line Termination**	**537 days**	**Mon 9/11/06**
43	Final Design, and specifications	88 wks	Mon 9/11/06
44	Procurement	52 wks	Mon 6/4/07
45	Construction	22 wks	Wed 4/30/08
46	**Sahtlam**	**537 days**	**Mon 9/11/06**
47	Final Design, and specifications	88 wks	Mon 9/11/06
48	Procurement	58 wks	Mon 4/23/07
49	Construction	32 wks	Wed 2/20/08
50	**Taylor Bay**	**537 days**	**Mon 9/11/06**
51	Final Design, and specifications	88 wks	Mon 9/11/06
52	Procurement	58 wks	Mon 4/23/07
53	Construction	32 wks	Wed 2/20/08
54			
55	**230 kV In-Service Date**	1 day	**Fri 10/31/08**



Vancouver Island Transmission Reinforcement
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Task	Milestone	Rolled Up Task	Rolled Up Progress	External Tasks	Group By Summary
Progress	Summary	Rolled Up Milestone	Split	Project Summary	

There is significant overlap of the Definition and Implementation Phases. The tender process for submarine cable manufacture and installation will start in 2005; however, no irreversible contractual commitments will be made prior to receipt of a CPCN. BCTC presently proposes to award a cable contract and perhaps a contract for the PST prior to receipt of the environmental approvals and other permits later in 2006. This is necessary to maintain the Project schedule because of the long lead time required to design, manufacture and install submarine cable. BCTC considers there to be little risk that the EA process will not be completed successfully or will result in changes to the design of the Project or conditions on the Project that would affect these decisions.

3.6.2 Status Report

The Definition Phase of VITR began in early 2004. Public consultation and initial contacts with First Nations and regulatory agencies began in November 2004. The first phase of Public Consultation is complete (see Section 5 for a summary of these activities). Examination of alternatives and conceptual design is also complete.

The Project continues on schedule for an in-service date of October 2008 subject to approval by the Commission and receipt of environmental approvals and ancillary permits. Through May 2005, approximately $3.5 million has been spent on Definition Phase activities for the Project. Figure 3-35 shows the proposed Project Budget, funding authorized to date, and current financial status.

Figure 3-35. Proposed Project Budget

British Columbia Transmission Corporation

VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT - Cost Status Report

Month Ending : May 31, 2005	Project Cost Estimate (1)	Costs to Date	Current Funding Authorized	Additional Funding Required at this Time	Estimated Future Phase 1 Funding Required	Total Estimated Phase 1 Costs
Phase 1 - Project Definition	8,493,000	2,913,686	8,493,000	-	-	8,493,000
Includes the following activities:						
Preliminary Engineering						
Environmental Studies						
Stakeholder Consultation						
CPCN Application and Approval Process						
EA Certificate Application and Approval Process						
Permit Applications and Approval Processes						
Implementation Phase Project Plan						
Final Implementation Phase Cost Estimates						
Phase 2 - Project Implementation		-	-	-	-	-
Submarine and Underground Cable Systems	139,507,000					
Overhead Lines	38,000,000					
Stations						
-ARN	1,533,000					
-VIT	13,489,000					
-TBY	3,310,000					
-SAT	2,580,000					
Phase 2 Subtotal	198,419,000					
Contingency	18,990,000		745,000		(245,000)	500,000
Overhead	6,530,000	176,006	261,000		-	261,000
IDC	12,553,000	62,870	530,000		-	530,000
Total Capital Costs	$ 244,985,000	$ 3,152,562	$ 10,029,000	$ -	$ (245,000)	$ 9,784,000
Phase 3 - Retirement/Dismantling	10,000,000					

(1) Overall capital cost estimate was prepared in 2004 dollars and has been inflated in accordance with a cash flow forecast
(2) No RAS costs have been included

3.7 Physical, Biological and Socio-Economic Effects

3.7.1 Introduction

The VITR Project is subject to detailed environmental assessment and approval processes (including the review and approval of socioeconomic effects) under the *British Columbia Environmental Assessment Act* (BCEAA), the *Canadian Environmental Assessment Act* (CEAA), the US federal National *Environmental Policy Act* (NEPA), and the Washington State *Environmental Policy Act* (SEPA). BCTC has identified the environmental and socio-economic issues raised as part of the public consultation process in this Application. However, given the comprehensive environmental review and approval processes that BCTC must satisfy, BCTC is not submitting detailed information on the potential environmental effects of the Project as part of this Application. BCTC anticipates that any CPCN for the VITR Project will be conditional upon receipt of the permits and regulatory approvals necessary to satisfy Canadian and US environmental assessment and protection requirements. The remainder of Section 3 provides a summary of the environmental assessment and approval processes that apply to the VITR Project.

The technical studies in support of the environmental assessments are currently in progress, and are anticipated to be completed later this year. BCTC will submit completed environmental assessments to the Canadian and US agencies in conformance with the applicable regulatory requirements, following the issuance of a CPCN by the Commission. Based on BCTC's ongoing dialogue with the Canadian and US regulatory agencies, the proposed design of the VITR Project, BCTC's experience (and that of its consultants) with similar projects, and the nature of the environmental assessment and approval processes themselves (including the preparation of a comprehensive series of Environmental Management Plans specifying the environmental practices and procedures to be followed during construction and operation of the Project), BCTC anticipates that any environmental and socioeconomic effects associated with the Project can generally be avoided or minimized through appropriate design or mitigation measures and that the Project will not cause any significant adverse physical, biological or socioeconomic effects.

3.7.2 Environmental Assessment and Approval Processes

BCTC initiated consultation with the Canadian and US environmental regulatory agencies in July 2004. Since that time, BCTC has engaged in extensive dialogue with these agencies regarding the scope of the environmental and socioeconomic studies for the Project, proposed assessment methods and formulation of detailed Terms of Reference for the environmental assessments, and the scope of work and level of detail necessary to prepare and submit technically defensible applications for the environmental assessment approval processes.

The following provides a summary of the major steps and milestones associated with each of the Canadian (BCEAA and CEAA) and US (NEPA and SEPA) environmental assessment and approval processes as they apply to the Project. Section 6 provides a summary of anticipated applicable Canadian and US permits, approvals, and authorizations for construction and operation of the Project.

3.7.2.1 British Columbia Environmental Assessment Act (BCEAA)

BCEAA requires that certain major project proposals in British Columbia obtain an Environmental Assessment Certificate before they can proceed. Environmental assessments provide a single integrated framework to address a broad range of environmental, health, heritage, socioeconomic, community and First Nation issues and concerns of various regulatory agencies and public stakeholders.

BCEAA is administered by the British Columbia Environmental Assessment Office (BCEAO), an independent provincial agency that coordinates assessment of the impacts of projects under BCEAA. The BCEAO is responsible for ensuring that project assessments:

(a) Are comprehensive and technically sound;

(b) Involve all potentially interested parties;

(c) Are conducted in an open, timely and efficient manner; and

(d) Adhere to the legislation.

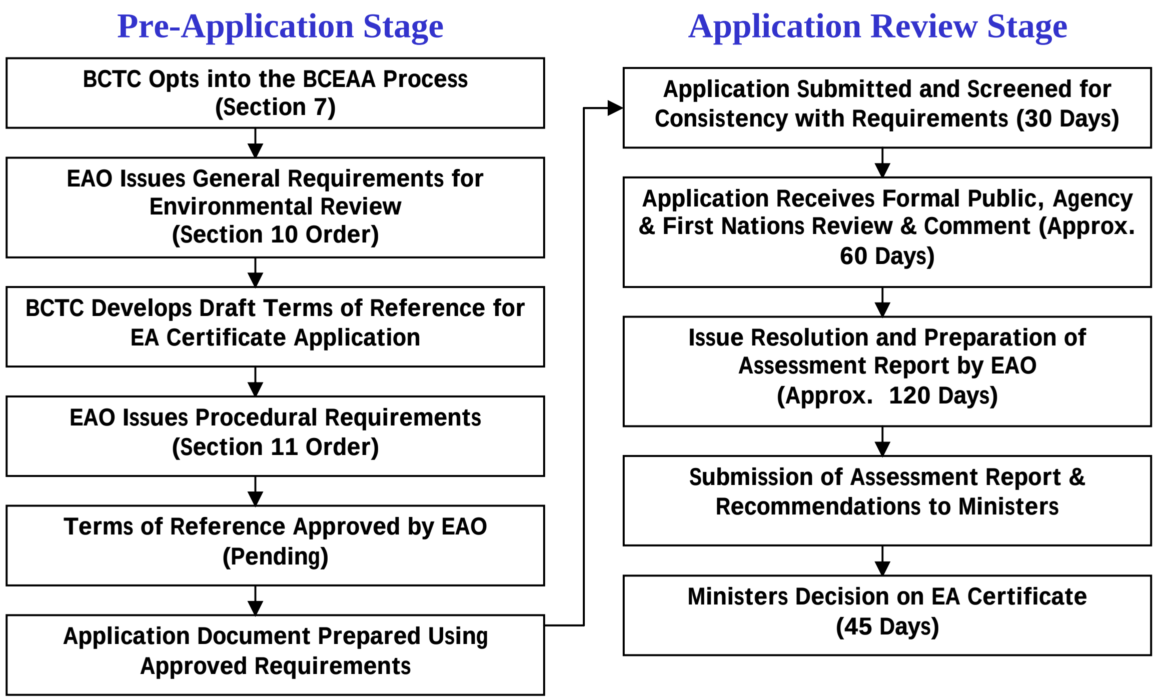
On November 10, 2004, BCTC applied to the BCEAO under section 7 of BCEAA to have the VITR Project designated as a “reviewable project”. The BCEAO granted this application on December 1, 2004 and, on January 11, 2005, issued an order under Section 10 of BCEAA setting out the general terms for the environmental review process for the Project (Appendix I). The letter attached to the Section 10 Order confirms that CEAA assessment requirements will be integrated into the British Columbia environmental assessment process, in accordance with the Canada/British Columbia Agreement for Environmental Assessment Cooperation.

Under BCEAA, the initial stages of the environmental assessment are undertaken during the Pre-application Stage, leading up to the submission of an Environmental Assessment Certificate Application (EAC Application). In the case of VITR, the Pre-application Stage has taken approximately seven months to date. During this time, BCTC has prepared detailed draft Terms of Reference (discussed below) which outline the scope of the detailed technical studies and consultation activities to be undertaken in conducting the environmental assessment of the Project and preparing the EAC Application. As indicated, BCTC anticipates completing these studies later this year and submitting its EAC Application to the BCEAO following receipt of a CPCN from the Commission.

Following submission of the EAC Application, the Application Review Stage begins. The BCEAO “screens” the Application for consistency with the approved Terms of Reference over a 30-day period. Once the Application has been accepted for technical review, it then receives formal public, agency, and First Nations review and comments over approximately a 180-day period, which includes approximately 60 days of review and 120 days of issue resolution. At the completion of the Application Review Stage, the BCEAO prepares an Assessment Report and makes recommendations to the provincial ministers to either grant or refuse an Environmental Assessment Certificate.

Figure 3-36 provides a schematic of the sequence of activities within each of the Pre-application Stage and the Application Review Stage for the VITR Project.

Figure 3-36. Summary of the Environmental Assessment Process for the VITR Project



3.7.2.2 Current Status of VITR under BCEAA

As indicated, BCTC's application to have VITR designated as a "reviewable project" under BCEAA was approved on December 1, 2004 and, on January 11, 2005, the BCEAO issued an order setting out the general terms for the environmental review process under BCEAA. In accordance with this process, BCTC has prepared draft Terms of Reference (TOR) as the basis for a Section 11 Procedural Order under BCEAA, confirming the issues to be addressed and information to be provided in BCTC's EAC Application.

BCTC has worked closely with the BCEAO, other regulatory agencies, the public and First Nations in developing and refining the draft TOR. The initial draft TOR were submitted and presented at an inter-agency pre-application meeting held in Victoria, B.C. on January 21, 2005. These draft TOR were subsequently reviewed and commented on by the various federal, provincial, and local government agencies interested in the Project. A copy of these draft TOR (and subsequent agency comments) was also posted on the BCEAO website.

BCTC subsequently revised the draft TOR to address the comments received from various agencies and re-submitted new draft TOR on March 15, 2005. The revised draft TOR was then provided for further input from the various regulatory agencies, and from the public and First Nations. A copy of this draft of the TOR was also made available on BCEAO's website. The BCEAO allowed 30 days for receipt of agency and public comments on the revised draft TOR.

On April 29, 2005, the BCEAO provided BCTC with copies of all comments from the various federal, provincial, and local government agencies, as well as comments provided by members of public and First Nations. BCTC has subsequently revised and modified the draft TOR to address this additional input and re-issued a further draft TOR on May 17, 2005. Final agency comments on this draft of the TOR were due on June 10, 2005.

BCTC anticipates that the final TOR will be formally approved in July 2005, and that the Section 11 Procedural Order will be issued by the BCEAO prior to that time. Once approved, the TOR and the Section 11 Procedural Order will be filed with the Commission.

The current draft TOR is organized as follows (Table 3-4).

Table 3-4. Framework for Draft Terms of Reference for Environmental Assessment Certificate (EAC) Application

Chapter	Content
1. Introduction	Project overview and rationale, including the scope of the environment assessment studies. Background information on BCTC. Purpose and organization of the EAC Application. Regulatory framework for the EAC Application and other legal orders or agreements required for the Project.
2. Information Distribution and Consultation	Notification and consultation activities to be undertaken during the pre-Application phase including public, First Nations, and agency review. Summarize how comments raised by these groups will be integrated into the planning, design, and implementation of the Project.
3. Review of Alternatives	Summarize evaluation process and criteria for assessing technically and economically feasible "alternatives to" the Project and "alternative means of carrying out" the Project. Provide rationale for selection of the preferred alternative based on engineering, environmental, cultural, socioeconomic, and health criteria.

Chapter	Content
4. Project Description	Describe Project components and existing and proposed infrastructure including transmission lines, substations, submarine cables, and cable terminals. Summarize construction, operation, and decommissioning activities. Identify proposed construction schedules, activities, labour force, costs, and milestones. Identify possible constraints with implications for design or implementation.
5. Scope of Environmental Assessment Process and Procedures	Describe scope of environmental assessment based on study area boundaries for each of the environmental components, and an explanation of the rationale adopted for establishing study boundaries. Prepare a series of maps/drawings to depict the study area boundaries for each of the technical disciplines for each of the major Project components. Describe the timeframes for conducting the assessments for each of the technical disciplines.
6. Baseline, Potential Environmental Effects Assessment, Mitigation Measures: Transmission Lines (Land Portion) and Substations	Summarize available baseline information on environmental resources along the land portions within the Project corridor. Environmental effects to be considered will include: geophysical conditions, climate, fish and aquatic habitat, wildlife and terrestrial habitat, vegetation resources, archaeological and cultural resources, land use, aesthetics and viewsheds, transportation and utilities, contaminated sites potential, socio-economic environment, public health (including air, noise, EMF), and First Nations interests. Evaluate potential effects associated with construction, operation and decommissioning of the land portions of the transmission lines and modifications to the existing substations. Recommend mitigation measures to minimize potential adverse effects.
7. Baseline, Potential Environmental Effects Assessment, Mitigation Measures: Submarine Cables and Cable Terminals	Summarize available baseline information on environmental resources along the submarine portions (Strait of Georgia and Trincomali Channel) of the Project area. Environmental effects to be considered will include: geophysical environment, marine fish and invertebrates, marine birds and mammals, marine vegetation (eelgrass and kelp beds), archaeological and cultural resources, navigation and shipping, infrastructure and utilities, contaminated sediments potential, socio-economic environment, public health, and First Nations interests. Evaluate potential effects associated with the construction, operation and decommissioning of the submarine cables and modifications to the cable terminals. Recommend mitigation measures to minimize potential adverse effects.
8. Effects of the Project on the Environment	Assess potential effects on transmission lines and submarine cables resulting from environmental forces and processes, including natural hazards due to seismic activity, flooding and erosion, wildfire, winds, precipitation (including ice storms and snow loading), storms and tsunamis, etc.

Chapter	Content
9. Accidents and Malfunctions	Summarize potential accidents and malfunctions that may occur during construction and operation of the transmission lines, substations, cable terminals, and cable-laying and cable-removal operations. Consider environmental and social effects of accidents and malfunctions due to electrical hazards, terrain hazards, traffic hazards, navigation hazards, mechanical failures, etc. Recommend mitigation measures to minimize potential for environmental effects and effects on public safety.
10. Environmental Monitoring and Follow-Up	Summarize environmental monitoring and follow-up programs to be implemented during construction and operation of the Project. Develop framework for environmental monitoring programs to evaluate the performance of the mitigation measures and environmental compensation.
11. Significance of Residual Effects	Summarize evaluation process and criteria to characterize the significance of predicted residual effects after mitigation measures have been applied to geophysical, biological, cultural, socio-economic, and public health concerns.
12. Cumulative Effects Assessment	Summarize evaluation process and criteria to characterize the significance of effects likely to result from the Project in combination with other projects or activities that have been or will be carried out, or have a high probability of occurring. Recommend mitigation measures and monitoring programs to evaluate their effectiveness.
13. Environmental Management Program	Develop framework for Environmental Management Plans (EMPs) describing practices and procedures to mitigate potential adverse environmental and socio-economic effects during construction and operation of the Project.
14. Conclusions and Environmental Commitments	Summarize potential effects, their significance, and recommended mitigation measures for environmental, socio-economic, cultural and health effects predicted to occur during construction and operation of the Project. Summarize public concerns and how they have been addressed using mitigation in the planning, design and implementation of the Project. Outline Environmental Management Plan components and associated habitat compensation strategies. Summarize predicted effects from the environment on the transmission line and substations, such as natural hazards and extreme climatic events. Provide a statement as to whether Project is predicted to cause significant adverse environmental, socio-economic, cultural, and health effects.

Copies of the draft TOR, including all agency, public, and First Nations comments are available on the BCEAO website at www.eao.gov.bc.ca. The EAC Application will be organized and structured consistent with the finalized TOR to facilitate a harmonized review of the Project under BCEAA and CEAA.

It is BCTC’s expectation that, based on the rigour of the BCEAA process, this process will:

(a) Enable a coordinated review process with other agencies, stakeholders, and jurisdictions, consistent with the *Canada – British Columbia Agreement on Environmental Assessment Cooperation* (March 2004);

(b) Provide a formal mechanism for coordinating information sharing with US regulatory agencies and stakeholders consistent with the *Memorandum of Understanding (MOU) between the Washington State Department of Ecology and the British Columbia Environmental Assessment Office* (November 2003); and

(c) Provide a mechanism for concurrent application of provincially administered permits and approvals, if desired, at the time of submitting the EAC Application.

3.7.2.3 Canadian Environmental Assessment Act (CEAA)

CEAA is the legal basis for the federal environmental assessment process. CEAA is administered by the Canadian Environmental Assessment Agency, an independent federal body accountable to Parliament through the federal Minister of Environment. The Canadian Environmental Assessment Agency is responsible for providing support and coordination with other federal, provincial, and local government regulatory agencies, First Nation, industry, and public stakeholders. Although the Canadian Environmental Assessment Agency does not administer or authorize any federal permit or approvals for proposed projects or activities, it does provide a coordination role with other federal departments and regulatory review processes, such as the BCEAA process. It also provides administrative and advisory support for review panels, mediations, and Comprehensive Studies, and promotes the development of class screenings.

Proposed projects and activities are subject to an environmental assessment and regulatory review under CEAA whenever a federal authority has a specified decision-making responsibility in relation to a project, also known as a “trigger”. Specifically, CEAA is “triggered” whenever one or more of the following conditions apply:

(a) A federal authority provides a license, permit, approval or authorization that is identified in the *Law List Regulations* that enables a project to be carried out. Examples of federal approvals include, but are not limited to, a Habitat Authorization Agreement under the *Fisheries Act*, an Approval under the *Navigable Waters Protection Act*, and a Disposal at Sea Permit under the *Canadian Environmental Protection Act*;

(b) The federal government provides financial assistance to a proponent to enable a project to be carried out;

(c) A federal authority sells, leases, or otherwise transfers control or administration of federal land to enable a project to be carried out; or

(d) A federal authority is the proponent.

Based on consultation with the Canadian Environmental Assessment Agency and other federal agencies, the VITR Project is likely subject to a "Screening Level Review" under CEAA since federal approvals and authorizations from Fisheries and Oceans Canada (DFO) and Environment Canada are likely required for the Project. Specifically, these include:

(a) A Habitat Authorization Agreement under section 35(2) of the *Fisheries Act* for the "harmful alteration, disruption, or destruction" (HADD) of fish habitat, that may be required for the proposed removal and installation of the submarine cables within the intertidal and shallow sub-tidal areas, and for potential effects associated with watercourse crossings along the land portion of the transmission line corridor; and

(b) A Disposal at Sea Permit under Part 7, Division 3 of the Canadian *Environmental Protection Act* related to the construction methods used for burying the submarine cables on or under the seabed.

In consultation with Transport Canada (Marine Division), it is understood that the Project will not require an Approval under the *Navigable Waters Protection Act* for the proposed replacement overhead transmission lines over Montague Harbour and Sansum Narrows, providing that the replacement transmission lines are installed to an elevation which is no lower than the existing lines at these crossings.

3.7.2.4 US National Environmental Policy Act (NEPA)

For the 12 km marine portion of the Project within US jurisdiction, the proposed removal of one set of the existing 138 kV submarine cables and installation of the new 230 kV cables will be subject to regulatory review under the *National Environmental Policy Act* (NEPA), and concurrently, the Washington *State Environmental Policy Act* (SEPA).

NEPA requires that an environmental review be conducted in connection with a proposed federal action, in this case, the issuance of a permit from a federal regulatory agency. For the VITR Project, two federal agencies have permitting authority, the US Army Corps of Engineers (USACE) and the US Department of Energy. The USACE will be the “lead agency” for Project review under NEPA.

It is anticipated that the scope of the environmental issues for the US portion of the Project will focus primarily on biological, physical, and cultural issues within the marine environment, and thus, be narrower than the scope of the environmental assessments required for the Canadian portion of the Project which will address both upland and marine components.

3.7.2.5 Washington State Environmental Policy Act (SEPA)

The *State Environmental Policy Act* (SEPA) is similar to NEPA, and requires that an environmental review be conducted in connection with a state or local agency's action or decision. Whatcom County will be the “lead agency” for review of the Project under SEPA.

As opposed to the environmental assessment and approval process under BCEAA, there are no regulatory-driven timelines for the review of an environmental assessment report under NEPA or SEPA. The actual timelines for agency and public review of an environmental assessment report are largely dependent on the level of analysis required by the US regulatory agencies.

It is anticipated that the SEPA review will be in the form of a checklist, which will be administered by Whatcom County during their Shoreline Substantial Development Permit review process. Public review for a SEPA checklist is approximately 14 days. The NEPA review process will likely occur within a 3 to 6 month period for the

USACE permit review. If the County requires an EIS, which is not anticipated, an additional 6 to 12 months may be needed for document preparation and review.

Depending upon the complexity of the technical issues, approximate timelines for regulatory review and receipt of US permits following submission of the environmental assessment documentation to satisfy the NEPA and SEPA processes are as follows.

Table 3-5. Timelines for US Permits and Approvals

Permit or Approval	Approximate Timeline
Presidential Permit	6 months
Section 404 and Section 10 Permits	3 to 6 months (assuming that Project is covered under Nationwide Permit 12 or some other Nationwide Permit)
Hydraulic Project Approval	45 days from completed application and SEPA review
Aquatic Use Authorization	6 to 12 months after completed application and SEPA review
Water Quality Certification	30 to 180 days
Whatcom County Shoreline Substantial Development Permit and Major Project Permit	180 days
Coastal Zone Management Certification	60 days after USACE permitting

3.7.3 Mitigation and/or Compensation Commitments

Applications for BCEAA environmental approvals, separate from this CPCN Application, will provide details on any proposed mitigation and compensation strategies, which in turn, will be subject to regulatory and public scrutiny. BCTC does not anticipate significantly increased costs associated with restrictions imposed on construction and operation of the Project or from mitigation or compensation agreements resulting from the environmental assessment and approval processes, recognizing that the proposed Project is entirely within an existing transmission corridor.

3.7.4 Electromagnetic Fields (EMF)

BCTC follows the regulatory standards and guidelines for EMF. In 2004, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) established 830 mG as a precautionary guideline in relation to EMFs. This standard has been endorsed by the World Health Organization (WHO). Since that time, Health Canada has indicated that it does not consider EMF guidelines necessary because the scientific evidence is not strong enough to conclude that typical exposures can cause health problems.

Based on previous Commission decisions, BCTC has taken a prudent approach in the preliminary design of the VITR Project and, as indicated previously in the Application, has selected new transmission support structures and conductor configurations that reduce EMF as much as practical. At all locations along the proposed corridor, the maximum public EMF exposure from the operation of project facilities will be a small fraction of the precautionary guidelines established by the ICNIRP. Normal day-to-day operating levels will be even lower. In addition, at nearly all locations, the maximum magnetic field exposure levels at the edge of ROW will be substantially less than they currently are in relation to the existing facilities.

The following table presents calculated maximum EMF levels for both the existing 138 kV lines and the proposed 230 kV facilities at tangent structure locations along the corridor.

Table 3-6. Calculated Maximum EMF Levels for Existing and Proposed Facilities

Location	ROW Width (metres (feet))	Existing at either ROW Edge (MG)	Existing Inside ROW (Directly under 138 kV line) (mG)	VITR at ROW Edge* (mG)	VITR Inside ROW (Directly over or under 230 kV line) (mG)	ICNIRP Guideline for Public Exposure (MG)
East Ladner	140 (455)	<10	120	<2	80	830
Tsawwassen	53 (175)	30	120	<3 & 30*	140	830
Galiano Island	53 (175)	15	25	<5	80	830
Salt Spring Island	115 (375)	15	25	<2	80	830
North Cowichan	53 (175)	30	120	<5	80	830

* <3 at the edge of the ROW nearest the underground cables; unchanged at edge with the remaining 138 kV overhead circuit.

While maximum EMF levels directly under the new double-circuit will, in some cases, be somewhat higher than under the existing facilities (over the new circuit in the case of Tsawwassen), these levels will more rapidly decline from the centre-line of the facilities and will be lower at the edge of the ROW and in adjacent homes and buildings.

During the public consultation process, BCTC provided stakeholders with project specific information as well as references to public sources of general information on EMFs. In the draft TOR for the EAC Application, BCTC has also identified EMFs as one of the areas that will be examined. Among other measures, BCTC has identified that it will evaluate potential changes in EMF levels associated with the Project relative to the existing baseline levels and will also provide existing and future estimated EMF levels in key receptors near the ROW, such as schools or daycare facilities. BCTC expects these requirements will form part of the finalized TOR for the environmental assessment and approval process.

There are further steps that BCTC could take to further reduce EMF levels or to reduce the EMF levels near individual residences and other facilities. These include measures such as relocating the facilities to other locations. These changes would result in significant additional costs and transfers the EMF levels to other locations. In some cases these could also result in significant negative environmental impacts from the creation of new corridors. Given the existing guidelines on public exposure to EMF, the EMF levels associated with the Project, and the existing EMF levels, BCTC does not believe these further steps are prudent.

4.0 PROJECT JUSTIFICATION

This Section addresses:

(a) The need for the VITR Project;

(b) The alternatives to the Project;

(c) The alternative means of carrying out the Project, including routing alternatives in Tsawwassen and the southern Gulf Islands; and

(d) The Risk Management Plan for the Project.

4.1 The Need for the VITR Project

Vancouver Island's electricity needs are met by a combination of on-Island generation and transmission from the Mainland. Only 30% of requirements are met by on-Island generation, the remaining 70% must come from the Mainland.

Load on Vancouver Island continues to increase with no appreciable increase in on-Island generation. At the same time, one of the main existing transmission connections to Vancouver Island (the HVDC system) is aging, technically obsolete and cannot be relied on to provide firm transmission capacity to Vancouver Island after 2007. A capacity deficiency is forecast for the winter peak season in 2007/2008. That deficiency will continue to grow in subsequent years.

The VITR Project is needed to provide additional reliable transmission capacity from the Mainland to southern Vancouver Island. This need will be critical for the 2008/2009 winter peak and beyond.

The following provides an overview of existing Vancouver Island supply, transmission system planning criteria, forecast Vancouver Island load demand, and the demand/supply balance. Appendix J provides a more detailed analysis and technical justification for the Project.

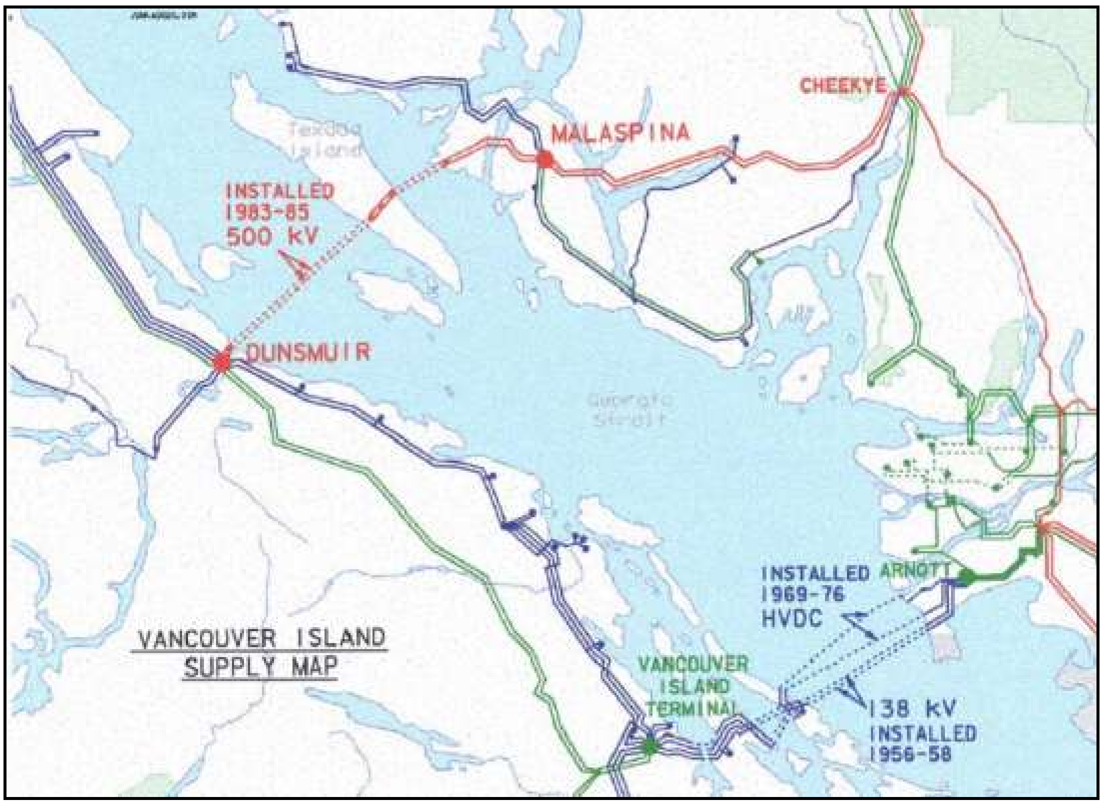
4.1.1 Existing Vancouver Island Electricity Supply

Electricity demand on Vancouver Island is supplied by a combination of on-Island generation and transmission from the Mainland. The existing generation on

Vancouver Island, including Island Co-Generation (ICG), provides approximately 690 MW of dependable capacity. This capacity represents only 30% of the Island's existing peak load with the remaining capacity being supplied from the Mainland. The Vancouver Island system supply is heavily dependent upon transmission interconnections with the Lower Mainland for both supply adequacy and system security.

The existing transmission interconnections to Vancouver Island shown in Figure 4-1 consist of two 500 kV AC circuits, two 138 kV AC circuits, and a bi-pole High Voltage Direct Current (HVDC) system. These facilities are described below.

Figure 4-1. Transmission Interconnections to Vancouver Island



4.1.1.1 138 kV AC

The original transmission connection between the Lower Mainland and Vancouver Island (and the Gulf Islands) consisted of two 138 kV AC circuits between ARN (in South Delta) and VIT (in North Cowichan) installed in 1956 and 1958. These circuits are currently used to supply the southern Gulf Islands radially from ARN with open ends at VIT under normal conditions. Under an emergency situation, such as losing the northern 500 kV connection (discussed below), the 138 kV circuits can be closed at VIT to synchronously connect the Vancouver Island system to the Mainland system with limited capability. This prevents the Vancouver Island system from being synchronously islanded.

The 138 kV circuits are ageing and have been de-rated from their original design capacity of 120 MW for each circuit to 100 MW each due to armour wire corrosion on the submarine cables. Although these cables are no longer used for bulk power transfer to Vancouver Island, they remain suitable as local supply circuits.

4.1.1.2 High Voltage Direct Current (HVDC)

The bi-pole HVDC system was installed in 1969 (Pole 1) and 1976 (Pole 2) between ARN and VIT. This system essentially parallels the 138 kV AC system. The HVDC system consists of two single-pole subsystems (Pole 1 & Pole 2), each of which can be independently operated with the earth return. Each pole subsystem contains large converter stations located at ARN and VIT, HVDC submarine cables and overhead lines. The connection to Vancouver Island through the HVDC system is non-synchronous.

The original design rating of the Pole 1 mercury arc converter subsystem was 312 MW, and the Pole 2 thyristor valve converter subsystem was rated 370 MW and can be overloaded to 476 MW under low ambient temperature. Both HVDC converter systems are aging, technically obsolete, no longer supported by the original manufacturer, and are among the last few systems of their kind in operation anywhere in the world.

Pole 1 is standby and no longer has any dependable capacity. The dependable capacity of Pole 2 has been de-rated to 240 MW until 2007, and it will be zero rated for planning purposes for the winter of 2007/2008. This means that the HVDC system can no longer be relied upon to provide any firm capacity to supply Vancouver Island after 2007. Limited investments have been made in the HVDC system to extend its life until replacement capacity can be put in service. The HVDC will still be available for emergency capacity beyond 2008 as long as it is economically feasible to maintain the system in an operable condition.

4.1.1.3 500 kV AC

Two 500 kV AC cable circuits were installed in 1983 and 1985, respectively on a separate northern corridor between Malaspina substation (near Pender Harbour) and Dunsmuir substation (near Qualicum Bay). Each of these circuits has a continuous summer rating of 1200 MW. The short-term summer rating for these circuits is 1300 MW based on a two-hour peak period. During periods of low ambient temperature, the corresponding ratings may be increased as much as 5%. These circuits are in excellent condition and provide a strong synchronous connection between Vancouver Island and the Mainland.

4.1.2 Vancouver Island Electricity Demand/Supply Gap

BC Hydro's October 2004 load forecast indicates that Vancouver Island probable peak loads will be approximately 100 MW higher than its 2003 load forecast (see Appendix J). The Vancouver Island peak demand (~2300 MW) during January 2005 is supportive of the most recent load forecast. The forecast peak demand curve and load supply over the next 20 years, after PowerSmart programs have been factored in, is shown in Figure 4-2. This forecast demand includes Vancouver Island system losses.

Figure 4-2. Vancouver Island Load Demand/Supply Balance

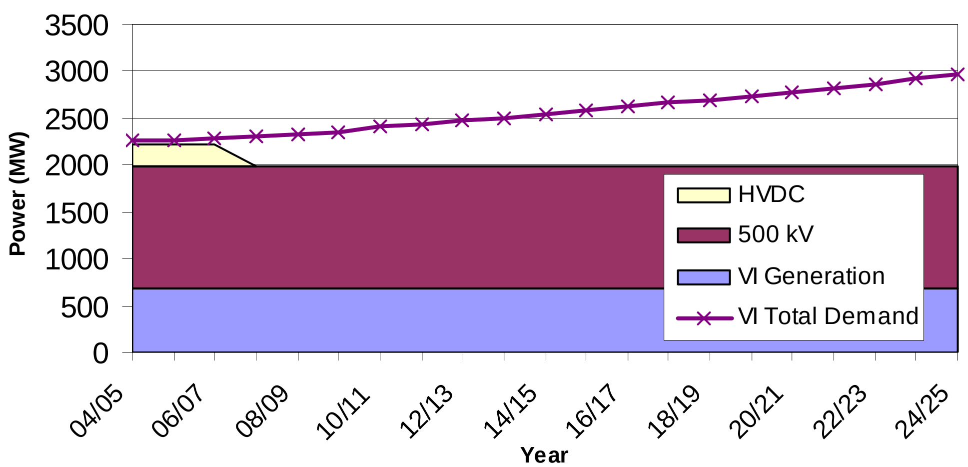


Figure 4-2 also shows the existing dependable supply sources on Vancouver Island. Vancouver Island is forecast to have minor supply deficits over the next two years with a significant shortfall forecast for 2007 and beyond, in the absence of additional dependable capacity.

4.1.3 Transmission System Planning Criteria

BCTC plans the bulk transmission system, of which the connections to Vancouver Island are a part, to meet NERC/WECC Planning Standards which include an N-1 criterion. This standard requires that the transmission system should be able to withstand an outage of any single element (such as a transmission line, a generator or a transformer) under any system condition with not service interruption. Another key issue for Vancouver Island supply is to verify that the system is capable of accommodating planned outages such as scheduled maintenance. This condition is typically referred to as N-1-1. The N-1 and N-1-1 standards dictate the Vancouver Island system planning and operation. Based on the planning standards and outage events in the past 10 years, retaining synchronous connection to the Mainland system is also critical for Vancouver Island secure operation. Please see Appendix K for a summary of BCTC's Transmission System Planning Criteria.

4.1.4 Bridging Vancouver Island Demand/Supply Gap

Figure 4-3 illustrates the demand and supply balance on Vancouver Island with the VITR Project in-service. The demand curve includes the offset for demand side management through BC Hydro's PowerSmart Program. The "VI Generation" reflects all existing contracted on-Island generation capacity additions over the next 20 years (except the recently cancelled Duke Point Power Project (DPP)).

Figure 4-3. Vancouver Island Electricity Demand/Supply Balance[2]

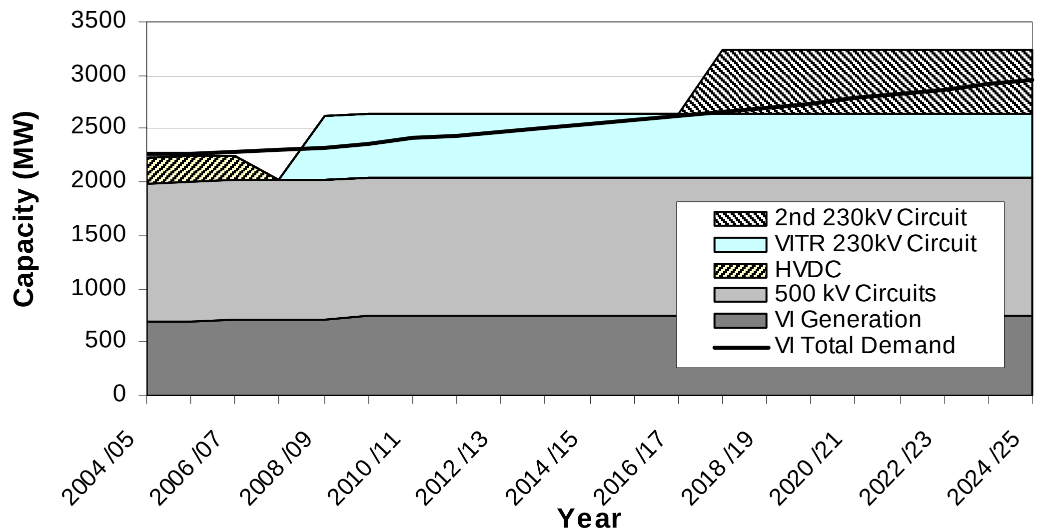


Figure 4-3 indicates that the Vancouver Island system will be short of power supply until the proposed 230 kV circuit is in service in October 2008. The shortfall in 2007, after the HVDC system is de-rated to zero, is significant (~300 MW). BCTC and BC Hydro have been developing a series of measures to address the capacity shortfall for the winter of 2007/08 (Appendix L). However, these measures do not provide long-term firm dependable capacity to Vancouver Island. Based on the above, the VITR Project needs to be in-service as soon as possible. The earliest practical in-service date is October 2008.

Figure 4-3, also indicates that additional transmission capacity will be required to supply Vancouver Island in approximately 2017. This forecast requirement may be served by the completion of the second 230 kV circuit between ARN and VIT. However, no decision has been made to pursue this project at this time, and this does not form a portion of this Application. If BCTC does decide to propose the completion of the second 230 kV circuit it will file a separate CPCN Application with the Commission as determined by actual load growth and new forecasts of demand and on-Island generation additions over the next few years.

[2] This figure includes a depiction of the 2nd 230 kV circuit coming into service in 2017, which will be subject to a future CPCN application.

4.2 Alternatives to the VITR Project

BCTC has considered a number of alternatives to the proposed VITR Project. This consideration included an assessment of alternatives over a long-term planning horizon.

This section provides a brief overview of the alternatives reviewed, the basis on which they were assessed, and the attributes of the proposed Project. Table 4-1 summarizes BCTC's assessment of the alternatives to the VITR Project.

Table 4-1. Summary Assessment of Alternatives to the Project

	HVDC Replacement	**HVDC Light®**	**New 500 kV AC Circuit**	**Reinforce-ment of Existing 500 kV Circuits**	**On-Island Generation**	**Upgrade Existing 138 kV Circuit to 230 kV**
Capital Cost	Moderate	Very High	Very High	Moderate	None planned	Moderate
Reliability	Inadequate	Adequate	Good	Inadequate	None planned	Good
System Stability	Inadequate	Adequate	Good	Inadequate	None planned	Good
O&M Costs	High	High	Moderate	Moderate	None planned	Low
Complexity	High	High	Moderate	High	None planned	Low
Energy Losses	High	High	Low	Low	None planned	Moderate

4.2.1 HVDC Replacement

As indicated, the existing HVDC system is among the last remaining systems of its kind operating anywhere in the world. The conversion equipment is ageing, technically obsolete, no longer supported by the manufacturer and, as a result, will be zero rated for planning purposes for the winter of 2007/2008.

One of the potential alternatives to the proposed Project is replacing the existing Pole 1 and Pole 2 converter stations with a new 300 kV conventional bi-pole HVDC system (with 540 MW capacity for each pole). As a long-term supply source, this could be done in two stages. Initially one new pole would be put in place, providing

540 MW of capacity, and then the second pole would be installed when further capacity is required.

The replacement would repair and reuse the existing HVDC submarine cables and overhead HVDC lines. Upgrades of the existing overhead sections of the HVDC line would be required for the second Pole 2 in the future.

One of the 138 kV circuits (1L18) would be decommissioned, and the submarine cables reused as the metallic return for the new HVDC system, in normal mode. The other existing 138 kV circuit (1L17) would be retained on a long-term basis to supply the southern Gulf Islands.

This option would continue to use all serviceable elements of the existing HVDC system including the submarine cables and overhead lines. As a result, this option is lower in cost than other HVDC alternatives.

Replacing the existing HVDC system was reviewed in June 2004 (Appendix P). That review concluded that this option would cost more than the proposed 230 kV AC solution; would have higher energy losses and higher operating and maintenance costs throughout its life, and would not adequately address the potential system stability problems for 500 kV outages. This analysis remains valid.

In addition to cost considerations, replacing the HVDC system also presents significant seismic, and therefore, reliability risks. The ARN site and HVDC cables in their present location are highly vulnerable to seismic risk. A new seismically compliant converter building and equipment would need to be built and foundations would have to withstand soil liquefaction conditions during a seismic event. However, even with these improvements, the existing submarine cables would remain at high seismic risk. Furthermore, HVDC reinforcement would also require that the repaired HVDC cables would remain reliable for a further 20 to 40 years. These cables are currently 29 to 36 years old, and it is uncertain that they would last another 20 to 40 years.

Finally, reliance upon the aging 138 kV submarine cables and overhead lines as a long-term solution for supply to the southern Gulf Islands is not practical. In later stages, the southern Gulf Islands would be supplied from VIT through the existing

138 kV overhead lines from VIT to Salt Spring Island Substation. Those lines would require life extension and require the additional on-going operating and maintenance costs of a separate supply system for the southern Gulf Islands. The existing 138 kV submarine cables in Trincomali Channel would eventually require replacement or new lower voltage submarine cables installed plus conversion of the Galiano Island supply to distribution voltage. When the second pole was put in place, a section of new metallic return for the HVDC facilities would also have to be built, including replacing the old 138 kV submarine cable used in stage 1 for the metallic return.

Based on the above, BCTC's analysis indicates that rebuilding/replacing the existing HVDC system is not justified in comparison to the proposed solution from either an economic or reliability point of view.

4.2.2 HVDC Light®

HVDC Light® is an ABB registered trademark for its product using voltage source converters (VSC) with pulse-width modulation.

The HVDC Light® technology was initially developed to remotely transfer power under "light duty" as its name suggests. HVDC Light® comes in unit sizes ranging from tens of MW up to a current maximum of 550 MW at DC voltages up to ±150 kV. There are currently two relatively large capacity HVDC Light® systems in operation. The Murraylink project in Australia has a capacity of 220 MW and connects the transmission systems in the states of South Australia and Victoria. The largest HVDC Light® application in-service is the 330 MW Cross Sound project systems between Connecticut and Long Island, NY.

One potential alternative to the VITR Project is to build four 330 MW HVDC Light® transmission systems, similar to the Cross Sound project, between the Lower Mainland and Vancouver Island. This alternative could be undertaken in stages, similar to the proposed Project, using the existing 138 kV corridor. Each HVDC Light® system would consist of two 330 MW HVDC Light® converters and two HVDC Light® cables between the terminal substations. The two cables, each rated 150 kV and 1200 amperes, would be bundled and buried underground or underwater along the existing route. Conceptually, the Mainland converter stations could be at TSW, ARN or ING. TSW or ING are preferred terminal station locations due to the risk of soil liquefaction during seismic events at ARN. However, locating the converter stations at ARN or ING would expose very long sections of underground cable to seismic failure in the unstable soils of the Fraser River Delta. Additional land would be required regardless of the site chosen.

It should be noted that ABB has not certified their HVDC Light® equipment for seismically active locations. Additional testing and, perhaps, redesign would be required to meet seismic requirements in this seismic zone.

An HVDC Light® product with a capacity of 550 MW was released to the market by ABB in 2005. Accordingly, another alternative would be to build two 550 MW HVDC Light® systems in two stages. Each HVDC Light® system, rated ±150 kV and 550 MW, would consist of two converters and two cables rated 2000 amperes. This option would likely be more economical than the 330 MW units, although the 550 MW product has not yet been commercially delivered or proven in-service. ABB has also indicated that a 700 MW ± 300 KV system is currently in development.

Similar to the conventional HVDC replacement option, an HVDC Light® solution would require the existing HVDC system to be removed in stages due to terminal site limitations, especially at VIT. The southern Gulf Islands would be supplied from VIT, through the existing 138 kV overhead lines between VIT and Salt Spring Island Substation, for the indefinite future. As indicated, any HVDC solution would require a separate AC transmission system to serve the southern Gulf Islands.

Appendices P and Q present a review of HVDC and HVDC Light® as an alternative for VITR. Appendix R shows an evaluation matrix for various HVDC solutions. BCTC met with ABB on June 7, 2005 to ensure that BCTC’s information regarding HVDC Light® technology is current and to discuss the potential use of HVDC Light® technology to supply Vancouver Island. All the information provided by ABB at this meeting was consistent with BCTC’s previous understanding and analysis with respect to ABB's Voltage Source Converter technology (HVDC Light®). This information continued to support BCTC’s analysis that an alternative based on HVDC Light® technology (or other voltage source converter technology) is not justified in comparison to the proposed solution. While HVDC Light® offers several technical advantages over conventional HVDC or AC transmission in some circumstances; its advantages are not significant in this application and any equivalent HVDC Light® solution, in comparison with the proposed Project, would have:

(a) Substantially higher capital costs;

(b) Higher operating and maintenance costs;

(c) Higher energy losses;

(d) Lower reliability and system security performance;

(e) More complexity, including the requirement for special tools, additional worker training and separate network modelling and grid operating procedures; and

(f) Reliance on a proprietary product and a sole source procurement procedure.

4.2.3 New 500 kV Circuit

A single 500 kV AC transmission circuit with a continuous rating of 1200 MW could replace the 138 kV circuits between ARN and VIT in lieu of a 230 kV solution. This would also require that the new 500 kV line be extended from ARN to ING in Surrey. Similar to the existing 500 kV cable system in the northern corridor between MSA and DMR, this option would also include overhead lines, submarine cables, a 1200 MVA transformer at VIT, and a larger shunt compensation equipment station on Galiano Island.

A third 500 kV circuit using the existing northern corridor crossing the Strait of Georgia north of Campbell River was also considered.

The 500 kV options were not considered feasible. They have very high costs, long lead-times, and significant associated environmental effects and regulatory approval hurdles. Additional 500 kV transmission capacity in the northern corridor would also require substantial reinforcement to the north-south transmission facilities on Vancouver Island. A new 500 kV line through Delta and Surrey to reach ING would have higher environmental effects and likely face considerable public opposition. Therefore, new 500 kV lines for near-term transmission reinforcements to Vancouver Island have not been pursued in further detail by BCTC.

4.2.4 Reinforcement of Existing 500 kV Circuits

This option involves installing a spare (seventh) single–phase cable parallel to the two existing 500 kV cable circuits north of Campbell River to reduce probability of loss of one of 500 kV circuits to Vancouver Island. However, this option requires complex switching facilities and does not provide the reliability benefits afforded by transmission capacity on the separate southern corridor. Accordingly, this was considered to be undesirable and technically inferior to the 230 kV AC option and was not pursued further.

4.2.5 On-Island Generation

BCTC has reviewed the demand and supply balance for Vancouver Island considering BC Hydro's 2004 load forecast, all existing on-Island generation resources and the capabilities of the existing transmission system. There are no specific generation options currently planned that could meet the forecast capacity deficits on Vancouver Island. Based on BC Hydro's load forecast, the VITR Project would be required on the proposed in-service date even if the DPP project were completed in 2007 as previously proposed. Cancellation of DPP has only increased the need for the Project.

BCTC also continues to believe that the long-term supply solution for Vancouver Island should include a combination of additional on-Island generation and transmission connections to the Mainland. The proposed Project is consistent with this position.

4.2.6 Preferred 230 kV AC Project

As indicated, BCTC proposes to build a 230 kV AC transmission solution in the southern corridor to Vancouver Island, as described in Section 3. This solution has significant advantages over any of the available HVDC (including HVDC Light®) or 500 kV AC alternatives, including:

(a) Better system performance:

   i. Separate corridor from the 500 kV northern connection (full N-1 compliance);

ii. Strong synchronous connection in parallel with the 500 kV system (better system stability);

iii. Much higher short-term overload capability that HVDC (better system security); and

iv. More seismic security.

(b) Much less uncertainty or inherent implementation or operational risk:

i. Lower environmental impact and regulatory risk (uses existing corridor);

ii. Technical simplicity and proven technology, no special training, tools, procedures and complicated system modeling requirements;

iii. Not dependent on sole-source acquisition of a proprietary system; and

iv. Easier and less costly to repair, replace or bypass individual components or sections.

(c) Significantly lower costs in all three main categories:

i. Overall Capital Cost;

ii. Energy Losses; and

iii. Operations and Maintenance Expenses.

4.3 Alternative Means of Carrying Out the Project

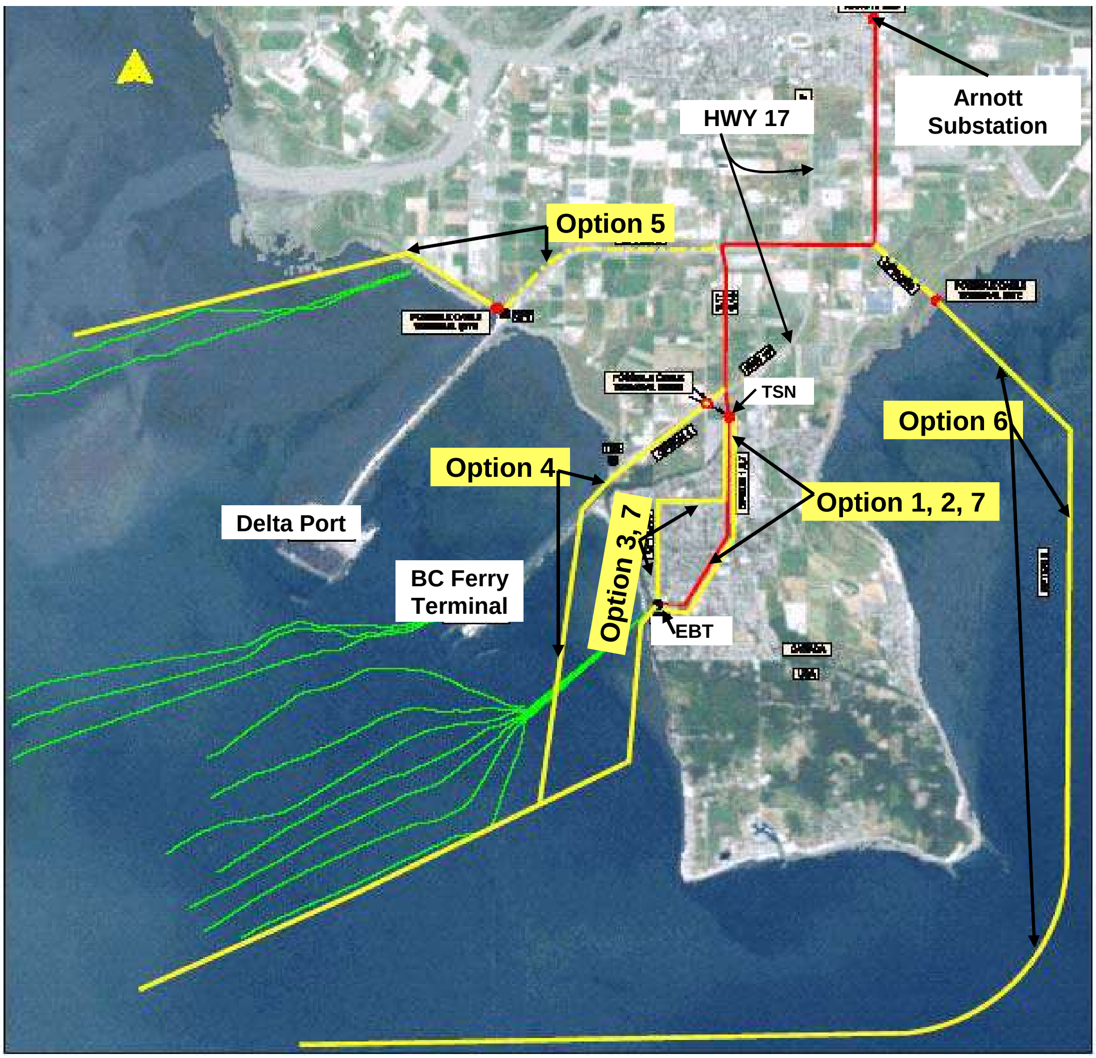
Within the parameters of a 230 kV AC transmission circuit from ARN to VIT, there are various alternatives means of carrying out the Project.

This section discusses the further analysis of alternative means of carrying out the Project that BCTC undertook, including a variety of alternatives suggested from the public consultation process (see Appendix R). This includes routing alternatives for Tsawwassen and the southern Gulf Islands and a further review of various HVDC solutions including a submarine cable bypass of the Gulf Islands.

4.3.1 Tsawwassen Area Options

Seven alternatives were identified as part of the public consultation process for the South Delta/Tsawwassen area. Each of these alternatives is shown on the map in Figure 4-4.

Figure 4-4. Tsawwassen Area Route Options



Option 1: A new 230 kV double-circuit overhead line on the existing 138 kV ROW.

Option 2: Same as Option 1, except in Tsawwassen, where one new 230 kV underground cable circuit would be built on the existing 138 kV ROW from TSW to EBT.

Option 3: Same as Option 2, except that the underground portion would be moved from the existing ROW to city streets through Tsawwassen.

Option 4: Same as Option 1, except that the line would bypass Tsawwassen by using the existing Highway 17 corridor (the BC Ferries Causeway).

Option 5: Same as Option 1, except that the line would bypass Tsawwassen by paralleling the existing HVDC Pole 2 corridor north of Deltaport Way.

Option 6: Same as Option 1, except that the line would bypass Tsawwassen to the East and South through Boundary Bay through a new ROW in US waters.

Option 7: Using Options 2 or 3 to accelerate the installation of a second set of 230 kV underground cables through Tsawwassen and remove both existing 138 kV overhead lines from TSW to EBT.

Table 4-2 indicates the criteria used by BCTC in this alternatives assessment and ranks the various options on the basis of those criteria. Detailed cost comparisons are shown in Table 4-3.

Table 4-2. Ranking of the Tsawwassen Alternatives

Criteria	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Incremental Cost for Tsawwassen 3.7 km*	$3.1M	+$24M	+$29M	+$30.5M	+$35.6M	+$106.5M	+$31.2M to +$37.76M
Reliability (including Seismic risk)	1	3	3	6	**	2	3
Environmental Effects	4	1	1	5	6	**	1
Community Impacts	7	5	6	2	3	1	4
First Nations Impacts	1	2	2	7	6	4	5
Implementation Risk	1	3	2	6	5	**	3
Regulatory Risk	1	2	3	5	6	**	4
Overall Ranking	2	1	3	4	**	**	4

Note: 1 is best; 7 is worst
* NPV, 2008 at 7%
** Indicates the option is infeasible

Vancouver Island Transmission Reinforcement (VITR) Project
Comparison of Suggested Route Options near Tsawwassen
Estimates in $1,000
Shows only incremental costs for 3.7 km segment on existing ROW from Tsawwassen Substation to English Bluff Terminal or equivalent replacement option

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Description of Options (See map on Figure 4-4)	Existing Route; Submarine cable to EBT, Overhead double-circuit on steel poles in existing ROW. All wood poles are removed.	Submarine cable to EBT; one underground circuit in ductbank from EBT to TSW on existing ROW, Overhead double-circuit on existing ROW from TSW to ARN. One existing 138 kV line remains in service on existing wood poles through Tsawwassen to serve Gulf Islands.	Submarine cable to EBT, one underground circuit in ductbank from EBT to TSW Sub, via English Bluff Rd, 12th Ave & 53 St, Overhead double-circuit on existing ROW from TSW to ARN. One existing 138 kV line remains in service on existing wood poles through Tsawwassen.	Submarine cable to near where shoreline meets BC Ferries causeway; One underground circuit direct buried along foreshore and in ductbank parallel to HWY17 to new terminal site near 52nd Street intersection. One existing 138 kV line remains in service on existing wood poles through Tsawwassen.	Submarine cables north through Canoe pass adjacent to Pole 2 cables; One underground circuit direct buried along dike to near CPT. Overhead on existing ROW from CPT to ARN. 1L17 and 1L18 remain in service on existing wood poles to serve Gulf Islands.	Submarine cable around Pt. Roberts to Boundary Bay terminating near existing HVDC electrode. Overhead on new ROW NW to existing 1L17/18 ROW to ARN. 1L17 and 1L18 remain in service on existing wood poles to serve Gulf Islands.
Cable and OH Transmission Lengths (m)						
Additional length of submarine cable (m)	0	0	0	1000	2700	17000
Additional length of land cable (m)	0	3650	4400	2550	1000	0
Total additional insulated cable length (m)	0	3650	4400	3550	3700	17000
Double-circuit overhead line length	3650	0	0	0	1526	-3650
Additional overhead line on Galiano Island (m)	0	0	0	0	1426	0
Total Length (m)	3650	3650	4400	3550	6652	17000
Total Incremental Length (m) over Base Case	0	0	750	-100	3002	13350
R/W Lengths and Costs						
Additional Land R/W (meters)	0	0	4400	0	2,952	
Additional Marine R/W (meters)	0	0	0	1000	25000	19,000
Estimated Cost for R/W for Sea Cables	$ -	$ -	$ -	$ 23	$ 6,900	$ 5,244
ed Cost for R/W for Land Cables, OH T/L, Terminal Station	$ -	$ -		$ 500	$ 1,531	$ 500
Material, Labour & Engineering						
Total insulated cable cost (not present worth)	$ -	$ 29,200	$ 35,200	$ 28,400	$ 29,600	$ 136,000
Total OH installation cost for 2 circuits	$ 3,650	$ -	$ -	$ -	$ 1,526	$ (3,650)
Cable terminal station ($ea)		$ 500	$ 500	$ 1,000	$ 5,500	$ 1,000
Seismic Upgrade costs - Terminal station		$ 240	$ 240	$ 240		$ 240
Seismic Upgrade costs - duct	$ -			$ 1,632		$ 128
Total Capital Cost Total OH and UG cost for 2 circuits on segment from EBT to TSW or cost for equivalent segment of respective Option Cost	$ 3,650	$ 29,940	$ 35,940	$ 31,795	$ 45,057	$ 139,462
VITR Capital Costs (2008)	**$ 3,650**	**$ 17,340**	**$ 18,340**	**16,779**	**30,257**	**71,462**
Potential Stage 2 Capital Costs (2018)	$ -	$ 12,600	$ 17,600	$ 15,016	$ 14,800	$ 68,000
Net Present Value of Both (2008, at 7%)	**$ 3,650**	**$ 23,745**	**$ 27,287**	**$ 24,412**	**$ 37,781**	**$ 106,030**
Option 7 (NPV of advance replacement of both 138 kV circuits on segment through Tsawwassen in 2008)		$ 29,940	$ 35,940			

Assumptions:

1. For Options 4 & 5, the additional costs for continued operation of a separate 138 kV system to serve the Gulf Islands is not included.
2. ROW/easements can be obtained in time for Options 4, 5 and 6, at reasonable cost.
3. Environmental permits can be obtained in reasonable time for Options 4, 5 and 6. Costs are not included.
4. For Option 2, Portions of second ductbank would be built initially to minimize disturbance to backyards, otherwise only one built for first stage.
5. New overhead lines on Hwy 17 may be combined 230 kV and DC1; 138 kV line would remain on existing ROW until 2nd stage, when DC1 would have to be removed.
6. Soils are liquefiable on and near Hwy 17 and in Tsawwassen Bay.
7. For Option 4, new 230 kV submarine cables on south side of ROW would have to cross over the 138 kV cables on north side of ROW.
8. Impacts of adding extra land cable length on transmission capacity, voltage control and losses are not included.

Based on the above, Options 1, 2, 3, or 7 are viable means of carrying out the Project. Option 4 is highly undesirable from the perspective of environmental effects, First Nations interests, seismic risk and construction costs. Option 5 is infeasible due to cost and seismic risk. Option 6 is infeasible due to cost and environmental effects.

Option 2 has been ranked No. 1, and is included in the scope of the Project described in Section 3, primarily because of the special circumstances related to the dense residential development that occurred in very close proximity to the ROW after the existing overhead corridor was established in the 1950s.

It is BCTC's conclusion that this is the best solution to balance the interests of local residents in Tsawwassen and reducing impacts on their property with the interests of BCTC for unobstructed access to its facilities and the interests of rate payers for reliable service at reasonable cost. Tsawwassen is a circumstance where development has been allowed to enclose the 3.7 km section, severely limiting access to the ROW for maintenance or vegetation management. Many homes adjacent to the ROW have been built with their foundations literally on the ROW boundary. While this is the case in few locations elsewhere on other BCTC transmission ROW, in no case is it so widespread or confining to system operations.

Although Option 1 has the lowest cost, BCTC proposes to proceed with Option 2 as the best solution, balancing the interests of all stakeholders.

4.3.2 Gulf Islands Route Options

Public consultation revealed strong opposition to replacing the two existing 138 kV overhead circuits on Galiano and Salt Spring Islands with a new 230 kV double overhead circuit. Several alternatives were evaluated as potential means to avoid construction of new overhead lines on the islands. Each of the alternatives is shown on a map in Figure 4-5.

Option 1: a new 230 kV double-circuit overhead line using the existing 138 kV ROW; both existing 138 kV circuits would be removed.

Option 2: Same as Option 1, except for 230 kV AC underground construction in selected areas on Galiano and/or Salt Spring Islands.

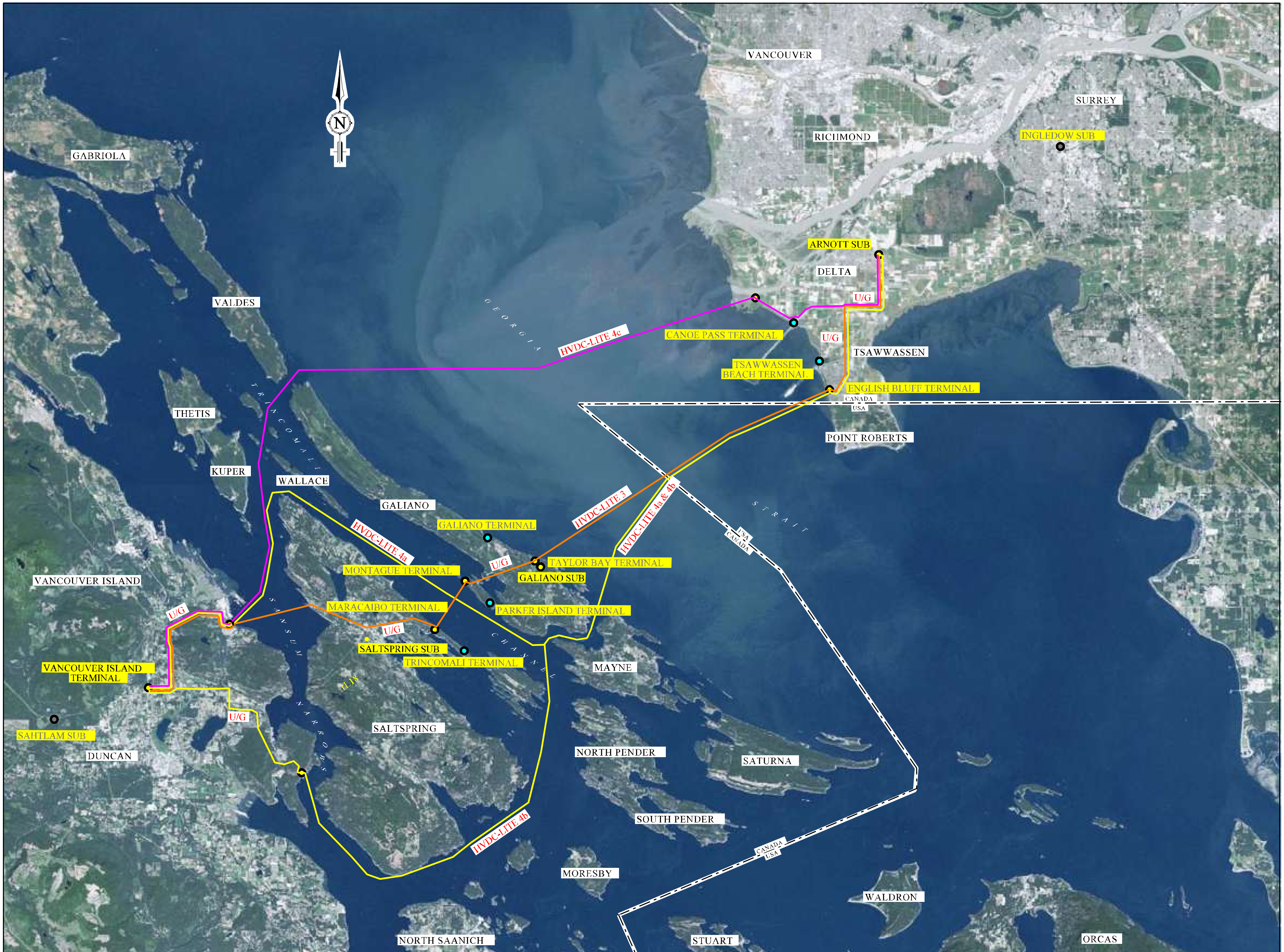


Figure 4-5. HVDC Light® Alternative Routes

DIGITAL MAP	PROJECT No.	BC hydro ENGINEERING PHOTOGRAMMETRY SERVICES
PREPARED BY GJB	PHOTO DATE 1999	VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT ARNOTT SUBSTATION TO VANCOUVER ISLAND TERMINAL HVDC LITE ALTERNATIVES
DATE JUN 23. 2005	PHOTO SCALE	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	
N.T.S.	DWG. SCALE AS SHOWN	CONTOUR INT. DWG. No. R. 0

Option 3: HVDC Light® on the existing 138 kV corridor though the Gulf Islands.

Option 4: An all-submarine cable route bypassing the Gulf Islands using one of the following routes (cables this long will require an HVDC solution):

(a) HVDC-1S: Active Pass South

(b) HVDV-1N: Active Pass North - same as Option 3(a), but go north around Salt Spring Island to the Crofton area.

(c) HVDC-2: Porlier Pass – follows the existing Pole 2 HVDC transmission corridor from ARN to Canoe Pass and head west to Porlier Pass, through the Satellite Islands to the Crofton area as per Option 3b.

Table 4-4 shows the evaluation criteria used to evaluate these options and BCTC's ranking of the options.

Table 4-4. Gulf Island Alternatives

Criteria	Option 1	Option 2	Option 3	Option 4 HVDC-1S	Option 4 HVDC-1N	Option 4 HVDC-2
Costs for the Project*	$245M	$280 to $332M	$421M**	$420 to $440M**		
Reliability (including seismic risk)	1	2	3	5	4	**
Environmental Effects	1	2	3	6	4	5
Community Impacts	6	5	4	3	2	1
First Nations Impacts	1	2	3	6	4	5
Implementation Risk	1	2	3	**	**	**
Regulatory Risk	1	2	3	6	4	5
Overall Ranking	1	2	**	**	**	**

Note: 1 is best; 6 is worst
* Construction Costs for Stage 1
** Indicates the option is infeasible

Detailed costs comparisons are shown in Table 4-5.

British Columbia Transmission CORPORATION

VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT - HVDC Light Capital Cost Comparison - Revised July 5/05

	Base Case 230kV AC, VIT to ARN, Seismically Secure	Conventional HVDC, Existing ROW, VIT to ING, Seismically secure	Conventional HVDC, Existing ROW, VIT to ING, Seismically secure	HVDC Light, Existing ROW, VIT to ARN, Not seismically secure	HVDC Light - Southern Bypass, VIT to ARN via Active Pass to Crofton, Not seismically secure	HVDC Light - Northern Bypass, VIT to ARN via Canoe Pass to Porlier Pass to Crofton, Not seismically secure
Cable ratings	3 x 230kVac 1540A Cables	Monopole: 2 x 300kV 2000A Cables	Monopole: 2 x 300kV 2000A Cables	Bipole: 2 x +/-150kV 1800A Cables	Bipole: 2 x +/-150kV 1800A Cables	Bipole: 2 x +/-150kV 1800A Cables
Ductbank configuration on land	One 4-way ductbank on land	One 3-way ductbank on land	One 3-way ductbank on land	One 3-way ductbank on land	One 3-way ductbank on land	One 3-way ductbank on land
Transmission capacity	Stage 1: 600MW	Stage 1: 600MW	Stage 1 : 600MW Reuse exisitng HVDC OH line from MTG west)	Stage 1: 540MW (ABB 'M6')	Stage 1: 540MW (ABB 'M6')	Stage 1: 540MW (ABB 'M6')
Phase 1 - Project Definition	**$8,493,000**	**$8,993,000**	**$8,993,000**	**$9,993,000**	**$9,993,000**	**$9,993,000**
Includes:		(add $500k Eng cost for Converter Sta.)	(add $500k Eng cost for Converter Sta.)	(add $1.5M cost for Converter Station, new crossing and 2 new cable terminals)	(add $1.5M cost for Converter Station, extended submarine length & 1 new term.)	(add $1.5M cost for Converter Station. extended submarine length & 1 new term.)
Preliminary Engineering						
Environmental Studies						
Stakeholder Consultation						
CPCN Application and Approval Process						
EA Certificate Application and Approval Process						
Permit Applications and Approval Processes						
Implementation Phase Project Plan						
Final Implementation Phase Cost Estimates						
Phase 2 - Project Implementation						
Overhead Lines	**$38,000,000**	**$44,916,853.9**	**$25,020,224.72**	**$0**	**$0**	**$0**
-Total Length:	35.6 km	52.6km	29.3km	-	-	-
Overhead line complete, $ per km	$1,067,416	$853,933	$853,933			
Submarine Cable Systems	**$125,363,000**	**$88,129,050**	**$88,129,050**	**$97,138,478**	**$157,421,772**	**$140,377,073**
-Total Length:	30.0 km	30.0 km	30.0 km	36km	65.3 km	57.5 km
Cable system materials, $ per km	$2,455,500	$1,645,185	$1,645,185	$1,316,148	$1,316,148	$1,316,148
Cable system installation, $ per km	$1,329,700	$997,275	$997,275	$997,275	$997,275	$997,275
Other incl. cable terminals	$11,807,000	$8,855,250	$8,855,250	$13,855,250	$6,355,250	$7,355,250
Underground Cable Systems	**$14,144,000**	**$8,715,620**	**$8,715,620**	**$80,218,088**	**$47,140,453**	**$45,607,052**
-Total Length:	3.7 km	3.7 km	3.7 km	36km	20.9 km	20.2 km
Cable system materials, $ per km	$1,231,351	$825,005	$825,005	$660,004	$660,004	$660,004
Cable system installation, $ per km	$575,676	$385,703	$385,703	$385,703	$385,703	$385,703
Civil materials, $/km	$164,324	$123,243	$123,243	$123,243	$123,243	$123,243
Civil installation - Stage 1 ductbank/manholes, $/km	$887,297	$665,473	$665,473	$665,473	$665,473	$665,473
Civil installation - Stage 2 ductbank/manholes, $/km	$724,000			$543,000	$543,000	$543,000
Other incl. cable terminals	$1,757,000	$1,317,750	$1,317,750	$12,821,351	$7,443,507	$7,194,203
AC Station Modifications						
-Arnott / ING	**$1,533,000**	**$3,100,900**	**$3,100,900**	**$3,100,900**	**$3,100,900**	**$3,100,900**
-VIT	**$13,489,000**	**$3,100,900**	**$3,100,900**	**$3,100,900**	**$3,100,900**	**$3,100,900**
-Shunt Compensation	**$5,890,000**	**$0**	**$0**	**$0**	**$0**	**$0**
AC/DC Converter Stations						
-Lower Mainland (Arnott or Ingledow)	**$0**	**$70,000,000**	**$70,000,000**	**$70,000,000**	**$70,000,000**	**$70,000,000**
-Vancouver Island Terminal	**$0**	**$70,000,000**	**$70,000,000**	**$70,000,000**	**$70,000,000**	**$70,000,000**
Additional Prop. & ROW				**$2,000,000**	**$4,450,000**	**$5,036,000**
Phase 2 Subtotal	**$198,419,000**	**$287,963,324**	**$268,066,695**	**$325,558,366**	**$355,214,024**	**$337,221,925**
Contingency	**$18,990,000**	**$29,695,632**	**$27,705,969**	**$33,555,137**	**$36,520,702**	**$34,721,492**
Overhead	**$6,530,000**	**$9,472,907**	**$8,838,204**	**$10,704,089**	**$11,650,104**	**$11,076,156**
IDC	**$12,553,000**	**$17,965,858**	**$16,762,112**	**$20,300,858**	**$22,095,025**	**$21,006,503**
Total Capital Costs (1)	**$ 244,985,000**	**$ 354,090,721**	**$ 330,365,980**	**$ 400,111,449**	**$ 435,472,856**	**$ 414,019,076**

(1) Cost estimates inflated in accordance with cash flow forecast
(2) Submarine cable lengths exceed centreline distance due to underwater topography plus cable "snaking" and spacing requirements

Based on BCTC's analysis, all options other than 1 and 2 are infeasible. Options 3 and 4 are infeasible primarily due to cost. BCTC does not believe this level of cost is justified given the available alternatives. All routes for Option 4 have substantial implementation risks due to technical challenges for cable installation and operation in Active Pass or Porlier Pass with high currents and marine traffic. Options 3 and 4 would also have significant environmental assessment risks, especially the marine bypass routes under Option 4. The HVDC-2 route for Option 4 has excessive seismic risk due to installation of a long section of cables in the Fraser River delta. In addition, all of the HVDC options (conventional or Light) are much more costly to build, operate, and maintain, and have inferior characteristics for system security.

Option 2 includes an unspecified quantity of underground 230 kV AC cable. It is not specific as to which sections could be built underground on the Gulf Islands. Any individual underground section would be approximately the sum of a $2M base for 2 new terminals plus an additional $4M per km for underground construction between the terminals. Given the existing overhead corridor, the nature of the proposed Project in comparison to the existing 138 kV facilities, and the proximity and number of landowners involved in the Gulf Islands, BCTC does not believe that the high incremental cost of underground construction is justified.

Based on the BCTC's alternatives analysis, BCTC's proposal uses Option 1 for the southern Gulf Islands portion of the Project, as described in Section 3. It is the least cost alternative and best performing.

4.4 Risk Management

The primary Project risks and proposed mitigation are:

(a) Schedule delay if CPCN approval is not received by February 1, 2006 – Meeting the in-service date requires BCTC to file the EAC Application under BCEAA early in 2006. This is also necessary to trigger the next stage of review under CEAA. The scope of the environmental assessment and approval process will be more complex, costly and time consuming without the single project definition that a CPCN approval provides. Meeting the in-service date also requires BCTC to commit capital dollars and award contracts in early 2006 to ensure timely cable delivery. BCTC is unable to do this without CPCN approval. BCTC is mitigating this risk by filing the CPCN Application now so that a CPCN can be issued prior to filing the EAC Application and capital can be expended and contracts awarded in early 2006.

(b) Scope and cost change arising from the environmental assessment and approval processes – BCTC is mitigating this risk by early engagement of the regulatory agencies, First Nations and the public. BCTC has begun the necessary technical environmental studies in accordance with the jointly developed draft TOR for the EAC Application to ensure completion on a timely basis. To date, this process has reflected BCTC's expectations.

(c) Cost and availability associated with submarine cable procurement – BCTC will mitigate this risk by beginning the tendering process in the fall of 2005. No contracts will be awarded until after a CPCN is granted.

(d) Cost escalation and schedule delay in obtaining underground rights in Tsawwassen on the existing ROW – BCTC will mitigate this risk by attempting to negotiate the exchange of overhead for underground rights for properties along the 3.7 km identified of the existing corridor in Tsawwassen where BCTC is proposing underground construction. Alternative mitigation measures include expropriation of undergrounds rights where negotiation is unsuccessful or reverting to use of existing overhead rights if directed by the Commission.

4.5 Rate Impacts

The total cost is estimated to be $245 million upon completion and at the time the Project comes into service. The Transmission rate impact of this Project is approximately 4.4% of the Total Transmission Revenue Requirement and is calculated in Table 4-6 below. Table 4-6 also shows that the average impact as a percentage of BC Hydro's Total F2006 Revenue Requirement is approximately 1%. The forecast expenditures for the VITR Project on which this rate impact has been based, including Interest During Construction (IDC), are shown by year in Table 4-7 below.

Table 4-6. Rate Impact

		BC Hydro Capital Structure	Capital Cost ($millions)	Cost Rate	Annualized Impact ($millions)
2	Equity component	28.4%	69.6	13.51%	9.40
3	Debt component	71.6%	175.4	5.5%	9.65
4	Total capital cost	100.0%	245.0		
5	Annual return				19.1
6	Annual depreciation				5.4
7	Grants and Taxes				1.1
8	Incremental annual OM&A				(0.5)
9	Total Change in Transmission Revenue Requirement				25.1
10	F2006 Transmission Revenue Requirement				566
11	Approximate Transmission rate impact percentage				4.4%
12	F2006 BC Hydro Revenue Requirement				2589
13	Approximate impact on BC Hydro rates				1%

Table 4-7. VITR Breakdown of Asset Categories

VITR Revenue Requirement Impact - $ millions
(Route 2)

ROE		13.51%
Interest		5.50%
Dividend		85% of Net Income

No.	Item	Formula	F2005	F2006	F2007	F2008	F2009	F2010	F2011	F2012	F2013	F2014	F2015
			100% Debt Financing during Project Construction					Use BCH Feb 2005 Approved D/E ratio of 71.6%/28.4%					
1	Equity - Opening						69.6	70.3	71.7	73.2	74.7	76.3	77.9
2	- Changes						4.7	9.7	9.9	10.1	10.3	10.5	10.7
3	- Dividend						(4.0)	(8.2)	(8.4)	(8.6)	(8.8)	(8.9)	(9.1)
4	- Closing						70.3	71.7	73.2	74.7	76.3	77.9	79.5
	ROE	(4 x ROE)					4.7	9.7	9.9	10.1	10.3	10.5	10.7
5	**ROE Change**						**4.7**	**4.9**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
6	Debt - Opening		0.0	2.8	9.4	31.4	113.3	175.4	172.7	167.3	161.9	156.5	151.1
7	- Changes (WIP)		2.8	6.6	22.0	81.9	131.7	0.0	0.0	0.0	0.0	0.0	0.0
8	- Changes (Depreciation)							(2.7)	(5.4)	(5.4)	(5.4)	(5.4)	(5.4)
9	- Closing	(6+7+8)	2.8	9.4	31.4	113.3	245.0	172.7	167.3	161.9	156.5	151.1	145.7
10	- Average	(6+9)/2	1.4	6.1	20.4	72.3	179.1	174.1	170.0	164.6	159.2	153.8	148.4
	Gross Interest before IDC		0.0	0.3	1.3	4.6	10.6						
11	Less: IDC		(0.0)	(0.3)	(1.3)	(4.6)	(5.8)	0.0	0.0	0.0	0.0	0.0	0.0
12	Interest excl IDC	(10 x Interest)-11	0.0	0.0	0.0	0.0	4.8	9.6	9.3	9.1	8.8	8.5	8.2
13	**Interest excl IDC - change**			**0.0**	**0.0**	**0.0**	**4.8**	**4.7**	**(0.2)**	**(0.3)**	**(0.3)**	**(0.3)**	**(0.3)**
	OMA (reduction in accretion expense)		0.0	0.0	0.0	0.0	(0.3)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
	OMA Change			**0.0**	**0.0**	**0.0**	**(0.3)**	**(0.3)**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
14	Grants & Taxes		0.1	0.1	0.1	0.1	0.6	1.1	1.1	1.1	1.1	1.1	1.1
15	**Grants & Taxes Change**			**0.0**	**0.0**	**0.0**	**0.5**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
16	Annual Depreciation		0.0	0.0	0.0	0.0	2.7	5.4	5.4	5.4	5.4	5.4	5.4
17	**Depreciation & Amortization Change**			**0.0**	**0.0**	**0.0**	**2.7**	**2.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
24 25	**Revenue Requirement Change**	**(5+13+15+17)**		**0.0**	**0.0**	**0.0**	**12.5**	**12.7**	**(0.0)**	**(0.1)**	**(0.1)**	**(0.1)**	**(0.1)**

5.0 CONSULTATION

5.1 Introduction

BCTC has engaged in public consultation on the VITR Project to ensure that all interested parties and potential stakeholders were provided with the opportunity to hear about, gather information, ask questions, and to express any concerns to BCTC about the Project prior to the final project design and the CPCN Application being filed. BCTC's goal was to engage the public in a process of communication and consultation to build a strong body of informed public opinion, leading to a project proposal that meets the technical requirements but that has also been informed by public and First Nations involvement, is cost effective and balances the competing interests of affected stakeholders.

Government agencies, the public, and First Nations have also had the opportunity to participate in public consultation efforts associated with the Project through the BCEAA process (see Section 3.7.2.1), particularly through the development of the TOR for the technical studies associated with VITR and the contents of the EAC Application. There will be further consultation opportunities as the environmental assessment and approval processes continue.

An overview of the public consultation activities on the VITR Project is provided below. A description of the consultation processes associated with the environmental assessment and approval process will generally not be repeated here except where these activities overlapped with other consultation activities.

5.2 VITR Consultation

5.2.1 General Approach

BCTC's general approach for notifying and consulting with public stakeholders and First Nations includes the following principles:

(a) Research: Identifying key audiences, gathering the views of stakeholders and identifying issues;

(b) Program Design: Developing communication and consultation objectives, based on reasonable commitment of personnel and financial resources to meet these objectives and to be flexible to respond to the public's interest, availability and ideas, and how they wanted to be consulted;

(c) Information Programs: Creating relevant Project information and distributing it to the appropriate public stakeholders and First Nations in a timely fashion; ensuring programs are sufficiently flexible to respond to the public and First Nations interests, availability, and ideas; and

(d) Decision Making: Incorporating local knowledge into the Project decision-making process where appropriate, seeking public acceptance where possible, and balancing the competing interests of affected stakeholders.

Within this context, the priorities of VITR consultation were to:

(a) Ensure that all communications materials (newsletters, information sheets, advertisements, etc.) were clear, consistent, factual and accurate in reflecting Project information, status, and timelines;

(b) Broadly distribute information about the Project;

(c) Involve the public as early as possible in the proposed Project to attempt to demonstrate that the Project could still benefit from public input and amendments made;

(d) Create multiple opportunities for stakeholders to educate themselves about the Project and to provide feedback to BCTC;

(e) All enquiries (phone calls, emails, letters, faxes, etc.) to be responded to as quickly as possible;

(f) The Project website be kept current with Project information and activities;

(g) Solicit public comment on issues and concerns about the Project and to demonstrate that those issues and concerns had been heard, understood and considered in the development of the final design of the Project;

(h) Report back to stakeholders using a variety of methods to ensure that stakeholders were aware of the input received and how it was used as route options were evaluated; and

(i) Share all relevant and pertinent information with all stakeholders until the end of construction of the Project.

5.2.2 Stakeholders

VITR consultation activities were designed to ensure that all interested parties and potential stakeholders had the opportunity to be involved in the process.

The general categories of potential stakeholders that were identified included:

(a) Canadian and US Federal, Provincial/State Government and Agencies;

(b) Elected Officials;

(c) Local Governments;

(d) Non-governmental organizations;

(e) First Nations;

(f) Special interest groups and concerned citizens;

(g) Community opinion leaders;

(h) Residents of the Cowichan Valley on Vancouver Island;

(i) Residents of Delta;

(j) Landowners along the route;

(k) Media;

(l) BCTC and BC Hydro employees; and

(m) Ministry of Energy and Mines.

5.3 Consultation Activities

5.3.1 Project Introduction and Notification

Communications to introduce the Project began in December 2004 and included:

(a) A letter mailed to approximately 465 property owners on the existing ROW (Appendix S-1); and

(b) Presentations and briefings to elected officials, municipal staff and community groups.

5.3.2 Project Website and Inquiries

To facilitate the future sharing of information, in January 2005, BCTC activated an email address for enquiries (community.relations@bctc.com) and an Internet website:

http://www.bctc.com/community_engagement/project_consultation/vancouver_island_transmission_reinforcement/ (Appendix S-2).

BCTC has responded to over 90 questions, inquiries and letters regarding the Project as well as numerous phone calls. The website is continually updated as new information becomes available. Since the website was established more than 850 hits have been recorded.

5.3.3 Project Briefings and Meetings

Since December 2004, BCTC has participated in more than 35 presentations and briefings, including Community Open Houses (discussed in Sections 5.3.5 and 5.3.6), about the Project to elected officials, municipal staff, community groups, local media, First Nations, government agencies, and BCTC and BC Hydro employees. A complete log of all meetings is attached as Appendix S-3.

5.3.4 Summary of Consultation Activities

5.3.4.1 December 2004

(a) Initial public consultation plan prepared.

(b) Letter to all property owners along the existing ROW to introduce the Project.

(c) Met with representatives of Tsawwassen community group Tsawwassen Residents Against Higher Voltage Overhead Lines (TRAHVOL).

5.3.4.2 January 2005

(a) Launched Project website.

(b) Met with key stakeholders to introduce the Project.

(c) Drafted information materials, Project brochure, information display panels and newspaper advertising.

(d) Hosted first Community Open House in Tsawwassen (see Section 5.3.5).

(e) Met with representatives of TRAHVOL.

(f) Briefed local media in Delta on the Project.

(g) Open Letter to Tsawwassen Residents published in the Delta Optimist on January 29, 2005 and in the South Delta Leader on February 4, 2005.

5.3.4.3 February 2005

(a) Continued consultation initiatives; monthly website updates, responded to information requests and questions.

(b) Hosted Community Open Houses on Galiano Island, Salt Spring Island and Vancouver Island (see Section 5.3.5).

(c) Met with representatives of TRAHVOL.

(d) Briefed BC Hydro Field Services staff on Vancouver Island on the Project.

5.3.4.4 March 2005

(a) Collected and compiled public input and comments received.

(b) Responded to information requests, questions and minor website traffic.

(c) Updated website and added resources as they became available.

(d) Met with representatives of TRAHVOL.

5.3.4.5 April 2005

(a) Planned for report back to communities.

(b) Updated BCTC staff on the Project.

(c) Responded to information requests, questions and minor website traffic.

5.3.4.6 May 2005

(a) Met with representatives of TRAHVOL.

(b) Met with representatives of Salt Spring Island community group Island Residents Against High Voltage Overhead Lines (IRAHVOL).

(c) Second community information session in Tsawwassen.

(d) Responded to information requests, questions and minor website traffic.

5.3.4.7 June 2005

(a) Second community information session on Salt Spring Island (see Section 5.3.6).

(b) Responded to information requests, questions and minor website traffic.

(c) Prepared public consultation feedback report for submission with CPCN Application.

5.3.5 Community Open Houses, January 27 to February 17

5.3.5.1 Preparations and Objectives

Initial Community Open Houses were arranged in four locations along the existing right-of-way:

(a) Thursday, January 27, 2005, Tsawwassen, South Delta Secondary School

(b) Saturday, February 5, 2005, Galiano Island, Lions Hall

(c) Saturday, February 12, 2005, Salt Spring Island, Lions Hall

(d) Thursday, February 17, 2005, Vancouver Island, Best Western Cowichan Valley Inn

The selection of locations and timing of these sessions were planned to maximize the opportunity for property owners and members of the public to attend.

The Community Open Houses were planned to meet several objectives:

(a) To familiarize as many people as possible who may be affected by the Project with Project information;

(b) To acquaint BCTC's VITR Project team members with the local communities, organizations and property owners;

(c) To identify issues and concerns;

(d) To identify what further information needed to be provided to the public and interested groups;

(e) To identify the best and most effective ways of communicating further information as it became available;

(f) To provide attendees with information on where they could learn more about the Project and information about the Project website and inquiry process;

(g) To identify individuals with particular concerns (or who require particular information) and to direct them to the appropriate Project team members; and

(h) To inform the public about the environmental assessment and approval process and the BC Utilities Commission CPCN review process.

5.3.5.2 Invitations/Announcements

BCTC informed all interested parties of the schedule of the Community Open Houses as follows:

(a) Property owners along the existing right-of-way were advised of the full schedule of open houses by letter (Appendix S-4) and invited to attend.

(b) Letters and email invitations were sent to regional and municipal officials. As well as inviting officials to attend a preview prior to the open houses, BCTC offered to arrange separate briefings and information sharing sessions at their convenience.

(c) The BCEAO provided BCTC with a list of government agencies that would have a potential interest in the VITR Project. BCTC briefed these agencies on the Project at an inter-agency meeting on January 21, 2005 arranged by the EAO and invited them to the Open Houses.

(d) Aboriginal community leaders were mailed invitations to participate in the Community Open House sessions and/or invited to request their own community-specific presentations. To date, no aboriginal communities have requested an Open House session for their community.

(e) Details of each Open House were advertised in seven local newspapers: South Delta Leader, Delta Optimist, Driftwood (Gulf Islands), Active Page (Galiano Island), Cowichan Valley Citizen, the Cowichan News Leader, and the Nanaimo News Leader (Appendix S-5).

5.3.5.3 Communication Material Developed for Open Houses

The following materials were developed for the Community Open House sessions (Appendix S-6):

(a) Project brochure;

(b) Information Display Boards describing the Project from need through the required approvals;

(c) Fact Sheets:

  i. Electric Magnetic Fields (EMF) (two), and

  ii. Underground Construction of Power Lines;

(d) Photo simulations showing the existing right-of-way and infrastructures as compared to the proposed new infrastructure; and

(e) Questionnaire.

Other materials made available for the open houses included:

(a) Aerial photos of the right-of-way;

(b) Diagrams of existing structures and proposed structures;

(c) Lower Mainland Transmission System map;

(d) Brochure: Planting Near Powerlines;

(e) Booklet: EMF – Electric and Magnetic Fields Association with the Use of Electric Power;

(f) Federal-Provincial-Territorial Radiation Protection Committee's Position Statement for the General Public on the Health Effects of Power-Frequency (60 Hz) Electric and Magnetic Fields - Issued on January 20, 2005;

(g) Federal-Provincial-Territorial Radiation Protection Committee's Response Statement to the Issue of Power-Frequency Magnetic Fields and Childhood Leukemia – Issued on January 20, 2005; and

(h) World Health Organization information on EMF.

Two "Have Your Say" boards were also available at each session where visitors could post their comments and questions about the Project for all other visitors to see. An exit questionnaire was also provided for visitors to record their comments, questions and reactions to the Project.

5.3.5.4 BCTC Project Team Attendance

Members of the BCTC Project team attended all Community Open Houses representing expertise in all aspects of the Project, for example: Engineering, Regulatory, Properties, Environment, Vegetation Management, Aboriginal Relations and Community Relations.

5.3.5.5 BCEAO Attendance

Representatives from the BCEAO also attended all Open Houses. The BCEAO display and information was set up separately from the Project displays to provide information and answer questions about the environmental review and approval process.

5.3.5.6 Visitor Attendance

Table 5-1. Open Houses Information Session Attendance

Location	Registered Visitors	Unregistered Visitors	Total Visitors	Project Team Members
Tsawwassen – Jan. 27	294	12	306	16
Galiano Island – Feb. 5	23	-	23	8
Salt Spring Island – Feb. 12	71	5	76	9
Vancouver Island – Feb. 17	28	3	31	9

5.3.5.6.1 Completed Questionnaires

As indicated, a questionnaire was provided to all Community Open House attendees to obtain input on the Open Houses and to provide an opportunity for attendees to write down their comments, concerns or questions. In addition to requesting that people prioritize general issues of concern to them (e.g. public health and safety, environmental protection, etc.) people were also asked specifically if they had received sufficient information and had been given sufficient opportunity to offer their input to a BCTC representative. Altogether, 210 members of the public completed and returned the questionnaire. 52% of those people expressed satisfaction on how the Project was explained and 83% reported that they had an opportunity to talk to a BCTC representative.

In addition, 84 people recorded their comments on the “Have Your Say” boards provided at each Community Open House.

5.3.6 Additional Community Information Meetings – May 31 and June 4, 2005

In response to concerns raised during the initial consultation sessions in January and February, BCTC committed to conducting a further review of alternative routes proposed by residents in Tsawwassen and the Gulf Islands. BCTC published an Open Letter to Tsawwassen Residents after the January 27 Open House confirming its commitment to exploring the alternative routes (Appendix S-7). BCTC also made a commitment to return to the communities of Tsawwassen and Salt Spring Island prior to filing an application with the BC Utilities Commission to present the various route alternatives studied, the criteria used, and the results of BCTC's analysis.

Meetings were arranged for:

(a) Tuesday, May 31, 2005, Tsawwassen, South Delta Secondary School Theatre; and

(b) Saturday, June 4, 2005, Ganges, Salt Spring Island, ArtSpring Theatre.

Residents from Galiano Island and Vancouver Island did not approach BCTC to request additional meetings or additional analysis of alternative routes. There was limited interest and attendance at the Open Houses in these communities. Accordingly, BCTC did not hold additional information sessions on Galiano Island or Vancouver Island. However, residents were invited to attend the further Salt Spring Island Information Session as described below.

5.3.6.1 Invitations/Announcements

BCTC informed all interested parties about the information sessions as follows:

(a) Property owners along the existing right-of-way on the Mainland were advised of the session in Tsawwassen by notice (Appendix S-8) mailed to their residence.

(b) Property owners along the existing right-of-way on Galiano Island, Salt Spring Island and Vancouver Island were advised of the session on Salt Spring Island by notice (Appendix S-9) mailed to their residence.

(c) Notices and emails for the two sessions were also sent to regional and municipal offices.

(d) Government agencies with an interest in the Project were advised of the information sessions at the inter-agency meeting on the Project hosted by the BCEAO on May 26, 2005.

(e) Details of each of the information sessions were advertised using two inserts in local newspapers: The South Delta Leader, The Delta Optimist and The Driftwood (Appendix S-10).

Project display materials were set up describing the Project. Additional display material describing the consultation process so far and the approvals process was presented (Appendix S-11). An alternatives matrix and map (Appendix S-12) describing the various route alternatives studied, the criteria used and the results of the analysis were provided at each of the sessions.

Members of BCTC's VITR Project team attended each of the information sessions to respond to questions. For the Tsawwassen session, Dr. Richard Gallagher from the BC Cancer Agency, a recognized expert on EMF issues, was retained to answer any health-related questions.

BCEAO representatives also attended both additional information sessions to provide information about the environmental review and approval process and respond to any questions.

PowerPoint presentations describing the Project, the Project schedule and regulatory review processes, the various route alternatives studied, the criteria used and the results of the analysis, were presented at each of the sessions (Appendix S-13 and S-14). These presentations were followed by a question and answer session.

A comment sheet was also provided for visitors to record their comments, questions and reactions to the Project. Altogether, thirty-four members of the public completed and returned comment sheets following the information sessions.

Audio recordings were made at of each of the two sessions. The audio files and a transcript of the recordings will be posted on the Project website once the transcripts have been completed.

Table 5-2 sets out the attendance at the additional Tsawwassen and Salt Spring Island information sessions.

Table 5-2. Tsawwassen and Salt Spring Island Information Session Attendance

Location	Registered Visitors	Unregistered Visitors	Total Visitors	Project Team Members
Tsawwassen – May 31	146	5	151	16
Salt Spring Island – June 4	147	6	153	11

5.4 Summary of Issues and Responses

The following provides a summary of the issues and concerns raised through public consultation.

Table 5-3. Issues Raised Through Public Consultation

Issue	Management of Issues
Property Values: • Residents in Tsawwassen and on Salt Spring expressed concern that property values would decrease as a result of increased voltage	BCTC's believes that the proposed routing and design along the existing ROW will have neutral to positive impacts for property owners along the existing ROW. To the extent that property values are affected by the existing lines on the ROW, this already occurs. The proposal to replace one existing line and use underground construction in Tsawwassen for 3.7 km will reduce the visual impact of BCTC's existing facilities by half. In segments where the two existing 138 kV lines are on two lattice steel structures, these will be replaced with a new double circuit line on single steel poles, again significantly reducing the visual impact. In other segments where the existing 138 kV lines are on four wooden H-frame poles, these again will be replaced with a new double circuit line on a single steel pole (except 3.7 km in Tsawwassen as described above), again reducing the visual impact. The draft TOR for the BCEAA process describe how these issues will be addressed in the Application for an Environmental Assessment Certificate.
Visual Impacts: • Taller poles • Possibility of strobe lights on tops of poles	Preliminary designs were done to minimize the visual impacts of the new facilities. In Tsawwassen, BCTC agreed not to recommend construction of overhead lines on the existing ROW and is proposing underground construction through the developed portion of Tsawwassen. In other areas, BCTC has decided to use single steel pole construction at higher cost rather than more obtrusive tower designs. Photo simulations were prepared for most sections of the Project to show members of the public what the proposed pole configuration would look like compared to the existing structures. In contrast to the proposed configuration, shorter poles would require separate single circuit lines (two poles instead of one) and/or shorter spans between poles, thereby increasing the number of poles. There is no requirement for strobe warning lights on any of the proposed structures.

Issue	Management of Issues
EMF: • Concerns about EMF levels from any lines near homes and schools and adverse health effects	Preliminary designs were selected to decrease EMF levels at the edge of the ROW. The VITR Project will comply with the precautionary exposure limits endorsed by the World Health Organization, Health Canada, and previous Commission decisions on EMFs. In an effort to ensure people had information about EMFs, third party sources of information including the World Health Organization, Health Canada and the BC Cancer Agency were identified for the public to contact. It is anticipated that EMFs will continue to be a topic of concern for some residents.
Increased voltage from 138kV to 230kV: • Concerns about adverse health impacts from EMF	BCTC clarified on a number of occasions that the actual power capacity (megawatts) of the line will increase five fold not 23 times as suggested by a number of concerned citizens. In Tsawwassen, with this increase in power and with one underground 230 kV circuit and one existing 138 kV overhead line, EMF levels at the edge of the current right-of-way would be the same or lower than they are today. If a second underground line is added, EMF levels will be lower at both edges of the right-of-way. In other locations along the right-of-way, EMF levels will be the same or lower at the edges of the right-of-way. BCTC builds all projects within safe exposure guidelines for EMFs as set by leading health authorities.
Disruption and inconvenience to property during construction	The construction plan will contain requirements regarding the need to minimize disruption to individuals and property owners. Every effort will be made during construction and clean-up to reduce the time when disturbances would occur in any one neighbourhood or property.
Noise during construction	BCTC has indicated that it will recommend mitigation measures to be undertaken during removal of the existing lines, construction and operation of the Project facilities to control excessive noises based on best management practices and applicable bylaws and Workers Compensation Board (WCB) requirements.
Impact on yards, gardens and agricultural operations from construction	BCTC will plan construction activities to minimize disturbance to yards and gardens and will restore or compensate for landscaping that may be disturbed during construction. BCTC has indicated that it will plan construction activities to minimize effects on planting, harvesting, grazing or other agricultural operations. Documented damage to crops or lands will be compensated for.
Use and condition of access roads during and after construction	BCTC will restore landscaping and conforming property improvements that may be disturbed during construction.
Telecommunication interference	BCTC committed to investigating the source of existing telecommunications interference in the Maracaibo area of Salt Spring Island to see if the source is related to transmission assets, distribution assets, or Telus-related assets. The existing telecommunications interference arises as a result of Telus placing their lines on the Distribution poles beneath the Distribution lines. There may be an additional small effect from the nearby transmission lines. The Project is unlikely to have any impact (positive or negative) on this.

Issue	Management of Issues
Use of pesticide for Vegetation Management	BCTC uses herbicides to manage problem vegetation when its use is prescribed according to Pest Management Plans or Pesticide Use Permits as regulated by the BC Ministry of Water, Land and Air Protection (MWLAP). This applies to Crown Lands. On private lands BCTC would only utilize herbicides if the owner consents to their use.
Control of invasive weeds such as scotch broom	BCTC recognizes that broom is an invasive plant. However, it is not classified by the Province as a noxious weed and no weed committee has been established by either the Islands Trust or the Capital Regional District to monitor or control broom. Broom is widespread on Salt Spring Island and Galiano. As such, its control would require concerted effort on the part of several stakeholders to ensure its localized control. BCTC communicated its willingness to work with the local government and residents if they wish to involve BCTC in an established broom control plan.
Fire Hazard posed by vegetation on the right-of-way	BCTC maintains the transmission rights-of-way on Vancouver Island and the Gulf Islands to control tall growing vegetation to ensure public and worker safety and system reliability. BCTC often mows or hand slashes and bucks up material to ensure that fuel buildup is kept to a minimum on the rights-of-way. BCTC completes work in accordance with Ministry of Forests' fire regulations and observes all work restrictions imposed. BCTC communicated its willingness to participate in the development of any community or local fire mitigation plan.
Compensation for Construction Inconvenience and Lost Revenue	BCTC explained that it typically does not compensate for construction inconvenience and lost revenue. Every effort will be made to minimize inconvenience and disturbance to property owners and communities.
Lack of underground rights on existing right-of-way and compensation for underground rights in Tsawwassen	BCTC explained that the CPCN Application for the Project will describe the preferred option of underground construction within the existing ROW and that it is not uncommon for CPCN applications to be submitted to the Commission with land rights pending. Should the Project be approved by the Commission, BCTC will enter into negotiations to attempt to exchange overhead rights for underground rights where required.
Routing Alternatives	Alternative route options were identified by community groups in Tsawwassen and on Salt Spring Island. Each of these options was studied to assess their technical feasibility as well as to evaluate social, environmental and cost implications. Additional community information sessions were held in Tsawwassen and on Salt Spring Island to explain BCTC's evaluation process and the results of the analysis of the various route options. A matrix and map was prepared and distributed to the public for their review at each of the information sessions (see Section 5.3.6).
Understanding underground construction of transmission lines	A fact sheet on underground power line construction was prepared and distributed at the open houses. A PowerPoint presentation on a recent underground construction project in the City of Vancouver was also posted to the Project website. This presentation was also provided to interested parties in response to various requests for information.

Issue	Management of Issues
Use of HVDC Light® technology	Residents from the Gulf Islands raised concerns about the HVDC Light® report and on BCTC's analysis of the potential use of HVDC Light® as an alternative to the proposed 230 kV system. BCTC provided a summary of the analysis at the Information Session on Salt Spring Island in early June and answered questions on the potential use of HVDC Light® technology. BCTC offered to continue the discussion with Gulf Islands residents around HVDC Light® technology and the Gulf Island's proposal of a submarine route prior to the filing of the CPCN Application. Due to conflicting schedules, this meeting could not be scheduled until July 18, 2005. BCTC will seek the Commission's guidance with regard to furthering the discussion on HVDC Light® once the CPCN process is underway.

5.4.1 Planned Ongoing Consultation Activities

To date, BCTC has responded to the questions and concerns raised by residents and interested parties in a number of ways including direct contact, open houses, information sheets, the Internet, local media and other opportunities that become available. Contingent on Project approval, BCTC will continue this communications and consultation program throughout the environmental assessment and approval, detailed design, and construction and restoration stages of the Project.

5.5 First Nations Consultation and Activities

5.5.1 Overview

The VITR Project crosses or comes close to the traditional territories of at least twenty aboriginal groups in British Columbia and Washington State. If developed within the existing ROW as proposed, it will not cross any Indian Reserves or proposed treaty settlement lands, and will only traverse Washington State submerged in the Strait of Georgia.

The First Nations in British Columbia who have been identified as potentially interested in the Project are: the Tsawwassen First Nation, Chemainus First Nation, Cowichan Tribes, Halalt First Nation, Lake Cowichan First Nation, Lyackson First Nation, Penelakut Band, Malahat First Nation, Pauquachin First Nation, Tsartlip First Nation, Tsawout First Nation, Tsleil-Waututh Nation, Semiahmoo First Nation, Katzie First Nation, Musqueam Indian Band, and the Sto:lo Nation. The Tribes in Washington State are the Lummi Nation, Nooksack Indian Tribe, Samish Indian Nation, and the Suquamish Tribe.

While the existing ROW does not directly impact any existing reserve or potential treaty settlement lands, activities to remove and replace the existing cables may affect terrestrial and aquatic plants and animals, including birds, that are of cultural or other significance to aboriginal peoples. Foreshore and submarine construction activities may affect terrestrial and aquatic plants and animals or the environment that supports them as well as the conduct of shellfish and finfish fisheries.

5.5.2 First Nations Consultation Activities

Notification regarding the nature and timing of the VITR Project has been made to those aboriginal groups that have traditional territories in the vicinity of the Project. These groups were asked if they believe that the Project may impact their interests and if so how they would like to be consulted. Follow-up phone calls and meetings were made, and will continue to be made, to ensure that the Aboriginal groups are aware of the ongoing progress of the VITR Project and that they have an opportunity to engage in consultation-related activities.

Primary consultation is being undertaken within the BCEAA process as determined by the BCEAO. In addition, BCTC continues to consult independently with the interested Aboriginal groups, with the assistance of BC Hydro Aboriginal Affairs, to address emerging issues related to the Project that are better addressed separately from the primary environmental and approval review that includes various stakeholders. The overall approach is to be inclusive of the Aboriginal groups, understand their interests and to attempt to avoid, mitigate or accommodate significant impacts on those interests by the Project, as appropriate. Close co-operation and co-ordination is taking place between BCTC and the BCEAO.

BCTC notified the BC Aboriginal groups of the proposed Project by registered mail on November 15, 2004 (Appendix S-15). The BCEAO also sent letters to a number of groups in early 2005. Follow-up communication ensued, primarily by telephone and mail, and three meetings were held with the Tsawwassen First Nation, one with the Tsleil-Waututh Nation, and one with the Sencoten Alliance (Pauquachin, Semiahmoo, Tsartlip and Tsawout First Nations).

The Tseycum First Nation advised that the Project does not infringe on their interests. Tsawwassen First Nation advised that they do wish to participate in formal consultation. The Sencoten (Pauquachin, Semiahmoo, Tsartlip and Tsawout) and Hul'qumi'num (Chemainus, Cowichan, Halalt, Lake Cowichan, Lyackson, and Penelakut) have indicated they would like to engage in consultation as groups rather than individually. These three Aboriginal groups – Tsawwassen, Sencoten and Hul'qumi'num - include all those whose Indian Reserves and core traditional territories appear to be the most proximal to the Project ROW.

BCTC sent draft TOR for the Project to the BC Aboriginal groups on March 18, 2005 with a request for comments back to the BCEAO by April 22, 2005 (Appendix S-16). No comments were received by the BCEAO. The Tsawwassen First Nation, Sencoten Alliance and Hul'qumi'num Treaty Group attended the EAO Inter-Agencies Meeting on May 26th, 2005 where BCTC provided an overview of the Project and a description of the alternative routes analyzed for Tsawwassen and the Gulf Islands. A revised version of the TOR was provided on May 26th with a request for comments back to the BCEAO by the end of June, 2005. No comments have been received to date by the BCEAO.

Consultation in British Columbia will focus on the eleven First Nations represented by these three Aboriginal groups. The EAO is in discussion with these Aboriginal groups regarding the Terms of Reference and the Section 11 Order under BCEAA. This consultation process, including, communication of key activities and progress, organization of technical group meetings and capacity funding, will continue to evolve as the Aboriginal groups better define their interests and the agencies determine their requirements and expectations.

6.0 OTHER PERMITS AND APPROVALS

6.1 Canadian Permits, Approvals and Authorizations

6.1.1 Canadian Federal Authorizations

Table 6-1 provides a summary of Canadian federal permits, approvals, and authorizations that will likely be required for construction and operation of the VITR Project.

Table 6-1. Summary of Canadian Federal Permits, Approvals and Authorizations

Enabling Legislation	Agency	Permits, Approvals, and Authorizations Applicable to the Project
Federal		
Sections 18 to 20 of the *Canadian Environmental Assessment Act*	Canadian Environmental Assessment Agency and “Responsible Authority”	Screening of the Project, preparation of a screening report, and decision whether to allow Project to proceed.
Section 35(2) of the *Canada Fisheries Act*	Fisheries and Oceans Canada (DFO)	*Habitat Authorization Agreement* for the potential "harmful alteration, disruption, or destruction" (HADD) of fish habitat
Section 5(1) of the *Navigable Waters Protection Act*	Transport Canada (Transport Canada Marine Division)	Transport Canada will likely issue a "Work Assessment", under Section 5(2) of the *Navigable Waters Protection Act* rather than a *Navigable Waters Protection Act* Approval under Section 5(1).
Divison 3, Section 125(1) of the *Canadian Environmental Protection Act*	Environment Canada (Industrial Programs and Ocean Disposal Group)	Disposal at Sea Permit

6.1.2 Provincial Permits and Approvals

Table 6-2 provides a summary of provincial permits and approvals that will likely be required for construction and operation of the VITR Project in addition to the requirement for a CPCN.

Table 6-2. Summary of Provincial Permits and Approvals

Enabling Legislation	Agency	Permits, Approvals, and Authorizations Applicable to the Project
Provincial		
British Columbia Environmental Assessment Act (Section 17(3))	British Columbia Environmental Assessment Office and relevant Ministers	Environmental Assessment Certificate
Water Act (Section 9)	Land and Water British Columbia Inc. (LWBC)	*Approval* for works in-and-about a watercourse
Heritage Conservation Act (Section 12)	Ministry of Sustainable Resources Management (Archaeology Branch)	*Heritage Alteration Permit* to remove and/or relocate a cultural resource or artifact (should any be identified)

6.2 US Permits, Approvals and Authorizations

The following summarize the applicable federal, state, and local legislation and regulatory approval requirements that may apply to the portion of the Project within the US waters.

6.2.1 Federal Permits, Approvals and Authorizations

6.2.1.1 US Department of Energy

A Presidential Permit must be obtained from the US Department of Energy before construction, operation, maintenance or connection of electrical transmission facilities across US international borders. BC Hydro currently holds a Presidential Permit for the installation, operation, and maintenance of electrical transmission lines between the Lower Mainland and Vancouver Island. This Presidential Permit was originally issued in 1955, and subsequently amended in 1958 and 1967. An additional amendment to the existing Presidential Permit or a new Permit will be required for the VITR Project.

6.2.1.2 US Army Corps of Engineers

Federal law requires permits for certain activities conducted in, over or under a navigable water of the US to assure compliance with the *Federal Water Pollution Control Act* and *Rivers and Harbors Act of 1899*. The US Army Corps of Engineers (USACE) administers these permit programs in connection with the construction of electrical transmission lines and various other activities in navigable waters of the US. As part of the USACE permitting process, the USACE will consult with the US Fish and Wildlife Service and National Oceanographic and Atmospheric Administration Fisheries Division (NOAA Fisheries) to assure compliance under Section 7 of the *Endangered Species Act*.

Table 6-3. Summary of US Federal Permits, Approvals, and Authorizations

Statutory Authority	Agency	Permits, Approvals, and Authorizations Applicable to the Project
Executive Order 11423	US Department of Energy	*Presidential Permit*
Section 404 of the *Federal Water Pollution Control Act*	USACE	*Nationwide Permit #12 for Utility Lines or Individual Permit*
Section 10 of the *Rivers and Harbors Act of 1899*	USACE	*Nationwide Permit #12 for Utility Lines or Individual Permit*
Section 7 of the *Endangered Species Act*	USACE (with USFWS and NOAA Fisheries)	*Either concurrence with the Project Biological Assessment, or a Biological Opinion*

6.2.2 Washington State Permits, Approvals and Authorizations

6.2.2.1 State Department of Natural Resources

The Project will be located on submerged lands owned by the State of Washington and managed by the Washington State Department of Natural Resources (DNR). Authorization from DNR by way of an agreement, lease, easement, or other instrument will be required for the installation of the new submarine cables. Rights-of-way were granted for the existing cables on state-owned lands in 1955, 1958, 1961, and 1968. It is likely that DNR will want to consolidate these old agreements under a new authorization for existing and proposed cables as a part of this Project. DNR will charge fees for this new use authorization and for any loss of harvestable geoduck clams resulting from Project implementation (field surveys for geoducks will be required for the Project prior to any trenching activity).

6.2.2.2 State Department of Fish and Wildlife

Under Washington State's Hydraulic Code, any project that will use the natural flow, or land below the high water mark of state fresh or salt waters, requires approval from the Washington Department of Fish and Wildlife (WDFW). WDFW issues Hydraulic Project Approvals (HPAs) to set project conditions to protect fish and fish habitat. WDFW has indicated that potential impacts to eelgrass will be an important consideration to be addressed prior to issuing an HPA for this Project.

6.2.2.3 State Department of Ecology

Applicants receiving a section 404 permit from the USACE are also required to obtain a section 401 Water Quality Certification from the Washington State Department of Ecology (Ecology). Issuance of a certification means that Ecology anticipates that a project will comply with state water quality standards. The certification for the VITR Project will likely include Best Management Practices for project construction, performance standards, contingency for potential impacts associated with the Project, and/or mitigation requirements. Additionally, Ecology has indicated that water quality monitoring and reporting will likely be required during cable installation.

Ecology must also assure that projects requiring federal permits undergo federal *Coastal Zone Management Act* (CZMA) review. This review will ensure that the Project complies with the several laws and regulations under the umbrella of the State's Coastal Zone Management Program. For this Project, CZMA review would include a check for compliance with the *Shoreline Management Act*, *Federal Water Pollution Control Act*, and *State Environmental Policy Act*.

Table 6-4. Summary of State Permits and Approvals

Statutory Authority	Agency	Permits, Approvals, and Authorizations Applicable to the Project
Washington State Aquatic Lands Act Chapter 79.9 through 96	DNR	*Aquatic Lands Use Authorization*
Washington State Hydraulic Code Chapter 77.55	WDFW	*Hydraulic Project Approval*
Federal Water Pollution Control Act Title 16, Chapter 33, Section 1251 et seq. And *State Water Quality Law* Chapter 90.48	Ecology	*Section 401 Water Quality Certification* (Washington State Department of Ecology has been delegated the authority to administer the *Federal Water Pollution Control Act*)
US Coastal Zone Management Act Title 16, Chapter 33, Section 1451 et seq.	Ecology	*Coastal Zone Management Certification*

6.2.3 Local Permits, Approvals and Authorizations

6.2.3.1 Whatcom County

Any substantial development on the shoreline or in waters of the State requires a permit or exemption pursuant to the *State Shoreline Management Act*. While Ecology has final oversight over the *Shoreline Management Act*, any shoreline permits or approvals are issued by the local jurisdiction with delegated authority. For the VITR Project, this jurisdiction is Whatcom County. Whatcom County has indicated that they will most likely require a Substantial Development Permit for this Project, and that they will require a Critical Areas Assessment Report and Habitat Management Plan as part of the application for the shoreline permit.

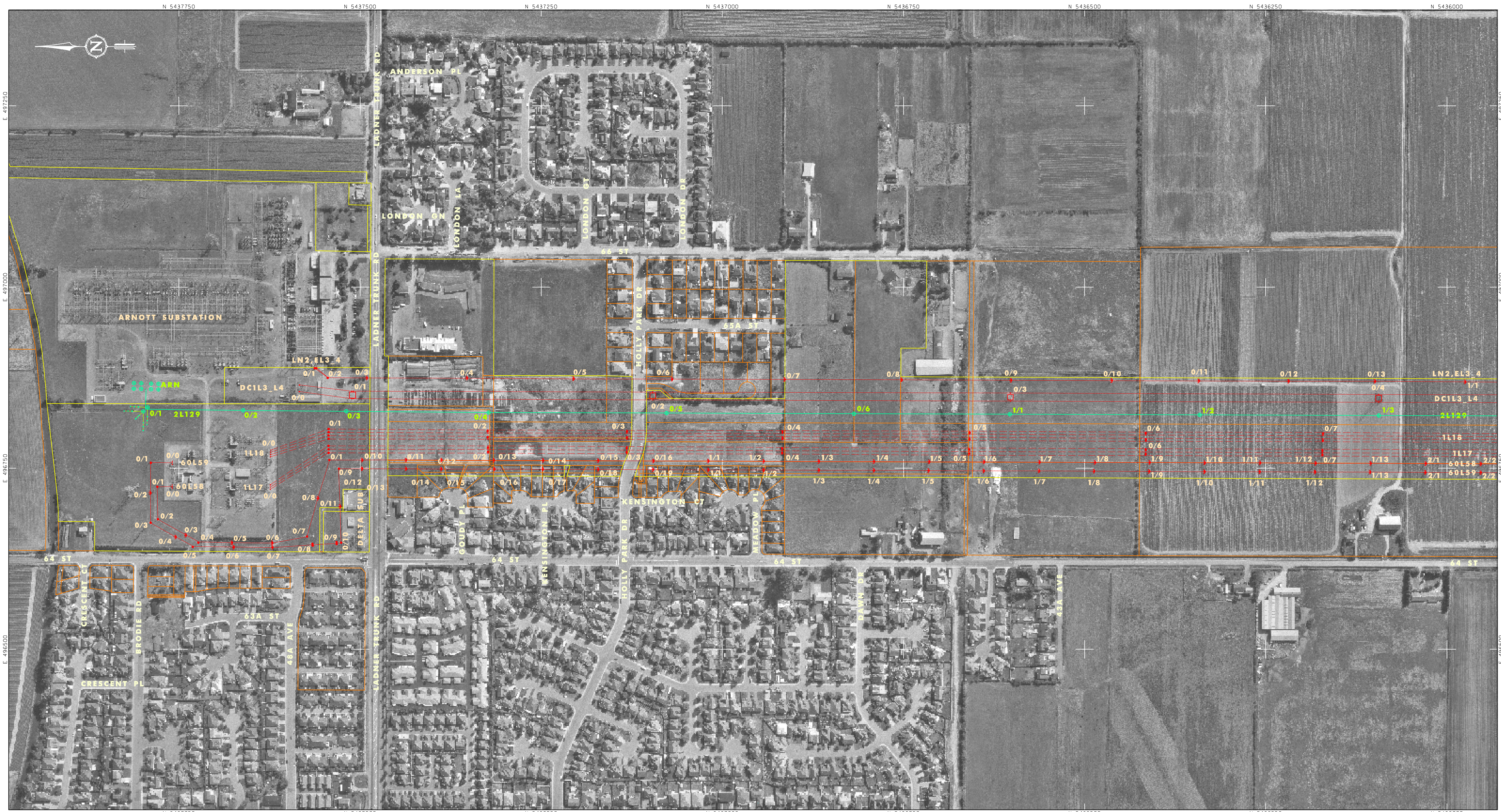
Pursuant to County Code, Whatcom County conducts special reviews of projects or developments that, because of their magnitude and impact, will tend to affect the public at large. A Major Project Permit is required for projects that meet certain criteria of cost, size, and potential environmental impact. A Major Project Permit may be required for this Project if the County determines that an Environmental Impact Statement (EIS) is required.

Table 6-5. Summary of Local Permits and Approvals

Statutory Authority	**Agency**	**Permits, Approvals, and Authorizations Applicable to the Project**
State Shoreline Management Act Chapter 90.58	Whatcom County/Ecology	*Shoreline Substantial Development Permit* (includes compliance with Critical Areas Ordinance)
Whatcom County Code Chapter 20.88	Whatcom County	*Major Project Permit*

Appendix A

Orthophotos of VITR Project Route



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

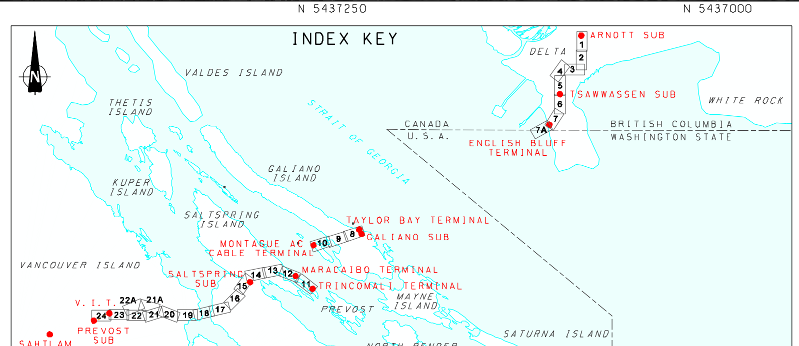
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER — 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



Metres 100 0 100 200

CADASTRAL NOTE:

THE DELTA AREA CADASTRE WAS ACQUIRED FROM THE CORPORATION OF DELTA.

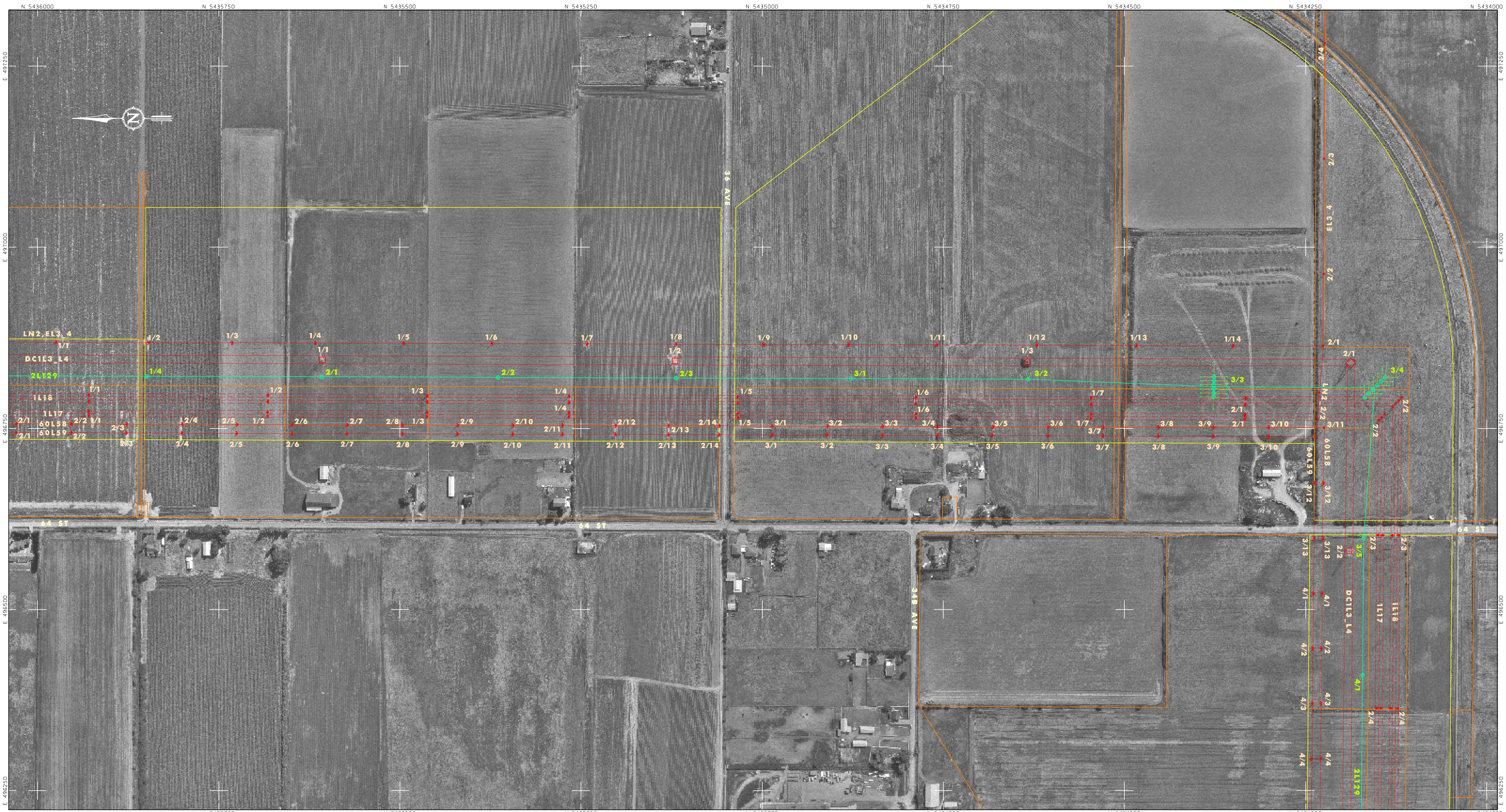
THE GULF ISLANDS CADASTRE WAS COMPUTED BY BCH SURVEY AND PHOTOGRAMMETRY SERVICES DEPARTMENT.

THE VANCOUVER ISLAND CADASTRE WAS ACQUIRED FROM THE COWICHAN VALLEY REGIONAL DISTRICT.

British Columbia Transmission Corporation™

BChydro ENGINEERING
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
PREPARED BY: GJB	PHOTO DATE: AUG 24, 1999	
DATE: JUN 28, 2005	PHOTO SCALE: 1:10,000	
GRID ORIGIN: UTM Z10/NAD83	DATUM: GEODETIC	SHEET 01 OF 24
N.T.S.: 92 B / G	DWG. SCALE: AS SHOWN	CONTOUR INT. / DWG. No. REDUCED 2L129 -T07- D1 / R. C



LEGEND

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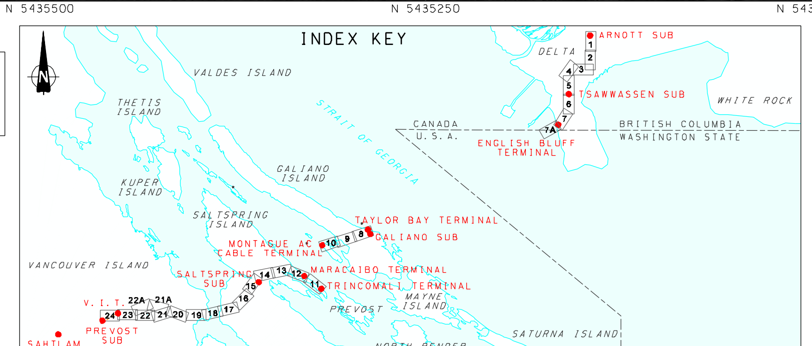

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ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT SHEET 02 OF 24
PREPARED BY: GJB	PHOTO DATE: AUG 24, 1999	
DATE: JUN 28, 2005	PHOTO SCALE: 1:10,000	
GRID ORIGIN: UTM Z10/NAD83	DATUM: GEODETIC	
N.T.S.: 92 B / G	DWG. SCALE: AS SHOWN	CONTOUR INT. — DWG. No.: REDUCED 2L129 -T07- D1 — R.: C

LEGEND

EXISTING TRANSMISSION CIRCUIT	
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HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
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MANHOLE	

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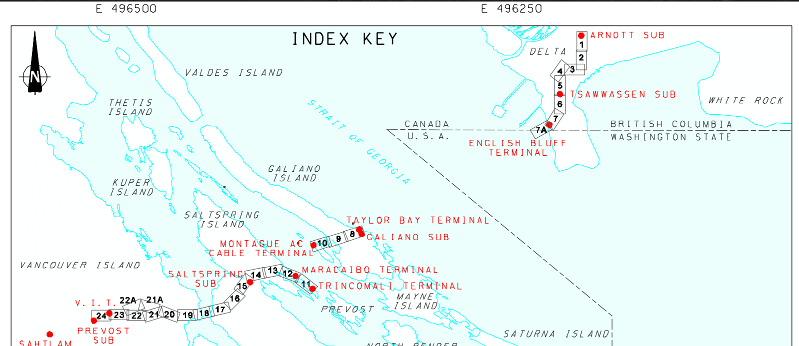
BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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British Columbia Transmission Corporation™

BC hydro ENGINEERING

SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.
PREPARED BY GJB	PHOTO DATE AUG 24, 1999
DATE JUN 28, 2005	PHOTO SCALE 1:10,000
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC
N.T.S. 92 B / G	DWG. SCALE AS SHOWN

Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

SHEET 03 OF 24

CONTOUR INT.	DWG. No. REDUCED 2L129 -T07- D1	R. C

LEGEND

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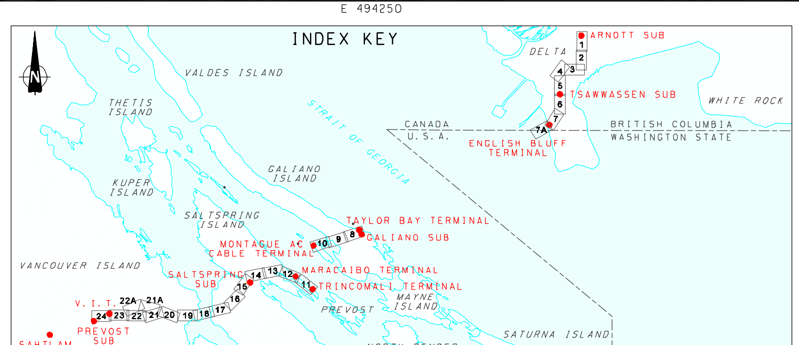

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DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
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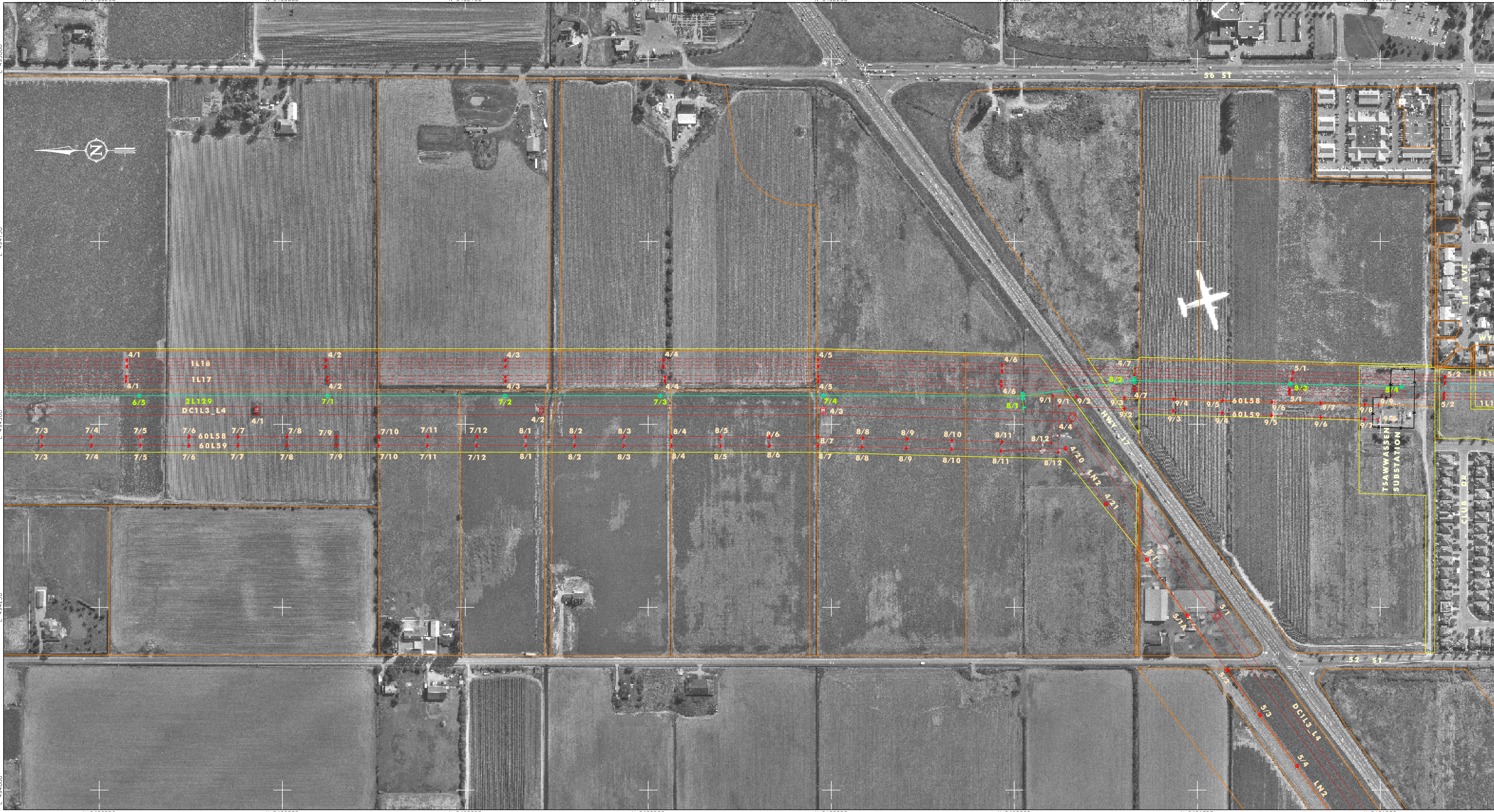

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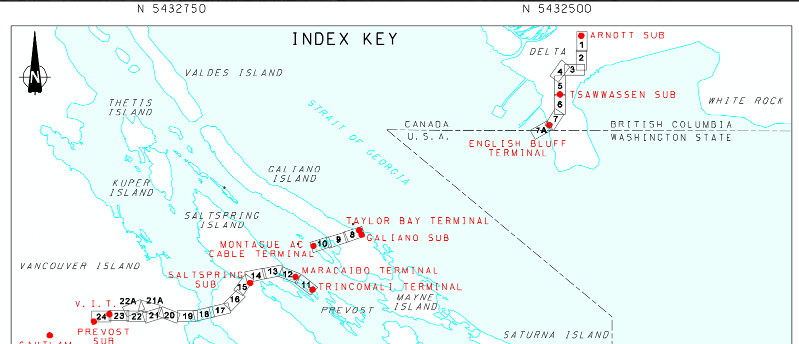
PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



Metres 100 0 100 200

CADASTRAL NOTE:

THE DELTA AREA CADASTRE WAS ACQUIRED FROM THE CORPORATION OF DELTA.

THE GULF ISLANDS CADASTRE WAS COMPUTED BY BCH SURVEY AND PHOTOGRAMMETRY SERVICES DEPARTMENT.

THE VANCOUVER ISLAND CADASTRE WAS ACQUIRED FROM THE COWICHAN VALLEY REGIONAL DISTRICT.

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SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 05 OF 24
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT.
		DWG. No. REDUCED 2L129 -T07- D1
		R. C

LEGEND

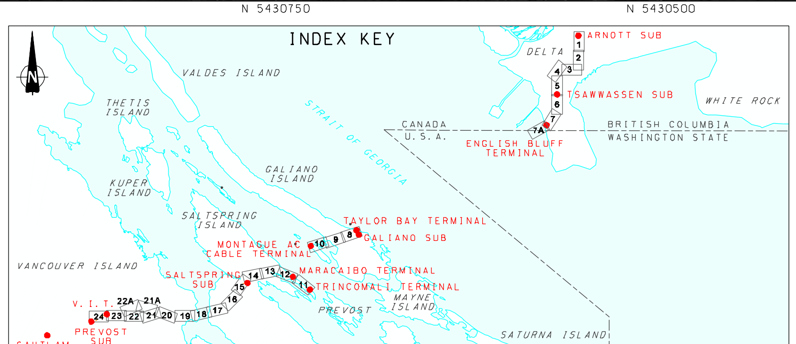
EXISTING TRANSMISSION CIRCUIT	
STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT	
STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES	
DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY



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SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
PREPARED BY: GJB	PHOTO DATE: AUG 24, 1999	
DATE: JUN 28, 2005	PHOTO SCALE: 1:10,000	
GRID ORIGIN: UTM Z10/NAD83	DATUM: GEODETIC	SHEET 06 OF 24
N.T.S.: 92 B / G	DWG. SCALE: AS SHOWN	CONTOUR INT. | DWG. No.: REDUCED 2L129 -T07- D1 | R.: C

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

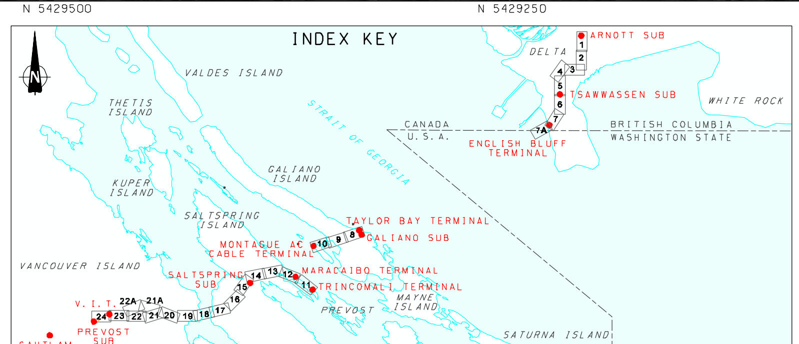
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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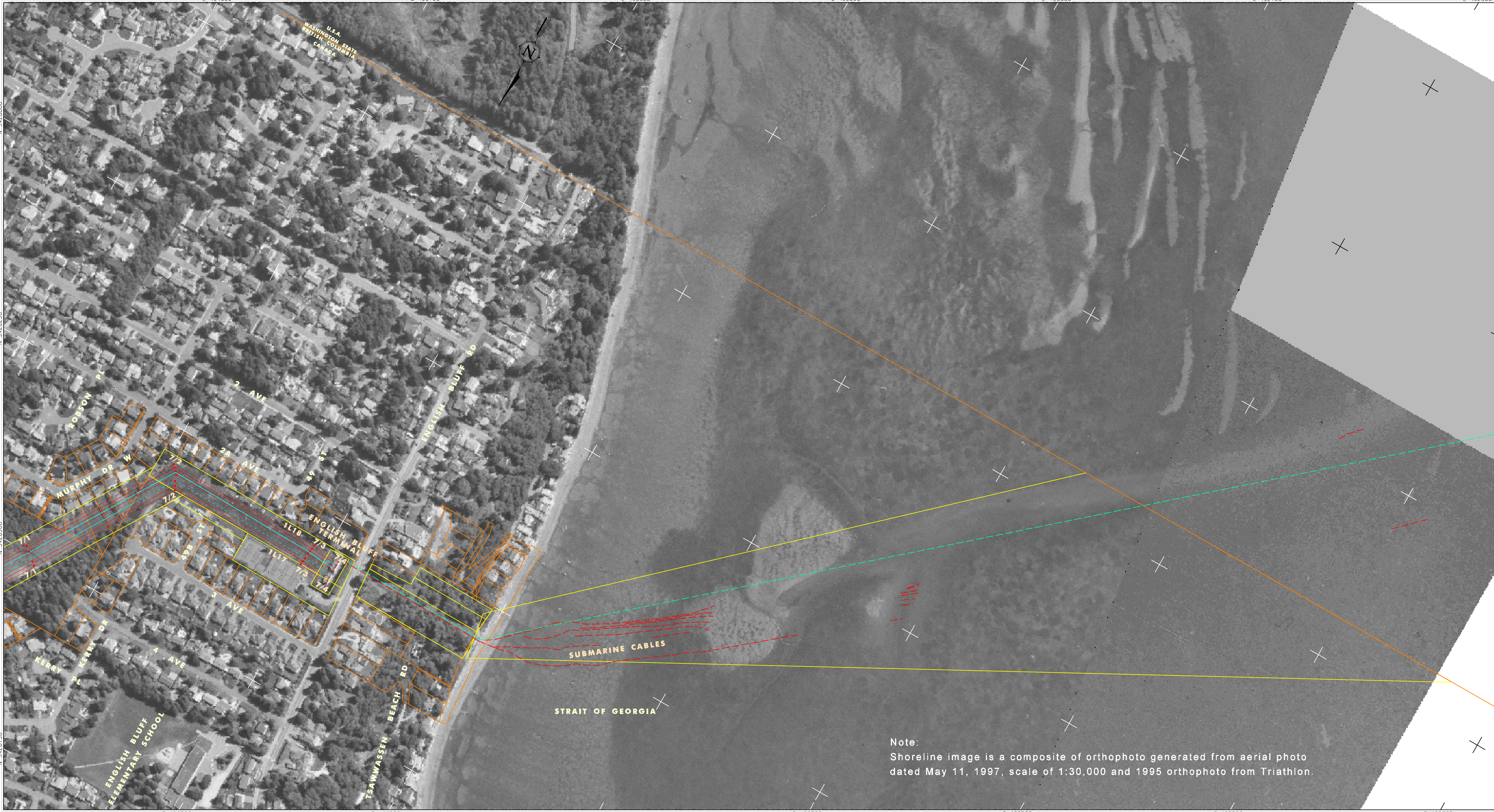
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.
PREPARED BY GJB	PHOTO DATE AUG 24, 1999
DATE JUN 28, 2005	PHOTO SCALE 1:10,000
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC
N.T.S. 92 B / G	DWG. SCALE AS SHOWN

Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

SHEET 07 OF 24

CONTOUR INT.	DWG. No.	R.
	REDUCED 2L129 -T07- D1	D



LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

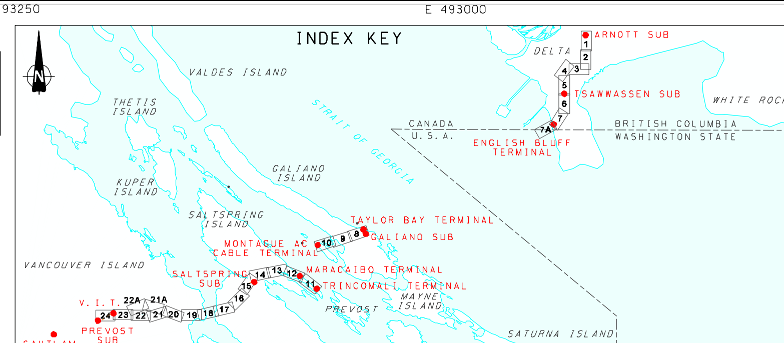
- STRUCTURES, ANCHOR AND GUY LINE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES
- REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

- DUCTBANK (STAGE 1)
- DUCTBANK (STAGE 2)
- MANHOLE

- CADASTRAL BOUNDARY
- BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



Metres 100 0 100 200

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British Columbia Transmission Corporation™

BC hydro ENGINEERING
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.
PREPARED BY GJB	PHOTO DATE AUG 24, 1999
DATE JUN 28, 2005	PHOTO SCALE 1: 10,000
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC
N.T.S. 92 B / G	DWG. SCALE AS SHOWN

Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

SHEET 7A OF 24

CONTOUR INT.	DWG. No.	R.
	REDUCED 2L129 -T07- D1	B

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

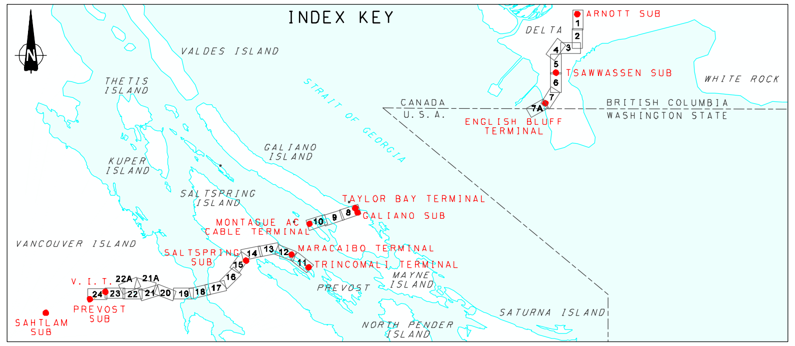
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



Metres 100 0 100 200

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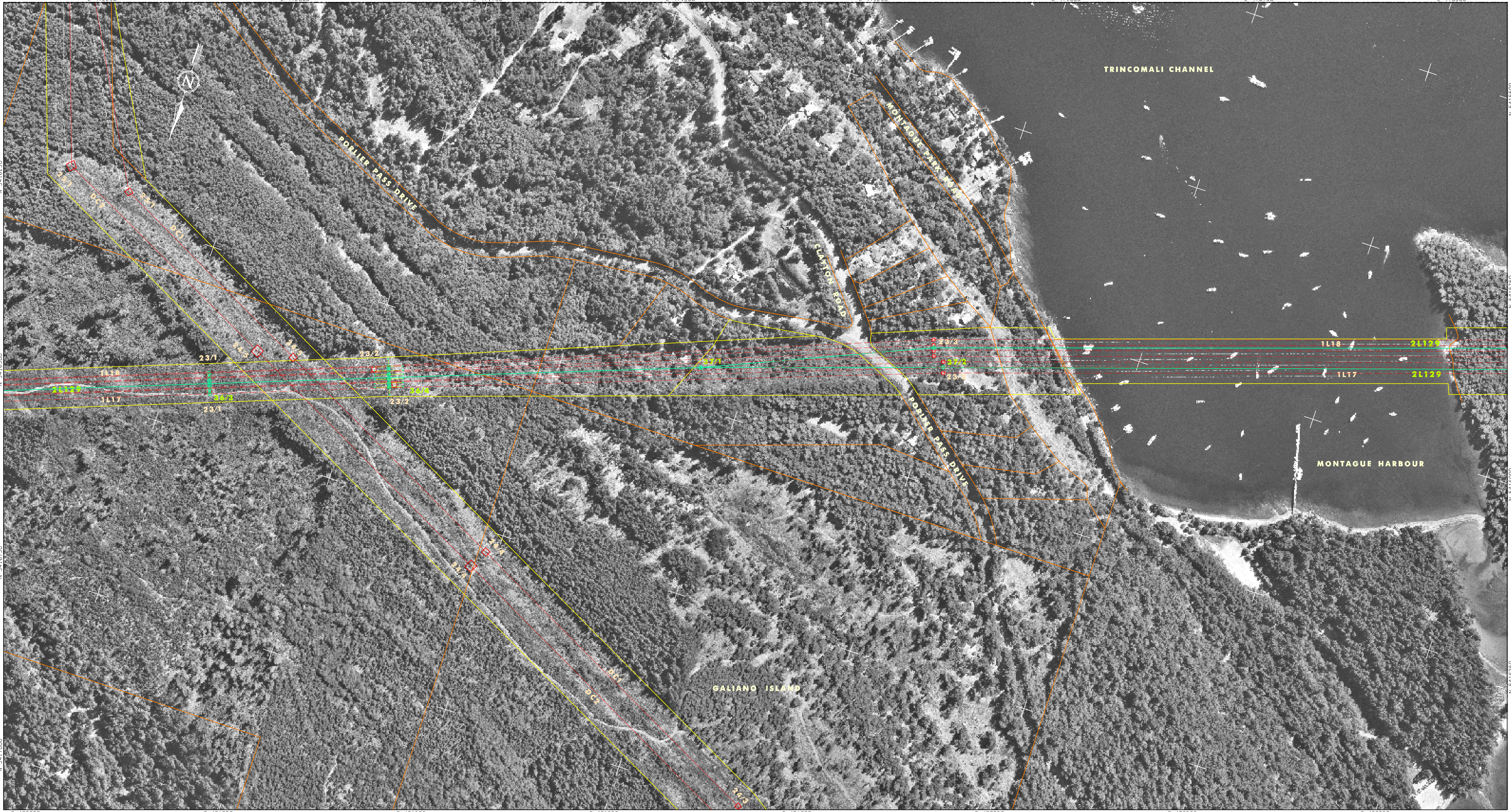
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 08 OF 24
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. / DWG. No. REDUCED 2L129 -T07- D1 / R. C



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

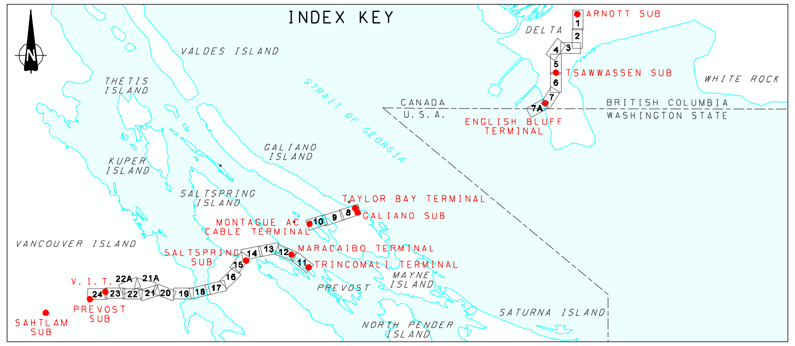
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER — 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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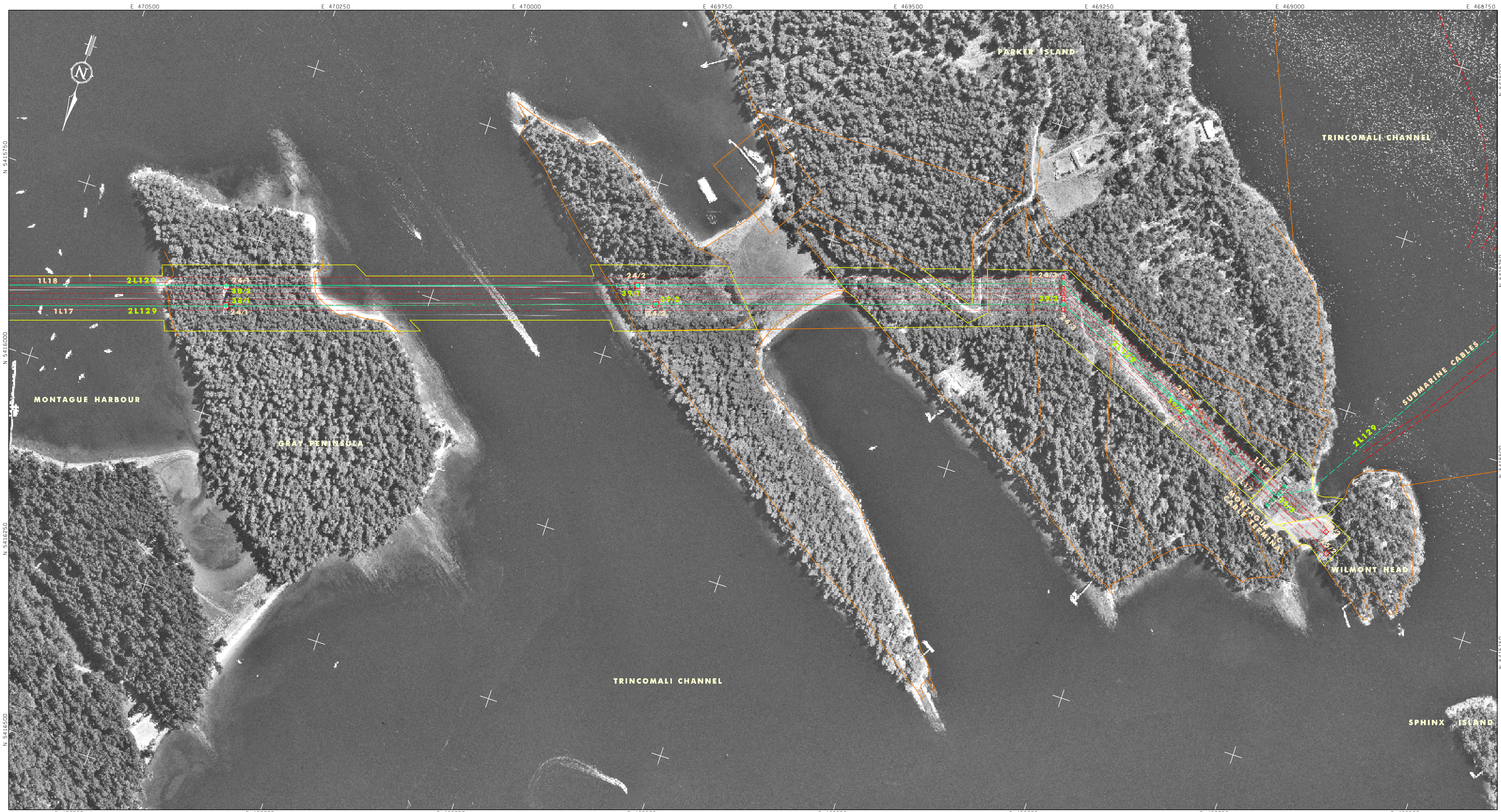
BC hydro — ENGINEERING
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 09 OF 24
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. / DWG. No. REDUCED 2L129 -T07- D1 / R. D



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

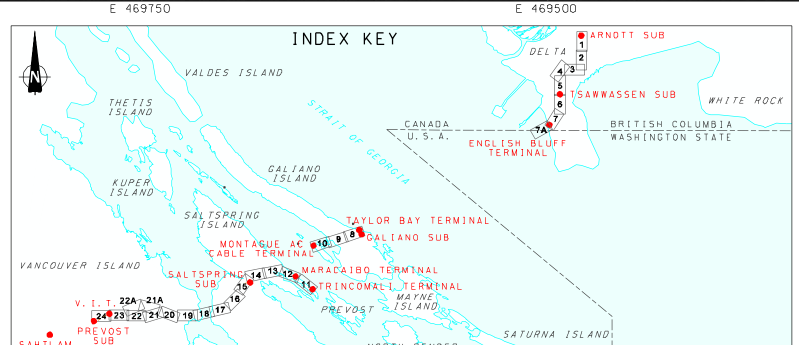
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY

BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY



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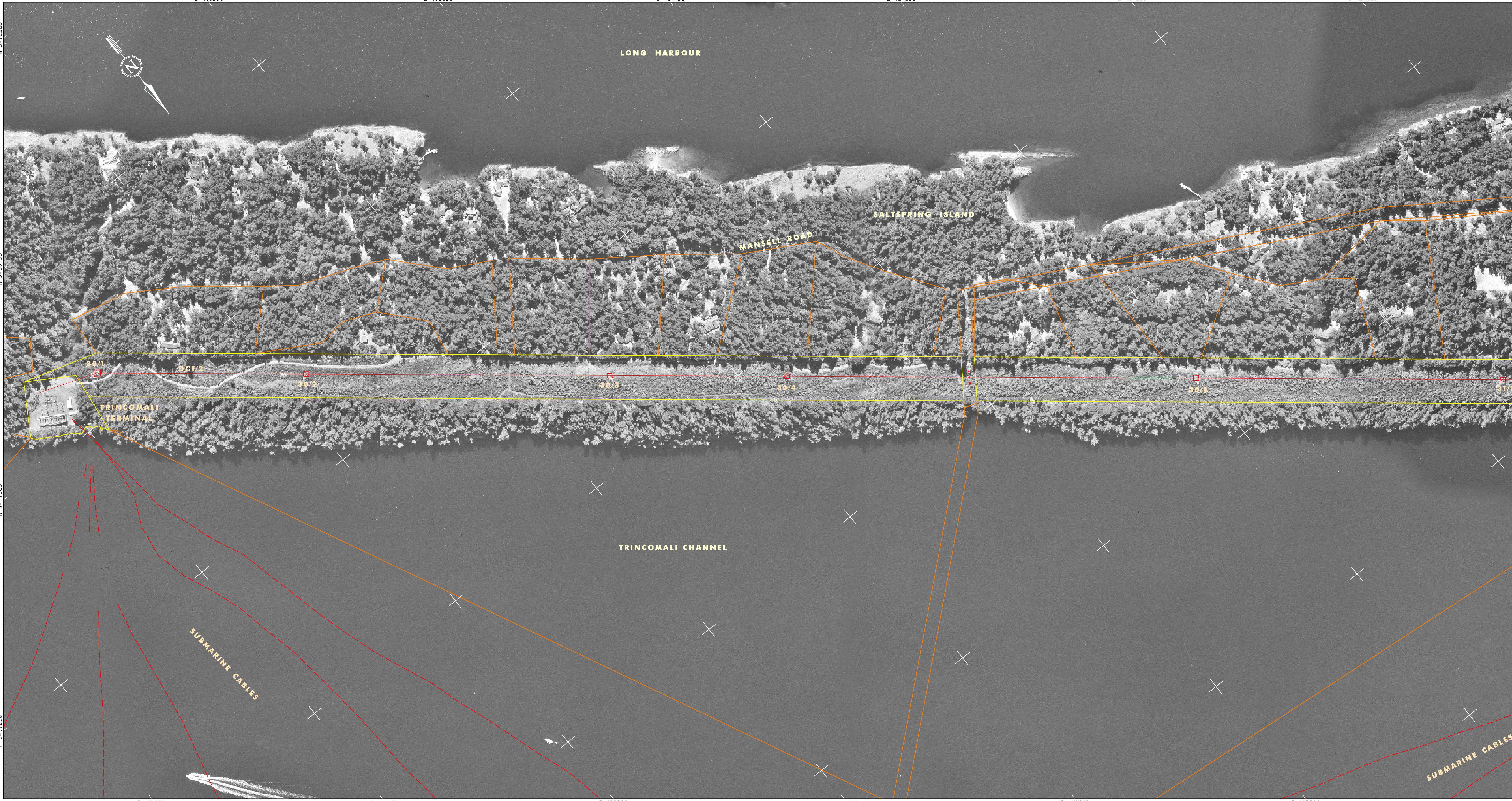
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	SHEET 10 OF 24
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. — DWG. No. REDUCED 2L129 -T07- D1 — R. D



LEGEND

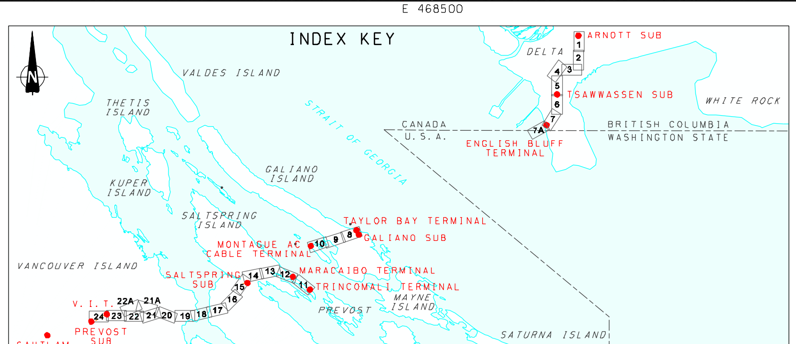
EXISTING TRANSMISSION CIRCUIT	
STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT	
STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES	
DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY



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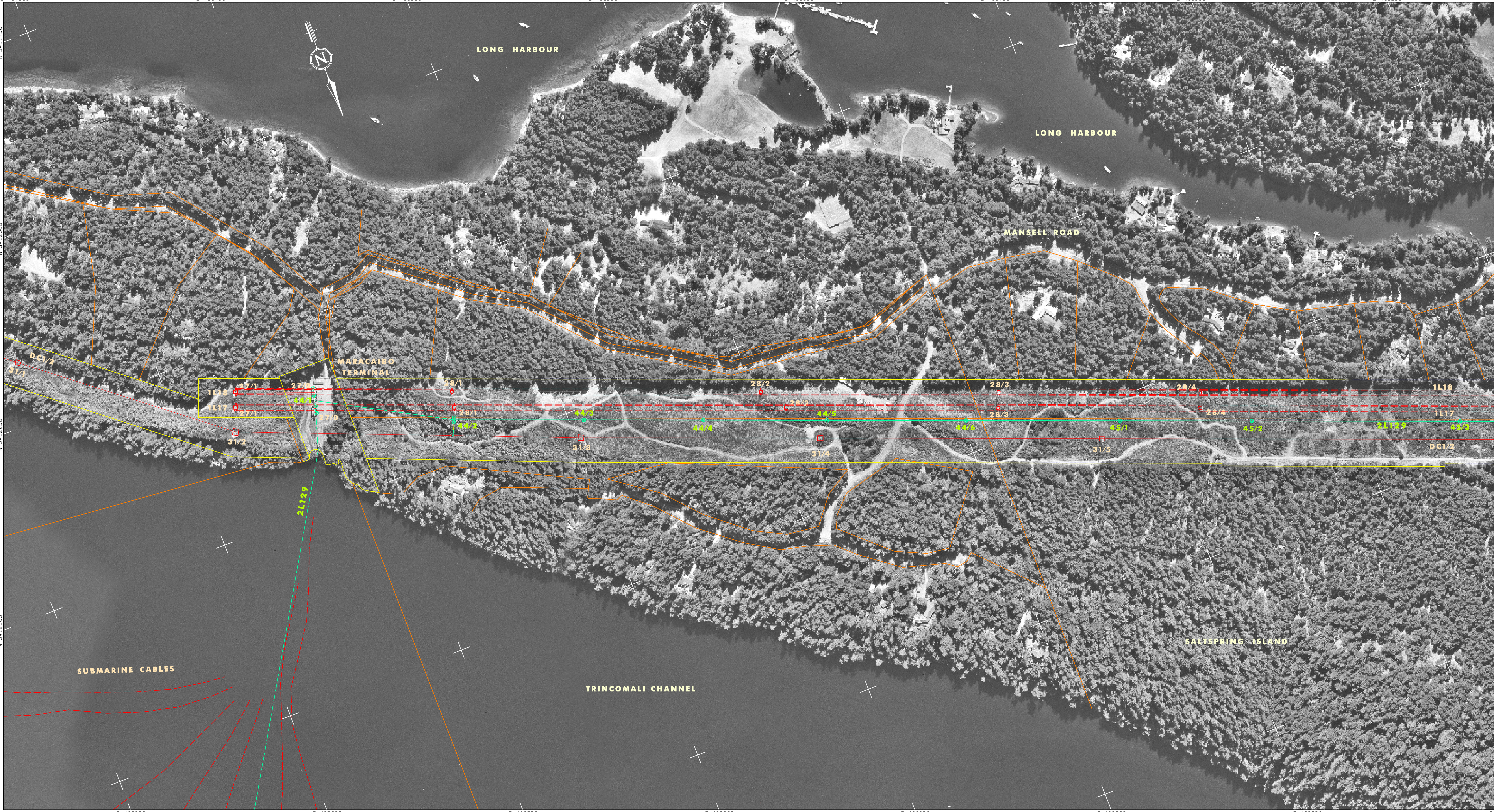
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.
PREPARED BY GJB	PHOTO DATE AUG 24, 1999
DATE JUN 28, 2005	PHOTO SCALE 1:10,000
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC
N.T.S. 92 B / G	DWG. SCALE AS SHOWN

Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

SHEET 11 OF 24

CONTOUR INT.	DWG. No.	R.
	REDUCED 2L129 -T07- D1	C



LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER . . . 2/3
- CONDUCTOR LINES

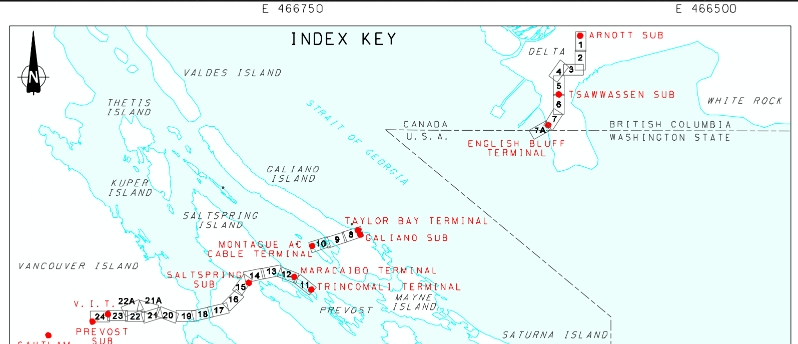
PROPOSED 2L129 CIRCUIT

- STRUCTURES, ANCHOR AND GUY LINE
- STRUCTURE NUMBER . . . 2/3
- CONDUCTOR LINES
- REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

- DUCTBANK (STAGE 1)
- DUCTBANK (STAGE 2)
- MANHOLE

- CADASTRAL BOUNDARY
- BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY



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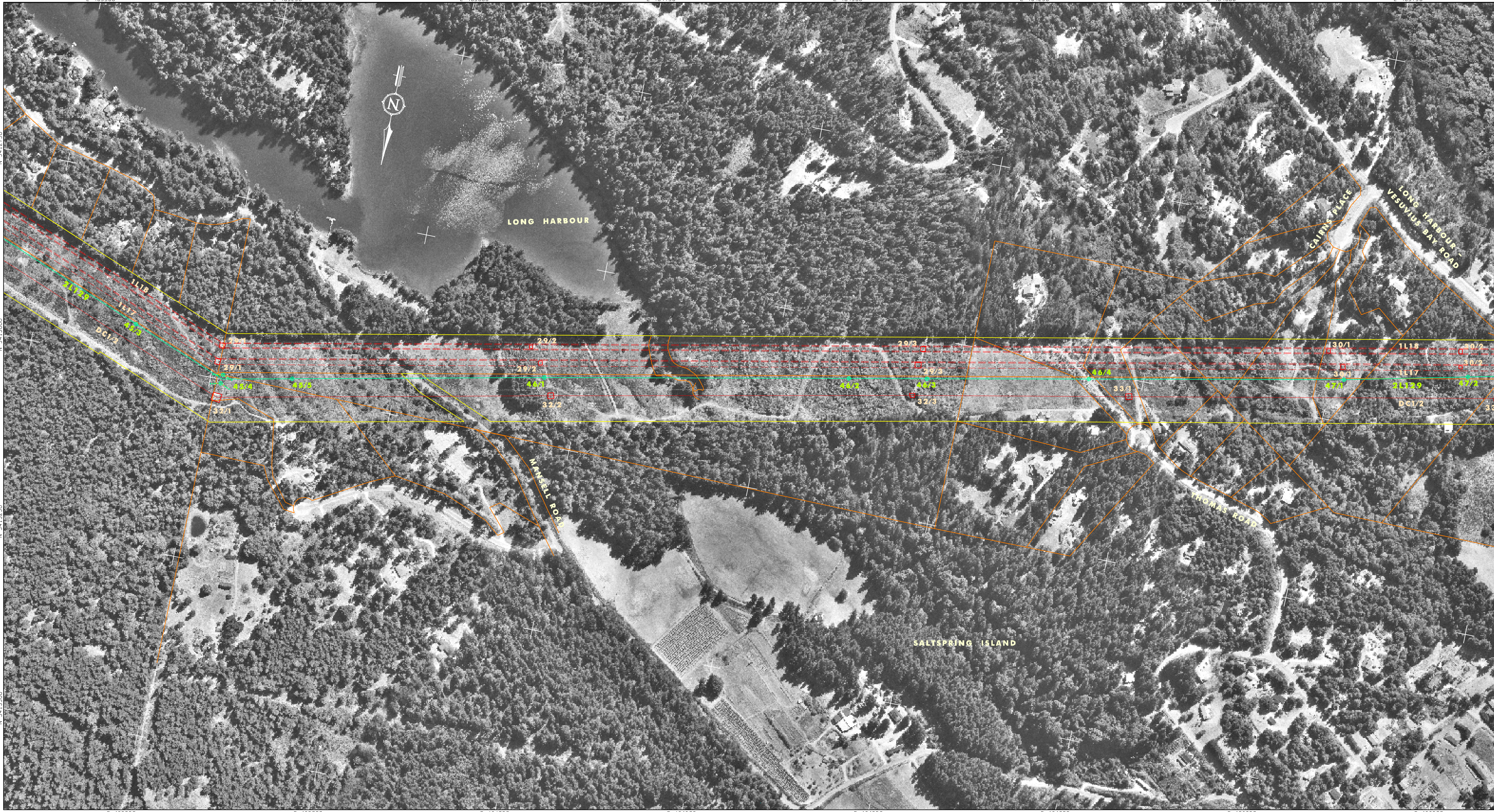
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

ORTHOPHOTO	PROJECT No.	
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT SHEET 12 OF 24
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. | DWG. No. REDUCED 2L129 -T07- D1 | R. C



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

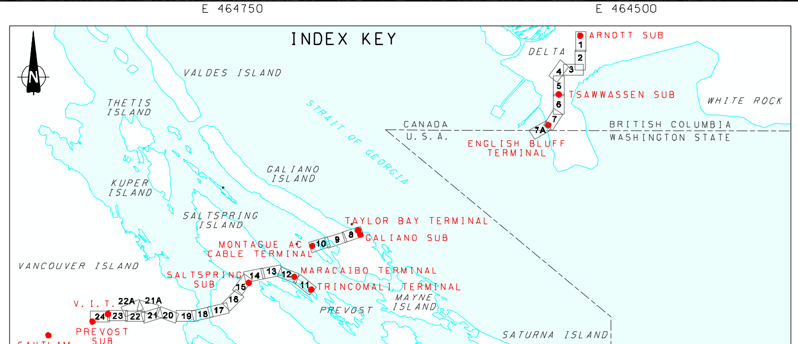
STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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ORTHOPHOTO	PROJECT No.	
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 13 OF 24
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. / DWG. No. REDUCED 2L129 -T07- D1 / R. D

LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES

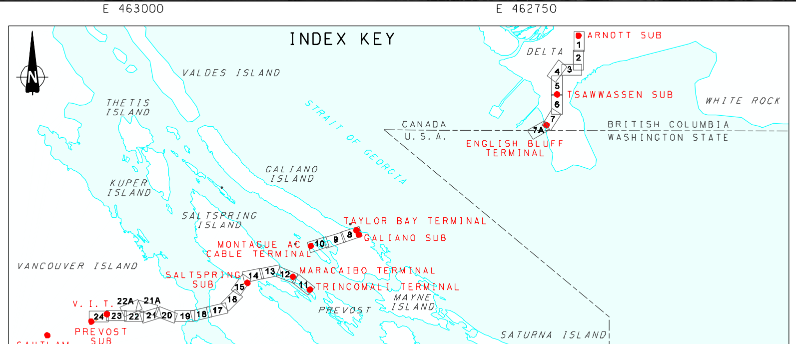
PROPOSED 2L129 CIRCUIT

- STRUCTURES, ANCHOR AND GUY LINE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES
- REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

- DUCTBANK (STAGE 1)
- DUCTBANK (STAGE 2)
- MANHOLE

- CADASTRAL BOUNDARY
- BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY



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British Columbia Transmission Corporation

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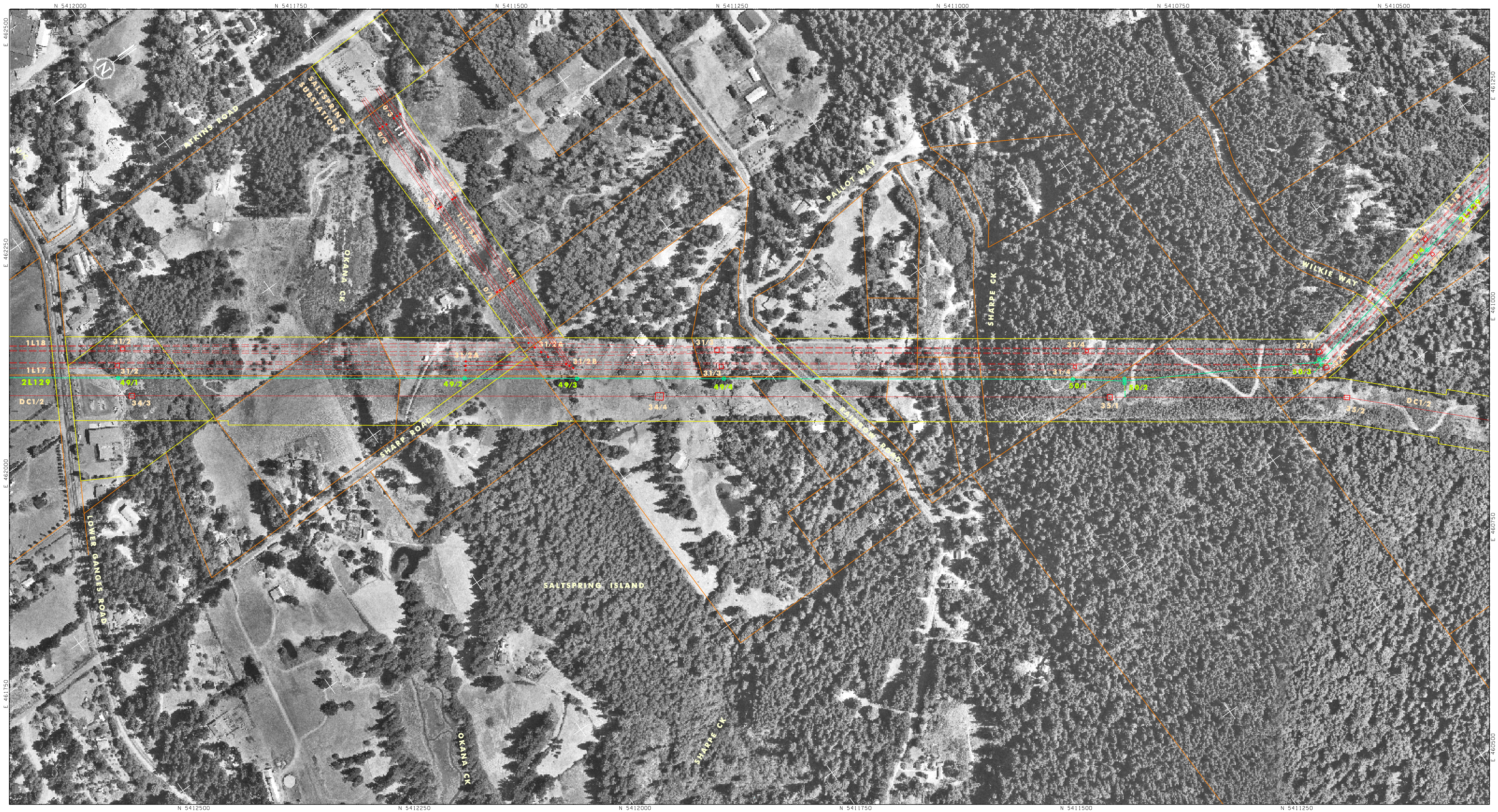
SURVEY & PHOTOGRAMMETRY SERVICES DEPARTMENT

Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

ORTHOPHOTO	PROJECT No.	
PREPARED BY: GJB	PHOTO DATE: AUG 24, 1999	
DATE: JUN 28, 2005	PHOTO SCALE: 1:10,000	
GRID ORIGIN: UTM Z10/NAD83	DATUM: GEODETIC	SHEET 14 OF 24
N.T.S.: 92 B / G	DWG. SCALE: AS SHOWN	CONTOUR INT. — DWG. No. REDUCED 2L129 -T07- D1 — R. D



LEGEND

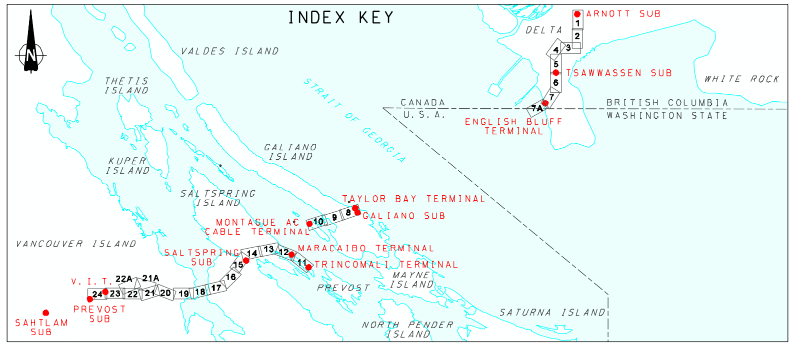
EXISTING TRANSMISSION CIRCUIT	
STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT	
STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES	
DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY



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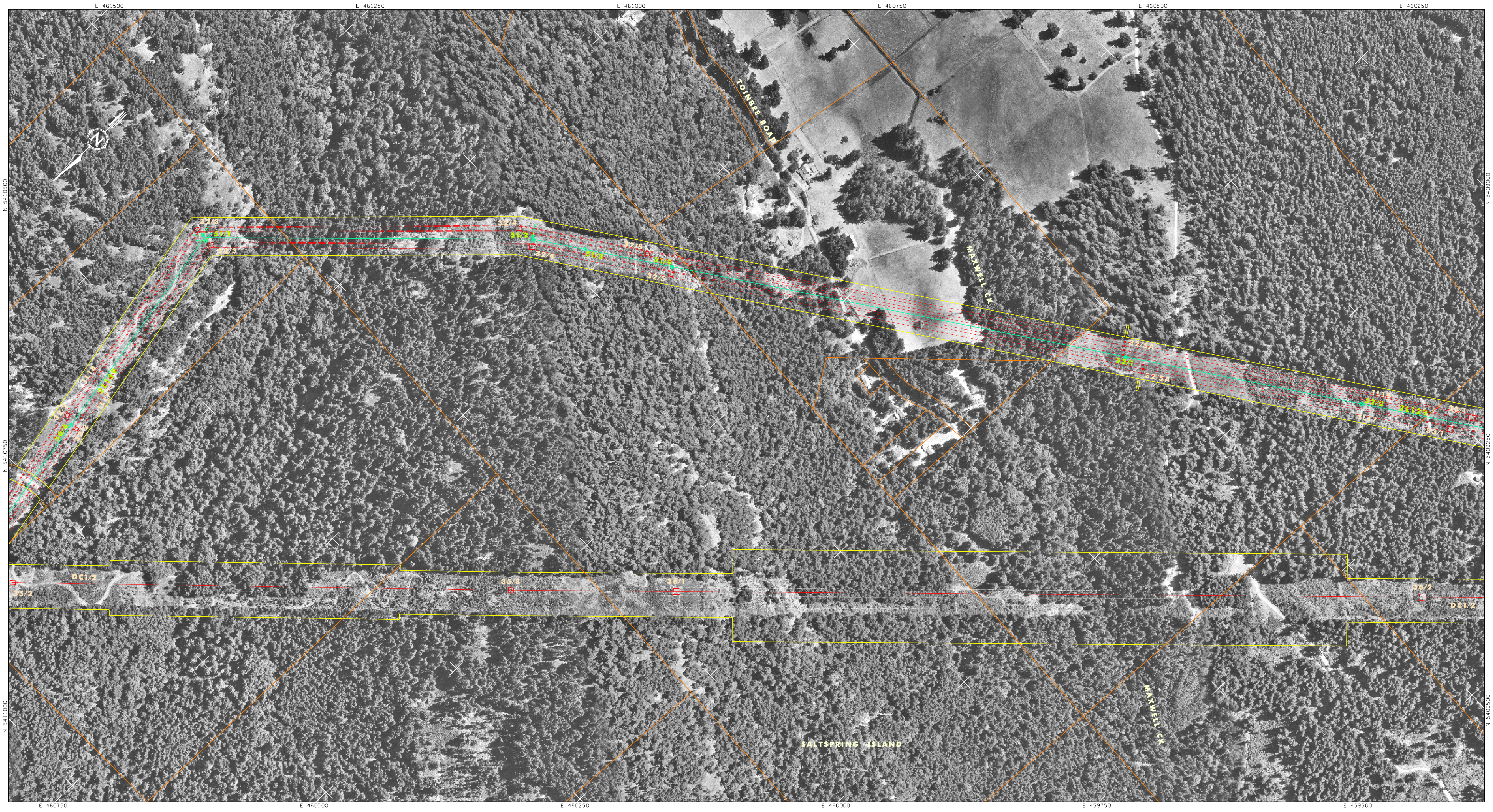
ORTHOPHOTO	PROJECT No.	Vancouver Island Transmission Reinforcement Project Replacement & Upgrading of 138 kV System Arnott to VIT
PREPARED BY GJB	PHOTO DATE AUG 24, 1999	
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 15 OF 24
N.T.S. 92 B / G	DWG. SCALE AS SHOWN	CONTOUR INT. / DWG. No. REDUCED 2L129 -T07- D1 / R. D



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)

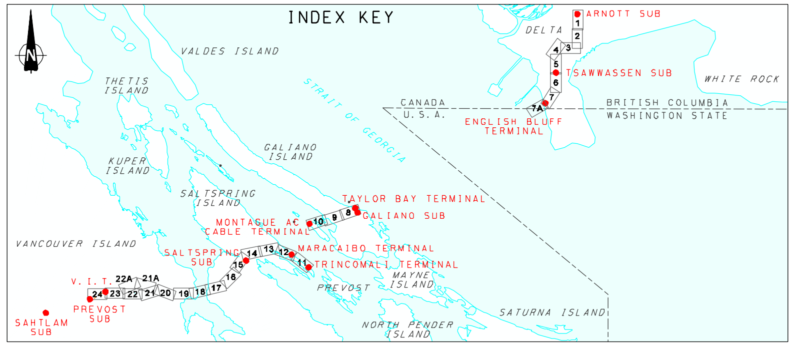
DUCTBANK (STAGE 2)

MANHOLE

CADASTRAL BOUNDARY

BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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CADASTRAL NOTE:

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DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC	SHEET 16 OF 24
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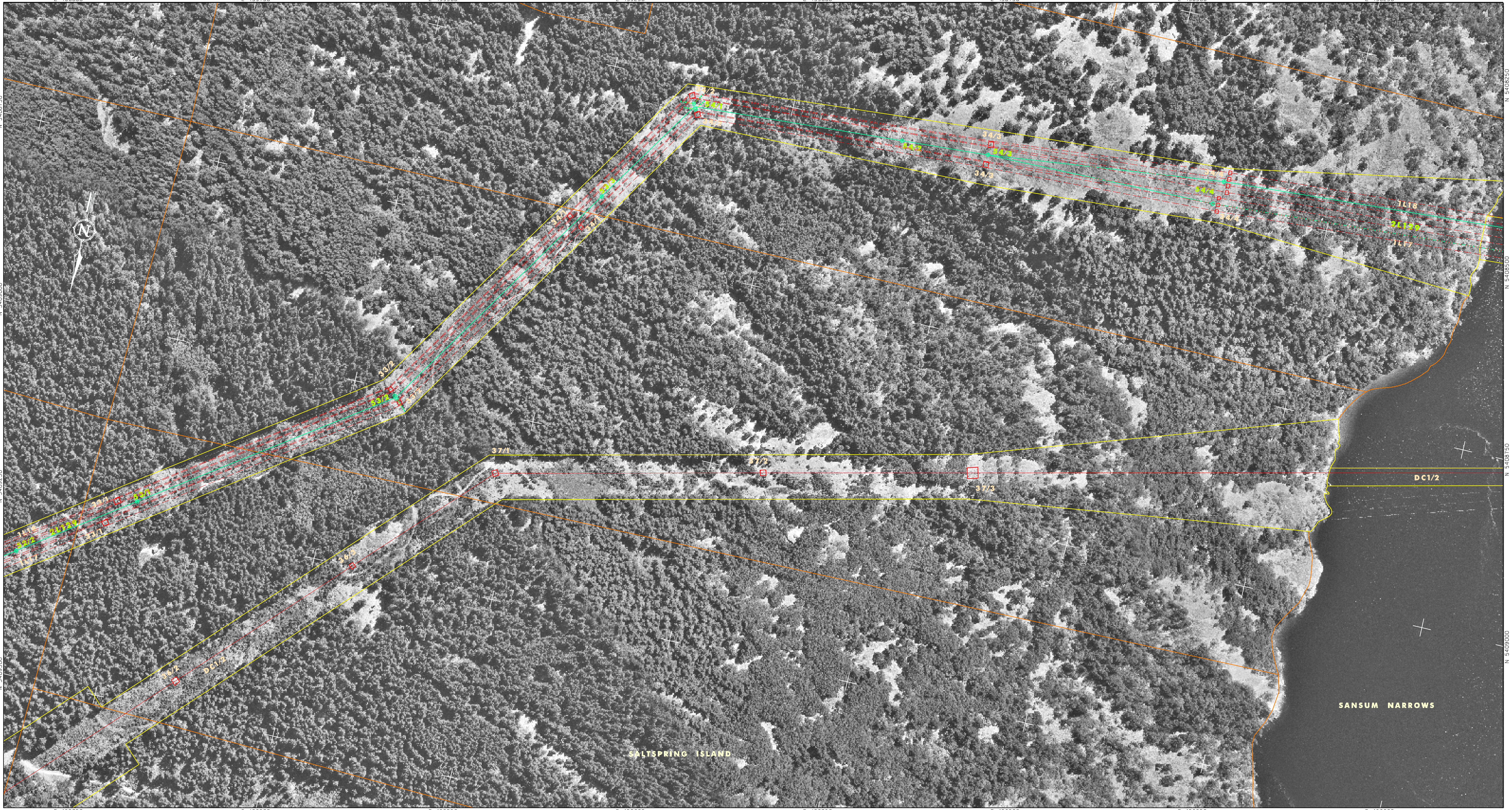


LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

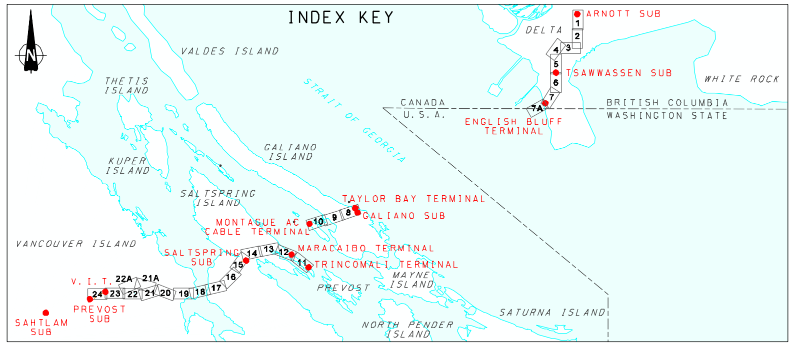
PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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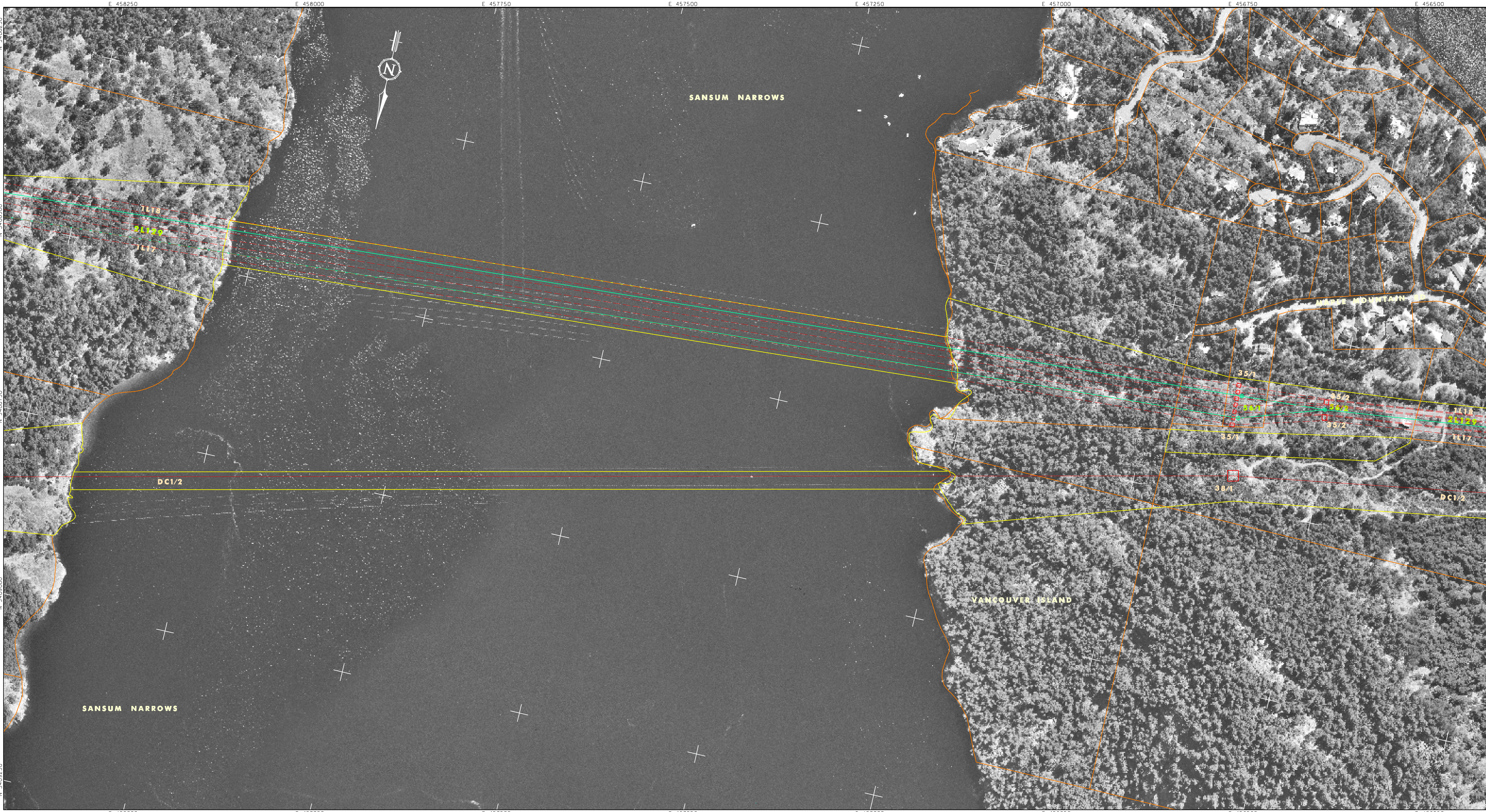

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EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
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CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

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BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

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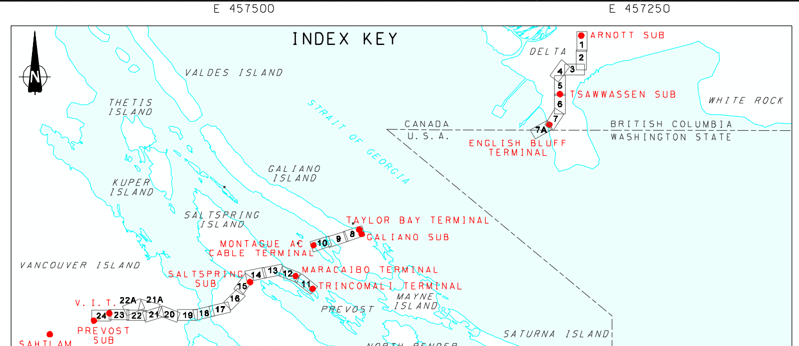

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GRID ORIGIN UTM Z10/NAD83	DATUM GEODETIC
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Replacement & Upgrading of 138 kV System
Arnott to VIT

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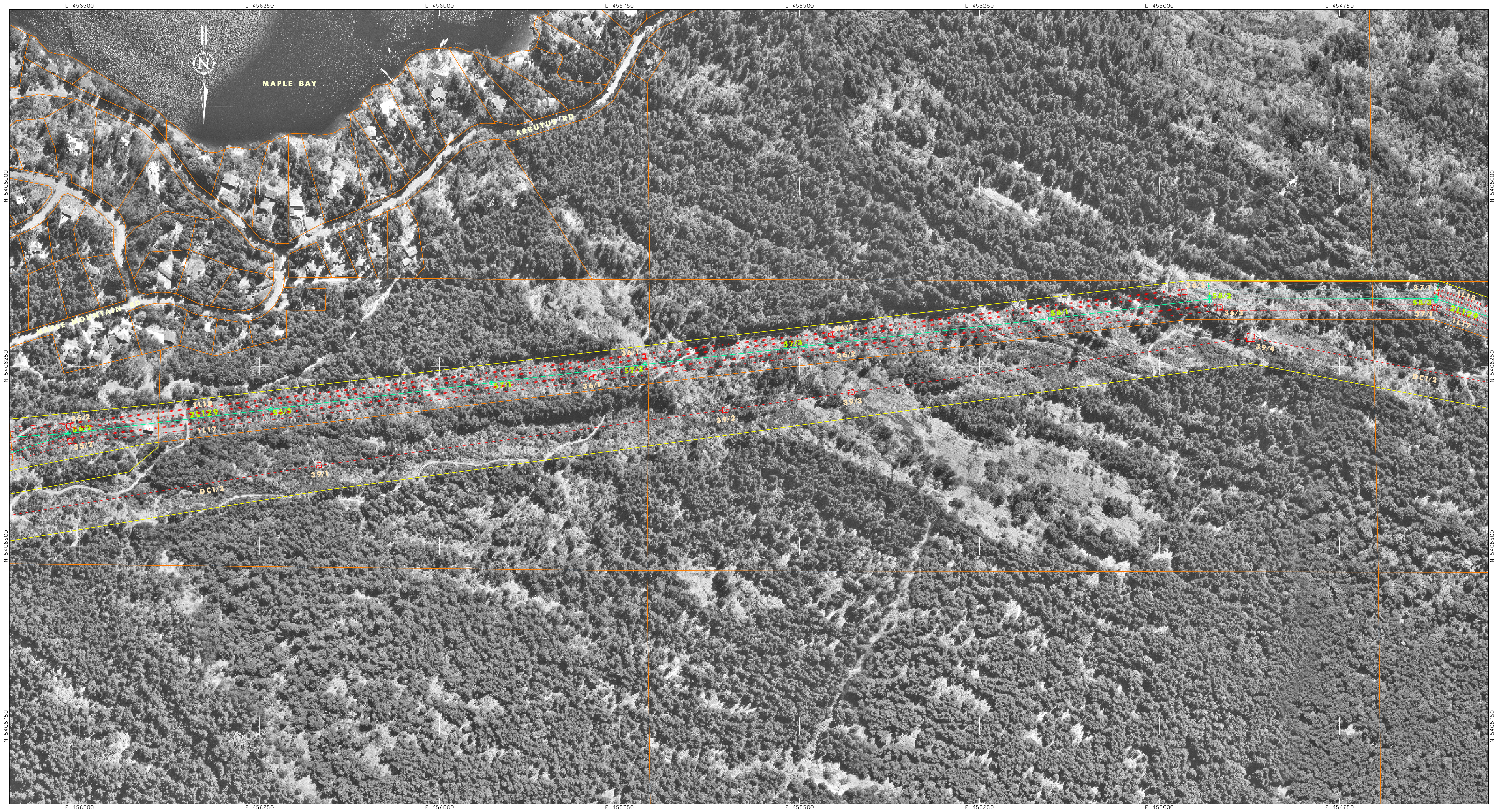

LEGEND

EXISTING TRANSMISSION CIRCUIT	
STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT	
STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
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REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES	
DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

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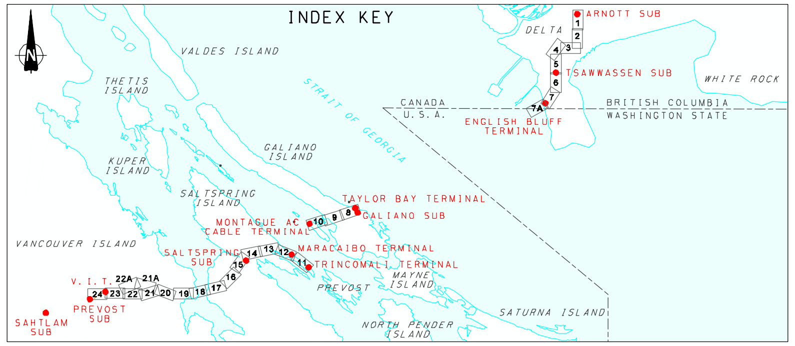

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PREPARED BY GJB	PHOTO DATE AUG 24, 1999	
DATE JUN 28, 2005	PHOTO SCALE 1:10,000	
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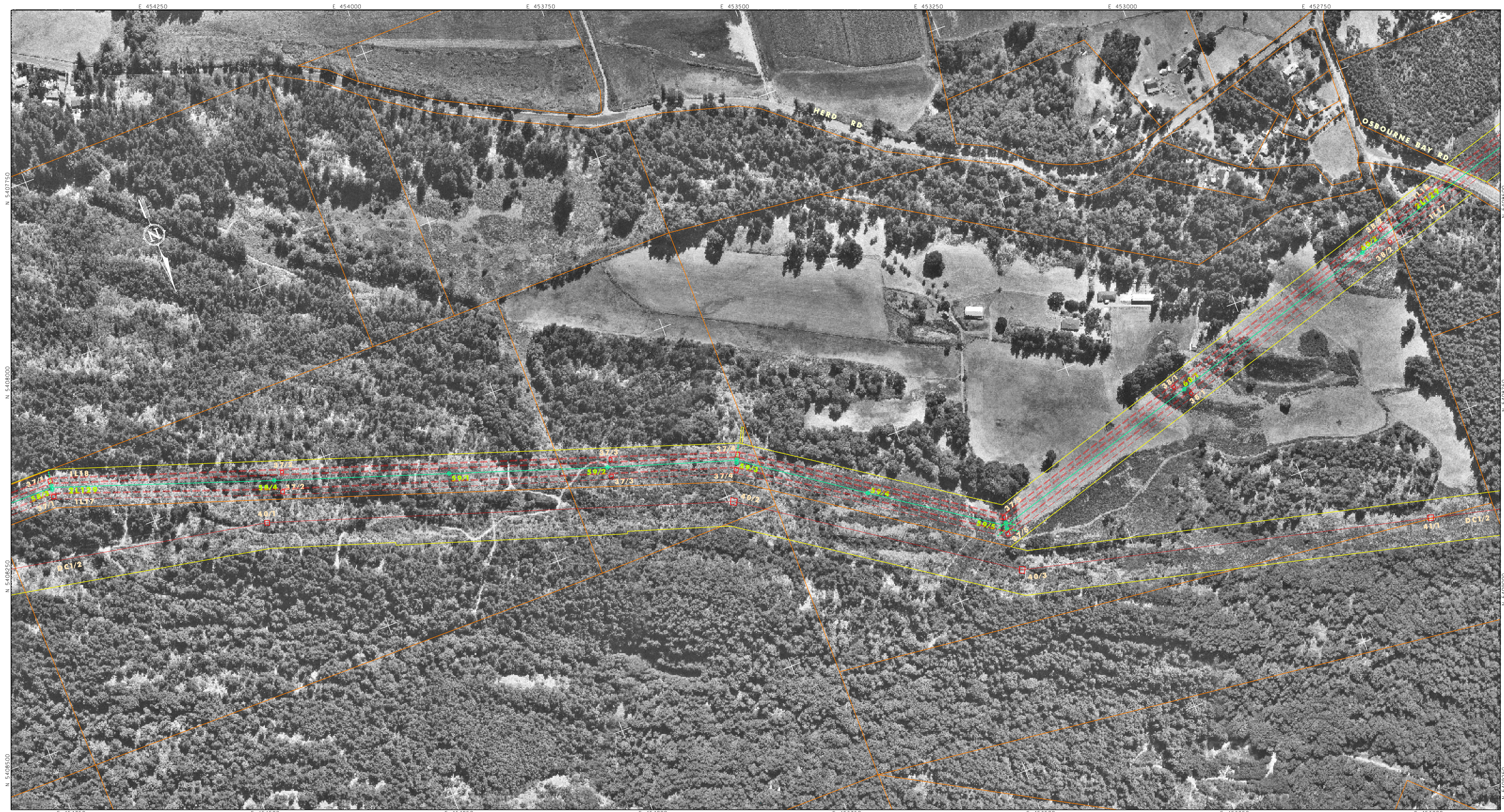
DWG. No. REDUCED 2L129 -T07- D1	R. C	



LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

- STRUCTURES, ANCHOR AND GUY LINE
- STRUCTURE NUMBER 2/3
- CONDUCTOR LINES
- REMOVAL OF EXISTING CIRCUITS

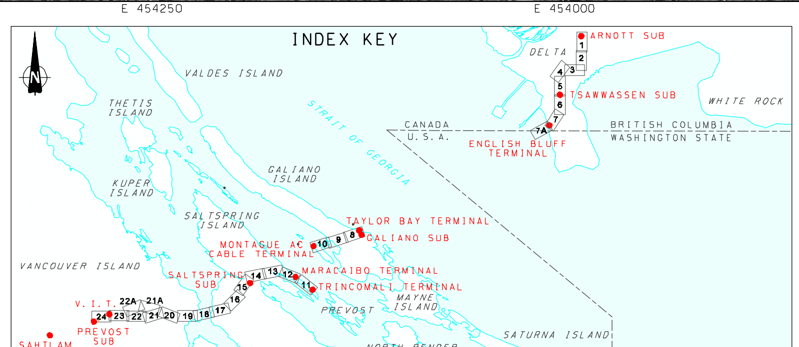
PROPOSED 230kV UNDERGROUND FACILITIES

- DUCTBANK (STAGE 1)
- DUCTBANK (STAGE 2)
- MANHOLE

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

INDEX KEY



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DATE: JUN 28, 2005	PHOTO SCALE: 1:10,000	
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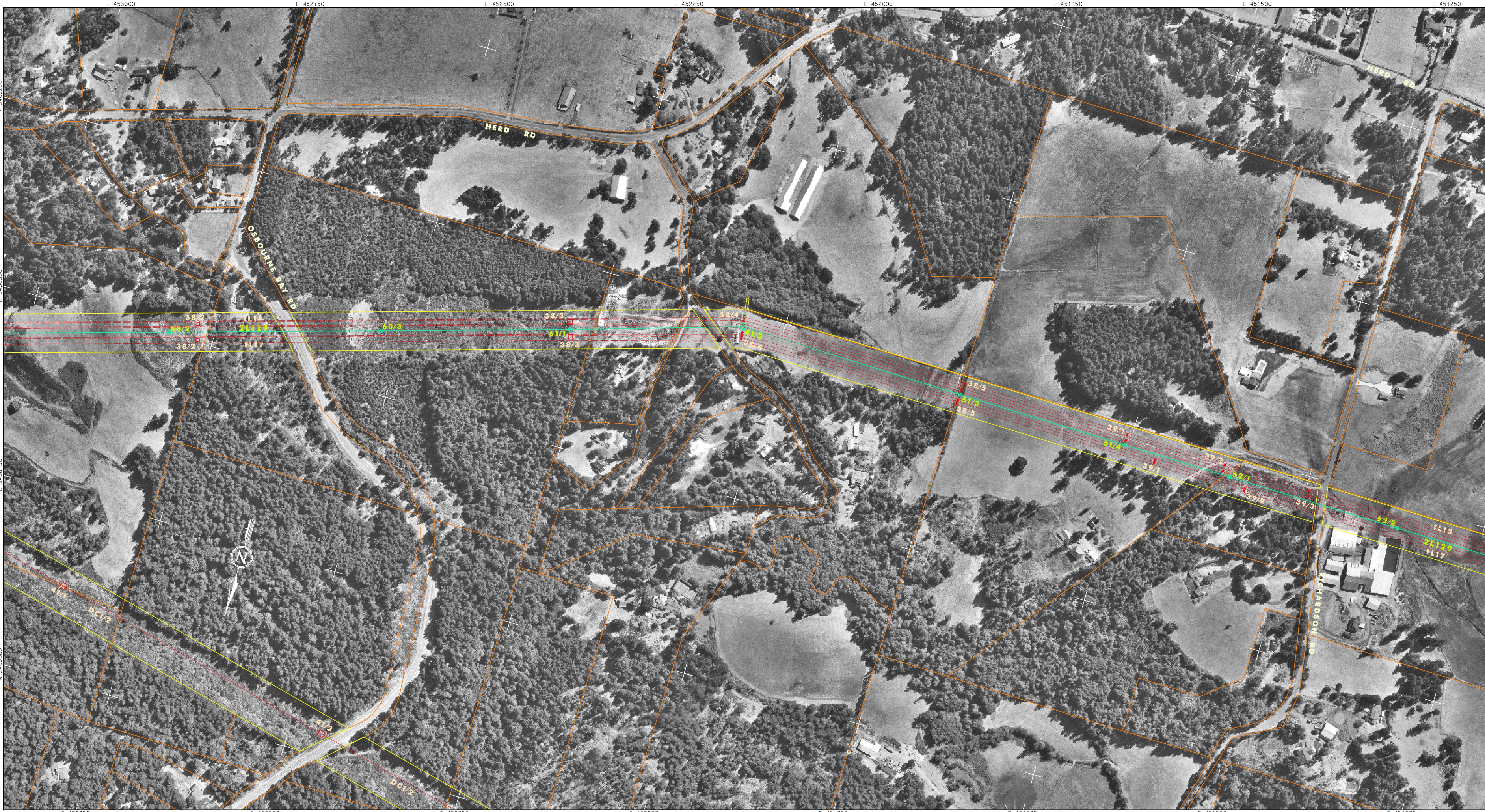

LEGEND

EXISTING TRANSMISSION CIRCUIT	
STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM	
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	
HORIZONTAL INSULATOR POLE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	

PROPOSED 2L129 CIRCUIT	
STRUCTURES, ANCHOR AND GUY LINE	
STRUCTURE NUMBER	2/3
CONDUCTOR LINES	
REMOVAL OF EXISTING CIRCUITS	

PROPOSED 230kV UNDERGROUND FACILITIES	
DUCTBANK (STAGE 1)	
DUCTBANK (STAGE 2)	
MANHOLE	

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

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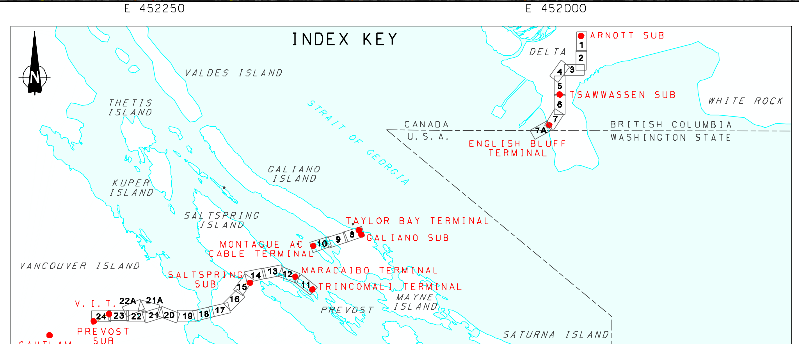

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Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

SHEET 21 OF 24

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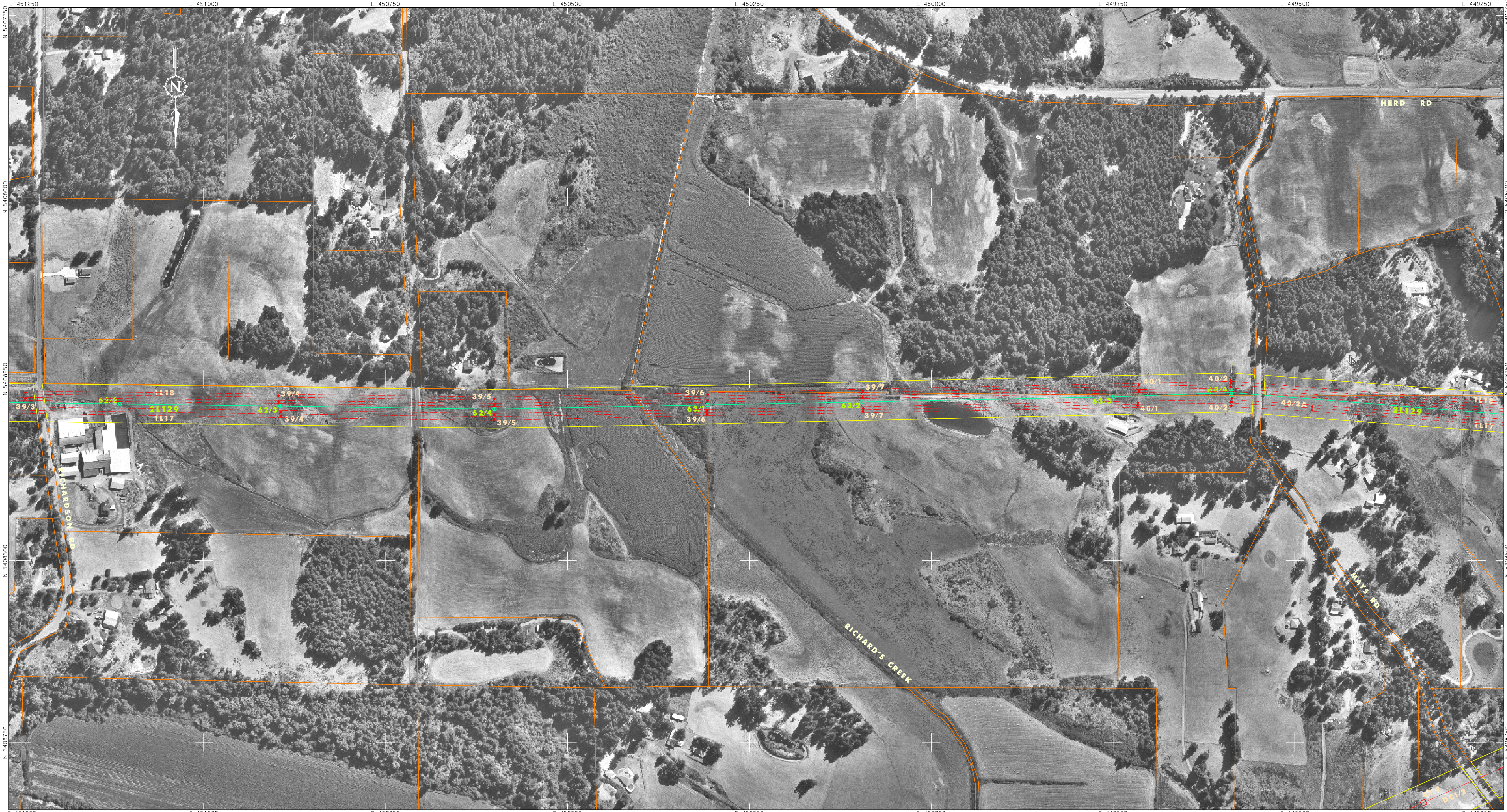

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL, ALUMINUM
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE
STRUCTURE NUMBER 2/3
CONDUCTOR LINES
REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)
DUCTBANK (STAGE 2)
MANHOLE

CADASTRAL BOUNDARY
BC HYDRO EASEMENT &
HYDRO OWNED CADASTRAL BOUNDARY

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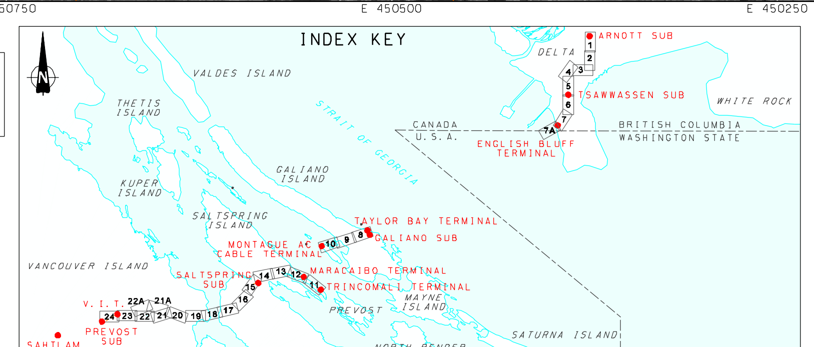

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Vancouver Island Transmission Reinforcement Project
Replacement & Upgrading of 138 kV System
Arnott to VIT

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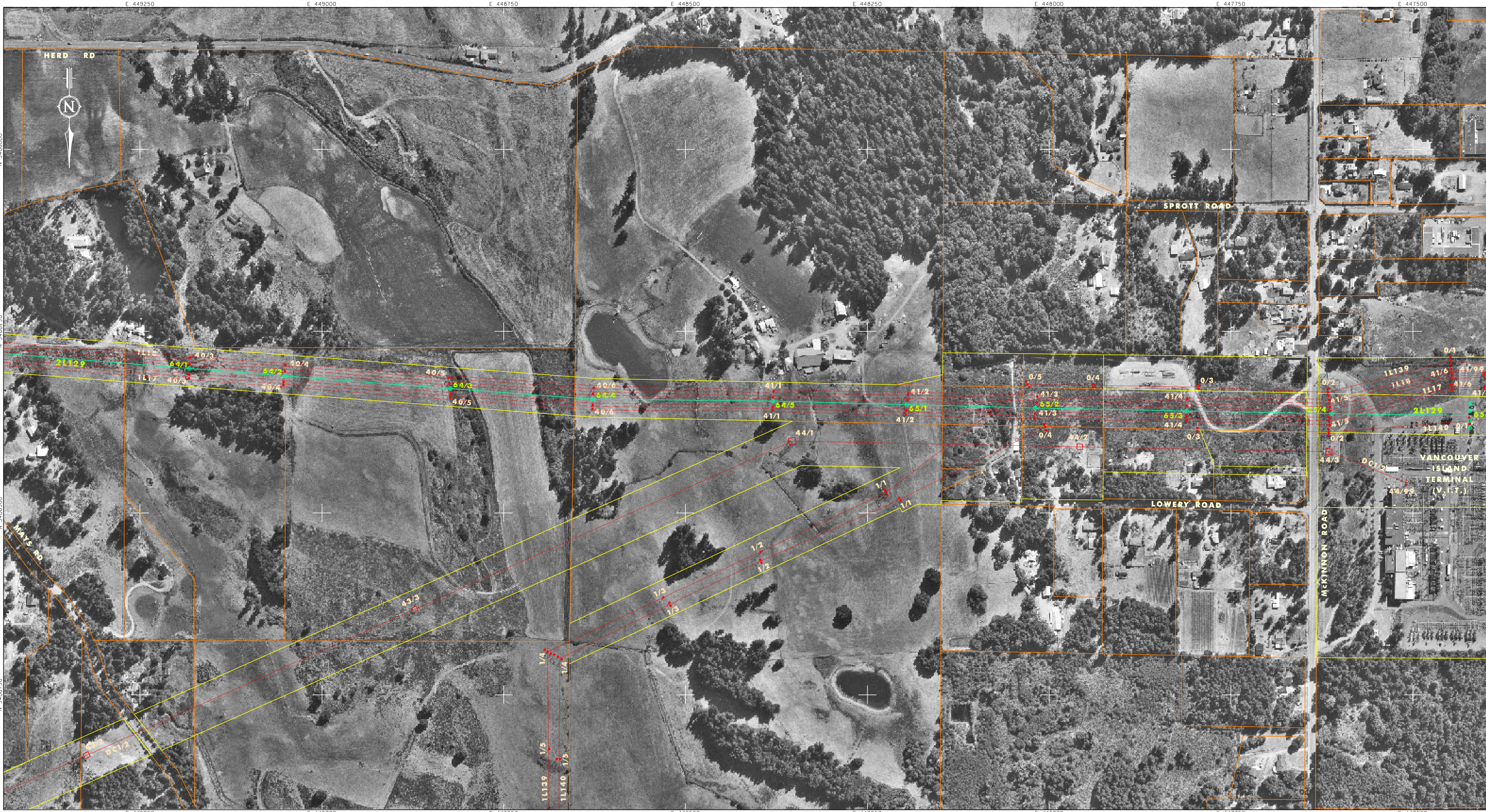
R. C



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY: STEEL, ALUMINUM

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)

DUCTBANK (STAGE 2)

MANHOLE

CADASTRAL BOUNDARY

BC HYDRO EASEMENT & HYDRO OWNED CADASTRAL BOUNDARY

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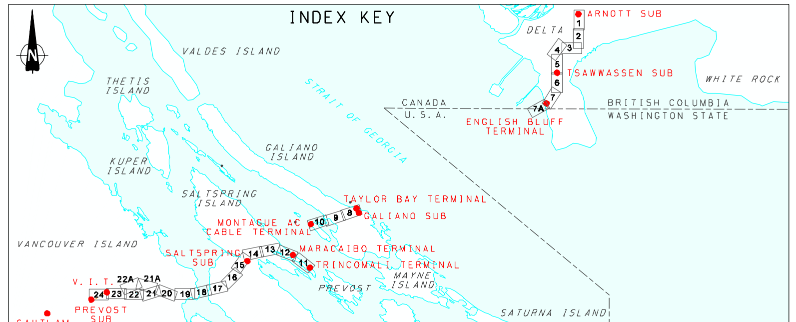

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Vancouver Island Transmission Reinforcement Project

Replacement & Upgrading of 138 kV System

Arnott to VIT

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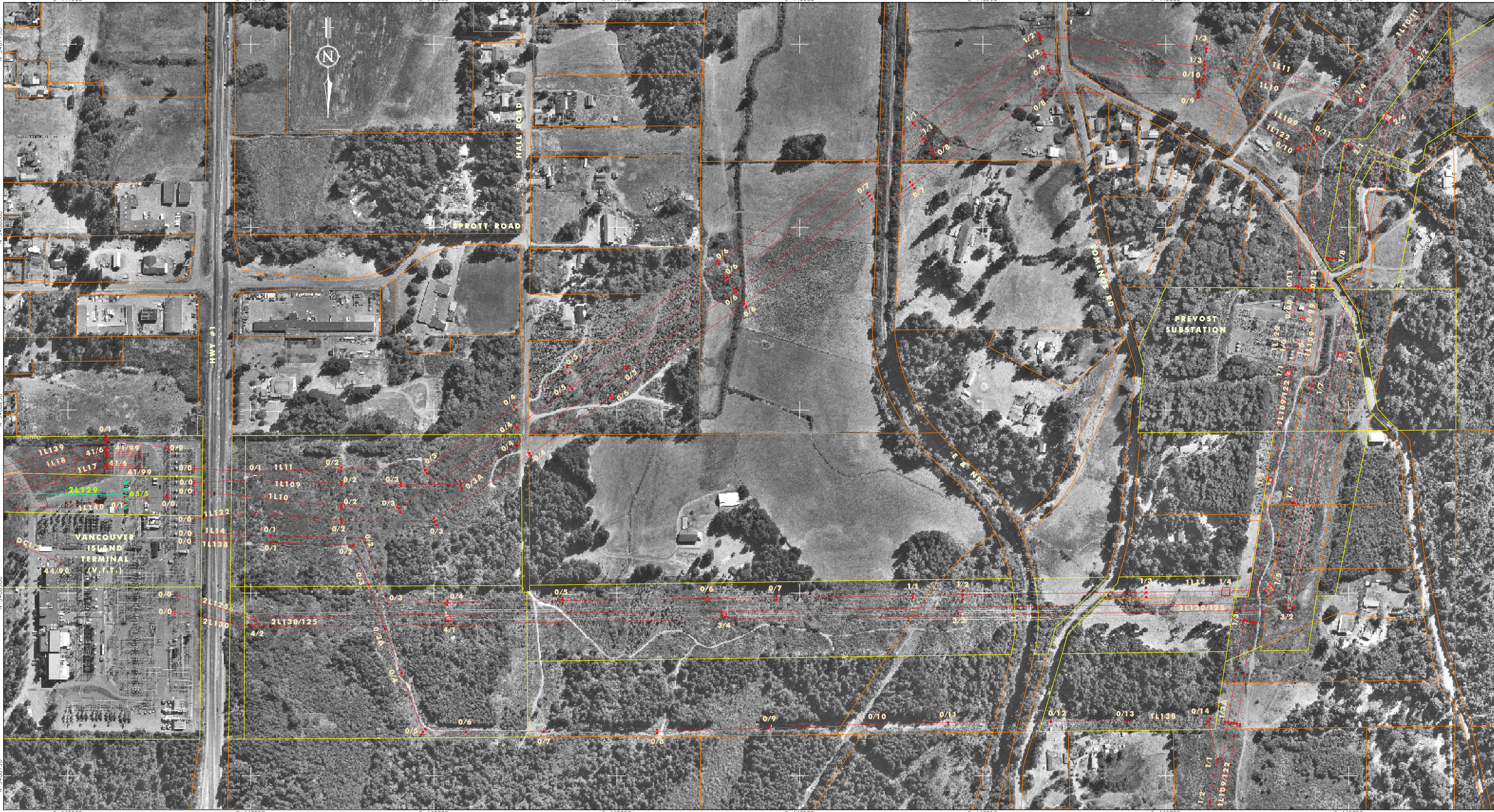

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
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WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

PROPOSED 2L129 CIRCUIT

STRUCTURES, ANCHOR AND GUY LINE

STRUCTURE NUMBER 2/3

CONDUCTOR LINES

REMOVAL OF EXISTING CIRCUITS

PROPOSED 230kV UNDERGROUND FACILITIES

DUCTBANK (STAGE 1)

DUCTBANK (STAGE 2)

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CADASTRAL BOUNDARY

BC HYDRO EASEMENT &
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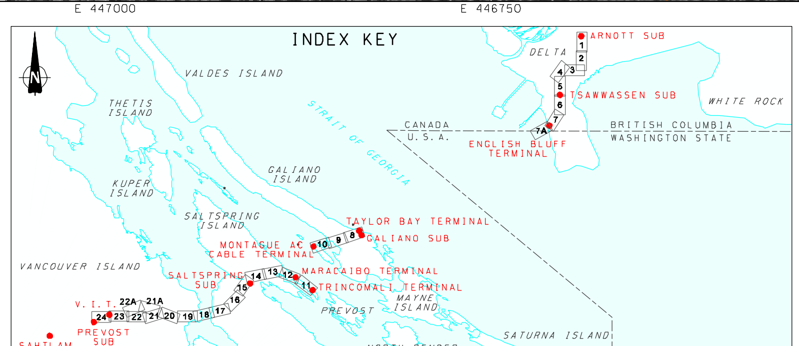

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Appendix B

Comparison of Alternative Structure Configurations and Placement in Existing Right-of-Way

VANCOUVER ISLAND TRANSMISSION REINFORCEMENT
REPLACEMENT AND UPGRADING OF EXISTING 138 kV TRANSMISSION SYSTEM
PROJECT: VITR

COMPARISON OF ALTERNATIVE STRUCTURE CONFIGURATIONS AND PLACEMENT IN EXISTING RIGHT-OF-WAY

Prepared for: **BC Transmission Corporation**

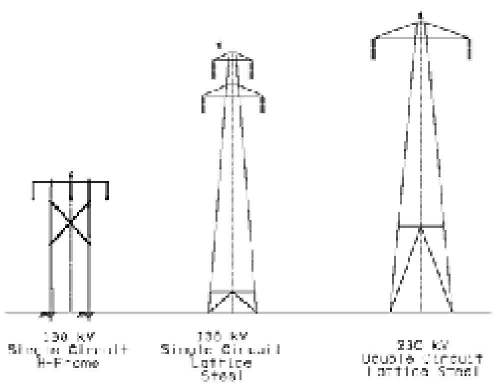
VANCOUVER ISLAND TRANSMISSION REINFORCEMENT REPLACEMENT AND UPGRADING OF EXISTING 138 kV TRANSMISSION SYSTEM PROJECT: VITR

COMPARISON OF ALTERNATIVE STRUCTURE CONFIGURATIONS AND PLACEMENT IN EXISTING RIGHTS-OF-WAY

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of this document is to report, summarize and compare possible different structure configurations or types that could be used to support new overhead conductors for the proposed 230 kV supply to Vancouver Island. This project will replace the existing two 138 kV transmission circuits between Arnott Substation (ARN) in Delta B.C. and Vancouver Island Terminal (VIT) in North Cowichan, B.C. The proposed replacement will ultimately comprise two 3-phase 230 kV AC circuits. Initially one 230 kV circuit will be placed into service while one 138 kV circuit will be retained for a period of time to supply the Gulf Island loads until the second 230 kV circuit is required. At that time, the Gulf Island supply will be converted to 230 kV tapping one or both of the 230 kV circuits.



Existing structures on the rights-of-way include 60 kV single circuit wood pole, 138 kV AC with H-frame wood pole and galvanized lattice steel types and 260/280 kV DC galvanized steel. A majority of the H-frame wood pole and galvanized lattice steel structures on circuits 1L17 and 1L18 will be removed during the construction for the first 230 kV circuit. The DC lattice steel structure will remain for the foreseeable future. The 60 kV circuits from Ladner to Tsawwassen will also remain.

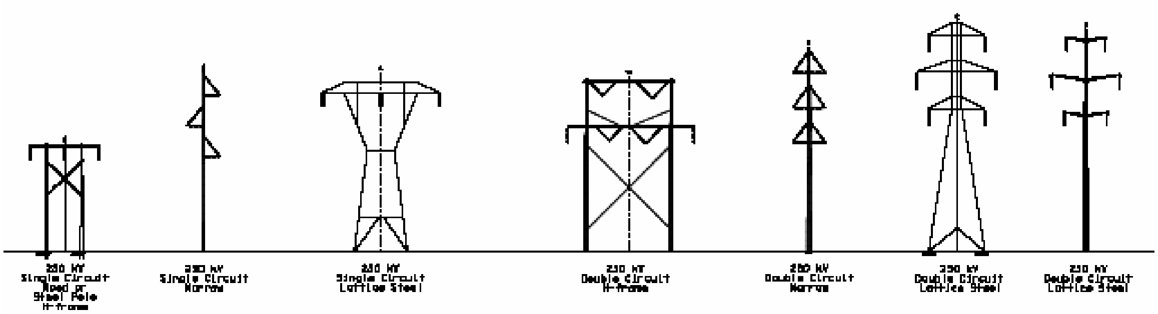
The initial project design assumptions and report, reference Report No. NPP2001-01, Project Planning Report for 230 kV Transmission Circuit, Arnott to VIT, November 2001, by BCTC, Network Performance Planning assumed the overhead lines would comprise double circuit galvanized steel pole or lattice steel construction. This was made without the basis of any comparisons or evaluations. Early-on, structure selection criteria were based on the following premise:

- minimize disturbance to the current uses of the existing rights-of-way,
- minimize the need for construction of new roads and vegetation removal, and
- aesthetic improvements.

The types of structures that are evaluated in this review are listed below.

- H-frame single circuit wood pole, in staged or ultimate installation, 1 x 3 arrangement
- H-frame single circuit steel pole, in staged or ultimate installation, 1 x 3 arrangement
- Braced post single circuit “narrow” steel pole, in staged or ultimate installation
- Single circuit lattice steel, 1 x 3 arrangement, in staged or ultimate installation

- Double circuit wood/steel pole H-frame, 4 x 2 x 2 arrangement
- Double circuit lattice steel, 3 x 2 arrangement
- Double circuit steel pole, 3 x 2 davit arm arrangement,
- Double circuit steel pole, 3 x 2 braced post arrangement.



Each type has its own advantages and disadvantages. The factors considered in the comparison, listed in random order include:

- Utilization of the existing right-of-way,
- Electro-magnetic field (EMF),
- Radio Interference (RI) and Audible Noise (AN),
- Dimensions in respect to footprint, overall height and height relative to adjacent facilities,
- Area beneath conductors and how it impacts right-of-way width and vegetation maintenance,
- Allowable spans and number of structures within a given length,
- Cost of the structures including foundations,
- Construction ease and infrastructure required for construction and
- Maintenance considerations.

This review does not attempt to develop a new family of towers but uses existing BCTC/BC Hydro standards, specifications and designs.

2.0 CONDUCTOR DATA AND ELECTRICAL CONSIDERATIONS

The single phase conductor option for the 230 kV overhead transmission component of the project is 1590 kcmil 45/7 ACSR “Lapwing”. Conductor size, strength, bare and loaded is provided below.

“Lapwing” Conductor Characteristics and Masses

Outside Diameter	38.2 mm
Rated Tensile Strength (RTS)	194,832 N
Bare Mass	26.0887 N/ m
Loaded Vertical Component	44.8089 N/m
Loaded Horizontal Component	25.6800 N/m

The two bundle phase conductor option for the 230 kV overhead transmission component of the project is 666.9 kcmil 24/7 ACSR "Mica ACSR". Data for this conductor option are provided below:

<u>"2 Bundle Mica ACSR" Conductor Characteristics and Masses</u>

Outside Diameter (each)	25.4 mm
Rated Tensile Strength (RTS- each)	106,000 N
Bundle Spacing and Orientation	457 mm flat
Bare Mass	12.5133 x 2 = 25.0266 N/m
Loaded Vertical Component	26.5549 x 2 = 52.1098 N/m
Loaded Horizontal Component	20.5600 x 2 = 41.1200 N/m

The recommended conductor design wind and ice load for a 1:200 year return period is 0.385 kN/m^2 wind and 12.7 mm radial ice.[1]

The conductor tension is limited by a set of conditions outlined in the BC Hydro Engineering Standards related to conductor accessories. Other factors affecting the maximum conductor tension are insulator and hardware strength co-ordination, relative ice and wind loading, ambient temperatures, wind speed and characteristics and resulting vibration, construction methodology and alignment.

Vibration Dampers	Initial Tension @ 10% Winter Design Temp. (-5^{o}C)	Final Tension @ 10 % Winter Design Temp. (-5 ^{o}C)	Final @ Mean Annual Temp. (10 ^{o}C)	Final Under Design Load Conditions (See Note 1)
Single Conductor per Phase				
No	26	23	19	60
Yes	28	25	22	60
Bundle , 2 Conductors per Phase				
No	31	28	23	60
Yes	33	30	25	60

It is intended to install armour rods with all suspension clamps.

The alignment figures into the equation by virtue of the relative number of angle structures. A higher maximum conductor tension on an alignment with many deflection angles will result in much heavier transverse loads thus needing stronger structures, increased insulator swings angles on angle suspension towers thus larger conductor clearance envelopes and more costly and complicated dead-end structures. An increased conductor tension may reduce conductor sag and allow longer spans but in rougher terrain the flatter conductor profile can impact insulator swing angles and problems with uplift in cold ambient temperatures.

[1] BC Hydro, Proposed 230 kV Transmission Line Arnott – VIT – Sahtlam, BC Hydro Engineering, Report No. E313, September 2004

A further factor in limiting the conductor tension is co-ordination of conductor tensions with the strength of guys and guy hardware if the structures will be guyed. Of initial interest is guying of the dead-end structures and second is the impact on suspension angle structures. For dead-end structures that are guyed, the industry standard is a guy angle of 45^{o}. In circumstances where space is limited the guy angle can be reduced to 30^{o} from vertical at the expense of increased vertical load onto the supporting structures and reduced conductor tension

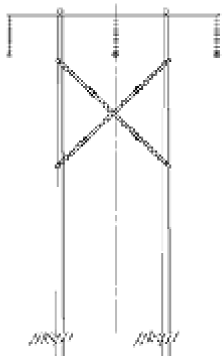
3.0 DESCRIPTION OF ALTERNATIVE STRUCTURE TYPES

The types of structures that are evaluated are listed below.

- H-frame single circuit wood pole, in staged or ultimate installation, 1 x 3 arrangement
- H-frame single circuit steel pole, in staged or ultimate installation, 1 x 3 arrangement
- Braced post single circuit "narrow" steel pole, in staged or ultimate installation
- Single circuit lattice steel, 1 x 3 arrangement, in staged or ultimate installation
- Double circuit steel pole, 4 x 2 x 2 arrangement
- Double circuit lattice steel, 3 x 2 arrangement
- Double circuit steel pole, 3 x 2 davit arm arrangement,
- Double circuit steel pole, 3 x 2 braced post arrangement.

<u>H-Frame Single Circuit Wood Pole, 1 x 3 Arrangement</u>

This type of support comprises flat configuration, 3-phase structures supported on two wood poles for tangent suspension structures and guyed three pole structures for medium angle suspension and dead-end types.



On suspension structures the conductor is attached to crossarms with I-type vertical suspension insulator strings approximately 2 m in length. Conductors are directly attached to the poles of dead-end structures with the insulators in a horizontal orientation. The spacing between each of the conductors is 5.5 to 6 m. Crossarms can be treated timbers or galvanized steel.

The appearance of these type of structures is similar to the existing 3-phase 138 kV H-frame structures of Circuit 1L17 located between ARN and EBT in Delta and on Vancouver Island near VIT. The difference between 138 kV and 230 kV H-frame structures is spacing between conductors (4.27 m vs. 5.5 m) and typical height (13 m conductor height/ 15 m overall height for 138 kV vs. 14.5 m conductor height/ 17 m overall height for 230 kV). The dead-end structures normally support a conductor tension not exceeding 33.3 kN.

The span length or distance between structures is similar to the equivalent 138 kV wood pole design, or approximately 225 m. The taller structure of the 230 kV design is due to a combination of increased vertical clearance and increased sag of the larger conductor the 230 kV line normally supports. If this wood pole design was to replace the existing 138 kV single circuit galvanized lattice steel structures located on Galiano and Salt Spring Islands and part of Vancouver Island the greater span length of the existing steel structures cannot be matched by 230 kV wood pole structures. The number of structures per unit would roughly double.

The wood poles used to support the structure are each typically 0.6 m in diameter at grade and are western red cedar. The poles are full length treated with chromium copper arsenic preservative (CCA). Wood timbers are pressure treated with CCA preservative. The poles are normally direct buried.

The unit cost of a basic 230 kV H-frame wood pole structure supported on 75’ class 1 poles is approximately $16,000. For the equivalent double circuit cost this would rise to $32,000 for a pair of structures. A kilometre of this type of construction including allowances for medium angle and dead-end structures is $200,000 for two circuits.

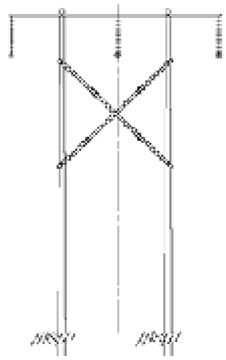
Fully treated wood poles now have a operation life of up to 70 years. Other wood components are replaced after about 25 years.

Standard right-of-way cross sections call for the edge of right-of-way to be off-set 15 m from the centre of the structure (centre phase) and in the case of two or more circuits, each circuit is separated by 21 m measured from the centre of the structure (centre phase). Two circuits will require a right-of-way width totalling 51 m or 167 feet. These dimensions are valid for spans up to 350 m in length.

The advantage of this type of construction is the lower height, low unit cost and the ability to stage construction and expenditures. Disadvantages include increased vegetation management area because of the increased area beneath conductors, highest relative EMF of all structure types and reduced operational life because of the wood components.

<u>H-Frame Single Circuit Steel Pole, 1 x 3 arrangement</u>

This type of support is similar to the H-frame wood pole type described above. The difference is, rather than wood poles and timbers, all components are made of galvanized steel. Angle suspension and dead-end structures are also guyed. The steel poles are physically similar to wood poles in outer dimensions and installation.



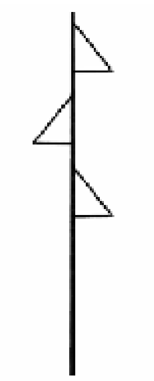
The use of steel poles and components allows the structure to support increased loads and an increased tensioned conductor, therefore longer spans can be achieved, e.g. increase from typical 225 m to 300 m. The poles maybe direct buried but because of the loads from the increased span lengths, the poles are normally set in steel culverts to increase the overturning resistance.

The unit cost of a basic 230 kV H-frame steel pole structure supported on 80' poles is estimated at approximately $25,000.

The advantage of this type of construction is the availability of taller poles and thus longer spans and the ability to stage construction and expenditures. Disadvantages include increased vegetation management area because of the increased area beneath conductors, highest relative EMF of all structure types, additional cost for shorter pole heights relative to utilizing wood poles.

<u>Braced Post Single Circuit "Narrow" Wood or Steel Pole</u>

This configuration places the conductors in a staggered vertical configuration, which reduces the width between outer conductors roughly in half, from the 11 m of the single circuit H-frame design but the overall height of the structure will increase by approximately 10 m to 28 m. Span lengths are generally shorter than possible with the flat two pole h-frame type because it is weaker in respect to transverse wind loads and to minimize pole height. The poles are slender having a base diameter of 0.6 m. For angle suspension, the conductors are arranged on one side and the pole is normally guyed. Placing all of the conductors on one side requires at least a 3 m increase the pole height. Dead-end structures have one pole and are normally guyed to minimize pole diameter, weight and the foundation. Angle and dead-end poles can be unguyed but at the expense of a having a much larger base and top diameter and a large foundation. In competent soils most tangent and guyed angle and dead-end structures can be set within a 0.9 m diameter direct buried galvanized steel culvert that improves stability.



Standard right-of-way cross sections call for the edge of right-of-way to be off-set 12.5 m from the centre of the structure and in the case of two or more circuits; each circuit is separated by 15.5 m measured from the centre of the structure. Two circuits will require a right-of-way width totalling 41 m or 133 feet.

Transverse loading due to wind pressure reduces the span length because the structure is not a frame like the wood and steel H-frame structures. Spans with the Lapwing conductor will be reduced to less than 200 m.

The unit cost of a basic 230 kV braced post single circuit “narrow” wood pole structure supported on 90 to 100’ poles is approximately $20,000.

Poles over 100’ for these structures have generally been supplied in galvanized steel and they can cost $12,000 each verses $5,000 for the wood poles. The advantage of the steel poles is they can be sectionalized for transportation and erected in sections by staking the pole section one on top of each other.

<u>Single circuit lattice steel, 1 x 3 or 3 x 2 Arrangement</u>

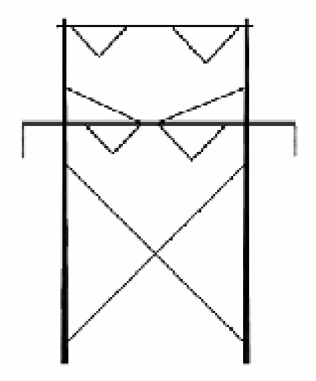
Single circuit lattice steel is a type of construction more applicable to supporting a large diameter conductor in rugged terrain where many long spans can be achieved or the mechanical loading criteria is high to severe. Typically the conductors are supported in a flat configuration like h-frame wood pole construction described previously. They also can be provided in a staggered vertical configuration. The longer spans they tend to support need a wider phase spacing, which for 230 kV can be 8 m square. The towers are self-supporting. The tower comprises individual galvanized angle steel that is bolted together to form a geometric frame. The towers normally have four legs with each leg supported on a steel mat type (grillage) or a drilled anchor with concrete pad/ frame foundation.

The unit cost of a basic 230 kV lattice steel structures supporting conductors supported on 70’ above grade is approximately $60,000. This type of single circuit 230 kV construction has not been used for many years.

The advantage of this type of construction is the longer spans and the ability to stage construction and expenditures. Disadvantages include increased vegetation management area because of the increased area beneath conductors, highest relative EMF of all structure types and cost.

Double Circuit Steel Pole H-frame, 4 x 2 arrangement

This arrangement in a wood and steel pole version has been installed on the Columbia Power Corp. 230 kV line from Brilliant GS to BC Hydro's Selkirk Substation, completed in 2001. The structure is fairly wide. It has two levels of conductors. The lower level supports four of the six phase conductors. The upper level supports the remaining two. The distance between each of the two supporting poles is 13 to 14 m. The distance between outer conductors is 20 m and this is approximately 12 less than two parallel flat configuration single circuit wood pole lines. Typically 100' poles were needed which provided a 28 m overall structure height, or about 11 m taller than the single circuit equivalent. It is about the same overall height as the single circuit "narrow" braced post structures.



Dead-end structures are almost exactly the same as the tangent structure in appearance. They are guyed. For heavy angles dead-ends are vertical in configuration and two poles are required, typically spaced apart 12 m. The vertical configuration increases the overall height by 6 m. In competent soils most tangent and guyed angle and dead-end structures can be set within a 0.9 m diameter direct buried galvanized steel culvert that improves overall stability.

The conductors for each circuit are in a delta configuration which helps to reduce the magnetic field, especially with the conductors in opposing phasing.

The structure is extensively braced. Crossarms and braces are all galvanized steel HSS box sections. The inner and upper insulators are V type strings, which restrict the swing of the insulator and conductor at the tower, thus allowing some compacting of the tower head. The lower two outer insulator strings a I type which can freely swing. This type of structure is fairly adaptable to having differential insulation installed, which mitigates against double circuit outages.

Span lengths are equivalent to wood or steel pole single circuit H-frames. The wide stance of the structure provides a very stable frame in respect to transverse wind loading. Longitudinally, the structure is weak. It is advisable to apply in-line longitudinal guys to some structures in longer tangent line sections.

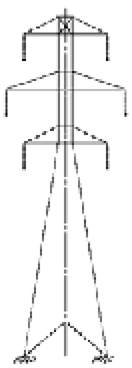
The use of tall wood poles adds considerable construction effort and handling in rougher terrain.

The typical installed unit cost of a wood pole variant of this structure is $30,000.

The advantage of this structure is its stability and reduced footprint and height compared to other double circuit types. It has advantages for converting single circuit to double circuit using the same conductor. Disadvantages include its' breadth, use of more expensive V-string insulator assemblies. The use of wood poles will greatly impact future maintenance work. The higher class of wood poles will greatly impact the ability to replace wood poles with the same in the future.

Double Circuit Lattice Steel, 3 X 2 Arrangement

These structures are a conventional utility arrangement for double circuit construction. It comprises galvanized lattice steel arranged in as a space frame and supported on four legs. One circuit is suspended on each side of the structure shaft. There are six cantilevered crossarms to support the conductor arranged in three levels. Each level of crossarms is vertically separated by 5.8 m. The upper and lower crossarms extend 4.3 m out from the centre of the structure. The middle phase attachment is offset by 2 m to increase clearance between phases and minimize clashing. Typical structures have a lowest conductor attachment height of 20 through 30 m with an overall structure height of 36 to 46 m.



The towers are self-supporting. The tower comprises individual galvanized angle steel that is bolted together to form a geometric frame. The towers normally have four legs with each leg supported on a steel mat type (grillage) or a drilled anchor with concrete pad/ frame foundation. The area taken by the base of a tangent tower is about 9 m square (81 m^2).

Most recent installations of this type tower family have used a twin bundle phase conductor which provides better sag characteristics because each conductor is smaller in diameter and higher installed tension. This approach is used to keep structure heights lower with the much longer spans that can be supported.

The unit cost of a basic steel structures supporting conductors supported on 20 m above grade is approximately $100,000. The structure cost per km length for this type of construction is $575,000 /km.

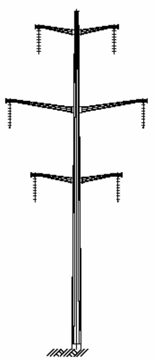
To match spans with the existing DC lattice steel structures and using a twin bundle conductor which will sag less than the Lapwing conductor, the attachment height of the lowest conductors on these type of structures will average 29 m which results in an overall structure height of 45 m. Reducing span length to reduce overall height will in many cases double the number of structures significantly increasing the cost per km.

The family of these type of structures also comprises a medium angle suspension and a heavy angle capable dead-end. These additional towers are heavier, have increased base plan area and are much more costly than the basic tangent suspension tower but have roughly the same outward appearance.

The advantage of this type of construction is the longer spans, which are typically 400 m in length and thus fewer structures. Disadvantages include increased cost, especially for a staged development, the size of work areas needed for construction assembly and visibility because of their height and short view bulk.

Double Circuit Steel Pole, 3 x 2 Davit Arm Arrangement

This configuration supports two circuits on a single steel pole. The six phase conductors are supported from steel tubular davit arms attached to the pole. Glass or porcelain suspension insulators in a string of fourteen units are suspended from each davit arm.



The spacing between phases, both vertically and horizontally are similar to the double circuit lattice steel towers. The use of davit arms rather than braced post insulators is because these types of steel poles normally support longer spans, in the order of 400 m, which require greater strength. Maintenance rigging is also made more convenient for the heavier weight of the phase conductor. The longer spans results in larger diameter and heavier poles. Tangent structures are usually over 1 m in diameter at groundline.

Angle suspension and dead-end structures comprise two poles with each circuit supported on a pole in a vertical configuration. They are comparatively taller to provide increased separation between phases because there is no off-set of the centre phase provided. The angle suspension and dead-end poles have been un-guyed and therefore quite massive in size, e.g. 2 m or more diameter at ground-line. There is no reason why guyed poles could not be used other than most past installations have been in situations where guying was undesirable from a land use or space perspective.

Most recent installations of this type tower family have used a twin bundle phase conductor which provides better sag characteristics because each conductor is smaller in diameter and higher installed tension. This approach is used to keep structure heights lower with the much longer spans that can be supported.

Foundations for this family of steel poles are large. For the unguyed two pole structures, especially the dead-ends, they are very large.

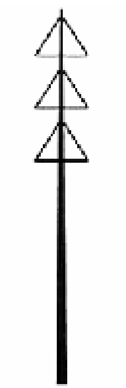
The unit cost of a basic tangent structure supporting conductors supported on 20 m above grade is approximately $120,000. The structure cost per km length for this type of construction is $470,000 /km. The two pole structures can range up to $300,000 each, mainly due to the foundations. Compared to lattice steel construction the steel poles are more expensive for the foundation and supply of the steel poles but the cost is considerably less expensive for assembly and erecting the steel poles compared to the assembly and erection of the lattice towers.

To match spans with the existing DC lattice steel structures and using a twin bundle conductor which will sag less than the Lapwing conductor, the attachment height of the lowest conductors on these type of structures will average 29 m which results in an overall structure height of 45 m. Reducing span length to reduce overall height will in many cases double the number of structures significantly increasing the cost per km.

Double Circuit Steel pole, 2 x 3 Braced Post Arrangement.

This configuration supports two circuits on a single steel pole. The six phase conductors are supported from composite insulator assemblies comprising a brace for vertical loads and a post for horizontal loads.

The phase conductors for each circuit are arranged vertically (one circuit on each side of structure). The phase conductors are off-set approximately 3 m from the centre of the pole and each phase is vertically separated by 5.5 m. The poles are slender having a base diameter of 0.6 m. For angle suspension, the conductors are arranged on one side and the pole is normally guyed. Dead-end structures have one pole per circuit and are normally guyed to minimize pole diameter, weight and the foundation size. Angle and dead-end poles can be unguyed but at the expense of a having a much larger base and top diameter and a large foundation. In competent soils most tangent and guyed angle and dead-end structures can be set within a 0.9 m diameter direct buried galvanized steel culvert that improves stability.



Installations to date have all been with a single conductor. Examples of the existing installations are the Jingle Pot Substation to Northfield Substation in Nanaimo and along 8th Ave/ Nordel Way in Surrey/ Delta.

This compact nature of this structure produces the least field affects and the least area impacts of all the types compared.

The unit cost of a basic tangent structure supporting conductors supported on 20 m above grade is approximately $80,000. The two pole guyed structures can range up to $180,000 each, mainly due to the cost of extra pole, foundations and guy anchors. Compared to other types of construction, the unit cost for structures per km is estimated to cost $560,000. Compared to the steel poles with davit arms, the additional cost per km is due to the increased number of structures because of the shorter span lengths.

4.0 PLACEMENT IN EXISTING RIGHT-OF-WAY

The basis for determining the horizontal distance to the edge of the statutory right-of-way (SRW) and separation from adjacent circuits is CAN/CSA C22.3 No. 1-01. The horizontal distances from conductors are the sum of minimum horizontal increments specified in the CSA document and swing of the conductor, both under specific conditions.

Existing circuits 1L17 and 1L18 are 138 kV AC. They parallel in places 25, 60 and 138 kV AC and 260/280 kV DC lines.

For a 230 kV phase to phase voltage/ 146 kV phase to ground voltage, the CSA electrical clearances to consider in developing right-of-way clearances and separations to adjacent circuits and structures are listed below.

CSA Horizontal Clearance Increments

Condition	Calculation	Increment Value
Clearance to assessable vertical surface – edge of SRW for swung 230 kV conductor	1.8 m + 0.01(phase to ground voltage-50 kV)	2.8 m
Clearance from swung 230 kV wire to adjacent structure	1000 mm +10(phase to ground voltage-50 kV)	2.0 m
Clearance to conductor not supported on the same structure, swung 230 kV to 25 kV	300 mm + 10(sum of phase to phase voltage –0.75 kV)	1.9 m
Clearance to conductor not supported on the same structure, swung 230 kV to 60 kV	300 mm + 10(sum of phase to ground voltage –0.75 kV)	2.1 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 138 kV AC	300 mm + 10(sum of phase to ground voltage –0.75 kV)	2.6 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 230 kV AC	300 mm + 10(sum of phase to ground voltage –0.75 kV)	3.2 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 280 kV DC	300 mm + 10(AC phase to ground voltage –0.75 kV)+6(DC voltage-0.75 kV)	3.7 m

For CSA based calculations, the horizontal displacement or swing of the conductor is based upon the sag of the conductor at 40^{o}C plus the length of vertical insulator strings (if applicable), all times a factor determined from the ratio of the proposed conductor diameter and unit mass for non-sheltered spans.

For the conductor types installed on the proposed 230 kV circuits and adjacent 25, 60 and 138 kV AC circuits and 260/280 kV DC circuits, the swing factors determined by C22.3 are as follows:

Conductor Displacement (Swing) Factors

Circuit & Conductor Type	d/w	Non-Sheltered Span Factor
25 kV Distribution – Partridge conductor	29.86	0.57
60 kV – Orchid conductor	26.36	0.54
138 kV – Ibis conductor	24.53	0.49
138 kV – Hawk conductor	22.36	0.46
230 kV - 2B Mica ACSR conductor	19.91	0.41
DC – Drake conductor	17.33	0.39
230 kV – Lapwing ACSR conductor	14.36	0.32

Comparative Sag/Tension Studies based on Layout Study

To ascertain reasonable span length and conductor sag values for this study, PLS-CADD models were prepared for each of the alternative structure configurations over a tangent section in Ladner, Delta and the Athol Peninsula on Salt Spring Island. The limiting conditions for the conductor were those that are normally used for the particular design. Lapwing or the alternative 2-bundle Mica ACSR were strung according to the normal practise with the tower type configuration. Summaries of each of the individual studies are listed hereafter.

Single Circuit Wood Pole H-Frame

- Layout in Delta matching DC towers and at mid-span, using single Lapwing. On Salt Spring structures located as required for the rougher terrain.
- Tension limited to 17% RTS to match normal limit for this design.
- Typical pole height 90-95 ft., 20.5 m height; 17.5 m conductor height.
- Delta sag @ 40C = 6 m
- Salt Spring sag @ 40^{o}C, Section 1 =8 m/Section 2 = 7 to 23 m.

Single Circuit Steel Pole H-Frame

- Layout in Delta matching DC towers and at mid-span, using single Lapwing. On Salt Spring structures located as required for the rougher terrain.
- Tension limited to 50% RTS (36% actual).
- Typical pole length 75 to 80 ft., 24 m height; 21 m conductor height.
- Delta sag @ 40C = 14 m
- Salt Spring sag @ 40^{o}C, Section 1 =13 m/ Section 2 = 7 to 16 m.

Single Circuit Wood/Steel Pole Narrow

- Layout in Delta matching DC towers and at mid-span, using single Lapwing. On Salt Spring structures located as required for the rougher terrain.
- Tension limited to 17% RTS to match normal limit for this design.
- Typical pole length 120 ft., 32 m height; 17.5 m conductor height.
- Delta sag @ 40C = 6 m.
- Salt Spring sag @ 40^{o}C = Section 1 = 8 m/ Section 2 = 7 to 23 m.

Double Circuit Wood/Steel Pole H-Frame

- Layout in Delta matching DC towers and at mid-span, using single Lapwing. On Salt Spring structures located as required for the rougher terrain.
- Tension limited to 17% RTS to match normal limit for this design.
- Typical pole Length 110-115 ft., 29 m height; 17.5 m min. conductor height.
- Delta sag @ 40C = 6 m.
- Salt Spring sag @ 40^{o}C, Section 1 = 8 m/ Section 2 = 7 to 23 m.

Double Circuit Lattice

- Layout to match DC tower spans using twin bundle Mica ACSR.
- Max. tension limited to 50% RTS.
- 45 m height; 29 m min. conductor height.
- Delta sag @ 40C = 20 m.
- Salt Spring sag @ 40^{o}C, Section 1 = 31 m/ Section 2 = 20 m.

Double Circuit Steel Pole

- Layout to match DC tower spans using twin bundle Mica ACSR.
- Max. tension limited to 50% RTS.
- 45 m height; 29 m min. conductor height.
- Delta sag @ 40C = 20 m.
- Salt Spring sag @ 40^{o}C, Section 1 = 31 m/ Section 2 = 20 m.

Double Circuit Steel Pole Narrow

- Layout in Delta matching DC towers and at mid-span, using single Lapwing. On Salt Spring structures located as required for the rougher terrain.
- Tension limited to 50% RTS (36% actual).
- Typical pole Length 120 ft., 32 m height; 17.5 m min. conductor height.
- Delta sag @ 40C = 6 m
- Salt Spring sag @ 40^{o}C, Section 1 =7 m/ Section 2 = 9 to 15 m.

Separation between Circuits of Same Construction on Existing SRW

If single circuit construction is employed, the required separation between the two circuits will be as follows, based on the line models for Delta and Salt Spring Island.

Proposed 230 kV Structure Configuration	Model Location	Required C/L to C/L Separation (m)	Required Minimum SRW Edge Distance (m)
Single Circuit H/F Flat Wood Pole	Delta	17.43	11.53
	Salt Spring	22.23	16.33
Single Circuit H/F Flat Steel Pole	Delta	20.03	13.63
	Salt Spring	20.99	14.59
Single Circuit Narrow	Delta	11.76	8.36
	Salt Spring	16.56	13.16
Single Circuit Flat Steel Lattice	Delta	31.77	23.87
	Salt Spring	27.26	19.36

Separation from Adjacent Transmission Circuits on Existing SRW

Proposed 230 kV Structure Configuration	Adjacent Circuit	Model Location	Governing Circuit	Governing Circuit Displacement from C/L (m)	Required Min. C/L to C/L Separation (m)
Single Circuit H/F Flat Wood Pole	DC	Delta	DC	14.3	23.5
	60 kV	Delta	230 kV	8.7	12.0
	DC	Salt Spring	DC	18.2	27.4
Single Circuit H/F Flat Steel Pole, 1 x 3	DC	Delta	DC	14.3	24.0
	60 kV	Delta	230 kV	10.8	14.1
	DC	Salt Spring	DC	18.2	27.9
Single Circuit Narrow, 1 x 3	DC	Delta	DC	14.3	21.0
	60 kV	Delta	230 kV	5.6	8.9
	DC	Salt Spring	DC	18.2	24.9
Single Circuit Flat Steel Lattice, 1 x 3	DC	Delta	230 kV	21.1	30.3
	60 kV	Delta	230 kV	21.1	24.4
	DC	Salt Spring	230 kV	16.6	25.6
Double Circuit H-frame 4 x 2 x 2	DC	Delta	DC	14.3	28.0
	60 kV	Delta	230 kV	14.2	17.5
	DC	Salt Spring	DC	18.2	31.9
Double Circuit lattice steel, 3 x2	DC	Delta	230 kV	19.9	29.1
	60 kV	Delta	230 kV	19.9	23.2
	DC	Salt Spring	DC	18.2	28.2
Double circuit steel pole davit arm, 3 x 2	DC	Delta	230 kV	19.9	29.1
	60 kV	Delta	230 kV	19.9	23.2
	DC	Salt Spring	DC	18.2	28.2
Double circuit steel pole, braced post, 3 x 2	DC	Delta	DC	14.3	21.0
	60 kV	Delta	230 kV	5.3	8.6
	DC	Salt Spring	DC	14.3	21.0
	DC	Salt Spring	DC	18.2	24.9

For comparing the SRW requirements of the above different designs the sum of the required minimum centre-line separation and the required minimum SRW edge boundary distance must be compared.

Sum of Minimum Centre-line Separations and Edge Distances

Proposed 230 kV Structure Configuration	Adjacent Circuit	Model Location	Sum of Min. C/L Separation and SRW Edge Distance (m)	Rank
2 x Single Circuit H/F Flat Wood Pole	DC	Delta	52.44	5
	60 kV	Delta	41.00	4
	DC	Salt Spring	65.94	6
2 x Single Circuit H/F Flat Steel Pole, 1 x 3	DC	Delta	57.64	6
	60 kV	Delta	47.80	6
	DC	Salt Spring	63.46	5
2 x Single Circuit Narrow, 1 x 3	DC	Delta	41.10	2
	60 kV	Delta	28.98	2
	DC	Salt Spring	54.60	4
2 x Single Circuit Flat Steel Lattice, 1 x 3	DC	Delta	85.91	8
	60 kV	Delta	80.01	7
	DC	Salt Spring	72.38	7
Double Circuit H-frame 4 x 2 x 2	DC	Delta	44.01	3
	60 kV	Delta	33.47	3
	DC	Salt Spring	52.71	3
Double Circuit lattice steel, 3 x2	DC	Delta	47.23	4
	60 kV	Delta	41.33	5
	DC	Salt Spring	50.85	2
Double circuit steel pole davit arm, 3 x 2	DC	Delta	37.11	4
	60 kV	Delta	31.21	5
	DC	Salt Spring	36.86	2
Double circuit steel pole, braced post, 3 x 2	DC	Delta	29.02	1
	60 kV	Delta	16.58	1
	DC	Salt Spring	29.66	1
	DC	Salt Spring	35.48	1

On the basis of SRW usage, the double circuit steel pole, braced post, 3 x 2 design requires the least area in respect to all model locations and adjacent circuit cases. The remaining types vary according to the situation. For example, the double circuit steel pole davit arm design is best for the longer spans found on Salt Spring Island and the easterly part of Vancouver Island.

5.0 COMPARISON OF STRUCTURE TYPES

Comparison and evaluation of the different types includes the technical and the visual. The siting depends on natural constraints such as land use

Evaluation Criteria	H-frame single circuit wood pole	H-frame single circuit steel pole	Braced post single circuit "narrow" steel pole	Single circuit lattice steel	Double circuit wood/ steel pole H-frame	Double circuit lattice steel	Double circuit steel pole, davit arm	Double circuit steel pole, braced post
Span Lengths								
Normal span length (m)	225	300	175	400	225	400	400	225
No. Structure/ km	4.4	3.3	5.0	2.5	4.4	2.5	2.5	4.4
Dimensions								
Overall Height (m)	17	20	28	24	28	45	45	32
Finished Base Area (m^2)	6.6	9.9	1.3	162	12.6	81	1.8	0.6
Disturbed Base Area (m^2)	16.5	22	6.3	512	28	144	7.1	3.1
Overall width, 2 cct (m)	32	32	22	46	20	12.5	10.6	6
Flexibility								
Staged Development	Yes	Yes	Yes	Yes	No	Yes except structure	Yes except structure	No
RI, AN & EMF								
RI	Not a factor because transmission line components are designed to meet standards.							
AN	Not a factor because transmission line components are designed to meet standards.							
EMF	3	3	3	3	1	2	2	2
Costs (structure component only)								
Tangent Str.	$16K	$25K	$20K	$60K	$30K	$100K/km	$120K	$80K/km
1 circuit	$100K/km	$120K/km	$150K/km	$150K/km	-	-	-	-
2 circuits	$200K/km	$235K/km	$300K/km	$300K/km	$250K/km	$575K/km	$470K/km	$560K/km

6.0 EVALUATION CONCLUSIONS

Considering the objectives outlined in the introduction, the initial proposal to use a double-circuit, braced-post steel pole design for the Vancouver Island Transmission Reinforcement project remains valid. Throughout the length of the existing right-of-way, the public and BCTC/BC Hydro have been at odds over vegetation management on the corridor, especially in Tsawwassen. The proposal to install the braced post narrow configuration steel poles meets the following goals:

- Reduce environmental impact
- Improve visual appearance
- Reduce required vegetation management on the ROW
- Reduce electro-magnetic field (EMF), where practical.

Though the initial cost for this type of structure will be greater than some of the alternatives, the long term environmental, visual and land use impacts will be less.

Appendix C

Preliminary Layout and Design Brief

VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT
PROJECT: VITR

PRELIMINARY LAYOUT AND DESIGN BRIEF

ENGINEERING

BC hydro

Report No. E377

June 2005

VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT
PROJECT: VITR

PRELIMINARY LAYOUT AND DESIGN BRIEF

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Disclaimer

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VANCOUVER ISLAND TRANSMISSION REINFORCEMENT PROJECT
PROJECT: VITR

PRELIMINARY LAYOUT AND DESIGN BRIEF
BC HYDRO ENGINEERING REPORT NO. E377

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Preface

The purpose of this report is to summarize preliminary design assumptions and layout for the staged replacement and upgrade to 230 kV of the existing 138 kV transmission system between Arnott (ARN) Substation in Delta, BC and Vancouver Island Terminal (VIT), in North Cowichan, BC on Vancouver Island.. This preliminary layout is not the final design. The purpose is to prove technical feasibility, provide reference for public consultation, environmental studies and agency referrals and in support of the project cost estimates.. The design basis in this Design Brief is founded on CSA, BC Hydro Transmission Engineering and industry standards.

1.0 REFERENCES

References for the design and construction specifications for Vancouver Island Transmission Reinforcement Project, are contained in the following documents:

- Comparison Of Alternative Structure Configurations And Placement In Existing Right-Of-Way, BC Hydro Engineering Report No. E377.
- Design Wind and Ice Loads, BC Hydro Engineering Report No. E313.
- Hazard Risk Assessment Report, BC Hydro Engineering Report No. E342.
- Preliminary Soil Report for Steel Pole Structure Foundations, BC Hydro Engineering Report No. E326
- Preliminary Steel Pole Foundation Design and Cost Estimates, BC Hydro Engineering Report No. E378
- Type S , T and A Towers Structural Assessment Report, BC Hydro Engineering Report No. E375
- Ground Resistivity Review, BC Hydro Engineering Report No. E380
- Preliminary Access Assessment for R/W Preparation, BC Hydro Engineering Report No. E7030
- Review of impacts on vegetation management in the ROW (See Preliminary Vegetation Assessment for R/W Preparation, BC Hydro Engineering Report No. E7031).
- CAN/CSA-015-90, Wood Utilities poles and reinforced stubs
- CAN/CSA-C22.3 No.1-M01, Overhead Systems
- CAN/CSA-O86.1M, Engineering Design in Wood (Limit Based Design)
- CSA/CAN3-G12-92, Zinc Coated Steel Wire Strand
- Design Guide (Draft), Wood Pole Structures (Draft), A. Zolotoochin, BC Hydro.
- Handbook of Steel Construction, Canadian Institute of Steel Construction
- ASCE (1990) Guide for Design of Steel Transmission Pole Structures
- ANSI/ASCE (1991), Design of Latticed Steel Transmission Towers, ANSI/ ASCE Standard 10-90
- ASCE (1988), Guide for Design of Steel Transmission Towers, ASCE Manual 52
- ASCE (1995), Guide for Design of Guyed Transmission Structures
- BC Hydro, Transmission Engineering Standards

2.0 LINE DESCRIPTION

The proposed construction will ultimately consist of two 230 kV circuits, each rated a 600 MVA. It is proposed to complete the circuits in two stages. In 2008, the first circuit will be commissioned with the second circuit following approximately 10 years later. To minimize the impacts of the project, it is proposed that the overhead portion of the two circuits be constructed as a double circuit transmission line. The project will remove both existing 138 kV single-circuit lines and install one new double-circuit 230 kV steel pole line. For the first stage, one of the two overhead circuits will be operated at 138 kV supplying SAL on Salt Spring Island and GLS on Galiano Island. This circuit will operate at 138 kV, but will be constructed to the same 230 kV standards as the other circuit.

2.1 Length of Route

The length of the route sections comprising the existing 138kV corridor over which the 230 kV replacement construction will be located is as follows:

Section	Distance (km)

ARN to EBT, *Mainland, overhead and buried cable*	12.4
EBT to TBY, *Georgia Strait, undersea cable*	23.5
TBY to MTG, *Galiano Isl., overhead*	5.0
MTG to MBO, *Tincomali Channel, undersea cable*	3.9
MBO to VIT, *Saltspring and Vancouver Isl., overhead*	21.9
Total, overhead and buried or undersea cable	66.7

The overhead construction between ARN and EBT terminates in the vicinity of TSW 60 kV substation and comprises 8.7 of the 12.4 km between ARN and EBT. In total the overhead construction is over a 35.6 km length.

2.2 Route Plan and Description

The route is shown on Orthophotos, Drawing 2L129-T07-D1, Sheets 1 to 24.

2.3 Right-of-Way Width

The existing 138 kV right-of-way is 53.34 m in width. From ARN to TSW it abuts rights-of-way for the DC1 and DC2 circuits and 60 kV circuits. On Saltspring Island the right-of-way again abuts the roght-of-way for the DC1 and DC2 circuits from MBO to the middle of the Island and on Vancouver Island from the west side of Sansum Narrows through to Maple Mountain. To minimize impacts, it is proposed to compact the proposed 230 kV construction with adjacent circuit rights-of-way wherever possible.

2.4 Circuit No.

It is proposed to identify the proposed 230 kV circuits as 2L129 and 2L130.

2.5 Loading Zones

There is only one loading zone. The ice and wind loading is the subject of BC Hydro Engineering Report No. E313, September 2004, titled Proposed 230 kV Transmission Line Arnott – VIT – Sahtlam, Design Wind and Ice Loading. The project specifications specify that the new 230 kV construction be designed for a 1 in 200 year return period. Report No. E313 recommends that the 1 in 200 year return period the following wind pressures and ice loading:

- 0.385kN/m^2 wind pressure, 12.7 mm radial ice for regular towers and
- 0.575kN/m^2 wind pressure, 12.7 mm radial ice for the Sansum Narrows crossing towers.

2.6 Special Crossings

Special crossings requiring high strength conductor to minimize conductor sag are required over Montague Harbour between Galiano and Parker Islands and over Sansum Narrows between Salt Spring and Vancouver Islands.

2.7 Substations/Taps

The proposed 230 kV double circuit transmission line will terminate at ARN (Arnott) substation in Ladner (Delta) and at VIT (Vancouver Island Terminal) near Duncan. For the first stage the second 230 kV overhead circuit will connect to existing 230 kV taps at both SAL (Salt Spring) 138/25 kV Substation on Salt Spring Island near Ganges and GLS (Galiano Substation) 138/25 kV Substation on Galiano Island near Taylor Bay. All existing taps are single circuit wood pole construction. The taps are presently individual taps to 1L17 and 1L18. With removal of one 138 kV circuit between ARN and VIT, these taps will become loops from the remaining 138 kV (230 kV overhead construction) circuit. Both SAL and GLS are physically located to the south of the 138 kV corridor. To minimize impacts of connecting the 230 kV construction (138 kV operating) to the existing taps, the operating 230 kV circuit should be located on the north side of the double circuit towers.

2.8 Conductor Types and Structure Configuration

1. Conductor Type

   Regular Construction
   - Existing 138 kV Conductor: Single 241.7 mm^2 26/7 ACSR "Hawk" (1 x 477.0 kcmil)
   - Proposed 230 kV Conductor: Single 805.9 mm^2 45/7 ACSR "Lapwing" (1 x 1590.0 kcmil)

   Special Crossings
   - Existing 138 kV Conductor: Single 238.3 mm^2 54/37 ACSR "Special" (1 x 477.0 kcmil)
   - Proposed 230 kV Conductor: Two bundle 238.3 mm^2 54/37 ACSR "Special" (2 x 477.0 kcmil)

2. Structure Configuration

   Regular Construction
   - Double circuit, single steel pole narrow with braced composite post composite insulators for tangent suspension structures,
   - Double circuit, guyed two steel pole narrow with braced post composite insulators, for medium angle suspension structures,
   - Double circuit, guyed two steel pole narrow with braced post composite insulators, for medium and heavy angle dead-end structures,
   - Two pole H/F and 3-wood pole dead-end, with and without groundwire.
   -

2.9 Groundwire Type and Configuration

At this time overhead groundwire is proposed for the substation terminations at ARN and VIT to BC Hydro standards which require the groundwire to extend for a minimum of three structures out from the station terminal structure or 500 m, whichever provides the greatest length.

The overhead groundwire is Size 9 7W Grade 1300 (9.14 mm OD). To provide effective shielding and minimize the top height of the tangent pole, it is proposed to attach the overhead groundwire to short davit arms extending from the centre pole. The overhead groundwire will be attached to each of the two poles of dead-end structures.

To aid in the determination whether is practical and effective to install continuous overhead shield wire, ground resistivity measurements were taken at representative locations along the 138 kV corridor. The measurements provide an indication as to the scope of work required to provide adequate structure grounding (reduce to 10 ohms) to make the overhead shield wire effective.

Alternatives to continuous or station only overhead groundwire to improve performance and equipment protection include the installation of overhead groundwire in critical locations, the installation of lightening arrestors or differential insulation to make one of the two circuits a sacrificial circuit in the case of lightening.

2.10 Conductor Ampacity

Design clearances shall be base upon a summer ambient of 30^{o}C, 0.6 m/sec (2'/sec) wind, for the thermal capacity of the conductor which is 100^{o}C.

Parameters used in the determination of the conductor ampacity are as follows:

Standard Conditions

Emissivity:	50%
Absorption:	50%
Wind:	0.6 m/sec (2'/sec) @ 90^o to line
Cloud/ Pollution:	4.0 factor
Elevation:	600 m (2,000')
Location:	49^{o}N, 123^{o}W
Summer ambient:	30^{o}C July 18:00 hrs
Winter Ambient:	10^{o}C December 18:00hrs

Conductor Rating

For 600 MVA, 0.95 pf, the required ampacity of the conductor is 1500 A. The charging current of the buried and undersea cables, adds approximately 125 A to the required ampacity from ARN to TBY for a total of 1625 A. The balance of the overhead line,,from TBY to VIT, needs only 1500 A.

3.09 Communication Fibre

An optical communication fibre may be installed from ARN to VIT as 1) an underbuilt ADSS cable or 2) if overhead shield wire is installed, then a OPGW (Optical Ground wire) attached in place of one of the two overhead shield wires.

Specifications for the fibre have not been specifically identified at this time. For estimate purposes, assume a 48 fibre ADSS cable. See Section 4.0 for data and loads and limiting conditions.

3.0 ROUTING

3.1 Route Plan

The route is shown on Orthophotos, Drawing 2L129-T07-D1, Sheets 1 to 24.

3.2 Loading Zones

The following table outlines the proposed conductor and structure loading:

Condition	Loading (Design)	Remarks
Regular Construction		
Maximum Ice and Wind on Conductor and Groundwire	12.7 mm radial ice, 0.385kN/m^2 Wind Pressure @ -18^{o}C conductor temperature	Equivalent to CSA Heavy, glaze ice, 0.9 N/m^3 density
Maximum Wind on Conductor and Groundwire	40 m/s (0.57 kN/m^2) wind @ -18^{o}C conductor temperature	Maximum wind, bare conductor
Wind on Structure	1.5 x maximum wind or 0.90 kN/m^2	
Ice on insulator assemblies	Bare mass x 1.5	
Ice/snow on structure	No allowance	
Special Crossings		
Maximum Ice and Wind on Conductor and Groundwire	12.7 mm radial ice, 0.57kN/m^2 Wind Pressure @ -18^{o}C conductor temperature	Equivalent to CSA Heavy, glaze ice, 0.9 N/m^3 density
Maximum Wind on Conductor and Groundwire	40 m/s (0.57 kN/m^2) wind @ -18^{o}C conductor temperature	Maximum wind, bare conductor
Wind on Structure	1.5 x maximum wind or 0.90 kN/m^2	
Ice on insulator assemblies	Bare mass x 1.5	
Ice/snow on structure	No allowance	

See Section 4.0 for conductor and groundwire loads and limiting conditions and Section 9.1 for Layout Load Checks on structures.

3.4 Right-of-Way Cross Sections

“Before” and “After” right-of-way cross sections are provided in Appendix C.

3.5 Minimum Off-sets from Highways and Roads

Minimum highway and local road clear zone requirements shall be in accordance with the provincial MOT Utility Policy Manual, latest revision. The clear zone is based on the applicable standard, e.g divided freeway, and the design speed. For example, a major local road on the islands may require 6 m whereas as divided highway could be up to 10 m.

3.6 Potential Hazards

Potential hazards to the integrity of the line are identified in Hazard Risk Assessment Report, BC Hydro Engineering Report No. E342.

3.7 Individual Structure Requirements

a) Specific locations

Specific proposed structure locations for preliminary layout have been identified as listed below. This is in addition to matching existing PI's (angle structure sites) of the existing 138 kV circuits.

T/L Location/ Reference	Specific Location Details
ARN to Hwy. #17,adjacent to DC Circuits (Delta)	Match step proposed 230 kV structures with existing DC lattice steel structures and at mid-span to mitigate increased sag of conductor
TBY to MTG (Galiano Island)	Attempt to locate proposed 230 kV structures in step with the existing 138 kV sites to minimize access road re-development
37.65 km to 39.5 km (Montague Harbour)	Investigate re-use of 138 kV single circuit structures/ or sites (Str. 23/3, 24/1, 24/2 and 24/3) for proposed 230 kV in single circuit configuration
47.7 km (Salt Spring Island)	Locate structure on south-east corner of intersection of Upper Ganges Rd. and Long Harbour Rd. adjacent to Str. 30/3 – 1L17
48.0 km (Salt Spring Island)	Locate structure on south side of Leisure Lane between Str. 30/4 – 1L17 and the road
48.5 km (Salt Spring Island)	Locate structure on west side of Kings Lane adjacent to Str. 30/5 – 1L17 and the road. The site is in conflict with a temporary building located between DC1 and 1L17. Check conditions of approval of the temporary building
48.5 km (Salt Spring Island)	If required do not locate structure in the cultivated field between Norton Rd. and Str. 31/1-1L17. Locate any new structure on the east side of Norton Road.
49.7 km (Salt Spring Island)	Locate proposed 230 kV structure in centre of the SAL tap point.
49.9 km (Salt Spring Island)	Locate structure adjacent to Str. 31/5 – 1L17 to avoid altering use of property for commercial business
53.8 km (Salt Spring Island)	If possible, avoid placing proposed structure in direct view from cabin located east of 138 kV R/W
61.3 km to VIT (Vancouver Island)	Cultivated land, attempt to maximize match-stepping of proposed 230 kV structures with sites for existing 138 kV structures, unless otherwise identified by consultation/ discussions with property owners (Str. 38/3-1L17 to VIT)

b) Switches

Not applicable

c) Temporary Connections

Temporary overhead connections will be required for maintaining supply to GLS and SAL Substations during construction and until such time as a second 230 kV circuit can be energized.

– ARN Substation 138 kV Connection, construct a 3-phase wood pole tap from the vicinity of 1L18 Str. 0/1 just outside the 138 kV substation and to the line left set of conductors of the proposed 230 kV

– TSW Cable Terminal, connect the 230 kV conductors to the existing 1L18 conductors on the proposed terminal structure and jumper through the dead-end to 1L18 on the south side.

– EBT Cable Terminal, Maintain 1L18 at EBT

– TBY Cable Terminal, tap the south 230 kV conductors terminated on new 230 kV type terminal structure to 138 kV potheads. Install single phase “Hawk” tap span across the incoming face of the station. Note, it is proposed to rotate the relative position of the operating circuits at TBY, e.g move operating 138 kV from north to south side and move operating 230 kV from south to north side.

– GLS 138 kV Substation, relocate and reconfigure the 3-phase wood pole 138 kV taps for expansion and relocation of the TBY cable terminal and to loop circuit 1L18 (left side 230 kV conductors into GLS

– MTG Cable Terminal, tap the south 230 kV conductors terminated on new 230 kV type terminal structure to 138 kV potheads. Install single phase “Hawk” tap span across the incoming face of the station

– MBO Cable Terminal, tap the south 230 kV conductors terminated on new 230 kV type terminal structure to 138 kV potheads. Install single phase “Hawk” tap span across the incoming face of the station

– SAL 138 kV Substation, connect existing 138 kV taps to loops from south 230 kV conductors operating at 138kV. This will require the installation of an in-line disconnect between each leg of the loop.

– VIT Substation, connect south 230 kV conductors to 1L18 bus.

3.8 Crossings List and Special Requirements

a) NWPA Crossings

See Section 9.3 for vertical clearance requirements. The Ministry of Transport, Canadian Coast Guard, Navigable Waters will decide on the basis of potential navigability whether application for exemption and application of NWPA minimum clearance requirements outlined in Section 9.3 is required.

Existing NWPA exempted crossings spanned by the 138 kV circuits are limited to Montague Harbour, Str. 23/3 – 1L18/18 to Str. 24/3 – 1L17/18 and Sansum Narrows, Str. 34/4 – 1L17/18 to Str. 35/1 – 1L17/18.

b) Airways and Airports

As a matter of normal procedure over Navigable Waters, all applications for exemption under NWPA are referred to the Federal Ministry of Transport, Airways for aerial hazard assessment.

The Boundary Bay Airport is the only known aerodrome facility in proximity to the 138 kV alignment.

The existing DC1/2, 138 kV and 60 kV corridor passes 1.6 km west of north-west corner of the Boundary Bay airport. The glideway extending from the east-west runway passes over DC1/2 spans 0/3 – 8/4 and 1L17/18 spans 0/6 – 0/7. In this section, the alignment for the proposed 230 kV will be west of the DC1/2 line. The existing circuits are not marked in any manner.

The existing 138 kV lines are provided with aircraft warning marking in the following locations:

Montague Harbour

- Marker spheres attached to the conductors of all four spans.
- Structures for 23/3, 24/1, 24/2 and 24/3 are painted in alternative bands of international orange and white. The condition of this painting is faded. Check crossing records for possible operational exemption to not maintain painting in lieu of marker spheres attached to the conductors

Howell Lane, Salt Spring Island

- Marker spheres attached to the conductors of the span of 1L18 between Str. 30/4 and 30/5. The conductors are very low in this location and do not appear to pose a hazard. The Lady Minto/Gulf Islands Hospital, located at 135 Crofton Road on Saltspring Island. The marked span is on the north approach to the hospital which is approximately 1 km south of the transmission corridor. The DC1/2 circuit which is higher in elevation than the 138 kV lines is not marked.

Toinbee Valley, Salt Spring Island

- The span between 1L17/18 structures 32/5 and 32/5A (long span decent to valley bottom) is marked.

Sansum Narrows

- Marker spheres attached to the conductors.
- Structures for 34/4 and 35/1 are painted in alternative bands of international orange and white. The condition of this painting is faded. Check crossing records for possible operational exemption to not maintain painting in lieu of marker spheres attached to the conductors
- Marker panels are installed on the shorelines of Saltspring Island and Vancouver Island.

c) Electrical Facilities

The proposed route crosses or parallels existing electrical facilities as follows:

Parallel Facilities

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
0.2 – 3.63 km	DC1/2	To the east of proposed 230 kV, maintain adequate clearance, check clearance from guys to DC conductors for right LA.of230 kC structures
0.2 – 3.63 km	60L58 and 60L59	To the west of proposed 230 kV
3.63 – 5.94 km	DC1/s	To the north of proposed 230 kV, maintain adequate clearance, check clearance from guys to DC conductors for left LA. of 230 kV structures
3.63 – 5.94 km	60L58 and 60L59	To the north of DC1/2.
5.94 – 8.20 km	DC1	To the east of proposed 230 kV, maintain adequate clearance, check clearance from guys to DC conductors for left LA. of 230 kV structures
5.94 – 8.20 km	60L58 and 60L59	To the west of DC1
8.20 – 8.62 km	60L58 and 60L59	To the west of proposed 230 kV, check clearance from guys to DC conductors for left LA. of 230 kV structures
Galiano/ Parker Islands		
35.05 – 35.72 km	Distribution line	D/L is off-set 24.5 m south of center of 138 kV R/W
Salt Spring Island		
44 – 60.7 km	DC1/2	Proposed 230 kV is to the west/ south of DC1/2
44 – 60.7 km	LN1 (DC metallic return)	LN1 is on the DC R/W to the east/ north of DC1/2 located on single wood poles
Vancouver Island		
56.53 – 59.9 km	DC1/2	Proposed 230 kV is to the south of DC1/2
65.0 – 65.75 km	DC1/2	Proposed 230 kV is to the south of DC1/2
51.30 – 65.75 km	Metallic Return/ Sea Retrun for DC	Proposed 230 kV is to the north of these lines located on single wood poles
65.33 – 65.75 km	1L139 (Crofton)	Proposed 230 kV is to the north of this single circuit wood pole line

Crossed Facilities

The electric facilities listed below are crossed by the proposed 230 kV alignment. The current DEM data does not include wire or pole detail. The LIDAR survey will contain the required data. It will be necessary to carry out a field survey to re-affirm this list and to include service connections:

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
0.33 km, Ladner Trunk Rd.	distribution line	230 kV aerial crossing
0.7 km, Holly Park Drive	distribution line	230 kV aerial crossing
2.77 km, 36th Ave.	distribution line	230 kV aerial crossing
3.85 km, 64th St.	distribution line	230 kV aerial crossing
6.0 km, Delta Port Way	distribution line	230 kV aerial crossing, possible conflict with poles by guys
6.67 km, 28th Ave.	distribution line	230 kV aerial crossing
8.19 km, Hwy. #17	60 kV circuits 60L58 and 60L59	230 kV aerial crossing, Str. No. 9/1 of 60L58 under right 230 kV circuit . May need to relocate 60L59 around west side of DC1 Str. 4/4 so 60L58 can use present 60L59 alignment east of DC1 Str. 4/4.
Galiano/ Parker Island		
35.72 km, Galiano Way Rd.	distribution line	230 kV aerial crossing
36.76 km	DC2	Proposed crossunder of DC2 by proposed 230 kV in single circuit configuration
36.8 km	DC1	Proposed crossunder of DC1 by proposed 230 kV in single circuit configuration
35.58 km, Porlier Pass Drive	distribution line	230 kV aerial crossing
37.8 km, Montague Park Rd.	distribution line	230 kV aerial crossing
39.3 km, Parker Island Road	distribution line	230 kV aerial crossing
Salt Spring Island		
44.81 km	distribution line	230 kV aerial crossing
45.98 km	distribution line	230 kV aerial crossing
46.89 km	distribution line	230 kV aerial crossing
47.56 km, Long Harbour Rd.	distribution line	230 kV aerial crossing
47.71 km, Upper Ganges Rd.	distribution line	230 kV aerial crossing
47.85 km, Leisure Lane	distribution line	230 kV aerial crossing
48.12 km, Leisure Lane	distribution line	230 kV aerial crossing
48.15 km	Private service connection?	230 kV aerial crossing
48.48 km	distribution line	230 kV aerial crossing
48.66 km	distribution line	230 kV aerial crossing

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
48.98 km	distribution line	230 kV aerial crossing
49.52 km	distribution line (service)?	230 kV aerial crossing
50.03 km	distribution line	230 kV aerial crossing
52.17 km	Gas pipeline	Location unknown, assumption only
Vancouver Island		
60.68 km	distribution line	230 kV aerial crossing
61.27 km	distribution line	230 kV aerial crossing
62.14 km	distribution line	230 kV aerial crossing
62.65 km	distribution line	230 kV aerial crossing
63.81 km	distribution line	230 kV aerial crossing
65.28 km	138 kV T/L	230 kV aerial crossing of 1L139 (Crofton)
65.73 km	distribution line	230 kV aerial crossing

c) Gas Pipelines (High Pressure)

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
Delta Port Way	Gas pipeline	Location unknown, assumption only
Hwy. #17 near TSW Sub.	Gas pipeline	Location unknown, assumption along south side of Hwy.
Galiano/ Parker Island		
None		
Saltspring Island		
None		
Vancouver Island		
None		

d) Highways and Roads

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
0.35 km	Hwy. #10 (Ladner Trunk Rd.)	Aerial crossing by 230 kV
0.7 km	Holly Park Road	Local road
2.17 km	Farm Road	Private road, check equipment height for any special requirements
2.77 km	36th Ave.	Local road
3.32 km	Farm road	Private road, check equipment height for any special requirements
3.47 – 3.58 km	Farm roads (3)	Private road, check equipment height for any special requirements
3.87 km	64th St.	Local road
4.53 km	Delta Port Way, north bound on ramp to Hwy. #17	Aerial crossing by 230 kV, possible changes as a result of Gateway Project
	Hwy. #17	Highway overpass approx. 5 m above grade
4.75 km	Delta Port Way, south bound exit ramp from Hwy. #17	Aerial crossing by 230 kV, possible changes as a result of Gateway Project
5.1 km	57B St.	Local road
5.69 km	Farm road	Private road, check equipment height for any special requirements
6.02 km	Delta Port Way	Aerial crossing by 230 kV, possible changes as a result of Gateway Project
6.68 km	28th Ave	Local Road
7.25 km	Farm road	Private road, check equipment height for any special requirements
7.50 km	Farm road	Private road, check equipment height for any special requirements
7.85 km	Road Allowance	
8.22 km	Hwy. #17	Maintain adequate set back from Hwy. R/W to allow for future widening.
Galiano/ Parker Island		
35.0 km	GLS access road	Private (BC Hydro) road, access through to GLS substation. Road to be relocated approximately 25 m west to accommodate changes/ additions and TBY cable terminal
35.7 km	Galiano Way Rd.	Local road
35.58 km,	Porlier Pass Drive	Local road
37.8 km,	Montague Park Rd.	Park access road
39.3 km,	Parker Island Road	Local road
39.4 km,	Parker Island Road	Local road
39.5 km,	Parker Island Road	Local road
39.7 km,	Parker Island Road	Local road
Saltspring Island		

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
44.09 – 45 46 km	Local/RW access roads	Local road/ driveway
45.97 km	Local/RW access road	Local road/ driveway
46.09 km	Local/RW access road	Local road/ driveway
46.23 km	Local/RW access road	Local road/ driveway
46.42 km	Local/RW access roads	Local road/ driveway
46.47 km	Local/RW access road	Local road/ driveway
46.51 km	Local/RW access road	Local road/ driveway
46.63 km	Local/RW access road	Local road/ driveway
46.89 km	Local/RW access roads	Local road/ driveway
46.95 km	Local/RW access road	Local road/ driveway
47.12 km	Local/RW access road	Local road/ driveway
47.17 km	Local/RW access road	Local road/ driveway
47.31 km	Local/RW access road	Local road/ driveway
47.58 km	Long Harbour - Vesuvius Bay Road	Local arterial road
47.73 km	Upper Ganges Road	Local arterial road
47.87 – 48.08 km	Leisure Lane	Local road
48.15 km	Driveway	Driveway
48.13 km	Howell Rd.	Local road
48.47 km	Kings Rd.	Local road
48.66 km	Norton Rd.	Local road
48.99 km	Lower Ganges Rd.	Local arterial road
49.49 km	Driveway from Sharpe Rd.	Driveway
49.57 km	Sharpe Rd. allowance	Road allowance
50.0 km	Rainbow road	Local arterial road
50.0 – 50.16 km	Local/RW access road	Driveway
50.2 km	Local/RW access road	Local road/ driveway
50.36 km	Local/RW access road	Local road/ driveway
50.39 km	Local/RW access road	Local road/ driveway
50.47 km	Local/RW access road	Local road/ driveway
50.58 km	Local/RW access road	Local road/ driveway
50.65 km	Local/RW access road	Local road/ driveway
50.75 km	Local/RW access road	Local road/ driveway
50.85 km	Wilkie Rd.(allowance)	Local road/ driveway/ road allowance
51.01 km	Local/RW access road	Local road/ driveway
51.05 km	Local/RW access road	Local road/ driveway
51.16 km	Local/RW access road	Local road/ driveway

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
51.21 km	Local/RW access road	Local road/ driveway
51.87 km	Local/RW access road	Local road/ driveway
52.17 km	Toinbee Rd.	Local road
52.53 km	Road	Farm road
52.60 km	Road	Farm road
52.91 km	Local/RW access road	Local road/ driveway
53.0 km	Local/RW access road	Local road/ driveway
53.18 km	Local/RW access road	Local road/ driveway
53.44 km	Local/RW access road	Local road/ driveway
53.55 km	Local/RW access road	Local road/ driveway
53.66 km	Local/RW access road	Local road/ driveway
53.79 km	Local/RW access road	Local road/ driveway
Vancouver Island		
56.77 km	Local/RW access road	Local road/ driveway to reservoir building on R/W?
56.83 km	Local/RW access road	Local road/ driveway
57.52 km	Local/RW access road	Local road/ driveway
57.94 km	Local/RW access road	Local road/ driveway
58.48 km	Local/RW access road	Local road/ driveway
58.70 km	Local/RW access road	Local road/ driveway
59.20 km	Local/RW access road	Local road/ driveway
59.30 km	Local/RW access road	Local road/ driveway
59.40 km	Local/RW access road	Local road/ driveway
59.84 km	Local/RW access road	Local road/ driveway
59.89 km	Local/RW access road	Local road/ driveway
60.38 km	Driveway	Farm Road
60.40 km	Driveway	Farm Road
60.69 km	Osbourne Bay Rd.	Local arterial road
61.14 km	Farm Rd.	Private Rd.
61.21 km	Drive way	Private Rd.
61.27 km	Local Rd.	Local Rd.
61.96 km	Drive way	Private Rd.
62.14 km	Local Rd.	Local Rd.
62.65 km	Richardson Rd.	Local Rd.
63.29 – 63.52 km	Parallel Farm Rd.	Private Rd.
63.81 km	Mays Rd.	Local Rd.
65.0 km	Drive way	Private Rd.

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
65.12 km	Farm Rd.	Private Rd.
65.31 km	Farm Rd.	Private Rd.
65.72 km	McKinnon Rd.	Local Road

e) Railways

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
6.07 km	BC Rail to Delta Port	Require crossing permit from BC Rail
Galiano/ Parker Islands		
None		
Saltspring Island		
None		
Vancouver Island		
None		

Note: A detail survey of all railway crossings is required for purposes of the railway application

3.09 Communication Facilities

Assume telephone (w/ messenger) and cable is underbuilt on a distribution line parallel situations and crossings. The following separate telephone/communication lines occur.

T/L Location or Other Reference	Feature	Impact/ Likely Mitigation/ Comments
Delta		
None known		
Galiano/ Parker Islands		
None known		
Salt Spring Island		
47.73 km Upper Ganges Rd.	Telus telephone aerial cables	230 kV aerial crossing
48.99 km Lower Ganges Rd.	Telus telephone aerial cables	230 kV aerial crossing
Vancouver Island		
65.72 km	McKinnon Rd.	230 kV aerial crossing

4.0 CONDUCTORS & GROUNDWIRES

4.1 Design Parameters

Limiting conditions outlined below provide the load factors related to mechanical loading applied on conductors and overhead groundwires by dead loads and live loads, e.g. tension due to ice, wind pressure and variance in conductor temperature.

Conductor and overhead groundwire temperatures for limiting conditions under 10% winter design temperature (WDT) and mean annual temperature (MA) are as follows:

10% WDT (final & initial):	0^{o}C
Mean annual temperature:	7.5 ^{o}C
Extreme cold (uplift)	-30 ^{o}C

Standard Conditions

Emissivity:	50%
Absorption:	50%
Wind:	0.6 m/sec (2'/sec) @ 90^{o} to line
Cloud/ Pollution:	4.0 factor
Elevation:	600 m (2,000')
Location:	49.1^{o}N, 123^{o}W to 48^{o}N, 123.7^{o}W
Summer ambient:	30^{o}C July 18:00 hrs
Winter Ambient:	10^{o}C December 18:00hrs

4.2 Conductor Types

The proposed regular 230 kV construction conductor type is a single 805.9 mm^2 45/7 ACSR "Lapwing" (1590 kcmil) per phase.

The alternative bundle bundle conductor for regular 230 kV construction is a two bundle single 337.9 mm^2 24/7 ACSR "Mica" (2 x 666.9 kcmil) per phase.

The proposed special conductor arrangement for the 230 kV spans over Montague Harbour and Sansum Narrows is a two bundle 238.3 mm^2 54/37 ACSR "Special" (2 x 470 kcmil).

The base conductor on the existing 138kV lines, circuits 1L17 and 1L18 is 241.7 mm^2 26/7 ACSR "Hawk". (477 kcmil).

4.3 Conductor Data and Characteristics

Lapwing Conductor

Description:	805.9 mm^2 45/7 ACSR "Lapwing" (1590 kcmil)
Aluminium area:	805.9 mm^2
Core Area:	55.7 mm^2
Total area:	861.6 mm^2
Aluminium content:	83.7%
Outside Diameter:	38.2 mm
Outside Diameter w/ armour rods:	60.25 mm

Stranding:	45 x 4.78mm, 7 x 3.18 mm
Rated RTS:	195,000 N
Material Type:	
Outer Layers:	1350 H-19
Core:	Grade 1300 (180)
Modulus of elasticity (N/mm^2 x 10^3):	65.50(EFIN) 53.09(EIL) 37.92(EIU)
Coefficient of linear expansion (/^{o}C x 10^{-6}):	20.88(AFIN) 20.34(AIL) 20.34(AIU)
AC Resistance @20^{o}C	0.03766 ohms/km
Bare Mass:	2.6602 kg/m

Loaded masses:

Loaded Masses				
Radial Ice * (mm)	Wind (kN/m^2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.7	0.385	44.2705	24.4860	50.5910
0	0.57	26.0877	21.7740	33.9805
12.7	0	44.2705	13.3560	44.2705
12.7	0.21	30.5018	11.2413	46.2412
0	0.21	26.0877	8.0220	27.2932
0	0	26.0877	0	26.0877

* - Density of 0.9 kg/m^3

Mica Conductor (Alternate)

Description:	337.9 mm^2 26/7 ACSR “Mica ACSR” (666.9 kcmil)
Aluminium (total) area:	337.9 mm^2
Core Area:	43.74 mm^2
Total area:	381.74 mm^2
Aluminium content:	73.2%
Outside Diameter:	25.40 mm
Outside Diameter w/ armour rods:	41.33 mm
Stranding:	24 x 4.23 mm, 7 x 2.82 mm
Rated RTS:	105,734 N
Modulus of elasticity (N/mm^2 x 10^3):	73.08(EFIN) 62.05(EIL) 44.82(EIU)
Coefficient of linear expansion (/^{o}C x 10^{-6}):	19.62(AFIN) 19.08(AIL) 17.64(AIU)
AC Resistance @20^{o}C	0.1176 ohms/km
Bare Mass:	1.2760 kg/m

Loaded masses:

Loaded Masses				
Radial Ice * (mm)	Wind (kN/m^2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.7	0.385	21.8689	18.1643	28.4287
12.7	0	21.8689	0	21.8689
0	0.57	9.5517	12.4146	24.0086
12.7	0.21	21.8689	11.2413	32.5073
0	0.21	9.5517	4.5738	10.5903
0	0	9.5517	0	9.5517

* - Density of 0.9 kg/m^3

SP470.3-54/37 Special (Special Crossings)

Description:	238.3 mm^2 54/37 ACSR "Special" (470 kcmil)
Aluminium (total) area:	238.3 mm^2
Core Area:	163.25 mm^2
Total area:	401.55 mm^2
Aluminium content:	59.3%
Outside Diameter:	26.07 mm
Outside Diameter w/ armour rods:	41.82 mm
Stranding:	54 x 2.37 mm, 37 x 2.37 mm
Rated RTS:	230,000 N
Modulus of elasticity ($N/mm^2 \times 10^3$):	105.49(EFIN) 89.63 (EIL) 86.18(EIU)
Coefficient of linear expansion ($/^oC \times 10^{-6}$):	15.12(AFIN) 14.40(AIL) 13.09(AIU)
AC Resistance @20^oC	0.111 ohms/km
Bare Mass:	1.9339 kg/m

Loaded masses:

Loaded Masses				
Radial Ice * (mm)	Wind (kN/m^2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.7	0.57	32.8148	29.3379	44.0173
12.7	0.385	32.8148	19.8160	38.3338
12.7	0	32.8148	0	32.8148
0	0.57	18.9651	14.8599	24.0934
12.7	0.21	32.8148	10.8087	34.5491
0	0.21	18.9651	5.4747	19.7395
0	0	18.9651	0	18.9651

* - Density of 0.9 kg/m^3

Hawk Conductor

Description:	241.7 mm^2 26/7 ACSR “Hawk” (477.0 kcmil)
Aluminium (total) area:	241.7 mm^2
Core Area:	39.3 mm^2
Total area:	281.0 mm^2
Aluminium content:	68.5%
Outside Diameter:	21.78 mm
Outside Diameter w/ armour rods:	34.48 mm
Stranding:	26 x 3.44 mm, 7 x 2.67 mm
Rated RTS:	86,400 N
Modulus of elasticity ($N/mm^2 \times 10^3$):	74.46(EFIN)
	55.16(EIL)
	46.88(EIU)
Coefficient of linear expansion ($/^oC \times 10^{-6}$):	18.9(AFIN)
	17.64(AIL)
	17.19(AIU)
AC Resistance @20^{o}C	0.1176 ohms/km
Bare Mass:	0.9740 kg/m

Loaded masses:

Loaded Masses				
Radial Ice * (mm)	Wind (kN/m^2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.7	0.385	21.8689	18.1643	28.4287
12.7	0	21.8689	0	21.8689
0	0.57	9.5517	12.4146	24.0086
12.7	0.21	21.8689	11.2413	32.5073
0	0.21	9.5517	4.5738	10.5903
0	0	9.5517	0	9.5517

* - Density of 0.9 kg/m^3

4.4 Conductor Loading and Limiting Conditions

Typically for single conductor 230 kV construction, vibration damping is not required, though performance of the circuit should be reviewed and depending upon exposure and span length vibration damping devises may be installed on a site-specific basis. Armour rods are provided for all suspension assemblies. For steel tower single conductor lines it has been practice to use higher conductor tensions to increase span length or reduce structure height and weight. This results in the need to provide damping near suspension assemblies and dead-ends. Bundle conductors are always provided with spacer dampers but rarely with armour rods in suspension assemblies.

Loading and limiting conditions for all proposed, alternative and existing conductor types based on BC Hydro Transmission Engineering Standards are provided below. The vibration protection systems assumed are identified in the “remarks” column.

In a typical span the “Lapwing” conductor will sag1 to 1.2 m more than the alternative “2B – Mica ACSR” conductor.

805.9 mm^2 45/7 ACSR "Lapwing" (1590kcmil), RTS = 195,000 N (Proposed Regular Construction)

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.385	-18	Final	50	Max. Design Loading
2	0	0.57	-18	Final	50	Maximum Wind Bare Conductor
3	0	0	0	Initial	28	10% Winter Design Temp. (WDI), with armour rods and vibration dampers
4	0	0	7.5	Final	22	Mean Annual, with armour rods and vibration dampers
5	0	0	0	Final	25	10% Winter Design Temp. (WDF), with armour rods and vibration dampers
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.7	0.285	- 18	Final		Insulator Swing (1.2 m absolute limit clearance)
8	0	0.21	-18	Final		Insulator Swing (1.8 m normal clearance)
9	0	0	15	Final		Phase spacing
10	0	0	15	Final		Clearance to groundwire
11	0	0.21	40	Final		Swing, sidehill clearance
12	0	0	40	Final		R/W Edge Distance & Circuit-Circuit
13	0	0	100	Final		Max. Conductor Sag

337.9 mm^2 24/7 ACSR "Mica" (666.9 kcmil), RTS = 106,000 N (Alt. Regular Construction)

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.385	-18	Final	50	Max. Design Loading
2	0	0.57	-18	Final	50	Maximum Wind Bare Conductor
3	0	0	-15	Initial	31	10% Winter Design Temp. (WDI), with spacer dampers
4	0	0	10	Final	23	Mean Annual, with spacer dampers
5	0	0	-15	Final	28	10% Winter Design Temp. (WDF), with spacer dampers
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.7	0.285	- 18	Final		Insulator Swing (1.2 m absolute limit clearance)
8	0	0.21	-18	Final		Insulator Swing (1.8 m normal

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^oC)	Condition	Limiting Tension (%RTS)	Remarks
						clearance)
9	0	0	15	Final		Phase spacing
10	0	0	15	Final		Clearance to groundwire
11	0	0.21	40	Final		Swing, sidehill clearance
12	0	0	40	Final		R/W Edge Distance & Circuit-Circuit
13	0	0	100	Final		Max. Conductor Sag

238.3 mm^2 54/37 ACSR "Special" (470 kcmil), RTS = 230,000 N (Proposed)

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^oC)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.385	-18	Final	50	Max. Design Loading
2	0	0.57	-18	Final	50	Maximum Wind Bare Conductor
3	0	0	0	Initial	34	10% Winter Design Temp. (WDI), based on 138 kV design criteria, with armour rods, vibration dampers and spacer dampers
4	0	0	7.5	Final	28	Mean Annual based on 138 kV design criteria, with armour rods, vibration dampers and spacer dampers
5						
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.7	0.285	- 18	Final		Insulator Swing (1.2 m absolute limit clearance)
8	0	0.21	-18	Final		Insulator Swing (1.8 m normal clearance)
9	0	0	15	Final		Phase spacing
10	0	0	15	Final		Clearance to groundwire
11	0	0.21	40	Final		Swing, sidehill clearance
12	0	0	40	Final		R/W Edge Distance & Circuit-Circuit
13	0	0	100	Final		Max. Conductor Sag

241.7 mm^2 26/7 ACSR "Hawk" (477.0 kcmil), RTS = 86,400 N (Existing 138 kV Wood Pole Conductor)

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^oC)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.38	-18	Final	20.6	Max. Design Loading (17.7 kN)
3	0	0	0	Initial	23	10% Winter Design Temp. (WDI)
4	0	0	7.5	Final	20	Mean Annual

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
5	0	0	0	Final	17	10% Winter Design Temp. (WDF)
6	0	0	-30	Initial		Extreme Cold Temperature
7	12.7	0.21	- 18	Final		Insulator Swing (1.1 m absolute limit clearance)
8	0	0.21	-18	Final		Insulator Swing
9	0	0	15	Final		Phase spacing
10	0	0.21	40	Final		Swing, sidehill clearance
11	0	0	40	Final		R/W Edge Distance & Circuit-Circuit
12	0	0	70	Final		Max. Conductor Sag based on existing circuit rating

Note: Everyday conductor tension is approximately 6,000 N

241.7 mm^2 26/7 ACSR "Hawk" (477.0 kcmil), RTS = 86,400 N (Existing 138 kV Steel Tower Conductor)

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.38	-18	Final	49.6	Max. Design Loading (42.8 kN) based on original design
3	0	0	0	Initial	-	10% Winter Design Temp. (WDI)
4	0	0	15	Final	18.22	Tension @ 15^{o}C
5	0	0	0	Final	-	10% Winter Design Temp. (WDF)
6	0	0	-30	Initial		Extreme Cold Temperature
7	12.7	0.21	- 18	Final		Insulator Swing (1.1 m absolute limit clearance)
8	0	0.21	-18	Final		Insulator Swing
9	0	0	15	Final		Phase spacing
10	0	0.21	40	Final		Swing, sidehill clearance
11	0	0	40	Final		R/W Edge Distance & Circuit-Circuit
12	0	0	70	Final		Max. Conductor Sag based on existing circuit rating

Note: Everyday conductor tension is approximately 15,000 N.

4.5 Groundwire Type

The proposed overhead groundwire is a Size 9 7W Grade 1300.

4.6 Groundwire Data and Characteristics

Steel area:	51.10 mm^2
Outside Diameter:	9.144 mm
Stranding:	7 x 3.05 mm
Rated RTS:	60051 N
Modulus of elasticity (N/mm^2 x 10^3):	189.16 (EFIN)

186.16 (EIL)
177.880 (EIU)

Coefficient of linear expansion (/^{o}C x 10^{-6}):	11.52 (AFIN) 11.52 (AIL) 11.52 (AIU)
Bare Mass:	0.4018 kg/m

Loaded masses:

Loaded Masses				
Radial Ice (mm)	Wind (kN/m2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.7	0.385	11.7422	13.2979	17.7401
0	0.57	3.9403	5.2098	6.5321
12.7	0	11.742	0	11.742
12.7	0.21	11.742	7.2534	13.8018
0	0.21	3.9403	1.9194	4.3829
0	0	3.9403	0.000	3.9403

* - Density of 0.9 kg/m^3

4.7 Groundwire Loading and Limiting Conditions

The following conditions are for steel, galvanized groundwire:

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.7	0.385	-18	Final	35	Max. Design Loading
2	0	0.57	-18	Final	35	Maximum Wind Bare Conductor
3	0	0	0	Initial	34	10% Winter Design Temp. (WDI)
4	0	0	7.5	Final	28	Mean Annual
5	0	0	0	Final		10% Winter Design Temp. (WDF)
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.7	0.285	- 18	Final		Suspension Assembly Swing
8	0	0.21	-18	Final		Suspension Assembly Swing
9	12.7	0	-18	Final		Clearance to conductor, conductor at @-18^{o}C
10	0	0	30	Final		Max. Groundwire Sag

Under condition 9, the clearance between the groundwire and conductor shall not be less than the 230 kV flash-over distance or 1.2 m.

Typically, vibration damping is not required, though performance of the groundwire spans should be reviewed during its operational life and depending upon exposure and span length vibration damping devises may be required on a site specific basis.

4.8 Communication Fibre Data and Characteristics

Details for a possible communication fibre to be strung as underbuild (ADSS) or overhead as one of the overhead shield wires have not been confirmed at this time. For cost estimate purposes, a 48 fibre ADSS cable with associate hardware, designed to be strung on spans of 300 m has been used.

4.9 Communication Fibres Loading and Limiting Conditions

The following design conditions are for example only and will vary according to the final selection of the type of fibre, if installed. For initial design purposes, the aim is to have the fibre sag not less than the conductor above it. Typical limiting conditions for ADSS fibre are provided in the following table:

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^{o}C)	Condition	Limiting Tension (%RTS)	Remarks
1A	12.7	57	-18	Final	30	Max. Design Loading, for special crossings
1B	12.7	0.385	-18	Final	30	Max. Design Loading, for regular spans
2	0	0.57	-18	Final		Maximum Wind Bare Fibre
3	0	0	-15	Initial		10% Winter Design Temp. (WDI)
4	0	0	10	Final	10	Mean Annual
5	0	0	-15	Final		10% Winter Design Temp. (WDF)
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.7	0.285	- 18	Final		Suspension Assembly Swing
8	0	0.21	-18	Final		Suspension Assembly Swing
9	0	0	30	Final		Clearance to conductor, conductor @ 100^{o}C
10	0	0.21	40	Final		Swing, sidehill clearance
11	12.7	0	-18	Final		Clearance to ground - winter
12	0	0	30	Final		Max. Fibre Sag - summer

Under the above conditions the ADSS fibre shall not sag less than the conductor above it shall

Under condition #11, the clearance between the ADSS and ground shall not be less than pedestrian clearance per CAN/CSA C22.3 No. 1-01.

5.0 INSULATORS, INSULATOR HARDWARE AND CONDUCTOR HARDWARE

5.1 Design Parameters

The mechanical loads applied on insulators, hardware and fittings by dead loads and live loads, e.g. conductor loads, wind on the structure and construction and maintenance loads, will be increased by a load factor of 2.0.

5.2 Insulation

Insulators and insulation for the project, based on a minimum equivalent of 12 suspension insulator units are as follows:

Composite Types

Suspension type

Application:	230 kV suspension strings & jumper suspension strings
Creepage distance:	3505 mm
Mfg.Cat. No.:	NGK E071-SC580-YB-08 c/w corona ring
Colour:	Light grey
Type:	70kN
Length:	2,025 mm
Mass:	7 kg

Dead-end type

Application:	230 kV dead-ends Lapwing conductor
Mfg. Cat. No.:	NGK 502-SC710-SK-08 , c/w corona ring
Ball & Socket:	Type K
Colour:	Light grey
M & E Rating:	222 kN (max. conductor tension for “Lapwing” is 73.1 kN)
Length:	2.505 mm
Mass:	11.3 kg

Post type

Application:	post for braced post suspension units & jumper posts
Minimum electrical requirements, IEC Methods	
Creepage distance:	3505 mm
Dry 60Hz one minute withstand:	570kV
Wet 60Hz one minute withstand:	405kV
Lightning Impulse withstand:	900kV
Minimum electrical requirements, ANSI Methods	
Creepage distance:	3505 mm
Dry 60Hz flashover:	690kV
Wet 60Hz flashover:	490kV
Critical Impulse flashover (Pos.):	1105kV
Critical Impulse flashover (Neg.)	1105kV
Mechanical Requirements	
Max. Vertical Load:	2.8 kN/ phase (working)
Max. Horizontal (transverse to conductor) load	
Compression:	13 kN/ phase (working)
Tension:	2 kN/ phase (working)
Max. Cantilever Load:	4.2 kN/ phase (parallel to conductor)
Mfg.Cat. No.:	NGK L2-SN491-21-W (Line Post, c/w corona ring, trunnion end)
Mfg.Cat. No.:	NGK L2-SN491-11 (Composite line post, tongue end)
Colour:	Light grey
Length:	2.119/ 2,112 mm (horizontal, vertical angle 12^{o})
Mass:	35.5 kg each

5.3 Suspension and Dead-End Hardware Assemblies

All hardware shall be in accordance with CSA/CAN Standard C83-96, Communication and Power Line Hardware. All steel hardware components shall have a minimum Charpy impact energy absorption/ toughness criteria of 20 joules @ -20^{o}C. All ferrous material including hardware, bolts and nuts shall be "hot dipped" galvanized in accordance with the requirements of CSA/CAN Standard G164M. All insulator hardware less than 160 kN M & E strength is J ball type.

See Appendix B of this Design Brief for suspension and dead-end insulator hardware assembly reference drawings.

Suspension Insulator Hardware Assemblies

Loaded weight or mass is bare weight or mass x 1.5 and represents an iced assembly. Suspension string lengths are the length from the structure support to the centre of the conductor in the suspension clamp and is the length that is used in swing calculations.

Porcelain/ Glass Insulator Alternative for Single Suspension

rating:	70 kN
insulators per string:	4
number of strings:	1
bare weight:	24 kg (235 N)
loaded weight:	36 kg (352 N)
length of assembly (swing):	0.772 m

Composite Suspension Insulator Assemblies

I - Type Suspension Insulator (Polymer) Hardware Assemblies for H/F Structures

rating:	70 kN
number of strings:	1 (equivalent to 12 disks)
bare wt.:	10 kg. (98 N)
loaded wt.:	15 kg. (147 N)
length of assembly (swing):	2.172 m

Dead-end Insulator Hardware Assemblies

Loaded weight or mass is bare weight or mass x 1.5 and represents an iced assembly. Dead-end string lengths are the lengths from the structure support to the outer extremity of the suspension insulators or composite insulator string.

Composite Insulator for Lapwing Conductor on Dead-end Structures (Full Tension)

rating:	220 kN
insulators per string:	1
number of strings:	1
bare weight:	25 kg (245 N)
loaded weight:	7.5 kg (367 N)
length of assembly:	2.505 m

Composite Insulator for Lapwing Conductor on Dead-end Structures (Slack Span)

rating:	220 kN
insulators per string:	1
number of strings:	1
bare weight:	25 kg (245 N)
loaded weight:	37.5 kg (367 N)
length of assembly:	2.505 m

Composite Insulator Alternative for Dead-end Structure in Uplift

- Dead-end insulator strings shall be reversed for positive conductor dip.

Braced Fixed Post Insulator (Polymer) Hardware Assemblies for Type A2, A2G, A2GT and D2

Brace:

rating:	120 kN
insulators per string:	1 (equivalent to 12 disks)
number of strings:	1
bare wt.:	45 kg. (441 N)
loaded wt.:	225 kg. (661 N)

Post:

rating:	230kV
insulators per string:	1 (equivalent to 12 disks)
number of strings:	1
bare wt.:	35.5 kg. (441 N)
loaded wt.:	225 kg. (661 N)

Assembly:

vertical height of assembly, on pole:	3.275 m
horizontal off-set of assembly, from pole:	2.216 m
vertical rise of attachment above base:	-0.45 m (-12^{o})
reference drawings:	

Note: use armour rod specified for Lapwing conductor size.

5.4 Conductor Hardware

All steel hardware components shall have a minimum Charpy impact energy absorption/toughness criteria of 20 joules @ -20^{o}C. All ferrous material including hardware, bolts and nuts shall be “hot dipped” galvanized in accordance with the requirements of CSA/CAN G164M.

a) Hold-down Weights

Hold-down weights are used to reduce insulator swing of suspension insulator hardware assemblies and suspension clamps attached to braced post insulator assemblies. When required they are attached to the conductor over armour rod adjacent to the conductor, in units of nominal weight of 45 kg. Weights may be installed in pairs of 45 kg increments to 360 kg per phase.

b) Conductor Fittings

Dead-end for slack span station connection and full tension application with Lapwing conductor shall be compression type.

Splices:	single or two-part compression type
jumper terminals:	use 4-hole nema pad jumper terminal for compression dead-end assemblies.
armour rods:	at all suspension assemblies
line guard:	none
patch rods:	yes, sized for conductor, to be used for conductor damage repairs
ampacts:	use ampacts for dead-end jumpers from strain clamps.

c) Conductor Dampers

Conductor vibration dampening is not specified for normal installation, see Section 4.4. Conductor vibration dampers (Stockbridge type) should be installed if after a period of operation excessive vibration or damage is observed.

5.5 Groundwire Hardware

Schemes for installing the overhead groundwire (shield wires) are shown on the following example B.C. Hydro Technical Guides:

- Insulated Shield Wires, Typical Insulated Shield Wire Schemes for cases where only the section of the line near the terminals is shielded
- Insulated Shield Wires, Typical Insulated Shield Wire Assembly
- Insulated Shield Wires, Typical Designs of Shield Wire Insulators.

6.0 WOODPOLE STRUCTURES

The following section outlines structure design information for the few cases where wood pole structures amy be required. Outlines of the existing 138 kV and proposed 230 kV structures are provided in Appendix D.

6.1 Structure Types and References

This type of single circuit 230 kV wood or steel pole structure is to be used only for special cases, primarily for the crossunders of Circuits DC1 and DC2 in Delta and on Galiano Island.

Single Circuit 230 kV (WP) Construction

Types	Reference Dwg.	Description	Approx. Line Angle Range (°)
A	2LGS-T08-D651	Two pole suspension H/F, steel crossarm, wood poles/ wood XB or steel poles/ steel XB, w/optional guys, 5.5 m phase spacing	0-4
D	2LGS-T08-D669	Guyed three pole suspension medium angle suspension , timber crossarms, wood poles or steel polesw/optional guys, 5.5 m phase spacing, poles off-set 2.7 m from C/L	4-30
J (0-20)	2LGS-T08-D648	Guyed three pole light angle dead-end, wood or steel poles, two hole tongue h-post supported jumpers in suspension clamp (h-post for LA < 20^o), 6.0 m min. pole spacing and adjust for LA	0-20
J (20-60)	2LGS-T08-D649	Guyed three pole medium - heavy angle dead-end, wood or steel poles, two hole tongue h-post supported jumpers in suspension clamp (h-post for LA $20^o < 60^o$), 6.0 m min. pole spacing and adjust for LA	20-90

6.2 Design Parameters

The following is for use in PLS-CADD wood pole structure models only.

Reference Standards and Publications

CAN/CSA-015-90, Wood Utilities poles and reinforced stubs
CAN/CSA-C22.3 No.1-M01, Overhead Systems
CAN/CSA-O86.1M, Engineering Design in Wood (Limit Based Design)
CSA/CAN3-G12-92, Zinc Coated Steel Wire Strand
Handbook of Steel Construction, Canadian Institute of Steel Construction
Design Guide (Draft), Wood Pole Structures (Draft), A. Zolotoochin, BC Hydro, June 1996.

a) Load Factors

The mechanical loads applied on wood pole structures by dead loads and live loads, e.g. conductor loads, wind on the structure and construction and maintenance loads, will be increased by the following load factors:

Dead loads:	1.00	all types of structures
Live loads	1.20	tangent structures (Types A, AG, AGT)]
	1.30	angle structures (Types D)
	1.50	dead-end structures (Types J, K and KG)
	2.00	construction and maintenance loads, all types of structures.
Wind on Poles	1.50	Wind pressure on a wood pole will be 1.5 times the wind pressure used in determining wind loads on conductors. Therefore, the wind load to be applied to structures based on the loading specified in Section 6.0 will be 1.5 x 0.385 kN/m^2 = 0.57 kN/m^2.

Seismic loads Not considered.

Anchor Capacity 2.00 Applied to loads resulting from live (design) loads.

Ultimate stress is the Design stress resulting from applied mechanical loads amplified by specified load factors.

b) Deflection of Poles

The maximum horizontal deflection at the top of a wood pole structure due to the effect of applied mechanical loads will be limited to 10% of the total length of the pole.

6.3 Wood Poles

All poles shall be Western Red Cedar (WRC) full length treated and butt gained, 12' from the butt.

a) Design stresses

Design stresses for wood poles used in PLS-CADD shall be as follows:

Type: Western Red Cedar	exclusion limit	default values	
Bending, f_b (single pole structures)	10%	23 MPa	3,300 psi
Bending, f_b (double pole structures)	20%	24.8 MPa	3,500 psi
Compression, f_c	10%	23 MPa	3,300 psi
Tension, f_t	10%	23 MPa	3,300 psi
Modulus E	mean	7,722 MPa	1,120,000 psi

b) Dimensions

Minimum dimensions for WRC poles shall be in accordance with CAN/CSA-015-90 - May 1990, Tables 7 and 11, respectively.

The lengths and classes of wood poles for use with single circuit construction are as follows:

Class 2, 50’ through 80’, 5' increments
Class 1, 50’ through 95’, 5' increments
Class H1 and greater, 50’ through 95', 5' increments

Wood Pole Property Label	Stock Number	Pole Species	Pole Class	Length (m)	Tip Circum. (cm)	Circum. At Dist. From Butt (cm)	Default Embedded Length (m)
WR-H2-50	4242500	WRC	H2	15.24	78.7	144.8	2.1

Wood Pole Property Label	Stock Number	Pole Species	Pole Class	Length (m)	Tip Circum. (cm)	Circum. At Dist. From Butt (cm)	Default Embedded Length (m)
WR-1-50	4242501	WRC	1	15.24	68.6	128.3	2.1
WR-2-50	4242502	WRC	2	15.24	63.5	120.7	2.1
WR-H2-55	4242550	WRC	H2	16.76	78.7	149.9	2.3
WR-1-55	4242551	WRC	1	16.76	68.6	133.4	2.3
WR-2-55	4242552	WRC	2	16.76	63.5	124.5	2.3
WR-H2-60	4242600	WRC	H2	18.29	78.7	154.9	2.4
WR-1-60	4242601	WRC	1	18.29	68.6	138.4	2.4
WR-2-60	4242602	WRC	2	18.29	63.5	129.5	2.4
WR-H2-65	4242650	WRC	H2	19.81	78.7	160.0	2.6
WR-1-65	4242651	WRC	1	19.81	68.6	142.2	2.6
WR-2-65	4242652	WRC	2	19.81	63.5	133.4	2.6
WR-H2-70	4242700	WRC	H2	21.34	78.7	165.1	2.7
WR-1-70	4242701	WRC	1	21.34	68.6	147.3	2.7
WR-H2-75	4242750	WRC	H2	22.86	78.7	170.2	2.9
WR-1-75	4242751	WRC	1	22.86	68.6	151.1	2.9
WR-2-75	4242752	WRC	2	22.86	63.5	141.0	2.9
WR-H2-80	4242800	WRC	H2	24.38	78.7	174.0	3.1
WR-1-80	4242801	WRC	1	24.38	68.6	154.9	3.1
WR-2-80	4242802	WRC	2	24.38	63.5	144.8	3.1
WR-H2-85	4242850	WRC	H2	25.91	78.7	177.8	3.2
WR-1-85	4242851	WRC	1	25.91	68.6	158.8	3.2
WR-2-85	4242852	WRC	2	25.91	63.5	148.6	3.2
WR-H2-90	4242900	WRC	H2	27.43	78.7	182.9	3.4
WR-1-90	4242901	WRC	1	27.43	68.6	162.6	3.4
WR-2-90	4242902	WRC	2	27.43	63.5	152.4	3.4
WR-H2-95	4242950	WRC	H2	28.96	78.7	185.4	3.4
WR-1-95	4242951	WRC	1	28.96	68.6	165.1	3.4
WR-2-95	4242952	WRC	2	28.96	63.5	154.9	3.4
WR-H3-100		WRC	H3	30.48	83.8	199.4	3.4
WR-H2-100		WRC	H2	30.48	78.7	189.2	3.4
WR-H3-105		WRC	H3	32.00	83.8	203.2	3.7
WR-H2-105		WRC	H2	32.00	78.7	193.0	3.7
WR-H3-110		WRC	H3	33.53	83.8	207.0	3.7
WR-H2-110		WRC	H2	33.53	78.7	196.9	3.7
WR-H3-115		WRC	H3	35.05	83.8	210.8	3.7
WR-H2-115		WRC	H2	35.05	78.7	199.4	3.7
WR-H1-115		WRC	H1	35.05	73.7	188.0	3.7
WR-H3-120		WRC	H3	36.58	83.8	213.4	3.7
WR-H2-120		WRC	H2	36.58	78.7	201.9	3.7
WR-H1-120		WRC	H1	36.58	73.7	191.8	3.7
WR-H3-125		WRC	H3	38.10	83.8	215.9	3.7
WR-H2-125		WRC	H2	38.10	78.7	205.7	3.7
WR-H1-125		WRC	H1	38.10	73.7	194.3	3.7

c) <u>Pole Classes</u>

The class of poles are employed for specific structure loading requirements shall be identified on the structure data sheets and profiles. As a minimum, Class H2 poles shall be used for all dead-end type structures.

6.4 Structure Crossarms and Timbers

a) Steel Crossarms

Steel crossarms shall be used on Type A, AG, AGT and D (new design) structures. All steel supplied for crossarms shall conform to the requirements of CSA/CAN-G40.21M - "Structural Quality Steels" and shall have a minimum Charpy impact energy absorption/ toughness criteria of 20 joules @ -20^{o}C. All steel crossarms shall be galvanized by the hot dip process in accordance with the requirements of CSA/CAN G164M - "Hot Dip Galvanizing of Irregular Shaped Articles.

The load carrying capacity of steel crossarms depends upon the characteristics of the individual cross section. The possibility of local and/ or global buckling must be taken into consideration. Due to the complexity of the design of steel crossarms, default values for the allowable stresses cannot be specified.

For PLS-CADD individual member sizes are assessed as follows:

allowable bending stress F_b = 0.75 Fy where F_y is the steel yield stress.

When allowable load factors corresponding to the structure type are included, the F_b values become:

Where F_y = 350 Mpa (50 ksi) for HT steel and F_y = 252 Mpa (36 ksi) for A36 steel.

	HT Steel	A36 Steel
F_b = 0.75 x Fy =	262 Mpa	189 MPa

b) Wood Crossarms and Timbers

If used, wood crossarms and crossbraces shall be sawn timber, Douglas Fir (DFir), select structural grade and pressure treated.

Ultimate allowable stresses for DFir crossarms and timbers shall be as follows:

Type: Douglas Fir	exclusion limit	default values	
Bending, f_b SS No.1	 10% 10 %	 28 MPa 21 MPa	 4000 psi 3000 psi
Compression, f_b SS No.1	 10% 10%	 28 MPa 21 MPa	 4000 psi 3000 psi
Tension, f_t			

Type: Douglas Fir	exclusion limit	default values	
SS No.1	10% 10%	28 MPa 21 MPa	4000 psi 3000 psi
Modulus E SS No.1	 mean mean	 13,580 Mpa 11,720 MPa	 1,970,000 psi 1,700,000 psi

6.5 Structure Hardware

All bolts will conform to CSA Std. C83.96, latest revision.

All hardware shall have a minimum Charpy impact energy absorption/toughness of 20 joules @ -20°C.

Guy hooks will be Heavy Duty, thimble type and use a minimum of a 7/8" diameter bolt.

All groups of hardware within normal reach of a Power-line Technician climbing a pole shall be bonded with #6 Cu wire.

6.6 Guys

a) Guy Size

Standard and optional guys for different structure types shall be as follows and as specified on the appropriate structure erection drawing:

suspension structures:	Size 12 Grade 1300 (1/2" Grade 180)
dead-end structures	Size 12 Grade 1100 (1/2" Grade 180)

c) Guy Requirements

Guys to suspension type structures will be attached to the structure guy hook and anchor rods using pre-formed guy grips. Side, tie and groundwire guys to dead-end type structures will be attached to the structure guy hook and anchor rods using pre-formed guy grips. In-line guys to dead-end structures will be attached to dead-end tees and anchor rods using pre-formed guy grips.

Unless otherwise specified, all guy angles shall be in accordance with the details shown on the applicable structure erection drawing. In summary the standard guy angles measured in the plane of the guy and pole (from vertical) are as follows:

Tangent structures & Light angle structures	30° minimum, 45° maximum
Medium angle structures	30° minimum, 45° maximum
Dead-end structures	45° longitudinal guys 30° side guys

d) Guy Loads (GL)

Maximum allowable guy load GL = 0.85 x RBL:

where GL = guy load as determined by PLS-CADD and RBL = rated breaking load (minimum breaking load specified in CSA CAN3-G12-92). For design values see the table below.

	Metric	Imperial
Strand size:	12 mm	1/2"
Grade	1300	180
Min.. Breaking load:	120 kN	25,500 lb.
Area:	97.0 mm^2	0.150 in^2
E:	189,606 N/mm^2	27,500,000 psi
EA:	18,300 kN	4,114,000 lb.

e) Guy Strain Insulators

As a normal practice guy strain insulators shall not be installed unless guys attach above conductors or guys/ anchors are within 22 m of adjacent circuit components. If it is determined that there is a flash-over potential, the offending guy shall have a guy insulator, equivalent in performance to the suspension type insulators, installed.

6.7 Pole Installation and Guy Anchors

a) Pole Installation

Poles set in earth rock, rock with overburden and slash shall be set to the depth shown on BC Hydro Dwg. G-T08-D460.

b) Guy Anchors

The basic details for guy anchors is shown on BC Hydro Dwg. G-T08-D459.

i) Anchor Types and Material

Anchors for installation in earth and rock will be employed. All metal components of guy anchors shall be galvanized steel. All anchor rods shall have a minimum Charpy V-notch energy absorption of 20 joules @ -20^{o}C.

Type 1 & 2 Anchors

Anchor rods for Types 1 & 2 log anchors in earth, are triple thimble eye (tripleye) 25.4 mm OD x 10' lg. supplied by Chance (Cat. # 7570). The tensile strength of the 25.4 mm (1") OD rods is 160 kN (36,000 lbs). Logs for log anchors shall be minimum 300 mm OD x 8' long. The minimum installed depth for log anchors shall be 1.8 m (Type 1) for single guy attachment and 2.4 m (Type 2) for dead-end guy anchor installations.

Type 13 Anchors

Anchor rod for Type 13 anchors in rock shall be triple thimble eye (tripleye) 25.4 mm OD x 10' lg. supplied by Chance (Cat. # 7570). The tensile strength of the 25.4 mm (1") OD rods is 160 kN (36,000 lbs). Anchors shall be have a grouted length of 1.2 m for a single guy attachment.

Type 21 (500 kV Type)

Anchor rod is 28.5 mm (1-1/4") OD Dywidag 50 ksi rod attached to a 0.9 m long back to back channel assembly. The anchor is intended to be set to a 2.4 m depth and backfilled with 0.6 m depth of mass grade concrete, then native fill compacted with two passes of the backfilling equipment.

ii) Anchor Capacity

The anchor type code, description and utilization is provided below.

Anchor Types, Descriptions and Utilization

Type	Description	Minimum Embedment (m)	Maximum Guy Load @ Normal Angle	Min. Guy Angle	Normal Guy Angle
Earth Anchors					
1	8' log anchor, 1" OD rod, ref. Dwg.	1.8 m	56 kN (12,500 lbs)	20^o	45^o
2	8' log anchor, 1" OD rod (for triple guy), Ref. Dwg.	2.4 m	56 kN (12,500 lbs)	30^o	45^o
21	0.9 m long back to back steel channel assembly plus 0.6 m mass grade concrete, 28.5 mm (1-1/8" OD) rod, separate top fitting, Ref. BC Hydro Dwg. 5LGS-T08-B1656	2.4 m	112 kN (25,000 lbs)	30^o	35^o
Rock Anchors					
13	1" rod, Ref. Dwg.	1.22 m	56 kN (12,500 lbs)	25^o	45^o
Dywidag	28.5 mm (1-1/8") rod, separate top fitting, Ref. BC Hydro Dwg. 5LGS-T08-D2314M	1.5 m	112 kN (25,000 lbs)	30^o	35^o

6.8 Structure Staking

The pole location for angle type suspension structures shall be off-set from the transmission line centre-line to compensate for the off-set of the conductor due to insulator swing. Specific types shall be off-set as follows:

Structure Type	Pole off-set from T/L C/L, left deflection	Pole off-set from T/L C/L, right deflection

	angle (m)	angle (m)
D	2.76	2.76

6.9 Structure Setting Tolerances

During construction, the following tolerances in structure locations and setting elevations are recommended without consultation with Design personnel:

structure location (centre)

along line	-	+/- 3 m.
off-line	-	+/- 1 m.

conductor attachment elevation

down	-	-0.5 m
up	-	+1 m

anchor location

general	-	+/- 1 m provided guy angle does not vary by more than 5^{o} measured from vertical.

6.10 Structure Grounding

Structures with groundwire shall be grounded in accordance with the example BC Hydro Dwgs. ESM41-S0100-01, Standards Grounding Details for Wood Pole Structures and Steel Poles and as shown on the appropriate Structure Erection Drawing.

Counterpoise or additional ground rods shall be added until a ground resistivity of 10 ohms or less is achieved. Ground resistivity measurements shall be taken at the time of pole setting and installation of the basic structure grounding as shown on the structure erection drawings. Measurements shall indicate whether poles are installed in metal culverts.

7.0 STEEL STRUCTURES

This section provides details of steel structures proposed for the replacement of the wood and lattice steel structures of circuits 1L17 and 1L18. Outlines of the existing 138 kV and proposed 230 kV structures are provided in Appendix D.

7.1 Structure Types and References

Review of proposed alignments, clearances and separations plus review and comparison of alternative structure types and configurations (See Comparison Of Alternative Structure Configurations and Placement In Existing Right-Of-Way, BC Hydro Engineering Report No. E377.

The types of double circuit 230 kV steel pole structures to be utilized between ARN and VIT, with the exception of the re-built single circuit crossings over Montague Harbour and Sansum Narrows are listed below.

Regular Structures

Proposed Structure Types, Double Circuit 230 kV Construction

Types	Reference Dwg.	Description	Approx. Line Angle Range (°)
A2	-	Single pole, suspension, brace post tangent w/ optional guys	0-4
A2G/A2GT	-	Type A2 w/ two suspension ohgw, w/optional guys	0-4
A2A	-	Single pole suspension, w/ davit arms, centre conductors off-set for long spans, suspension insulators	0- 4
D2		Guyed 2-steel pole light & medium angle suspension, brace post	4-30
D2G		Guyed 2-steel pole light & medium angle suspension w/ ohgw, brace post	4-30
J2	-	Guyed 2-steel pole medium angle dead-end, two hole tongue h-post supported jumpers in suspension clamp (h-post for LA < 60^o)	35-60
K2	-	Guyed 2-steel pole dead-end heavy angle dead-end, two hole tongue h-post supported jumpers in suspension clamp (h-post for LA < 60^o)	60-90
K2G	-	Guyed 2-steel pole dead-end heavy angle dead-end w/ohgw, two hole tongue h-post supported jumpers in suspension clamp (h-post for LA < 60^o)	60-90

Special Structures

Proposed Structure Types, Special Single Circuit 230 kV Construction

Types	Reference Dwg.	Description	Approx. Line Angle Range (°)
AX	-	Single circuit 3-phase flat suspension, modified galvanized lattice steel 138 kV Type S. Conductor height is 47.5 m.	-
JX	-	Single phase guyed steel pole dead-end, replaces 138 kV type T supporting conductors spanning Montague Harbour and Sansum Narrows. Height 21.6 m ground to conductor. The conductor tension per phase is 254 kN.	-
Term	-	Single circuit 3-phase full tension portal steel pole/ HSS dead-ends for cable terminals, Height to conductor 18 m min. w/ allowance for two wire overhead ground.. The conductor tension in each phase is 74 kN	-

The review of selected 138 kV structure types for potential re-use in whole or part, for the 230 kV replacement is contained in a report titled "Type S , T and A Towers Structural Assessment Report, BC Hydro Engineering Report No. E375. The conclusion is the four type S suspension structures supporting the conductor over Montague Harbour will support the proposed 230 kV conductor load In addition, clearance checks determined the phase spacing provided by the extremities of the existing tower bridge is adequate as well as the resulting circuit to circuit separation.. NWPA clearance checks over Montague Harbour determined that the support height provided by the Type S structure is not adequate. Therefore, to minimize disturbance in the Marine Park, the four towers will be modified to increase their attachment height in a flat configuration. The increase in attachment height is due to deficiencies in the NWPA safe navigable clearance due to changed parameters, the longer insulation of the 230 kV and tolerances. Existing Str. 24/1 must be raised 8 m and Str. 24/2 must increase 10 m.

The approach being proposed is to design and fabricate the appropriate galvanized lattice steel extension that will attach to the tower waist and fabricate new galvanized lattice steel k-frame and bridge. The existing bridge and k-frames will be removed (by helicopter) and replaced with the new components, again by helicopter.

The same study determined that the existing single phase 138 kV type T galvanized lattice steel structures cannot support the load and will therefore need to be replaced. To again provide the lightest possible simple structures the replacement it is proposed that they be replaced (3-phases per 230 kV circuit) by single phase guyed steel poles. The steel poles would be located just outside the perimeter of the lattice tower away from the long span it will support. The attachment heights will need to be 21.5 m for all eight sites. Using steel poles will allow for simple height adjustment for changes in site conditions.

For cable terminals and VI Substation, it is proposed to design and install a-frame full tension tubular steel station terminal structure for each circuit termination. An 18 m conductor support height appears to meet requirements. The reasons are two fold. First to do away with the need to install dead-end structures outside of the station, therefore reducing clutter. Second is to do way with the additional structures the present 138 kV terminations have, so as to free up land adjacent to the cable terminals for helicopter landing pads.

7.2 Design Parameters

The following is for use in PLS-CADD steel pole structure models only.

Reference Standards and Publications

CAN/CSA-C22.3 No.1-01, Overhead Systems
CSA/CAN3-G12-92, Zinc Coated Steel Wire Strand
Handbook of Steel Construction, Canadian Institute of Steel Construction
ASCE (1990) Guide for Design of Steel Transmission Pole Structures
ANSI/ASCE (1991), Design of Latticed Steel Transmission Towers, ANSI/ ASCE Standard 10-90
ASCE (1988), Guide for Design of Steel Transmission Towers, ASCE Manual 52
ASCE (1995), Guide for Design of Guyed Transmission Structures

a) Load Factors

The mechanical loads applied on wood pole structures by dead loads and live loads, e.g. conductor loads, wind on the structure and construction and maintenance loads, will be increased by the following load factors:

Dead loads:	1.00	all types of structures
Live loads	1.20	tangent structures (Types A2, A2A, A2G, S & A2GT)

	1.30	angle structures (Types D2 and D2G)
	1.50	dead-end structures (Types J2, K2, K2G, JX & Term)
	2.00	construction and maintenance loads, all types of structures.
Wind on Poles	1.50	Wind pressure on a wood pole will be 1.5 times the wind pressure used in determining wind loads on conductors. Therefore, the wind load to be applied to structures based on the loading specified in Section 6.0 will be 1.5 x 0.385 kN/m^2 = 0.57 kN/m^2.
Seismic loads		Not considered.
Anchor Capacity	2.00	Applied to loads resulting from live (design) loads.

. 0.9 kN/m2 wind on projected area of the structure with maximum ultimate loading.

For construction, each structure including the foundation shall be capable of withstanding 0.43 kN/m2 wind applied on the structure without any guys, conductors, groundwire or communication fibre attached to the structure.

b) Deflection of Poles

The maximum horizontal deflection at the top of a steel pole structure due to the effect of applied mechanical loads will be limited to 10% of the total length of the pole.

7.5 Steel Poles

For the preliminary layout (tower spotting) prepared for feasibility study, public consultation and cost estimates the following assumptions have been made in regard to the steel poles.

a) Design stresses

Design stresses for wood poles used in PLS-CADD shall be as follows:

Type: Steel Pole	default values	
Yield Stress	448 MPa	65,000 psi
Modulus E	199,948 MPa	29,000,000 psi

c) Dimensions and Pole Classes

The following pole dimensions are used in the PLS-Pole structure models. The dimensions are based on Thomas & Betts LD Express tables for 12 sided poles. For the preliminary layout, three classes of poles were developed. First is the Light Duty (LD) based on a 3/16" wall thickness. Second is the Medium Duty (MD) series, based on a 5/16" wall thickness. Lastly is the Heavy Duty (HD) series which are based on a 3/8" wall thickness.

The final dimensions and wall thickness will depend on a number of factors. For the procurement process a specification are prepared outlining load requirements, basic dimensions and attachment details. The successful pole supplier will be responsible for the detail design of the pole(s) based on the specifications. The supplier will have leeway in grade of steel, wall thickness, plan dimensions within certain limits, length of sections that make-up a pole, etc.

Basic Dimensions Used for PLS-POLE Models

Steel Pole Property Label	Length (m)	Default Embedded Length (m)	Base Plate (mm)	Shape	Tip Diameter (mm)	Base Diameter (mm)
Poles with Embedded Length included in Length						
06-080	24	3.0		12T	259	598
06-085	26	3.2		12T	259	620
06-090	27	3.4		12T	259	642
06-095	29	3.5		12T	259	664
06-100	30	3.7		12T	259	686
06-105	32	3.8		12T	259	708
06-110	34	4.0		12T	259	730
06-115	35	4.1		12T	259	752
06-120	37	4.3		12T	259	774
07-080	24	3.0		12T	261	594
07-085	26	3.2		12T	261	615
07-090	27	3.4		12T	261	637
07-095	29	3.5		12T	261	659
07-100	30	3.7		12T	261	681
07-105	32	3.8		12T	261	703
07-110	34	4.0		12T	261	724
07-115	35	4.1		12T	261	746
07-120	37	4.3		12T	261	768
08-080	24	3.0		12T	261	640
08-085	26	3.2		12T	261	664
08-090	27	3.4		12T	261	689
08-095	29	3.5		12T	261	714
08-100	30	3.7		12T	261	738
08-105	32	3.8		12T	261	763
08-110	34	4.0		12T	261	788
08-115	35	4.1		12T	261	813
08-120	37	4.3		12T	261	837
09-080	24	3.0		12T	261	683
09-085	26	3.2		12T	261	710
09-090	27	3.4		12T	261	738
09-095	29	3.5		12T	261	765
09-100	30	3.7		12T	261	792
09-105	32	3.8		12T	261	820
09-110	34	4.0		12T	261	847
09-115	35	4.1		12T	261	875

Steel Pole Property Label	Length (m)	Default Embedded Length (m)	Base Plate (mm)	Shape	Tip Diameter (mm)	Base Diameter (mm)
09-120	37	4.3		12T	261	902
10-080	24	3.0		12T	273	724
10-085	26	3.2		12T	273	753
10-090	27	3.4		12T	273	782
10-095	29	3.5		12T	273	811
10-100	30	3.7		12T	273	840
10-105	32	3.8		12T	273	869
10-110	34	4.0		12T	273	899
10-115	35	4.1		12T	273	928
10-120	37	4.3		12T	273	957
15-120	37	4.3		12T	305	1067
Poles Set on Imbedded Stubs, Height from Grade						
08-080A	24			12F	245	640
08-085A	26			12F	245	665
08-090A	27			12F	245	689
08-095A	29			12F	245	714
08-100A	30			12F	245	738
08-105A	32			12F	245	763
08-110A	34			12F	245	788
08-115A	35			12F	245	812
08-120A	37			12F	245	837
09-080A	24			12F	245	683
09-085A	26			12F	245	710
09-090A	27			12F	245	738
09-095A	29			12F	245	765
09-100A	30			12F	245	792
09-105A	32			12F	245	820
09-110A	34			12F	245	847
09-115A	35			12F	245	875
09-120A	37			12F	245	902

Steel Pole Property Label	Length (m)	Default Embedded Length (m)	Base Plate (mm)	Shape	Tip Diameter (mm)	Base Diameter (mm)
10-080A	24			12F	258	724
10-085A	26			12F	258	753
10-090A	27			12F	258	782
10-095A	29			12F	258	811
10-100A	30			12F	258	840
10-105A	32			12F	258	869
10-110A	34			12F	258	898
10-115A	35			12F	258	928
10-120A	37			12F	258	957

Note:

10-080

7.4 Crossarms

Davit arms for the Type A2A structure are assumed to be fabricated from 65ksi steel.
HSS sections are assumed for other uses.

7.5 Structure Hardware

All bolts will conform to CSA Std. C83.96, latest revision. All hardware shall have a minimum Charpy impact energy absorption/toughness of 20 joules @ -20^{o}C.

All attachment and lugs for steel poles will be an integral part of the pole design and fabrication. The specifications for attachments and lugs will be prepared on the basis of past practice of providing both permanent attachments and construction/ maintenance attachments.

7.6 Guys

c) Guy Size

Standard and optional guys for different structure types shall be as follows and as specified on the appropriate structure erection drawing:

– All guys on Type A2 and A2G steel pole structures shall be Size 12
– All guys on Type A2A steel pole structure shall be Size 12
– All guys on Type D2and D2G steel pole structures shall be Size 16

- All guys on Type J2 steel pole structures shall be Size 16
- All guys on Type K2 and K2G steel pole structures shall be Size 16

d) Guy Requirements

Standard guying requirements will be shown on each of the respective structure erection drawings.

Unless otherwise specified, all guy angles shall be in accordance with the details shown on the applicable structure erection drawing. In summary the standard guy angles measured in the plane of the guy and pole (from vertical) are as follows:

Tangent structures & Light angle structures	30^{o} minimum, 45^{o} maximum
Medium angle structures	30^{o} minimum, 45^{o} maximum
Dead-end structures	45^{o} longitudinal guys
	30^{o} side guys

]

e) Guy Loads (GL)

Maximum allowable guy load GL = 0.85 x RBL:

where GL = guy load as determined by PLS-CADD and RBL = rated breaking load (minimum breaking load specified in CSA CAN3-G12-92). For design values see the table below.

	Metric	Imperial
Strand size:	12 mm	1/2"
Grade	1300	180
Min.. Breaking load:	120 kN	25,500 lb.
Area:	97.0 mm^2	0.150 in^2
E:	189,606 N/mm^2	27,500,000 psi
EA:	18,300 kN	4,114,000 lb.

	Metric	Imperial
Strand size:	16mm	5/8"
Stranding	19 strand	
Grade	1500	220
Min.. Breaking load:	205 kN	46,100 lb.
Area:	151.6 mm^2	0.235 in^2
E:	189,606 N/mm^2	27,500,000 psi
EA:	28,750 kN	6,462,500 lb.

f) Guy Strain Insulators

As a normal practice guy strain insulators shall not be installed unless guys attach above conductors or guys/ anchors are within 22 m of adjacent circuit components. If it is determined that there is a flash-over potential, the offending guy shall have a guy insulator, equivalent in performance to the suspension type insulators, installed.

7.7 Soils Types and Description

Refer to the following report:

– Sub-surface and surface soils investigation in representative areas, see Preliminary Soil Report for Steel Pole Structure Foundations, BC Hydro Engineering Report No. E326.

7.8 Anchors

Preliminary assumptions:

- Anchors will be required for each guy. It is not anticipated that multi-guys to a single anchor will be achievable or practical.
- The anchor capacity shall match the strength of the guy strand that connects to it, including appropriate load factors.
- Some type A2 structures may require one or more side guys for LA or load.
- Type AGT structure will require on in-line guy for terminating the overhead shield wire and possibly two side guys to stabilize the pole.
- Type D2 structures will require three side anchors. Alternative guying, e.g. flared guying will double this number and one anchor for the under-built ADSS communication fibre.
- Type J2 structure will require twelve in-line and three side anchors and two anchors for the under-built ADSS communication fibre.
- Type K2 structure will require twelve in-line anchors and two anchors for the under-built ADSS communication fibre.
- Type K2G structure will require twelve in-line anchors four in-line anchors for the overhead shield wire and two anchors for the under-built ADSS communication fibre.

References:

– Preliminary foundation design in support of cost estimating, see Preliminary Steel Pole Foundation Design and Cost Estimates, BC Hydro Engineering Report No. E378.

7.10 Foundations

References:

– Sub-surface and surface soils investigation in representative areas, see Preliminary Soil Report for Steel Pole Structure Foundations, BC Hydro Engineering Report No. E326.

– Preliminary foundation design in support of cost estimating, see Preliminary Steel Pole Foundation Design and Cost Estimates, BC Hydro Engineering Report No. E378.

In general terms, the following list identified the foundation types and conditions that will be experienced along the length of the corridor for the proposed 230 kV line:

- Steel caisson foundations in the Fraser River delta (ARN x new TSW Cable Terminal);
- Rock Foundations on Galiano Island, Salt Spring Island and the Maple Bay area of Vancouver Island.
- Concrete foundations in locations with shallow soft soils overlaying rock or more competent soils such as on Vancouver Island, west of Maple Bay.
- Direct burial of pole ends in areas with good granular soils.

7.10 Structure Staking

The pole location for angle type suspension structures shall be off-set from the transmission line centre-line to compensate for the off-set of the conductor due to the off-set of the conductor attached to the end of the braced post insulator assembly and/or the spacing of the poles. Specific types shall be off-set as follows:

Structure Type	Pole off-set from T/L C/L, left deflection angle (m)	Pole off-set from T/L C/L, right deflection angle (m)
D2	2.4	2.4
J2 (30^o LA)	5.8	5.8
J2 (45^o LA)	6	6
J2 (45^o LA)	6.15	6.15
K2 (90^o LA)	6.95	6.95

7.10 Structure Setting Tolerances

See Section 6.9.

7.11 Structure Grounding

Structures with groundwire shall be grounded in accordance with the example BC Hydro Dwg. ESM41-S0102-01, Standard Grounding Details for Steel Pole Structures.

Counterpoise or additional ground rods shall be added until a ground resistivity of 10 ohms or less is achieved. Ground resistivity measurements shall be taken at the time of pole setting and installation of the basic structure grounding as shown on the structure erection drawings. Measurements shall indicate whether poles are installed in metal culverts, caissons or rock foundations, etc..

7.12 Climbing Aides

Steel poles shall be provided with lugs for McGregor type detachable climbing ladders. Ladders of this type as shown on BC Hydro Dwg. ESM41-F0101-01 R00 are used by BC Hydro, and have been confirmed to have the same dimension.

8.0 SPECIAL DESIGN CONSIDERATIONS

8.1 Structure Numbering and Orientation

Structures shall be permanently numbered in the form of kilometre/structure number in line km, commencing at ARN and continuing through to VIT. The chainage shall nominally take into account the hainage of buried and undersea cable. Based on overhead and cable lengths from ARN to VIT, structure numbers at the end cable terminals for continuation of overhead structure numbering shall be as follows:

TBY Cable Terminal: 35,000 m (35/1 for TBY terminal)
MBO Cable Terminal: 44,000 m (44/1 for MBO terminal)

The terms “left” and “right” used in descriptions shall conform to the following:

left - refers to location left of centre-line when viewed towards the increasing structure number.

right - refers to location right of centre-line when viewed towards the increasing structure number.

The terms “ahead” and “back” used in descriptions shall conform to the following:

ahead - refers to location ahead of a structure or point on centre-line when viewed towards the increasing structure numbering, e.g. towards VIT from ARN

back - refers to location back of a structure centre or point on centre-line when viewed towards the source, or VIT to ARN.

8.2 Structure Site Protection and Security

a) Erosion Prevention

Sites which require moderate to extensive access road cuts or benching, or sites in order to perform the work shall be reviewed to determine if alternative hand excavation or helicopter construction techniques are warranted to minimize disturbance.

Scarification and removal of low growing species must be minimized and ground disturbance shall conform wherever possible to the clearing standard recommended for the area.

All disturbed sites, e.g. structure sites and conductor stringing sites, shall be seeded with an appropriate seed mixture immediately after completion of construction.

8.3 Aerial Marking

If the transmission line is identified in a specific location as a hazard to low flying fixed wing aircraft and helicopters, the transmission line conductor or adjacent supporting structures or both will be marked.

Generally, the philosophy for marking requires the hazard to be marked, e.g. if the conductor is a hazard then it shall be marked, if it is the structure then it shall be marked.

Reference section 3.8 for preliminary Crossing List and Special Requirements.

The following outlines the methods of marking:

a) Conductor - Marker Spheres

If required it is proposed to utilize P & R Industries type marker spheres which attach directly to the single conductor using armour rod (2 sets / marker sphere). The diameter and unit mass of the marker sphere as follows:

diameter:	914 mm (36")
Unit mass (bare w/ armour rod):	11.4 kg (111 N)

EHV spheres are required for 230 kV and above.

Typically, MOT - Airways standards require marker spheres of the above diameter to be attached at 150 m intervals with alternating international orange and white spheres, with the pattern starting and ending with international orange spheres. Multiple marker sphere installations shall be installed on alternative phases to distribute loads. For parallel flat spans it maybe possible to treat two circuits as one when distributing the marker spheres.

To facilitate helicopter platform work it is recommended marker spheres be located on the outer phases only.

On bundle conductors a suspension type marker sphere is required. In this situation, the stock marker sphere is a 1320 mm OD attached to a modified two bundle spacer damper.

b) Marking Structures

Wood Poles

When a pole structure is identified as a hazard, marking of the pole to MOT - Airways standards is required. Marking comprises seven equal bands of alternating international orange and white, with international orange on the top and bottom of the poles, structure or separate marker poles.

Marker poles can be installed adjacent to the crossing structure or in a more conspicuous location. For marking at others right-of-way crossings, consideration to installing the marker pole some distance either side of the transmission line on the "other" right-of-way should be given as this provides the air traffic personnel with additional warning time.

Methods of marking include painting of the poles, applying "Vexar" plastic mesh or installing separate marker poles adjacent to the structure that are either painted, have "Vexar" or plated with coloured aluminium sheets.

Both painting and “Vexar” have proved to be high maintenance alternatives that loose their colour over a relatively short period of time. Also painting of CCA treated poles does not work and “Vexar” makes climbing difficult. The preferred method is the separate pole, aluminum sheet installation.

Steel Pole Structures

Steel pole structures that need to be painted for aircraft warning marking will be painted in seven equal bands of alternating international orange and white, with international orange in a controlled environment (painting sub-contractor) over the galvanized pole.

Lattice Steel Structures

Galvanized lattice steel structures that need to be painted for aircraft warning marking will be painted in seven equal bands of alternating international orange and white, with international orange. Painting will be carried out on-site by a qualified painting contractor.

9.0 LAYOUT PARAMETERS

9.1 Layout Load Checks

Refer to Section 4.4 and 4.7 for conductor and overhead groundwire loading and limiting conditions, respectively.

Combined vertical and transverse load checks shall be carried out on suspension and dead-end structures under the following loaded conductor conditions:

- The maximum ice and wind shall be applied simultaneously on all phases and neutral conductors and overhead groundwire(s) attached to the supporting structures.

- Suspension structures shall be checked for uplift under the extreme cold temperature, initial, to prove that the insulators will not float.

- Suspension post insulator structures shall be checked for uplift under the extreme cold temperature, initial, to prove that the insulators are not overloaded in a uplift direction and that the uplift load does not exceed the dead mass of the pole. If necessary guying can be added.

- Dead-end structures shall be checked for uplift under the extreme cold temperature, initial, to prove that loading of structure components is not exceeded.

Ultimate design stresses are used in PLS-CADD.

9.2 Right-of-Way Edge Distance and Circuit to Circuit Separation

For conductors (including existing conductors, as applicable for parallel situations) the following factors for determination of conductor swing in accordance with CAN/CSA C22.3 No.1-01 are used. The wind on bare conductor is roughly equivalent to a wind pressure of 0.23 kN/m^2 or 18 m/s.

The following swing factors shall be used:

Circuit & Conductor Type	d/w	Non-Sheltered Span Factor
25 kV Distribution – Partridge conductor	29.86	0.57
60 kV – Orchid conductor	26.36	0.54
138 kV – Ibis conductor	24.53	0.49
138 kV – Hawk conductor	22.36	0.46
230 kV - 2B Mica ACSR conductor	19.91	0.41
DC – Drake conductor	17.33	0.39
230 kV – Lapwing ACSR conductor	14.36	0.32

The right-of-way edge distance, from transmission line centre-line, is the sum of the following:
- phase spacing
- conductor sag (final) @ 40^{o}C, plus swung suspension insulator string length

- minimum design clearance or increment as per CAN/CSA C22.3 No.1-01 Table 9.

The circuit to circuit clearance, from the transmission line centre-line, is the sum of the following:

- phase spacing
- conductor sag (final) @ 40^{o}C, plus swung suspension insulator string length times the displacement factor for the specific conductor of the conductor having the greatest displacement while the adjacent conductor with less sag is at rest.
- minimum design clearance or increment as per CAN/CSA C22.3 No.1-01 Table 15.

If the spans are adjacent the swing of the conductor having the largest displacement maybe reduced by 50 percent.

CSA Horizontal Clearance Increments

Condition	Calculation	Increment Value
Clearance to assessable vertical surface – edge of SRW for swung 230 kV conductor	1.8 m + 0.01(phase to ground voltage-50 kV)	2.8 m
Clearance from swung 230 kV wire to adjacent structure	1000 mm +10(phase to ground voltage-50 kV)	2.0 m
Clearance to conductor not supported on the same structure, swung 230 kV to 25 kV	300 mm + 10(sum of phase to phase voltage –0.75 kV)	1.9 m
Clearance to conductor not supported on the same structure, swung 230 kV to 60 kV	300 mm + 10(sum of phase to ground voltage –0.75 kV)	2.1 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 138 kV AC	300 mm + 10(sum of phase to ground voltage –0.75 kV)	2.6 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 230 kV AC	300 mm + 10(sum of phase to ground voltage –0.75 kV)	3.2 m
Clearance to conductor not supported on the same structure, swung 230 kV AC to 280 kV DC	300 mm + 10(AC phase to ground voltage –0.75 kV)+6(DC voltage-0.75 kV)	3.7 m

9.3 Conductor Clearances

Vertical and horizontal clearances used in the design of the Vancouver Island Transmission Reinforcement Project, shall be the greater of BC Hydro Engineering Standard, Vertical Clearances for Overhead Lines on the BC Hydro Transmission System, Manual 41K, Section 2, R0 dated October 1988" and CAN/CSA C22.3 No.1-01. A copy of the BC Hydro standard is attached as Appendix B.

a) Minimum (Standard) Clearances

All vertical clearances shall assume as a minimum that land under the line is assessable to vehicles and equipment. If the ground slopes are greater than 30^o then "pedestrian only" vertical clearances may apply. Clearances over land accessible to vehicles allows for a maximum vehicle height of 4.15 m. Regardless of the fact that much of the alignment is only accessible by foot or helicopter, vehicle access clearance will be used as a basis of the design.

Minimum Horizontal Design clearances to surfaces other than the transmission plant shall be in accordance with CAN/CSA C22.3 No. - 01 Clause 4.7.3.2 & 4.7.3.3. The clearances are as follows:

Voltage, phase to ground (kV)	Minimum horizontal Clearance (m)
Communication fiber	0
230 kV (146 kV phase to ground)	2.8

b) <u>Special, Logging, Mining Roads and Work Areas</u>

Clearances over land accessible to vehicles allow for a maximum vehicle height of 4.15 m. Clearances over all logging and mining roads crossed by the 230 kV conductors and communication fiber shall be based on a vehicle height "L" of 7.6.

In absence of site specific information, the clearance for crossing of logging and mining roads plus recommended tolerances shall be as follows:

138 kV: 7.6 m +3.0 m = 10.6 m
230 kV: 7.6 m +3.5 m = 11.1 m
Communication fibre: 7.6 m +0 m = 7.6 m

Clearance assumes snow has been cleared from the road surface.

c) <u>Allowance for Snow</u>

The mean annual maximum snow depth per CAN/CSA C22.3-No.1-01, Table D3 for the nearest reference stations to the project site are as follows:

Reference Location	Mean Annual Max. Snow Depth (m)
Ladner	0.3
Duncan	0.4

For "Lapwing" conductor sagged to the specified limiting conditions and a 240 m ruling span, the variance in final sag between a 100°C (summer) and 70°C (winter) maximum conductor temperature is 0.15 m. On this basis of the above no allowance for snow will be added to the vertical clearances in a) above because of the very small difference. The remainders of the tolerance will more than make-up for the difference.

d) <u>High Water Mark, Flood Areas</u>

Safe Navigable Clearances above all waters shall be measured from the observed HWM, to be determined from observations by the surveyors.

Vertical clearances over NWPA crossings identified in Section 3.0 shall be in accordance with Table 3, CAN/CSA C22.3 No. 1-01 and clearances established for existing crossings such as over Montague Harbour (38.1 m) and Sansum Narrows (52.5 m reference by DC1)

Clearances must include clearance from any aircraft warning marker spheres attached to the energized conductor.

Chart #3473 for Montague Harbour states that the HHWLT is 4.1 m above chart datum. The datum for Chart #3475 at Montague Harbour is recorded as 3.56 m below BM 20, 1964, 46 m west of the Montague Ferry dock. The web based listing of bench marks states that the bench mark's geodetic elevation is 3.563 m. Therefore, the chart datum in Montague Harbour is 0.003 m geodetic and the HHWLT has a geodetic elevation of 4.1 m.

The high water large tide elevation at Sansum Narrows crossing is is 1.20 m (3.94') geodetic.

e) <u>Vertical Clearance to Other Electrical Plant (supported by different structures)</u>

Vertical clearances to wires (structures) crossed by this 230 kV line, but not attached, shall be in accordance with Table J contained in BC Hydro Engineering Standard, Vertical Clearances for Overhead Lines on the BC Hydro Transmission System, Manual 41K, Section 2, R0 dated October 1988.

f) <u>Phase to Phase Clearance</u> (Same circuit, single and double circuit)

For phase conductors within 45^o or less of horizontal, and spans less than 450 m, phase to phase clearance shall be checked for a conductor condition of bare @ 15^{o}C and shall not be less than permitted by CAN/CSA. C22.3 No.1-01, Clause 4.9.1 and Table 17.

g) <u>Tolerances</u>

A tolerance allowance of 1.3 m is recommended for all vertical clearances and clearances to other plant. The tolerance is a summation of individual tolerances for survey, design, structure installation and sagging.

9.4 <u>Structure Clearance Checks</u>

a) <u>Insulator Swing</u>

Insulator swing on suspension structures shall be checked under each of the following conditions:

1. <u>Switching surge</u>, minimum clearance 1.2 m (absolute limit) for a conductor loading condition of 12.7 mm radial ice, 0.21 kN/m^2 wind @-18^{o}C to the face of the pole or crossarms/braces.

2. <u>Maintenance</u>, minimum clearance 1.8 m (0.6 m work space plus 1.2 m absolute limit, for normal work limit) for a conductor loading condition of bare, 0.21 kN/m^2 Wind @-18^{o}C. This clearance for this condition is measured to the face of the nearest pole.

b) <u>Conductor to Guys</u>

Clearance to guys shall be checked under swing condition 1) above, maximum sag or uplift and the clearance shall not be less than 1.2 m for situation arising from wind blown conductor, and not less than 1.8 m in situations where the conductor is at rest.

10.0 SUBSTATIONS AND LINE TAPS

10.1 Substation Connections

Station connections will be made to the proposed 230 kV terminal towers within the 230 kV section of the ARN and VIT stations.

At ARN, there will be slack span into the station. The design of the station terminal towers is to BC Hydro Engineering Station Standard ES 21-R0221-01R00 230 kV Steel Tower, Lattice Type – Single Bay General Arrangement Drawing.

Conductor Attachment Height above top of concrete pedestal	- 14.4 m
Groundwire height above above top of concrete pedestal	- 18.0 m
Conductor Phase Spacing from tower center-line	- 3.05 m
Groundwire spacing from tower center-line	- 6.2 m
Distane between masts	- 12.4 m
Maximum Tension of Conductor/ phase, design load	- 15.57 kN
Maximum Tension of Groundwire/ ea., design load	- 11.12 kN
Maximum deflection at attachment - horizontal	- 30^o
Maximum deflection at attachment – vertical (dip)	- 20^o

At VIT, each circuit will terminate onto a full tension terminal structure that can take full line tension of the conductors and over shield wires. The structure will be a flat portal type. Details remain to be established.

10.2 Cable Terminal Connections

Termination of the overhead circuits at the new TSW cable terminal and existing TBY, MTG and MBO site will be into flat portal type, full-tension terminal structures. For preliminary structure spotting and design it is assumed that the dimensions of the structure will be similar to the dimensions provided above for the station terminal towers shown on BC Hydro Engineering Station Standard ES 21-R0221-01R00.

10.3 Gulf Island 138 kV Substation Connections

For estimate purposes, it is assumed that the existing 138 kV taps to GLS will be re-arranged to accommodate the proposed adjustment in location of TBY cable terminal and the reactor installation. This will likely require re-construction of a part of the existing 1L17 tap, moving it further west.

On a conceptual basis it is assumed that that the re-configured 138 kV taps will comprise a vertical structure, slack span tap to the initial stage 1L18 side of the proposed double circuit 230 kV line.

11.0 SPECIFICATIONS

This section references the specifications for the transmission line material procurement, right-of-way preparation and construction work.

a) Material

Material Item	Reference Standard	Remarks
Poles/Wood	CAN/CSA-015-90 or later revision	
Treatment - wood products	CAN/CSA-080-M89	
Timbers - wood	"NLGA Grading Standards Select Structural Beam and Stringers"	
Crossarms - steel	CSA/CAN-G40.21M - "Structural Quality Steels"	
Power line hardware, including bolts, shackles, clevis fitting, guy grips, ground rods, etc.	CAN/CSA C83-96	Refer to Appendix K of C83-96 for a complete list of components covered by this standard
Suspension Insulators (CSA Type CS-3)	CAN/CSA-C411.1M89	
Composite Dead-end and Suspension Insulators	CEA Purchasing Specification for Dead-end/Suspension Composite Insulator for Overhead Distribution Lines, LWIWG-01 (96)	
Composite Line Post Insulators	CEA Purchasing Specification for Line post Composite Insulator for Overhead Distribution Lines, LWIWG-02 (96)	No agreed standards, though IAC standard near completion
Conductor	CAN/CSA-C49.1-M87 CAN/CSA-C49.6-M85 CAN/CSA-C49.7-M85	
Suspension clamps	CAN/CSA-C83-96	
Dead-end strain clamps	CAN/CSA-C83-96	
Compression joints	CAN/CSA-O57	
Armour rods	No applicable standard	

All steel components shall have a minimum Charpy impact energy absorption/toughness criteria of 20 joules @ -20 ^{o}C. All ferrous material including hardware, bolts and nuts shall be "hot dipped" galvanized in accordance with the requirements of CSA/CAN Standard G164M.

b) Clearing

See BC Hydro Engineering Report No. E7031, Preliminary Vegetation Assessment for R/W Preparation, April 2005.

c) Construction

Specifications (Construction Requirements) for the construction of the double circuit 230 kV transmission line will be prepared closer to the time tenders for construction are called and final design is near completion.

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12.0 PRELIMINARY LINE LAYOUT AND DATA

a) Preliminary Structure Spotting

To support engineering feasibility studies, public consultation, environmental studies and cost estimating, preliminary structure spotting has been completed for the entire length of the route. This layout was completed using a digital elevation model of the existing corridor complete with existing structure geometry and location. The preliminary structure spotting allows evaluation of different structure types and configurations. It also examination of individual structure loading using the proposed conductors, limiting design conditions, minimum clearances and expected severe weather loading.

Although the final results will depend on detailed line design to be completed later, the conceptual layout shown in Appendix E provides the following structure placements and heights compared to the existing 138 kV circuits:

Segment	Existing 138 kV Structure Type and Placement	Proposed 230 kV Structure Placement	Typical 230 kV Height
1 – South Delta	Wood H-frame structures, 230 m span, not matched to adjacent to HVDC lattice steel structures	Match step with HVDC towers plus additional mid-span structures	30 m
2 – Tsawwassen	Wood H-frame structures, 230 m span, match stepped for each circuit	None – remove one of two existing 138 kV lines	None
4 – Galiano Island	Lattice steel structures, 350 m span, match stepped for each circuit	For the majority of sites the proposed structures will be generally match stepped with the existing structure locations. Terrain and increased sag of the new conductor will require at least two additional structure locations. The cross under of the HVDC transmission lines at the summit of Galiano Island will require lower, flat single-circuit construction	30 m
4 – Montague Harbour, Parker Island	Lattice steel structures, match stepped for each circuit	New single-phase steel pole structures will be located at the same sites as the existing structures. The bases of the four taller lattice steel structures adjacent to Montague Harbour will be modified to support new heads and height extensions necessary to maintain safe navigation clearances	Increase height of four existing lattice Steel structures by 8 – 10 m

Segment	Existing 138 kV Structure Type and Placement	Proposed 230 kV Structure Placement	Typical 230 kV Height
6 – Salt Spring Island	Lattice steel structures, 350 m span, match stepped for each circuit	On the Athol Peninsula (Nose Pt.) and the western half of the island, the proposed structures have been placed where terrain and clearances dictate. This will result in a few additional mid span structures. Within the central portion of the island where the terrain is more favourable. The proposed 230 kV structures will be generally match stepped with the existing 138 kV lattice steel structures	30 m
7 – Sansum Narrows	Single-phase lattice steel structures	New single-phase steel pole structures will be located at the same sites as the existing towers	25 m
8 – Vancouver Island, Lattice Steel Section	Lattice steel structures, 350 m span, match stepped for each circuit	Due to the rugged terrain and the shorter allowable spans for the new structures, the structures have been placed where terrain and clearances dictate. A few additional mid-span structures are required.	30 m
8 – Vancouver Island, Wood H-frame section	Wood poles, 230 m span, match stepped for each circuit	Match step with existing 138 kV wood pole structure locations	30 m

c) <u>Data Required for Construction</u>

For construction the following data shall be prepared for construction:

- sufficiently detailed alignment plans
- alignment plans showing width and treatment for right-of-way preparation work
- profiles of the alignment showing structure position, conductor profile and structure location information
- structure data sheet summary, showing structure number, type, pole length and class, number of anchors and types, survey reference location and elevations
- bill of material for all components of the work
- structure erection drawings with bills of material for each structure type
- pole and anchor installation details
- insulator hardware assembly details (maybe shown as part of structure erection drawings)
- manufacturers drawings, showing details of structure and insulator hardware
- conductor sag/tension data and sag data, to be issued after confirmation of as-built structure location data within a section

Upon completion of construction, as-built data reflecting the following shall be provided for operating staff:

- sufficiently detailed alignment plans reflecting as-built structure locations
- alignment plans showing width and treatment for right-of-way preparation work, including access retained for maintenance and operation
- as-built profiles of the alignment showing as-built structure position, conductor profile

and structure location information

- as-built structure data sheet summary, showing structure number, type, pole length and class, number of anchors and types, survey reference location and elevations
- as-built bills of material for all components of the work
- structure erection drawings with bills of material for each structure type
- pole and anchor installation details
- insulator hardware assembly details (maybe shown as part of structure erection drawings)
- manufacturers drawings, showing details of structure and insulator hardware
- as-built conductor sag/tension data and sag data, to be issued after confirmation of as-built structure location data within a section.

APPENDICIES

A BCTC System Application.

Vancouver Island Transmission Reinforcement Project

System Application

(Summary)

Report Number: SPPA2005 – 21

System Planning (LM/VI), June 2005
British Columbia Transmission Corporation

Executive Summary

The Vancouver Island Transmission Reinforcement Project is planned to replace and upgrade the existing 138 kV circuits between ARN and VIT to meet Vancouver Island load demand. For planning purposes it is assumed that eventually two 230 kV transmission circuits with 600 MW each will be built in two stages. The first circuit in-service date is scheduled to be October 2008 and 2017 for the second circuit.

The recommended system specifications are listed below:

- The planned circuit is able to transfer 600 MW to Vancouver Island.
- The maximum continuous voltage rating of the planned circuit is 252 kV.
- The bus arrangements associated with the connection of Pole 1 facilities in the existing HVDC system need to be modified at both terminals to accommodate the planned circuit.
- A further modification at both terminals will be required in the second stage, dependent on the availability of the existing HVDC system at that time.
- A 600 MVA phase shifting transformer with ± 20 degree no load control range (33 steps) will be able to meet system requirements..
- The phase shifting transformer should have the flexibility to operate in either of the following manners: power flow control, fixed phase angle control, bypass control and RAS control. The preferred mode is a fixed phase angle control.
- The phase shifting transformer should have sufficient capability to withstand a short circuit current through the transformer. The maximum short circuit current through the phase shifter in all faulted events should be used to specify the fault duty of a phase shifter.
- One switchable shunt reactor at SAT and one non-switchable shunt reactor at TBY each with 66.1 MVA at 230 kV will provide sufficient capability and flexibility to handle high voltage problems in the system.
- It is preferred to energise the cable circuit from the ARN side, and a provision should be made to energise the circuit from VIT in a contingent situation.
- The breakers on the circuit at both terminals should have sufficient capability to close on and to trip the circuit during an energizing process.
- A provision should be made to prevent an out-of-step tripping during an acceptable swing process. Meanwhile, the station facilities and protection schemes should be capable of tripping the circuit during an unacceptable swing or a frequency slip.
- The double circuit towers will not be equipped with shielding nor tower footing resistance lowered to acceptable standard. However, one span of the overhead lines connected at each cable terminal or each station will be shielded with low tower footing resistance.
- High speed single-pole and three-pole automatic reclose will be applied on the 230 kV circuits to maintain synchronism for a fast system recovery.
- The South Gulf Islands load will be supplied radially from VIT with a backup supply from ARN through a 138 kV circuit 1L17 in the first stage, and will be tap-supplied from the 230 kV circuits through a converted 230 kV substation on Salt Spring Island in the second stage.

Content

1. Introduction

The Vancouver Island Transmission Reinforcement Project is planned to replace and upgrade the existing 138 kV circuits between ARN and VIT to meet Vancouver Island load demand. For planning purposes it is assumed that eventually two 230 kV transmission circuits with 600 MW each will be built in two stages. The first circuit in-service date is scheduled to be October 2008 and 2017 for the second circuit. [1].

Each of the circuits consists of two sections of submarine cables (~32 km) crossing Georgia Strait and Trincomali Channel, one section of underground cables (~4 km) in the Tsawwanssen area and three sections of overhead lines (~35.3 km) on Lower Mainland, South Gulf Islands and Vancouver Island [2] as shown in Figure 1. The overhead line sections for both circuits and the cable sections for one circuit with a phase shifting transformer (PST) at VIT will be built in the first stage. One of the overhead lines and the 230 kV cable will operate at 230 kV to transfer 600 MW from Lower Mainland to the Vancouver Island load centre. The other 230 kV built overhead lines together with one of the existing 138 kV submarine cables will operate at 138 kV to radially supply South Gulf Islands from either ARN or VIT in the first stage. At the second stage, the cable sections for another circuit with a PST will be added. There will be two 230 kV circuits to supply Vancouver Island together with the existing two 500 kV circuits. At that time, the South Gulf Island loads will be tap-supplied from the proposed 230 kV circuits.

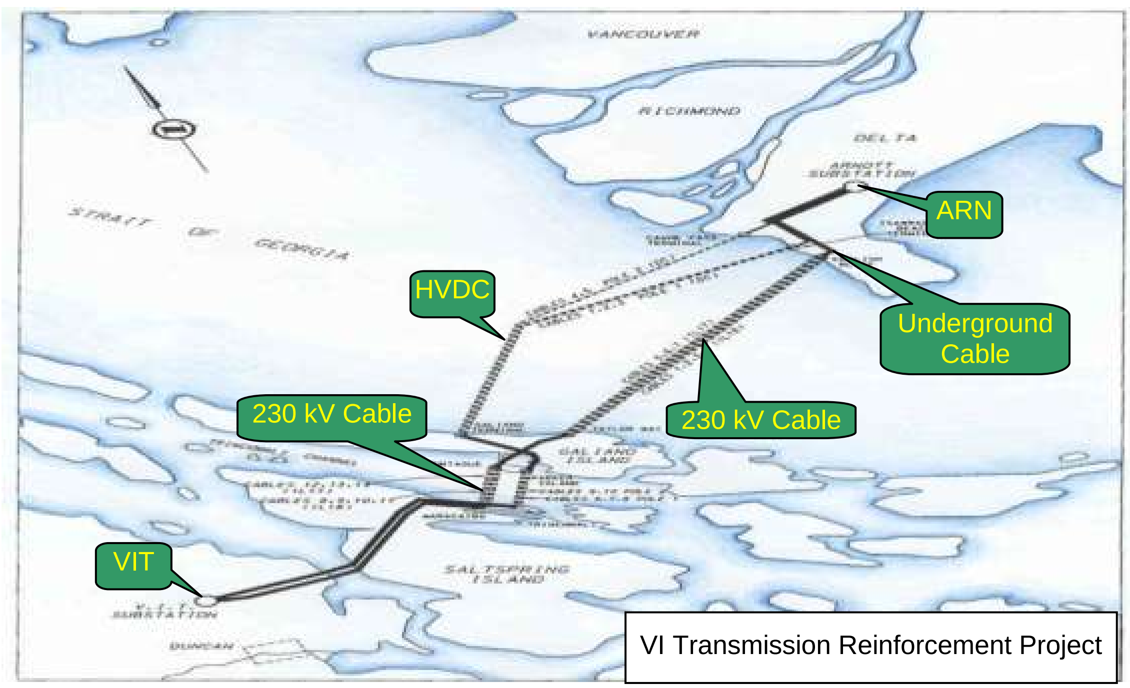


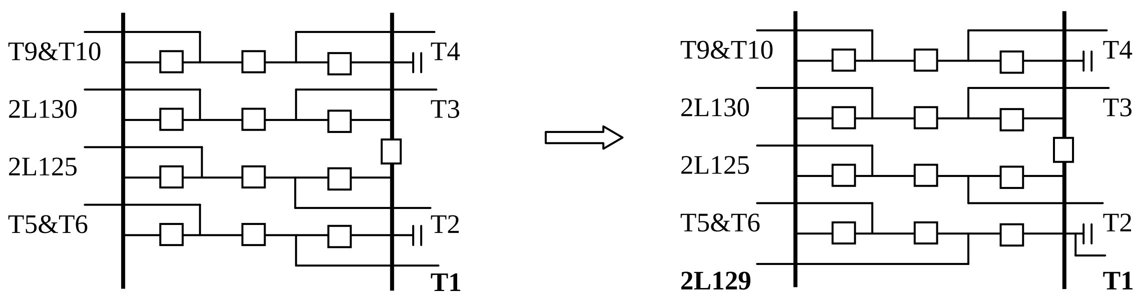
Figure 1: Vancouver Island 230 kV Transmission right of way

This document summarises technical requirements for the planned circuits.

2. System Configuration

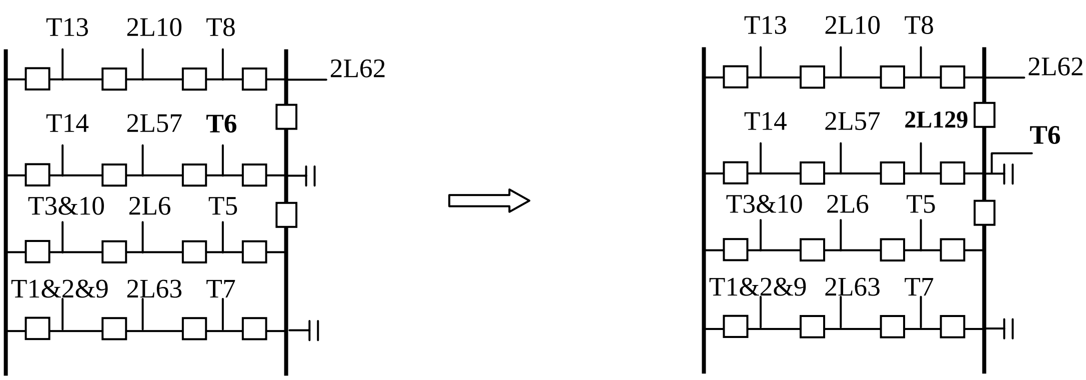
As mentioned above, the planned two 230 kV cable circuits will be terminated at ARN and VIT. When the first circuit is built, the existing HVDC system will be able to remain in service for some time to provide operational flexibility.

In order to accommodate the proposed circuit at ARN and VIT in the first stage, the bus arrangements at both terminals need to be modified. One of DC transformers in the Pole 1 system can be terminated with the Pole 1 filter at each terminal and switched together on load. A provision should be made to switch the DC transformer and the filter independently under an off load condition. The new circuit can therefore, be terminated in the bus position evacuated from the transformer at each terminal. Figures 2 and 3 illustrate such modifications at VIT and ARN for the first stage respectively.



(Current Arrangement) (Modified Arrangement)

Figure 2: 230 kV bus modification at VIT at the first stage



(Current Arrangement) (Modified Arrangement)

Figure 3: 230 kV bus modification at ARN at the first stage

In the second stage, further bus modifications at both terminals will be needed, dependent on the availability of the existing HVDC system at that time. The circuits 2L10 and 2L57 need to be upgraded when the second cable circuit is in service.

3. Circuit Rating

The 600 MW rating of the planned circuit is a nominal rating. This means that the circuit is able to transfer 600 MW at the receiving end of the circuit on Vancouver Island. The sending end rating of the circuit is therefore higher than 600 MW due to power losses and reactive power transfers.

It is identified that 450 ~500MW power flow on the planned circuit will result in the lowest transmission losses on the overall system during the F2009 peak load. The circuit with the 600 MW nominal rating is able to operate without a phase shifting transformer at the peak time under a normal system operating condition. However a phase shifting transformer inserted into the circuit is required under a contingent situation [3].

The circuit with a higher rating tends to reduce reliance of the circuit on a phase shifting transformer to operate. Other benefits on system performance could also be applicable. However, the circuit with 600 MW nominal rating is considered to be practical and with reasonable costs. A phase shifting transformer with 600 MVA nominal rating to match the circuit rating is also deemed to be a maximum practical rating.

A short term emergency rating of the circuit will benefit the system operation on Vancouver Island, which need to be developed based on the maximum continuous rating and a certain operating assumption.

4. Phase Shifting Transformer

The planned 230 kV circuit will operate in parallel with other AC transmission facilities to/on Vancouver Island. There will be two paths involved in the parallel operation. One is from CKY to VIT through MSA, DMR and SAT (northern path), and the other from ING to VIT through ARN (southern path) as shown in Figure 4. The two paths are interconnected on the Lower Mainland side through MDN.

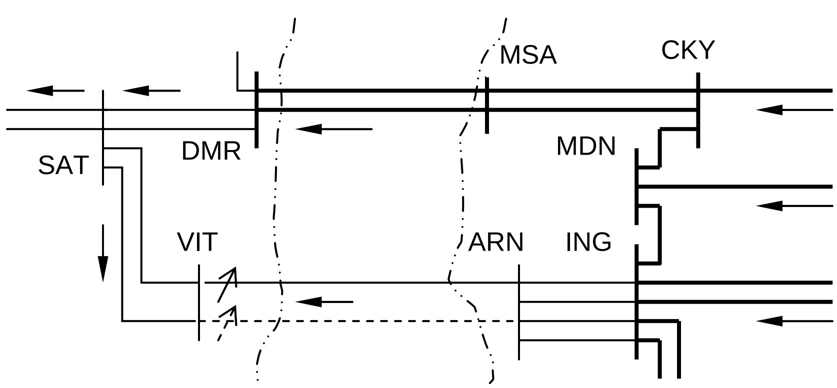


Figure 4: Circuits involved in paralleled operation

Natural power flow distribution on the two paths depends on the impedance of the two paths, which varies with system configuration and operating conditions. For example, a circuit or a transformer on one of the paths can be out of service due to a faulted event or for maintenance. The path impedance will increase and power flow on the path will decrease. Under a certain operating conditions, one of the paralleled paths may overload while the other may have more room to reach their limits. Such overloading could happen on either path under different operating conditions. In this case, the transfer capability on the paralleled paths would not be able to be fully utilized. A phase shifting transformer (phase shifter) installed with each circuit can be used to control power flow on the parallel paths.

The phase shifting transformer should be able to carry the maximum power flow of 630 MVA continuously to match the cable circuit rating.

(1) Control Objectives

The VIT phase shifting transformer has the following control objectives:

- Maximise power flow on the paralleled transmission circuits under different system configurations and different operating conditions for different planning terms.
- Optimise power flow on the paralleled circuits to reduce transmission losses on the overall BCTC transmission network.
- Adjust the circuit loading to assist system voltage control at off-peak load time, especially on the Vancouver Island side.

(2) Operating Method/Procedure

In order to achieve the above control objectives, the VIT phase shifting transformer should have the flexibility to operate in either of the following manners:

- Control by power flow:

  Set power flow on the 230 kV circuit at a predefined level for overall system economic operation. During contingent situations or other changes in the system, adjust the phase shifter to maintain the predefined power flow on the circuit. This form of control implies automatic and continuous control.

- Control by phase angle:

  Set the phase shifter at a fixed tap (angle) position during normal conditions. Change the tap position according to some predefined setting for contingent cases. This form of control implies non-continuous control by remote supervision.

- Bypass control:

The phase shifter is bypassed for maintenance or for specific conditions such as Vancouver Island loss of 500 kV supply, or for economic operation under suitable system conditions.

- Control for Remedial Action:

  There are a few remedial action schemes (RAS) in the Vancouver Island supply system like cable overload protection, over-voltage protection and under-frequency load shedding. The phase shifter control needs to be coordinated with the existing RAS and new RAS to be added in future.

In the power flow mode, depending on the allowed tolerance, the tap position may be required to change quite often as the Vancouver Island load level and the generation schedule change. This may have an adverse affect on the life of the on-load tap changer (LTC) and may require costly maintenance.

For the phase angle mode, since the tap is normally fixed at a certain position, the flow on the 230 kV circuit will be allowed to change with any load level or generation schedule changes. The tap position will only change under the operator’s direction or a RAS triggering when the need arises. This means less tap changes resulting in lower operating cost. This method of operation should be used if there is no significant compromise on the objectives of the phase shifter.

For the bypass mode, the 230 kV circuit will operate without a phase shifter inserted in for multiple purposes as mentioned earlier. The circuit can be overloaded at heavy load time on Vancouver Island, especially under a contingent situation. In this situation, the circuit will be protected by the cable overload protection scheme through Vancouver Island load shedding or by other RAS.

A provision should be made to implement the RAS. A new RAS may include the functions of switching control mode, adjusting tap position and bypassing the phase shifting transformer with the tap position at zero.

(3) Control Range

Power flow studies show 230 kV cable circuit loading depends very much on system configuration. The circuits between DMR and SAT are 500 kV built, operating at 230 kV currently. Therefore, the SAT 500 kV conversion will dramatically reduce the northern path impedance. Before the conversion, the phase shifter is mainly used to prevent overloading on the 230 kV cable circuit between ARN and VIT while a major concern becomes to increase power flow on the 230 kV circuit after the conversion. It means that the phase shifter at VIT needs to operate at a retard angle before the conversion and a neutral or advanced angle after the conversion. Here, the advanced (negative) angle means that the load (station) side voltage of the shifter will lead the source (line) side voltage [4]. Both scenarios with/without the conversion for different planning terms were considered to determine the control range of the phase shifting transformer at VIT.

Overloading on the paralleled circuits most likely occurs at contingent situations. Three scenarios are identified to have major impact on the circuit loading. One is loss of either 230 kV lines between DMR and SAT, which will increase the northern path impedance most and cause the 230 kV cable circuit overloaded most. This scenario could cause south Vancouver Island power shortfall and dominates requirement of the phase shifter positive (retard) angle before the second 230 kV cable circuit in service. Loss of either 500 kV cable circuits does not make much change in the northern path impedance, and therefore the effect on power flow is not so significant. However loss of one of 500 kV cable circuits can substantially reduce the Vancouver Island supply capability and overload the other 500 kV cable circuit under a heavy load demand especially after the SAT 500 kV conversion. This scenario dominates requirement of the phase shifter negative (advanced) position. Loss of either 230 kV cable circuits when the second cable is in service is another scenario. If this outage is combined with heavy Vancouver Island load demand and without the SAT conversion, a higher positive (retard) tap position of the phase shifter is needed to avoid severe overloading on the other 230 kV cable circuit.

It is concluded that the phase shifter with no load control range (-20, 20) degree should be able to meet the control objectives of the phase shifting transformer at VIT. A 33-step tap changer of the phase shifter should be sufficient to precisely control power flows on the circuit. A shifter with higher control range can provide additional flexibility for unforeseen system conditions in future. Engineering is therefore encouraged to do so if no significant cost increase involved [3].

(4) Fault Duty

A phase shifter at VIT is required to have sufficient capability to withstand short circuit current through the phase shifter under a faulted system event for the planning terms. Faulted events in a power system include 3-phase balanced fault, single phase to ground fault, line to line fault and double line to ground fault. According to the information from Engineering, unbalanced fault events dominates short circuit current levels in south Vancouver Island. Three phase fault currents were calculated and the results are listed below. Unbalanced fault studies will be carried out by Engineering to specify station equipment and for P&C uses. The maximum short circuit current through the phase shifter in all faulted events should be used to specify the fault duty of a phase shifter.

Table 1 lists the 3-phase fault currents through the phase shifter and the total 3-phase fault currents on the faulted buses for different planning terms and different fault locations [3]. In the 2009 planning term, a single 230 kV cable circuit was assumed in service but without SAT 500 kV conversion and a winter peak time was used in the fault analysis. Two 230 kV cable circuits in service and the SAT conversion were considered for the F2019 planning term. The main factor influencing the fault current level at VIT is the system configuration such as the SAT conversion and the addition of the 230 kV cable circuits. A longer planning term beyond F2019 is expected to have minor influence on the fault current level, especially for the short circuit current through the phase shifter.

Table 1: 3-phase Fault Currents for Different Scenarios [3]

Term	Fault location	Fault Contribution through PST (kA)	Total Fault Current (kA)
F2009	Line side	4.64	10.83
	Station side	4.31	12.60
	PST bypassed	-	14.30
F2019	Line side	6.20	12.24
	Station side	3.53	18.24
	PST bypassed	-	20.40

5. Voltage Control and VAR Compensation

The planned cable circuit will be able to transfer 600 MW active power to Vancouver Island but also be a system reactive power source (200~260 MVA). It is identified that reactive power from the cable charging will be able to support heavy power transfer through the circuit without additional reactive power compensation.

However, the charging power from the circuit could result in a high voltage problem at a light load time especially for the Vancouver Island side since the system on Vancouver Island is relatively small. Therefore it is preferred to energise this cable circuit from the ARN side, and a provision should be made to energise the circuit from VIT in a contingent situation.

It is identified that one switchable shunt reactor at SAT and one non-switchable shunt reactor at TBY each with 66.1 MVA at 230 kV will provide sufficient capability and flexibility to handle high voltage problems under various operating conditions [5].

The planned circuit is required to have a 252 kV maximum continuous voltage rating. The breakers on the circuit at each terminal should have sufficient capability to close on and to trip the circuit under a normal or a contingent condition or during an energising process.

6. Swing Centre

Certain RAS should be provided to prevent out-of-step tripping when Vancouver Island loss of 500 kV supply under certain conditions. But if the needed RAS failed, an out-of-step tripping may occur. When the RAS fails, the swing center is expected to appear inside of the phase shifting transformer or on the planned circuit.

A provision should be made to prevent an out-of-step tripping during an acceptable swing process. Meanwhile, the station facilities and protection schemes should be able to trip the circuit during an unacceptable swing or a frequency slip.

7. System Insulation Coordination & Switching

The basic insulation and switching requirements for the two ARN-VIT circuits are described in Appendix 1 from lightning, switching and temporary overvoltage operating conditions, and are summarized below:

Lightning Performance

The double circuit towers will not be equipped with continuous shielding nor tower footing resistance lowered to acceptable standard due to low iso-keraunic conditions in the southern coastal region and economic considerations. However, to avoid direct lightning strikes to the phase conductors near the cable terminals and stations, one span of the overhead lines connected at each cable terminal or each station will be shielded with low tower footing resistance to minimize backflashes within the shielded section.

The cable sections of the planned circuits are longer than 2 km, and are naturally protected from lightning surges generated on the unshielded overhead lines. Surge arrestors will be applied at the line/cable junction to ensure absolute overvoltage limits from all overvoltage conditions. Surge arrestors will also be installed in the stations to protect the station equipments from lightning surges.

High Speed Auto-Reclose

When lightning strikes the towers or phase conductors, majority of the faults will be single-line-to-ground (SLG) since the initial flashover reduces the possibility for multi-phase faults. Multi-phase faults on one circuit can happen sometime but there is more potential for simultaneous faults occurring on both circuits, especially common phase SLGs. From system security perspective, it is desirable to minimize complete loss of load. High speed single-pole and three-pole automatic reclose should be applied on the 230 kV circuits to maintain synchronism as well as fast recovery, which will significantly improve the circuit reliability level.

For a single line to ground (SLG) fault and the line equipped with single pole reclose (SPR) feature, the faulted phase needs to be opened for minimum of 1.0s to allow for secondary arc extinction and subsequent insulation di-electric recovery. Since synchronism is maintained by the two phases, reclose can be initiated from ARN and the VIT end closed shortly thereafter. For multi-phase faults, the circuit must be tripped 3-phase and reclose operation initiated from ARN station with synchro check performed at the VIT end. When synchronism is not observed, the circuit should be tripped automatically.

Temporary Overvoltages

For the ARN-VIT circuits, two types of temporary overvoltages can be expected. One is associated with common load rejections while the second more serious situation exists during the first stage due to differential insulation on parallel circuits with dual voltages.

Temporary overvoltages as high as 1.5 pu can be expected on long cable circuits following large load rejections, especially when the last terminal to open has low source strength. In the ARN-

VIT case, application of 66.1 MVAr shunt reactors which compensates a portion of the cable capacitance will reduce this possibility.

In the project first stage, when parallel circuits are operated at 230 kV and 138 kV, there exists possibility for severe temporary overvoltage conditions for 138 kV circuit. Should simultaneous faults occurs at the double circuit tower, the 230 kV conductor will be in contact with the 138 kV circuit temporarily until line protection removes the 230 kV sources. To protect the 138 kV cables and transformers, initial plans are to apply the lowest possible surge arrestors compatible for these conditions so that they will not fail during normal operating conditions and even during temporary simultaneous parallel line faults. However, for excessive or sustained conditions, some surge arrestors are expected to fail short-circuit sacrificially to protect the 138 kV equipment.

8. Reliability Issues:

- Spare Phase Cable

The planned circuit is expected to have a reasonable reliability level. It should be understood that a single cable failure of the circuit could result in the circuit out of service up to three months to be repaired according to the information from Engineering. This consequence is severe especially at the project first stage.

The mentioned consequence should be acceptable because Vancouver Island can be supplied through the 500 kV circuits during the planned circuit out of service. In addition, the existing HVDC system may still be available for some time at the project first stage. It is not expected that a spare phase cable could reduce much of Expected Energy not Served (EENS) on Vancouver Island, and a heavy price tag would go with the spare phase cable. An installed spare phase cable at the first stage is therefore not recommended although a spare cable section about 5 km may need in storage to speed up a potential repair process.

In the second stage, a single cable failure is expected to have less impact on Vancouver Island supply compared to the first stage. It is therefore not desire to add an installed spare phase cable in the second stage.

- Spare Phase Shifting Transformer

The phase shifting transformer on the circuit can be out of service for a long time if a severe damage inside of the transformer occurs. The planned circuit without the transformer is able to operate within its thermal limit during most of the time until another major outage such as loss of one of 2L123 & 2L128 and 5L29 & 5L31 occurs in the project first stage. In an extreme event, if overloading on the 230 kV circuit becomes inevitable due to PST damage at peak time plus another major failure, the VIT buses can be split to have the 230 kV circuit to solely supply the VIT transformers T5&T6. This means that the proposed circuit is still able to supply up to 400 MW to Vancouver Island.

A spare phase shifting transformer is not recommended because a similar phase shifter like that in the Nelway substation is relatively reliable, the probability of the failure combination is extremely low and the low probability risk can be mitigated by operational measures. In addition, a spare phase shifting transformer would also go with a large cost.

9. South Gulf Islands Supply

As mentioned in section 1, the South Gulf Islands load will be supplied from VIT with a backup supply from ARN through the 138 kV circuit 1L17 at the project first stage.

In the second stage, both 230 kV circuits will be in service and the South Gulf Islands load will be tap-supplied from the two 230 kV circuits through a converted 230 kV substation (SAL) on Salt Spring Island. And the Galiano Island load can be served from SAL through lower voltage circuits.

10. Recommended System Specification

- The planned circuit is able to transfer 600 MW to Vancouver Island.
- The planned circuit is required to have a 252 kV maximum continuous voltage rating.
- The bus arrangements associated with the connection of Pole 1 facilities in the existing HVDC system need to be modified at both terminals to accomodate the planned circuit.
- A further modification at both terminals will be required, dependent on the availability of the existing HVDC system at that time.
- A 600 MVA phase shifting transformer with ± 20 degree no load control range (33 steps) will be able to meet system requirements. A phase shifting transformer with higher control range is encouraged for additional flexibility in future if no significant cost increase involved.
- The phase shifting transformer should have the flexibility to operate in either of the following manners: power flow control, fixed phase angle control, bypass control and RAS control. The preferred mode is a fixed phase angle control.
- The phase shifting transformer should have sufficient capability to withstand a short circuit current through the transformer. The maximum short circuit current through the phase shifter in all faulted events should be used to specify the fault duty of a phase shifter.
- One switchable shunt reactor at SAT and one non-switchable reactor at TBY each with 66.1 MVAr at 230 kV will provide sufficient capability and flexibility to handle high voltage problems in the system.

- It is preferred to energise the cable circuit from the ARN side, and a provision should be made to energise the circuit from VIT in a contingent situation.

- The breaker on the circuit at each terminal should have sufficient capability to close on and to interrupt the circuit under a normal or a contingent condition or during an energizing process.

- A provision should be made to prevent an out-of-step tripping during an acceptable swing process. The station facilities and protection schemes should be capable of tripping the circuit during an unacceptable swing or a frequency slip.

- The double circuit towers will not be equipped with shielding and appropriate low tower footing resistance. However, one span of the overhead lines connected at each cable terminal or each station will be shielded with low tower footing resistance.

- High speed single-pole and three-pole automatic reclose will be applied on the 230 kV circuits to maintain synchronism as well as fast recovery.

- The South Gulf Islands load will be supplied radially from VIT with a backup supply from ARN through the 138 kV circuit 1L17 at the first stage, and will be tap-supplied from the 230 kV circuits through the converted 230 kV substation on Salt Spring Island in the second stage.

It should be noted that the above recommendations are based on a series of assumptions. These recommendations need to be revised if a significant change on the assumptions occurs.

References

1. Vancouver Island Transmission Reinforcement Project, Technical Justification, SPPA2005-20, Jun 2005.

2. 230 kV Transmission Circuit from Arnott to VIT, SP2003-04, Jun. 2003.

3. Vancouver Island Transmission Reinforcement Project, System Application on Phase Shifting Transformer Specification and Circuit Rating, System Planning Report, SPPA2005-22, Jun. 2005.

4. IEEE Std C57.135-2001™, IEEE Guide for the Application, Specification and Testing of Phase-Shifting Transformers.

5. Vancouver Island Transmission Reinforcement Project, System Application on System Voltage Control, System Planning Report, SPPA2005-23, Jun. 2005.

Appendix 1:

System Insulation Coordination & Circuit Switching

The planned mainland (ARN) to Vancouver Island (VIT) circuit connection has two main stages of development, initial and ultimate, each requiring different operating schemes and corresponding system components. Consequently, major system components which are acquired for the first stage should also be compatible for the ultimate stage.

In the first stage, one of the two circuits will be operated at 230 kV connecting the mainland to Vancouver Island while the second line will be operated as a radial circuit from either VIT or ARN stations to the 138 kV Salt Spring (SAL) and Galiano (GLS) distribution stations. The new overhead sections of the second line will be insulated for the ultimate 230 kV but will be operated at 138 kV together with several existing equipment such as cables and transformers which are rated only for 138 kV.

In the ultimate stage, the new circuits will be operated as parallel 230 kV circuits between ARN and VIT. Therefore, the lines and cables as well as all associated circuit equipment will be fully rated for 230 kV operation. In the ultimate plan, the SAL loads will be supplied by taps from both 230 kV circuits while the GLS load is expected to be supplied from SAL at 25 kV distribution level.

In the following sections, basic insulation and switching requirements for the two circuits and stations during the initial and ultimate operating stages are described. For reliable system and application of economical equipment, insulation coordination is applied to both circuits and stations utilizing surge arresters and system protection and control for all operating conditions.

1. System Insulation Coordination

The basic insulation requirements for the two ARN-VIT circuits are described considering lightning, switching and temporary overvoltage operating conditions. In the present plan, these circuits will have two distinct operating conditions.

In practice when two circuits are completely independent there are no major concerns using equipment with mixed insulation levels as long as they are operated higher than the lowest common level. In the initial stage, the two circuits operating at 230 kV and 138 kV will share the double circuit towers. Due to low iso-keraunic conditions in the southern BC coastal region and for economic reasons, the double circuit towers will not be equipped with continuous shielding nor tower footing resistance lowered to acceptable standard. As a result, when lightning strikes these towers or phase conductors, there is potential for simultaneous faults occurring on both circuits. From system security perspective, it is desirable to minimize complete loss of load so some methods of maintaining partial load as well as synchronism to perform fast automatic recovery from temporary faults are explored.

Transmission Circuits

In the ultimate stage each of the 230 kV circuits will consist of three line and three cable sections. In addition, each circuit will be equipped with phase-shifter at VIT terminal to regulate the power flow. In addition, to compensate for part of the cable capacitance, 66.1 MVar shunt reactors will be applied at Taylor Cable Terminal.

In the initial stage, one of the circuit being operated as a radial 138 kV circuit will have all components rated for 138 kV except for overhead lines which will have the 230 kV insulation level. Consequently, it will be necessary to ensure that disturbances generated within the 230 kV line sections are properly limited to 138 kV level for the existing cables and station transformers.

In the ultimate stage, all the overhead and cable sections and associated line equipment including load transformers will be designed to 230 kV insulation standard. The overhead line sections will be supported by 230 kV double circuit towers. To avoid direct lightning strikes to the phase conductors near the cable/line interface, the overhead sections at each cable terminal and station will have shielding over at least one span. .

ARN & VIT Stations

All new equipment at the two stations will be designed for 230 kV operation. In addition, to assist in the station equipment insulation coordination, each of the overhead line will be shielded (0.5 km from station) to prevent direct strikes to phase conductors close to the station.

1.1 Circuit Lightning Performance

Overhead Line Sections

The unshielded lines on double circuit towers are vulnerable to multiple faults when lightning strikes the towers or the phase conductors. When the parallel circuits are operated at the same voltage level, simultaneous insulation flashover on the same phase of both circuits can be expected. With multiple lightning strokes, possibilities exist for flashovers on different phases due to the bias from the power frequency voltage and negative or positive lightning strokes over few cycle intervals.

Up to medium level lightning, majority of line faults are expected to be limited to single-line-to-ground (SLG) since the faulted phase conductor behaves as a shield wire and energy required to flash other phases are reduced. This knowledge is the main reason why single circuits are often equipped with single-pole reclose (SPR) feature to maintain synchronism and achieve fast automatic load recovery from fault disturbance. Even for double circuit operations, particularly for unshielded lines, SPR can have tremendous benefit to system security. Since simultaneous multi-phase faults on double circuits are rare,   one circuit in SPR mode allows the parallel circuit with multi-phase fault to execute high speed 3-phase trip and reclose.   Secondly, should the 3-phase reclose is unsuccessful,   there exists another chance that SPR itself will be successful. As a result, system separation rarely occurs from lighting strikes when both lines are equipped with SPR feature.

Cable Sections

Long cables over 2 km are naturally protected from lightning surges generated on the unshielded overhead lines.   Nevertheless, surge arresters are often applied at the line/cable junction to ensure absolute overvoltage limits from all overvoltage conditions. . In order to prevent direct strikes to the cable pothead or surge arresters, one span of the overhead line should be shielded with low tower footing resistance to minimize backflashes within the shielded section.

Line Shunt Reactors

The shunt rectors applied on the line must be protected by surge arresters from lightning. In order to prevent direct strikes to the shunt reactors and surge arresters, one span of the overhead line should be shielded with low tower footing resistance to minimize backflashes within the shielded section.

1.2 Switching Performance

During normal operating conditions, the two parallel circuits will be energized and de-energized with normal system voltages.   During fault clearing operations, when suitable conditions exist, line protection is expected to execute both single-pole and three-phase auto reclose.

When circuits consist of both cables and lines with large surge impedance differences, incident surges are transmitted and reflected according to their ratios. In general, when surges which are generated on a line with high surge impedance encounters the cable with lower values, only portion of the incident surges are transmitted into the cable. On the other hand, when surges propagating in the cable encounter an open circuit, large inductance or overhead line, those surges can expect to double at the interface.   In general, for the line/cable combinations, switching overvoltages occur due to superposition of travelling waves established within each line and cable section.

1.2.1 Circuit Energization

With random circuit breaker closing, the instant of switching can occur near the source peak voltage.   Since the circuit is de-energized, the largest energizing transients are expected to be less than 2.0 PU without any control. With the presence of SAs at the line and cable terminals, switching overvoltages can be limited to 1.8 PU.

1.2.2 High Speed Automatic Circuit Reclose

During high speed reclose operations some trapped charges will remain on the line and cable and reactors, particularly on the unfaulted phases. With random reclosing of CBs, switching transients of 2.0 PU can be generated resulting in proportionally larger overvoltages at the cable and line terminals. However, when SAs are applied at the line and cable terminals, these overvoltages can be safely limited to 1.8 PU.

3-Phase Auto-Reclose

During parallel line operations, 3-phase high speed reclose can be applied without any concern for out-of-phase condition since the parallel circuit maintains synchronism. Even during single circuit mode of operation, automatic 3-phase reclose is also possible provided synchro-check is performed at the receiving end (VIT) due to possible parallel circuit operation of CKY-DMR 500 kV and DMR-VIT 230 & 138 kV circuits.

Single Pole Reclose

When SLG faults occurs on a circuit equipped with SPR, line protection opens only the faulted phase while the other two phases remain connected. Due to the fault, the trapped charges remaining on the faulted phase are usually small and remain low even with electro-magnetic induction from the healthy phases. For the VIT-ARN line/acble combination with or without the 66.1 MVar line reactors, the secondary arc extinction is expected to be successful due to the combination of relatively small arc current below 10 A and subsequent recovery voltages below 0.2 PU. Consequently, with synchronism maintained by the two phases and largest single-phase reclosing transient generated by the CBs to be less than 1.2 PU, successful SPR can be expected.

1.3 Temporary Overvoltages

Temporary overvoltages are expected during normal system disturbances and equipment are rated accordingly. For the ARN-VIT circuits, two types of system temporary overvoltage conditions are expected. One is associated with common system disturbances such as load rejections while the second more serious situation exists during the first stage due to different operating voltage levels with incompatible insulations.

1.3.1 230 kV and 138 kV Common Tower Fault

In the initial stage, when parallel circuits are operated at 230 kV and 138 kV, severe temporary overvoltage condition must be expected for the 138 kV circuit. Since simultaneous faults are expected with the unshielded double circuit towers, the 230 kV phase conductor can contact the 138 kV temporarily until the line protection removes the 230 kV supplies. With high impedance tower fault, the 138 kV cables and associated line equipment could be subjected to well over 1.5 PU power frequency overvoltages while voltages at the stations will be held down closer to 1.0 PU by the 138 kV sources as long as the 138 kV line CBs remain closed.

To protect the cables and transformers, initial plans are to apply the lowest possible SAs compatible for these conditions so that it will not fail during normal operating conditions including temporary simultaneous parallel line faults. However, when prolonged and/or excessive overvoltage conditions exist, SAs are expected to fail short-circuit thereby sacrificing to protect the more expensive 138 kV equipment.

1.3.2 Load Rejection

Temporary overvoltages as high as 1.5 PU can be expected on long cable circuits following large load rejections, especially when the last terminal to open has low source strength. In the ARN-VIT case, application of 66.1 MVars shunt reactors which compensates large portion of the cable capacitance will reduce this possibility.

2 System Switching Operations

The switching operations required for the first and ultimate stages are described according to the desired circuit operating performance. The primary difference is that in the first stage the two circuits are operated independently from each other while in the ultimate stage, the two 230 kV circuits are operated in parallel while the SAL loads will be connected to each circuit by CBs.

2.1 Initial Stage: Independent 230 kV and 138 kV Circuit Operations

2.1.1 230 kV Circuit Switching Operations

The 230 kV circuit will be operated as a single independent circuit to transfer power between the mainland and the island.

Circuit Energization
The circuit will be energized from ARN end (preferred) with possibility for automatic closing at the VIT end by using the synchro check. When the VI system is being manually synchronized, it is recommended that circuit energization be delayed until the VI system frequency is ready to be synchronized to the mainland.

Circuit High Speed Reclose
For SLG faults where the circuit is equipped with the SPR feature, only the faulted phase will be opened for minimum of 1.0 s to ensure secondary arc extinction and adequate insulation dielectric recovery. Since synchronism is maintained by the two phases, reclose can be initiated from ARN and the VIT end to be closed as soon as sufficient fundamental voltage condition is observed. There will be no need to perform synchro check for SPR,

For multi-phase faults, the circuit must be tripped 3-phase and reclose operation initiated from ARN station while the VIT end is closed automatically only when synchro check is satisfied. When synchronous condition is not acceptable, the ARN end should be tripped automatically to de-energize the circuit.

2.1.2 138 kV Circuit Switching Operation

Normally, the 138 kV circuit together with the unloaded Salt Spring and Galiano station transformers will be energized simultaneously from the VIT 138 kV terminal. The 138 kV circuit beyond Galiano will be isolated by an open DS while the cable and line are energized from ARN to provide some voltage support while monitoring the condition of the cable.

When the VIT 138 kV supply is not available, the SAL and GLS station will be energized from the ARN 138 kV circuit. The VIT-SAL 138 kV circuit is expected to be isolated at SAL by a DS and grounded at VIT when not in use.

For any fault occurring on the two 138 kV circuits, the circuit must be tripped at the supply end without any high speed reclose. The trapped charges remaining on the circuit should be properly discharged by VTs since the HV side of the SAL and GLS transformers are effectively ungrounded. When the 138 kV circuit supply is lost, the SAL and GLS transformers and the distribution circuits will remain connected and re-energized together with the line.

2.2 Ultimate Stage: Parallel 230 kV Circuit Operation

2.2.1 230 kV Circuit Switching Operations

The two 230 kV circuits in the ultimate stage will be operated as parallel circuits together with the 500 kV CKY-DMR circuits connecting the mainland (ARN) to Vancouver Island (VIT) systems. Consequently, each circuit can directly influence the load and performance of the parallel circuit as well as power flows on the 500 kV circuits.

Normal Condition with 2 Circuit Operation

Circuit Energization:

During normal operation the circuits will be manually energized from ARN (preferred, VIT alternate) station with automatic synchro check performed at VIT before the CBs are closed. In the event synchronism criteria is not met, the circuit must be manually closed using proper synchronizing procedure.

During the circuit energization process, the 230 kV CBs at SAL should remain open. After the line is successfully energized, the station transformer(s) can be energized individually.

High Speed Auto-Reclose

With both circuits operating in parallel, opportunities to maintain synchronism for single and multi-phase faults and fast restoration of one or both circuits are possible.

During SLG faults, each circuit will be expected to perform independent single pole reclose operation with reclosing performed from ARN station without any need for synchronization check at the VIT end.   The CBs at the SAL must be opened on the faulted phase or 3-phase to eliminate source possibility of sustained source voltage on the faulted phase through the delta windings. The reclosing time should be delayed for 1.0 s to allow secondary arc extinction and insulation dielectric recovery.

During multi-phase faults, the faulted circuit must be tripped three-phase at both terminals as well as at the SAL station. If the parallel circuit is in operation, high speed reclose switching should be performed after 0.8 s (to allow proper arc extinction due to induction from the parallel circuit) from ARN station without any need for sychronization check at the VIT end. The unloaded SAL transformer(s) can be energized individually after successful energization of each circuit is completed.

During simultaneous SLG and multi-phase fault condition, it is preferable to have faster (no less than 1 cycle) reclosing time for the 3-phase reclose since synchronism is maintained by the parallel circuit which should be in the SPR mode due to the SLG fault. The SAL 230 kV and 25 kV CBs must be opened 3-phase as soon as the line supply is lost and load recovery procedure initiated only after successful line restoration.

For the rare simultaneous multi-phase faults on both circuits, it will be necessary to perform 3-phase trips (ARN, VIT & SAL) and reclose from ARN end and perform synchro check at the VIT end before closing the line CBs. In the event synchronous condition is not satisfied at VIT, the circuit should be tripped automatically at ARN.

Contingency Condition: Single Circuit Operation

Circuit Energization:
Identical to normal condition.

High Speed Auto-Reclose with Single Circuit
For SLG faults, normal SPR operation can be performed during single circuit operation. During multi-phase faults, the circuit must be 3-phase and reclose performed from ARN end with synchro check performed at VIT before the CBs are closed. In each case, the SAL CBs should be opened single or 3-phase consistent with the line tripping mode.

2.2.2 Supplies to SAL & GLS Loads

Since the SAL and GLS loads are supplied through the line connections at SAL, these loads will be lost only when multi-phase faults occur simultaneously on both circuits. For temporary line faults, restoration to two transformer operation will depend on transformer energization and load side CB reclosing speed.

B BC Hydro Engineering Standard, Vertical Clearances for Overhead Lines on the BC Hydro Transmission System, Manual 41K, Section 2, R0 dated October 1988

C Right-of-Way Cross Sections

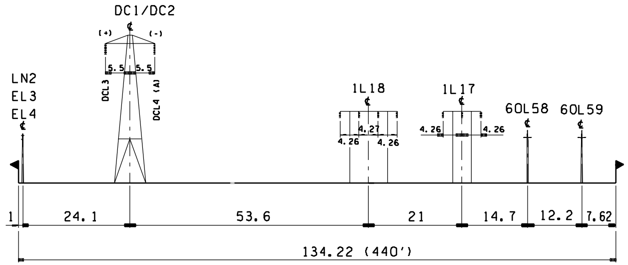
Cross sections showing the “existing” and “proposed” arrangement of circuits on BC Hydro right-of-way are shown on the following figures:

Fig: R/W Section – Delta (Existing)
Fig: R/W Section – Delta (Proposed)

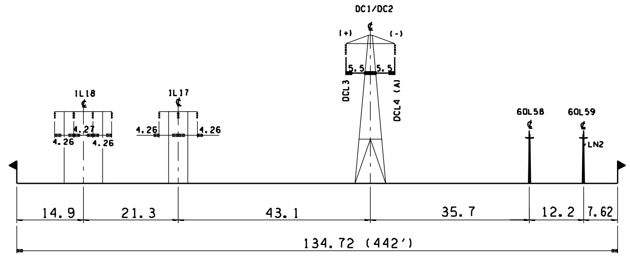
Fig: R/W Section – Galiano (Existing)
Fig: R/W Section – Galiano (Proposed)

Fig: R/W Section – Saltspring (Existing)
Fig: R/W Section – Saltspring (Proposed)

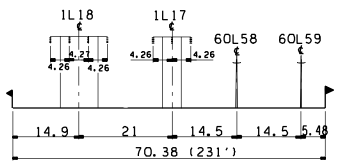
Fig: R/W Section – Van. Isl. (Existing)
Fig: R/W Section – Van. Isl. (Proposed)



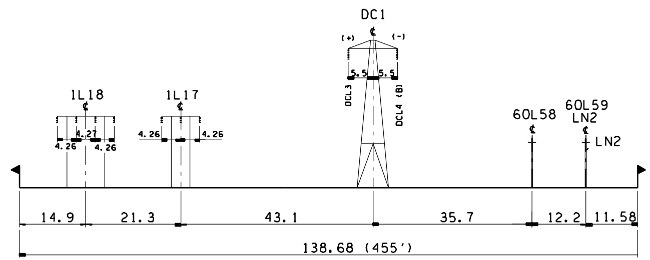
LADNER, ARNOTT SUBSTATION SOUTH TO
DELTA PORT INTERCHANGE



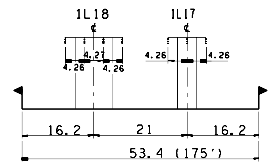
DELTA PORT INTERCHANGE - INCLUDING
CROSSING OF HWY. #17



TSAWWASSEN SUBSTATION AREA



DELTA PORT TO TSAWWASSEN AND HWY. #17



TSAWWASSEN TO ENGLISH BLUFF

NOTE:
1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

EXISTING

British Columbia Transmission CORPORATION™

BC hydro ENGINEERING

VANCOUVER ISLAND REINFORCEMENT PROJECT

EXISTING R/W CROSS SECTIONS
LADNER AND TSAWWASSEN IN DELTA

DATE JAN/05

DWG NO FIG.: R/W SECT. - DELTA (EXISTING)

R A

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	#	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT

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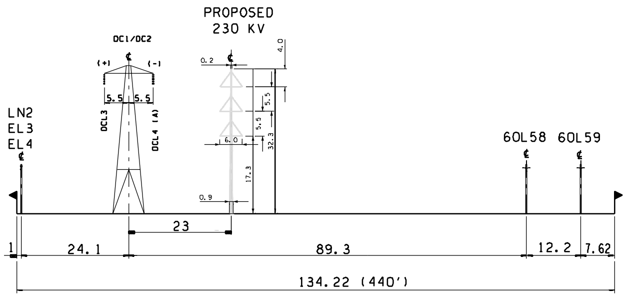
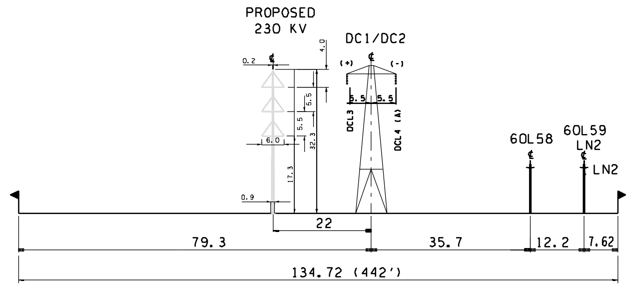
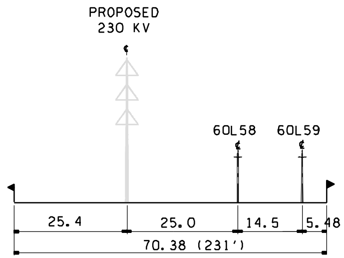


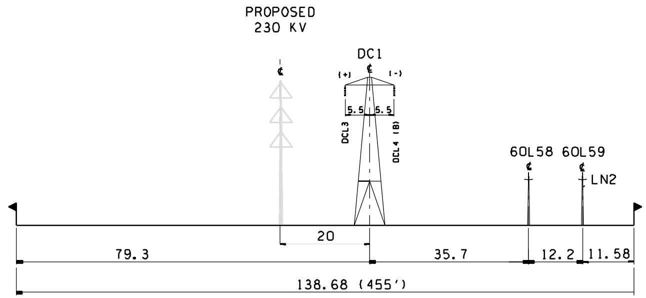
LADNER, ARNOTT SUBSTATION SOUTH TO
THE VICINITY OF DELTA PORT INTERCHANGE



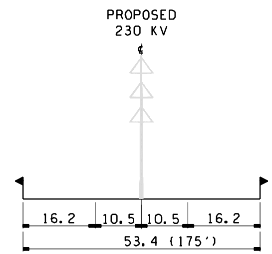
DELTA PORT INTERCHANGE - INCLUDING
CROSSING OF HWY. #17



TSAWWASSEN SUBSTATION AREA



DELTA PORT INTERCHANGE TO TSAWWASSEN AND HWY. #17



TSAWWASSEN TO ENGLISH BLUFF

NOTE:
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UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

PROPOSED

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VANCOUVER ISLAND REINFORCEMENT PROJECT

PROPOSED R/W CROSS SECTIONS
LADNER AND TSAWWASSEN IN DELTA

DSGN | INDEP CHKD | DFTG | DFTG CHKD | INSPD | REV | ACPT

DATE JAN/05

DWG NO CAD FIG: R/W SECT. - DELTA (PROPOSED) R B

REF# | DRAWING NUMBER | TITLE — REFERENCE DRAWINGS

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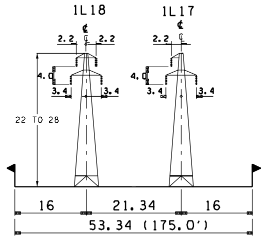
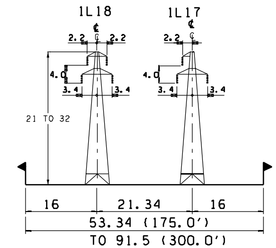
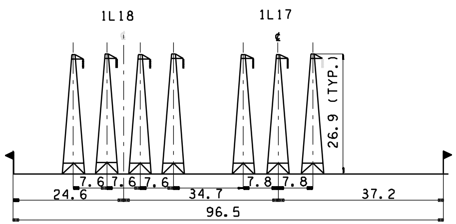


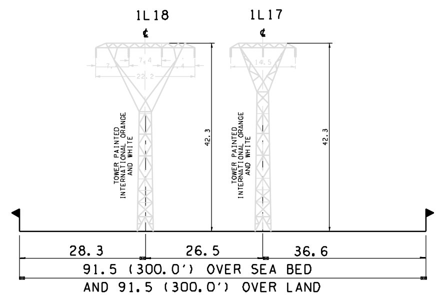
GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM TAYLOR BAY TO PORLIER PASS DRIVE



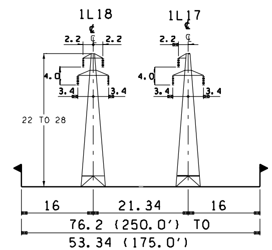
GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM BC HYDRO DC1/2 R/W, 1.8 KM WEST OF
TAYLOR BAY TO PORLIER PASS DRIVE



GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM THE BC HYDRO DC1/2 R/W, 1.8 KM
WEST OF
TAYLOR BAY TO PORLIER PASS DRIVE
PARKER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
ON LOTS 35, 2 AND 34 DL 9



GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CICRUITS 1L17/18
FROM WEST OF PORLIER PASS DRIVE
TO PARKER ISLAND, SPANNING
MONTAGUE HARBOUR



PARKER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM LOT 33 DL 9 TO MTG CABLE TERMINAL

NOTE:
1. ALL DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

EXISTING

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VANCOUVER ISLAND REINFORCEMENT PROJECT

EXISTING R/W CROSS SECTIONS
GALIANO ISLAND

DSGN		DATE	JAN/05
INDEP CHKD		DISTR	
DFTG		DWG NO / CAD	FIG: R/W SECT. - GALIANO (EXISTING)
DFTG CHKD		R	A
INSPD			
REV			
ACPT			

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	№	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
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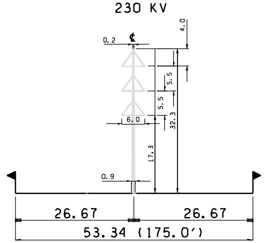
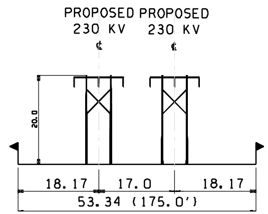
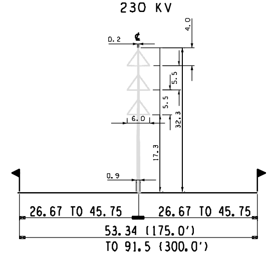


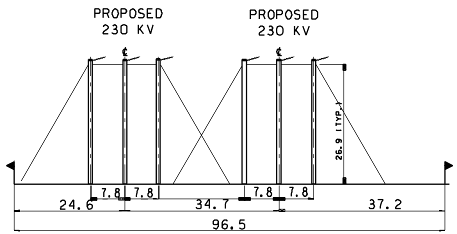
GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM TAYLOR BAY TO BC HYDRO
DC1/2 R/W, 1.8 KM WEST OF
TAYLOR BAY



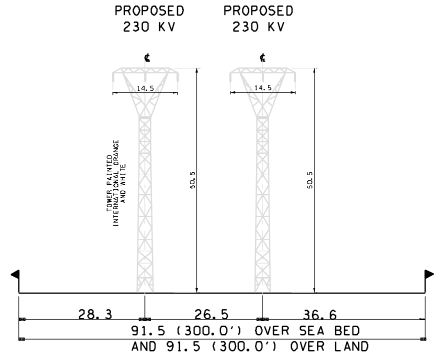
GALIANO ISLAND
EXISTING BC HYDRO 138kV R/W FOR
CIRCUITS 1L17/18
AT CROSSING OF BC HYDRO
DC1/2 R/W, 1.8 KM WEST OF
TAYLOR BAY



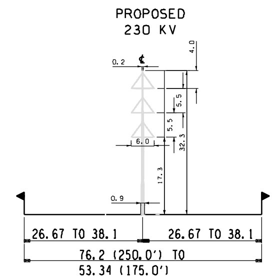
GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM BC HYDRO DC1/2 R/W, 1.8 KM WEST OF
TAYLOR BAY TO PORLIER PASS DRIVE



GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM THE BC HYDRO DC1/2 R/W, 1.8 KM
WEST OF
TAYLOR BAY TO PORLIER PASS DRIVE
PARKER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
ON LOTS 35, 2 AND 34 DL 9



GALIANO ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CICRUITS 1L17/18
FROM WEST OF PORLIER PASS DRIVE
TO PARKER ISLAND, SPANNING
MONTAGUE HARBOUR



PARKER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM LOT 33 DL 9 TO MTG CABLE TERMINAL

NOTE:
1. ALL DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

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VANCOUVER ISLAND REINFORCEMENT PROJECT

PROPOSED R/W CROSS SECTIONS
GALIANO ISLAND

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	#	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT

REFERENCE DRAWINGS | REFERENCE DRAWINGS | REVISIONS

DSGN / INDEP CHKD / DFTG / DFTG CHKD / INSPD / REV / ACPT

DATE JAN/05 | DISTR | DWG NO CAD FIG.: R/W SECT. - GALIANO (PROPOSED) | R A

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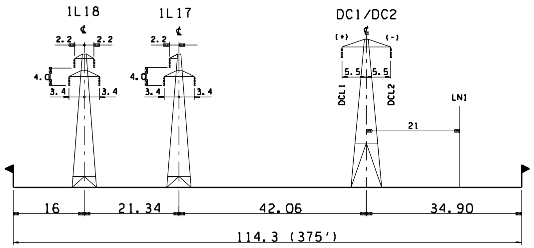
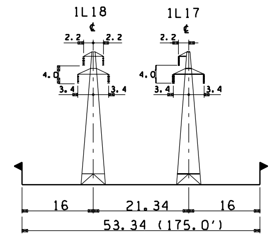
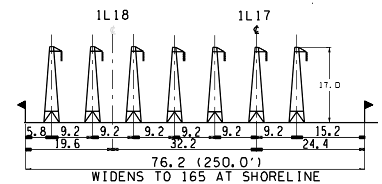


SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18 AND DC CIRCUITS DC1/2
FROM MARICAIBO TERMINAL ON ATHOL
PENINSULA THROUGH UPPER GANGES TO
WILKIE WAY ON MT. BELCHER



SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM WILKIE WAY ON MT. BELCHER
ACROSS TOINBEE RD. VALLEY TO THE
EAST SIDE OF SANSUM NARROWS



SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
ON THE EAST SIDE OF SANSUM NARROWS
AT 138 kV STR. 34/4

EXISTING

NOTE:
1. ALL DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

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VANCOUVER ISLAND REINFORCEMENT PROJECT

EXISTING R/W CROSS SECTIONS
SALTSPRING ISLAND

DSGN	
INDEP CHKD	
DFTG	
DFTG CHKD	
INSPD	
REV	
ACPT	

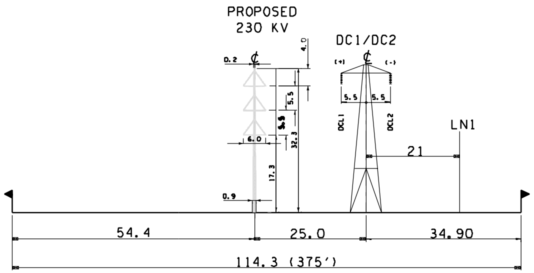
DATE JAN/05 DISTR

DWG NO CAD FIG.: R/W SECT. - SALTSPRING (EXISTING) R A

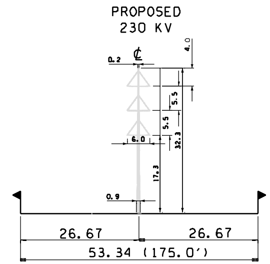
REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	#	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT

REFERENCE DRAWINGS | REFERENCE DRAWINGS | REVISIONS

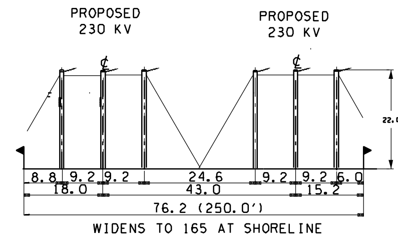
CAD FILE No.: $FILE$



SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18 AND DC CIRCUITS DC1/2
FROM MARICAIBO TERMINAL ON ATHOL
PENINSULA THROUGH UPPER GANGES TO
WILKIE WAY ON MT. BELCHER



SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM WILKIE WAY ON MT. BELCHER
ACROSS TOINBEE RD. VALLEY TO THE
EAST SIDE OF SANSUM NARROWS



SALTSPRING ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
ON THE EAST SIDE OF SANSUM NARROWS
AT 138 kV STR. 34/4

PROPOSED

NOTE:
1. ALL DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

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VANCOUVER ISLAND REINFORCEMENT PROJECT

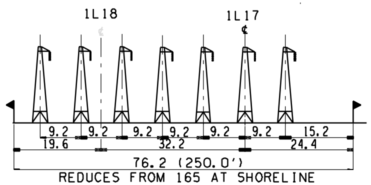
PROPOSED R/W CROSS SECTIONS
SALTSPRING ISLAND

DATE JAN/05

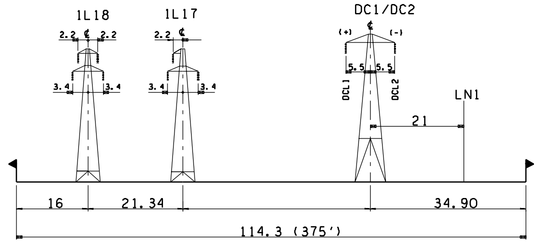
DWG NO CAD FIG: R/W SECT. - SALTSPRING (PROPOSED) R A

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE		NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
REFERENCE DRAWINGS			REFERENCE DRAWINGS			REVISIONS										

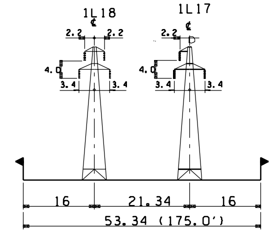
DSGN
INDEP CHKD
DFTG
DFTG CHKD
INSPD
REV
ACPT



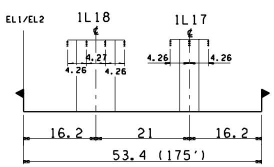
VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
WEST SIDE OF SANSUM NARROWS
AT 138 kV STR. 35/1



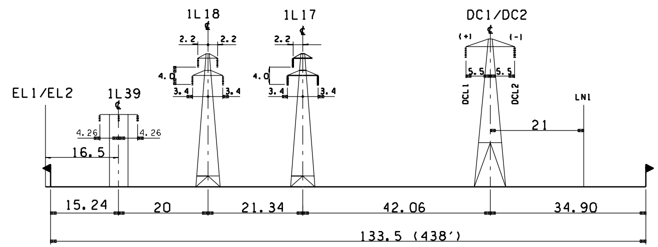
VANCOUVER ISLAND
EXISTING BC HYDRO R/Ws FOR 138 kV
CIRCUITS
1L17, 1L18 AND DC CIRCUITS DC1/2
FROM WEST OF SANSUM NARROWS CROSSING
TO A POINT 800 M NORTH-EAST OF OSBOURNE
BAY RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM BETWEEN A POINT 800 M NORTH-EAST
OF OSBOURNE BAY RD. TO 500 M WEST OF
OSBOURNE BAY RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM 500 M WEST OF OSBOURNE RD.
TO 800 M EAST OF McKINNION RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/Ws FOR 138 kV
CIRCUITS 1L39, 1L18,
1L17 AND DC CIRCUITS DC1/2
FROM A POINT 800 M EAST OF McKINNON RD.
TO BC HYDRO VANCOUVER ISLAND TERMINAL
(VIT), WEST OF McKINNON RD.

NOTE:
1. ALL DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

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BC hydro ENGINEERING

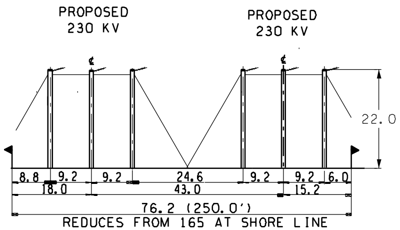
VANCOUVER ISLAND REINFORCEMENT PROJECT

EXISTING R/W CROSS SECTIONS
VANCOUVER ISLAND

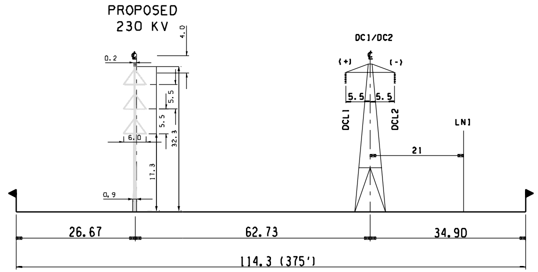
DATE JAN/05

DWG NO CAD FIG: R/W SECT. - VAN. ISL. (EXISTING) R B

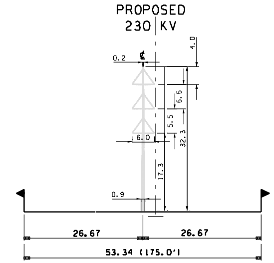
REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
	REFERENCE DRAWINGS			REFERENCE DRAWINGS			REVISIONS								



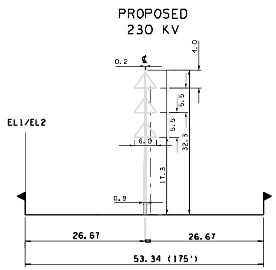
VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
WEST SIDE OF SANSUM NARROWS
AT 138 kV STR. 35/1



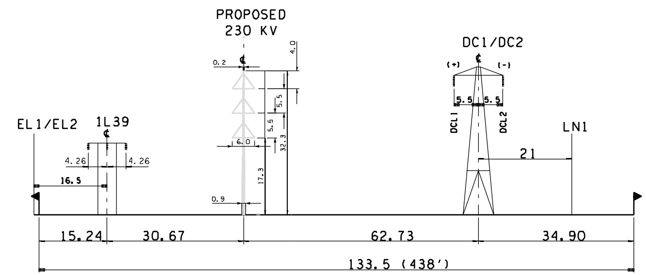
VANCOUVER ISLAND
EXISTING BC HYDRO R/Ws FOR CIRCUITS
1L17 AND 1L18 AND DC CIRCUITS DC1/2
WEST OF SANSUM NARROWS CROSSING
TO A POINT 800 M NORTH-EAST OF OSBOURNE
BAY RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM BETWEEN A POINT 800 M NORTH-EAST
OF OSBOURNE BAY RD. TO 500 M WEST OF
OSBOURNE BAY RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/W FOR 138 kV
CIRCUITS 1L17/18
FROM 500 M WEST OF OSBOURNE RD.
TO 800 M EAST OF McKINNION RD.



VANCOUVER ISLAND
EXISTING BC HYDRO R/Ws FOR 138 kV
CIRCUITS 1L39, 1L18,
1L17 AND DC CIRCUITS DC1/2
FROM A POINT 800 M EAST OF McKINNON RD.
TO BC HYDRO VANCOUVER ISLAND TERMINAL
(VIT), WEST OF McKINNON RD.

NOTE:
1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.
2. ALL VIEWS ARE FROM ARN TOWARD VIT.

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VANCOUVER ISLAND REINFORCEMENT PROJECT

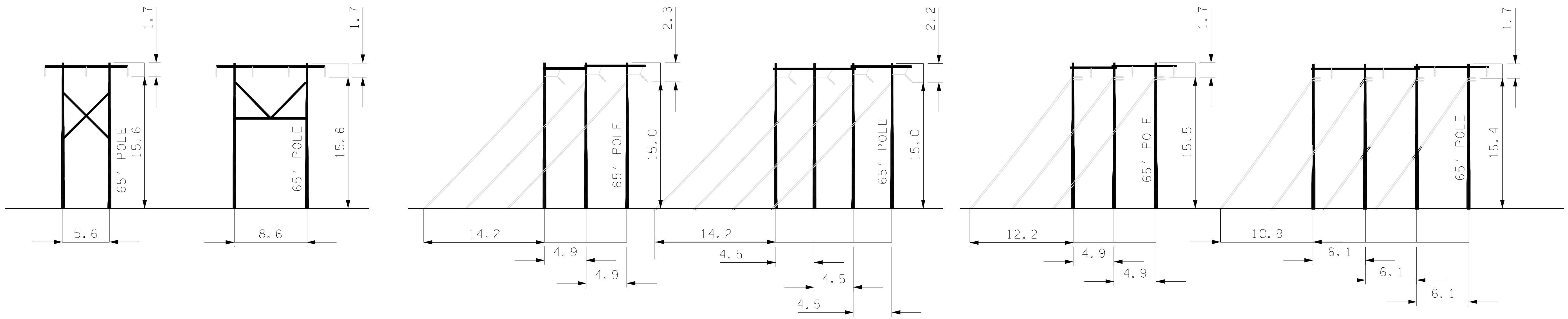
PROPOSED R/W CROSS SECTIONS
VANCOUVER ISLAND

DATE JAN/05

DWG NO FIG.: R/W SECT. - VAN. ISL. (PROPOSED) R B

D Vancouver Island Reinforcement Project T/L Structures Existing 138 kV and Proposed 230 kV Types

1. Str. Fig. #1, Existing and Proposed Types in 138 kV Wood Pole Sections
2. Str. Fig. #2 , Existing and Proposed Types in 138 kV Steel Structure Sections

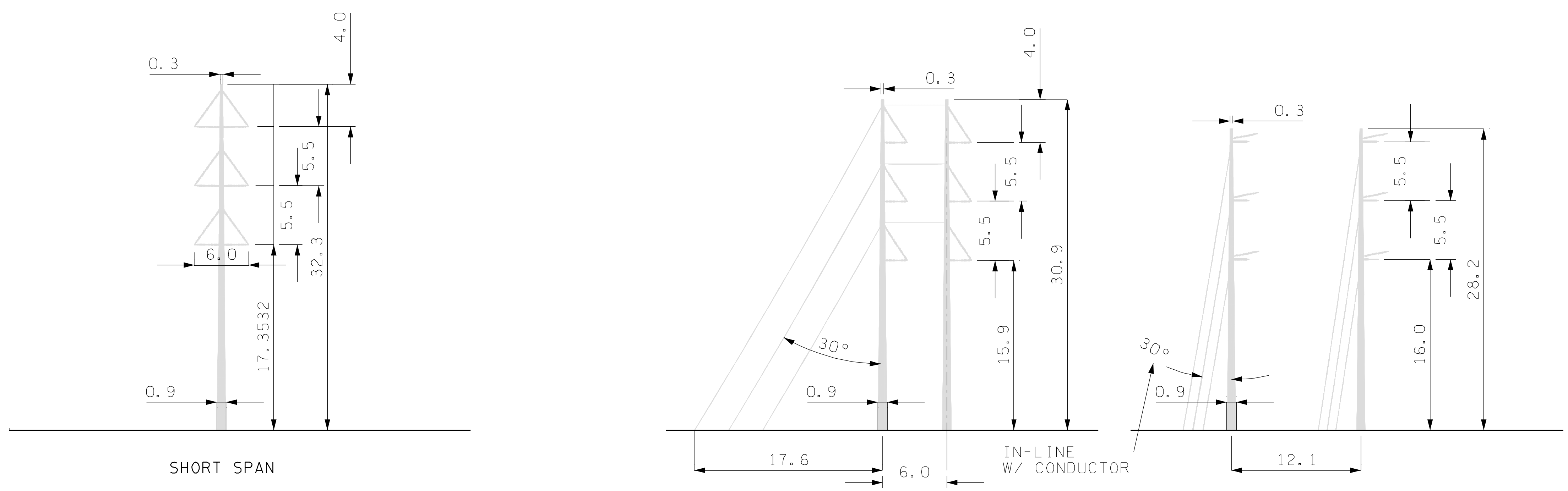


3 AND 4-PHASE
WOOD POLE TANGENT

3 AND 4-PHASE
WOOD POLE MEDIUM ANGLE

3 AND 4-PHASE
WOOD POLE DEAD-END

EXISTING 138 kV STRUCTURES



SHORT SPAN

DOUBLE CIRCUIT
STEEL POLE TANGENT

DOUBLE CIRCUIT
STEEL POLE MEDIUM ANGLE

DOUBLE CIRCUIT
STEEL POLE DEAD-END

PROPOSED 230 kV STRUCTURES

NOTE:
ALL DIMENSIONS ARE IN METRES.

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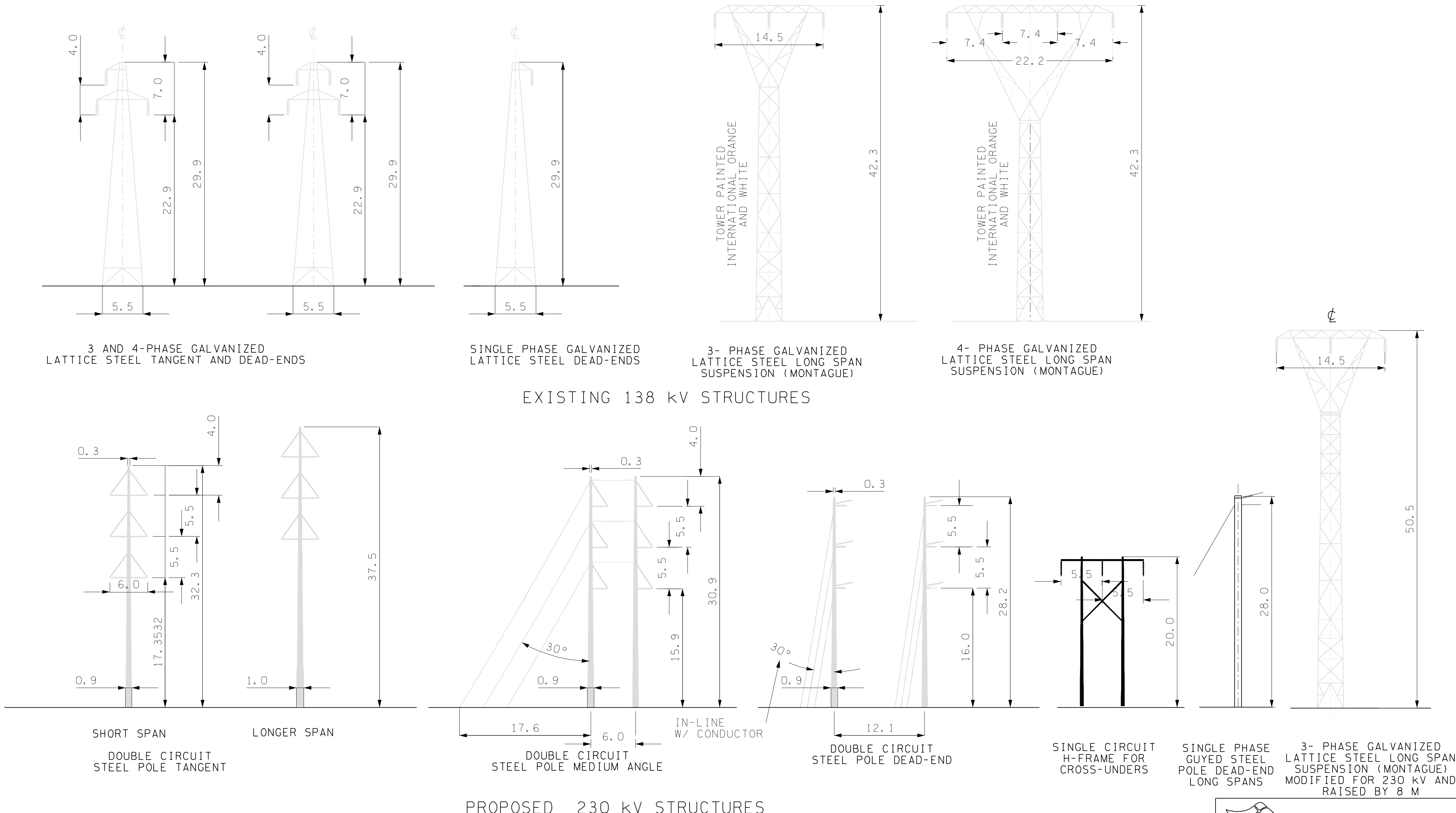
VANCOUVER ISLAND REINFORCEMENT PROJECT
T/L STRUCTURES
EXISTING 138 kV AND PROPOSED 230 kV TYPES

REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	#	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
REFERENCE DRAWINGS			REFERENCE DRAWINGS			REVISIONS										

DSGN / INDEP CHKD / DFTG / DFTG CHKD / INSPD / REV / ACPT

DATE Jan/05 DISTR DWG NO CAD FIG. STR. #1 R

CAD FILE No.: $FILE$



NOTE:
ALL DIMENSIONS ARE IN METRES.

British Columbia Transmission CORPORATION™

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VANCOUVER ISLAND REINFORCEMENT PROJECT
T/L STRUCTURES
EXISTING 138 kV AND PROPOSED 230 kV TYPES

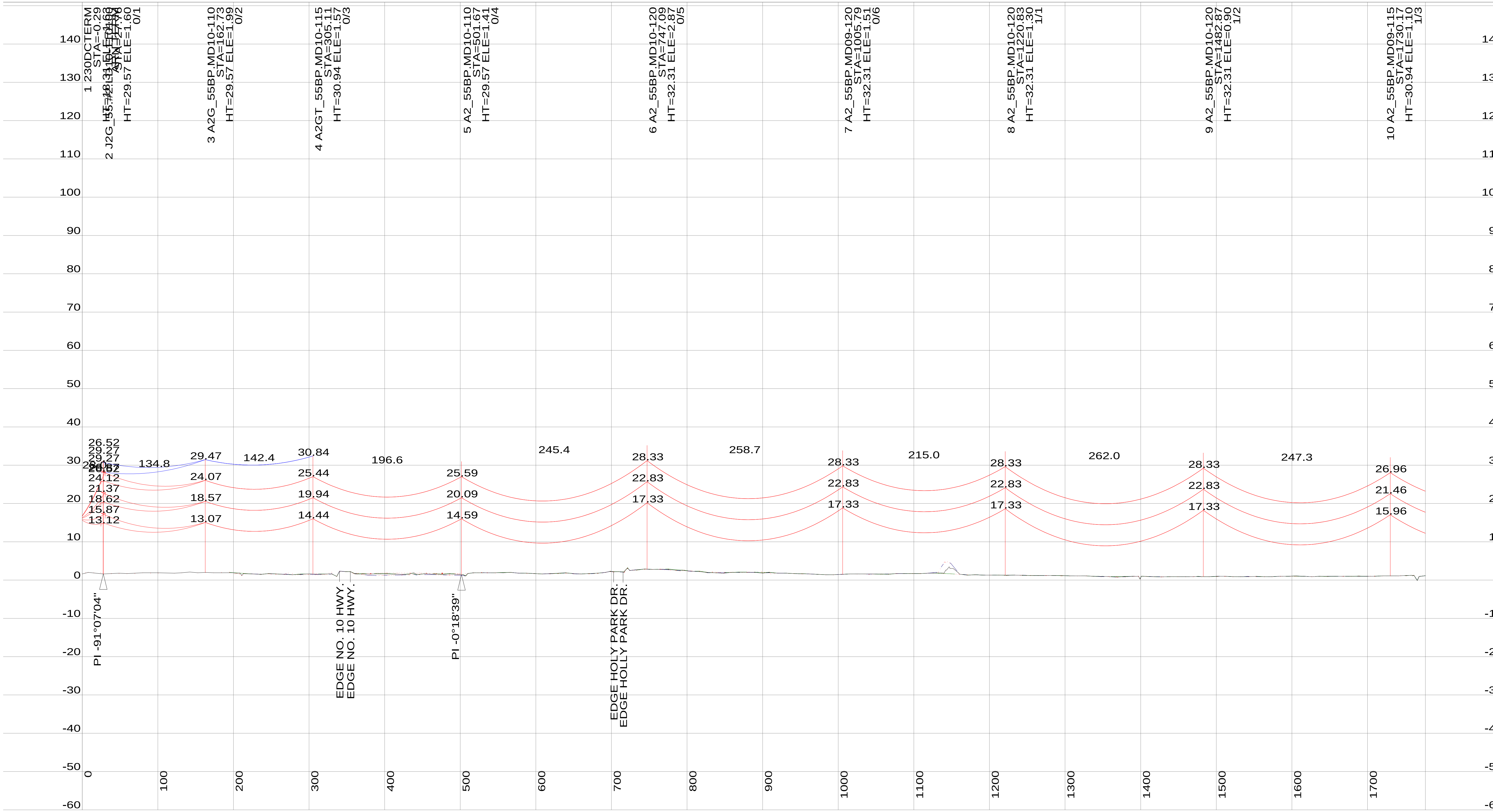
REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE	#	NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
REFERENCE DRAWINGS			REFERENCE DRAWINGS			REVISIONS										

DSGN / INDEP CHKD / DFTG / DFTG CHKD / INSPD / REV / ACPT

DATE Jan/05 DISTR # DWG NO CAD FIG. STR. #2 R

CAD FILE No.: $FILE$

E ARN x VIT, VI230DEF Preliminary Structure Layout Profiles



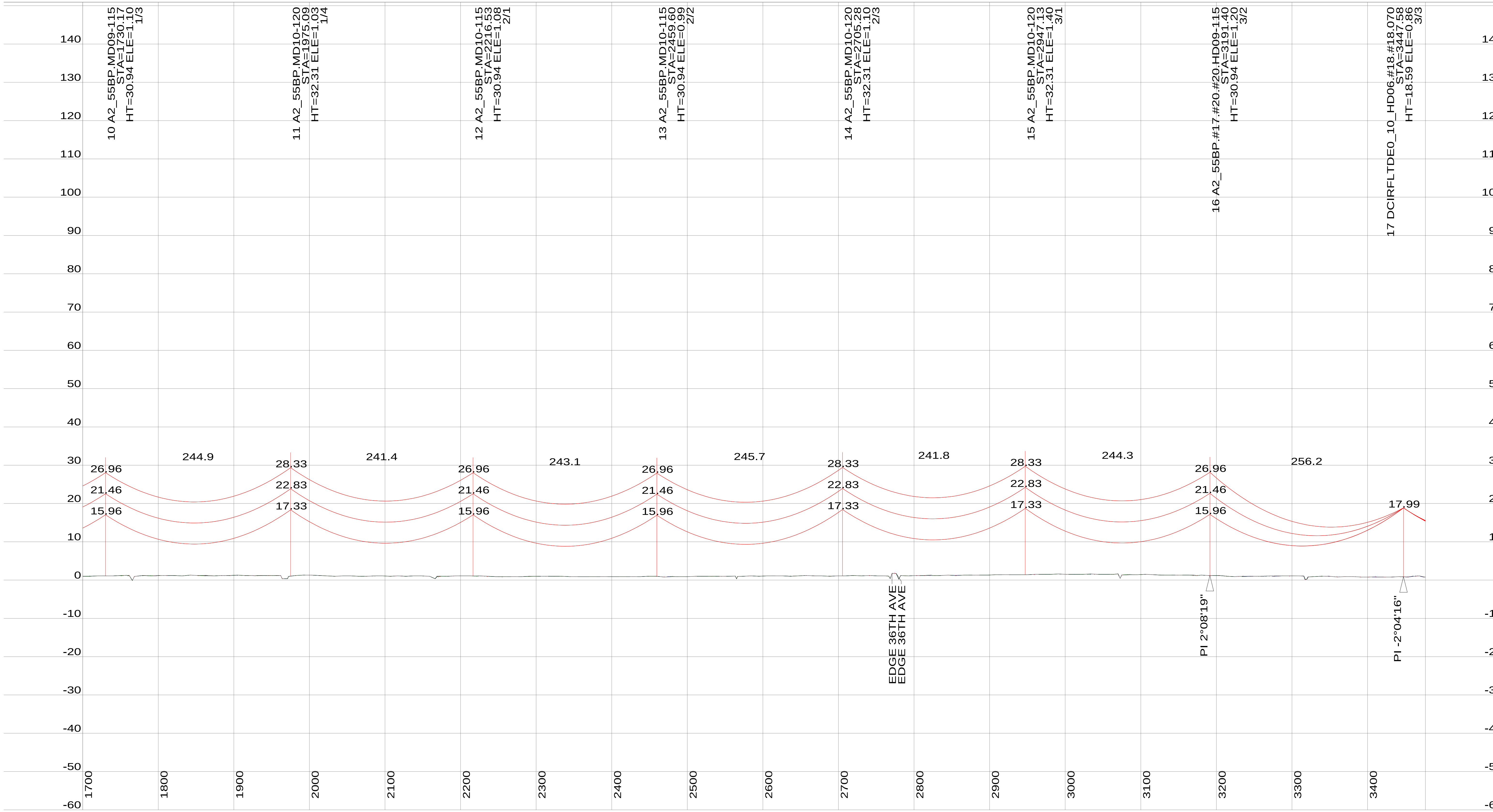
50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 1 OF 25 — REV. A

PLS-CADD DRAWING



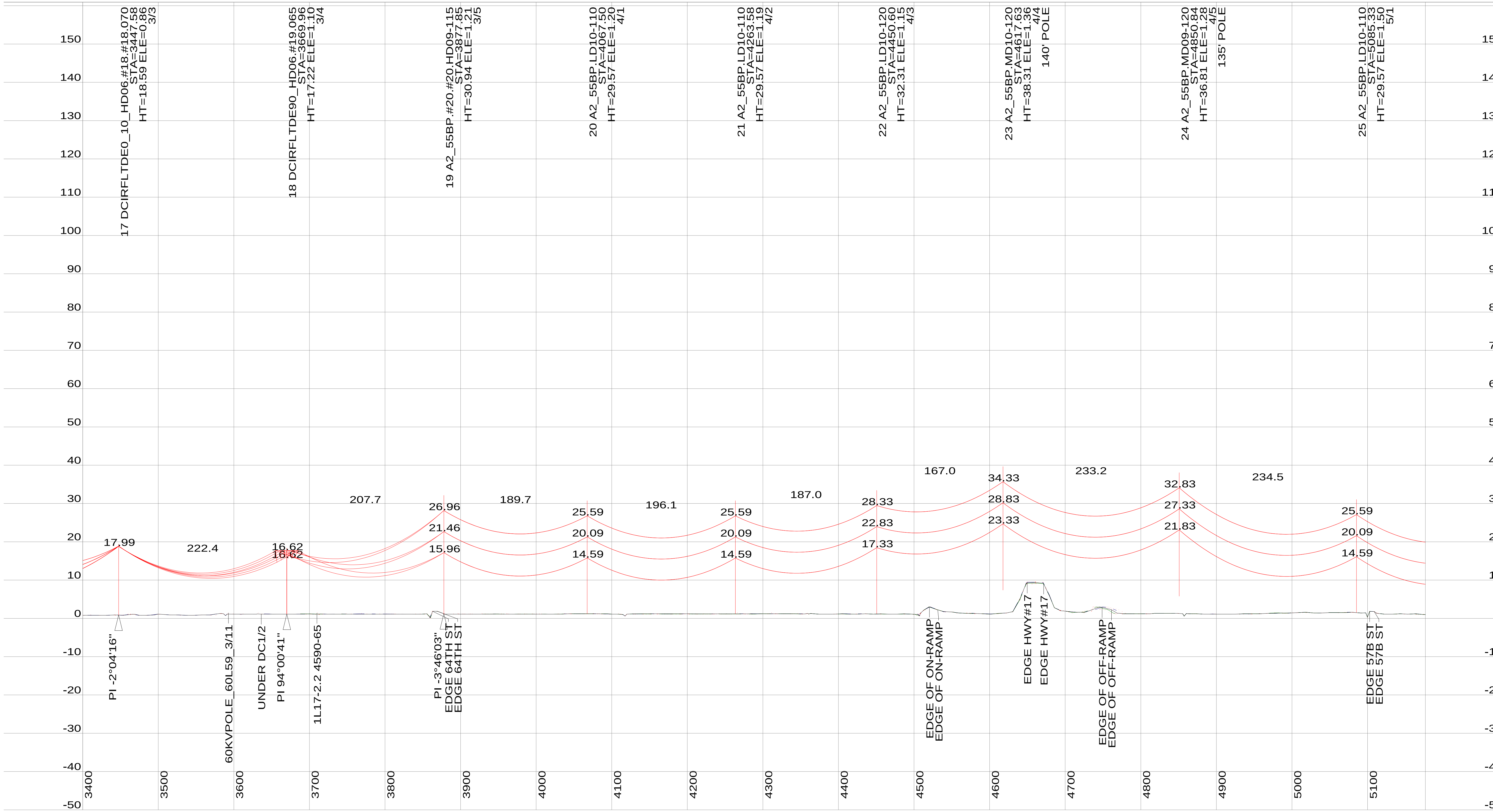
50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING	
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE	
ACCEPTED BY:		
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 2 OF 25	REV. A

PLS-CADD DRAWING



50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

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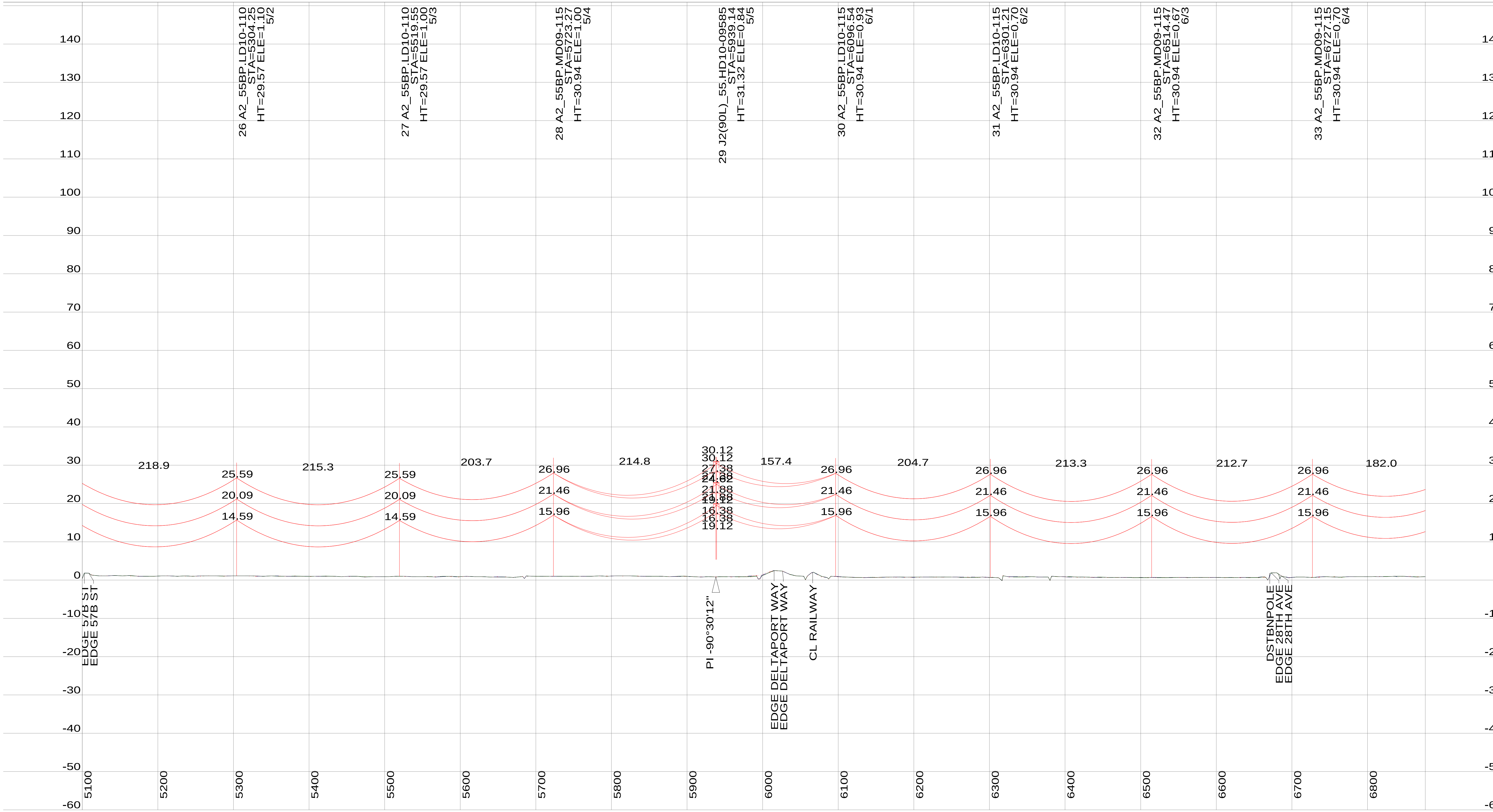
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 3 OF 25 — REV. A

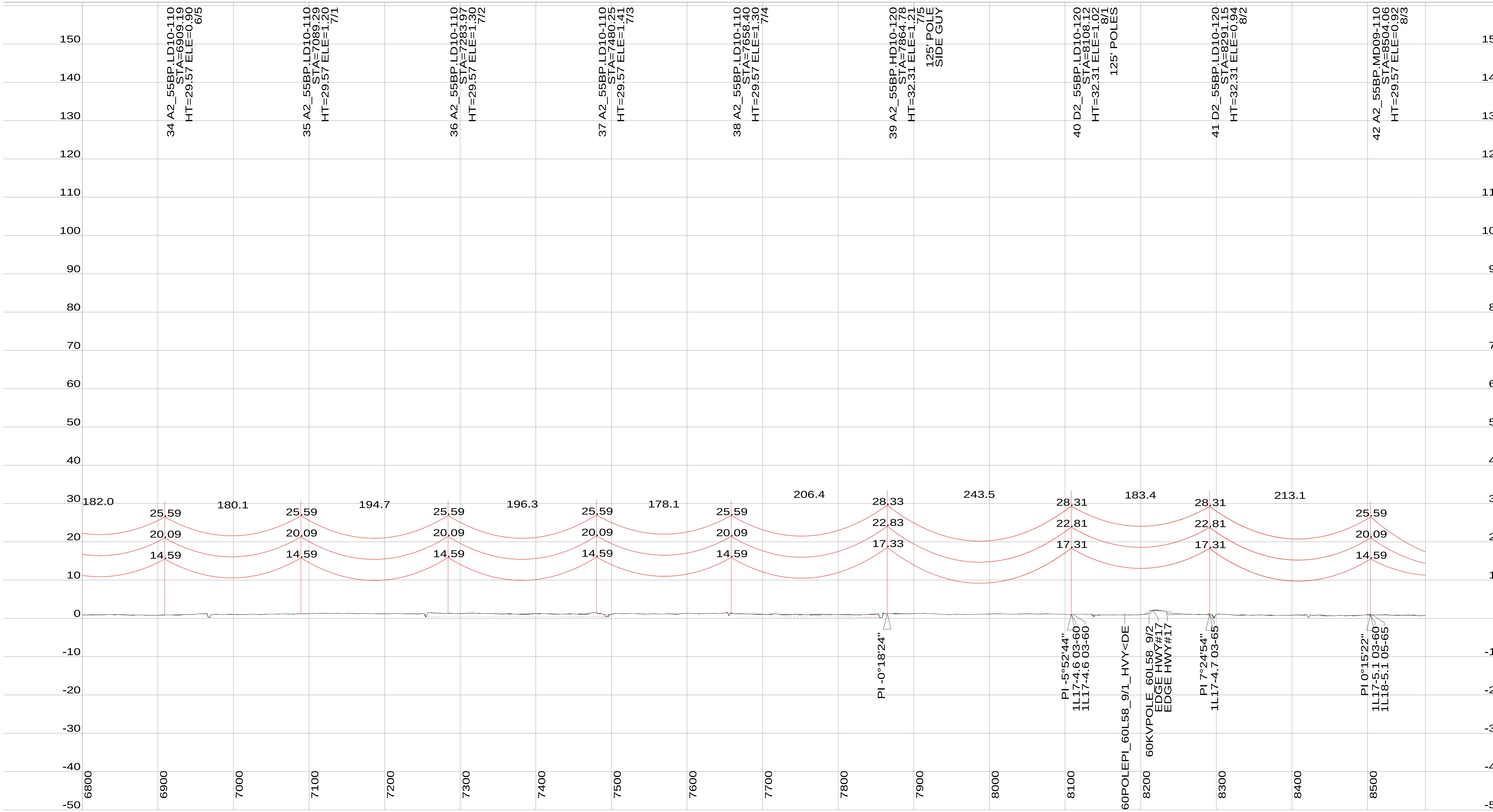


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 4 OF 25 — REV. A



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10.0 M VERT. SCALE

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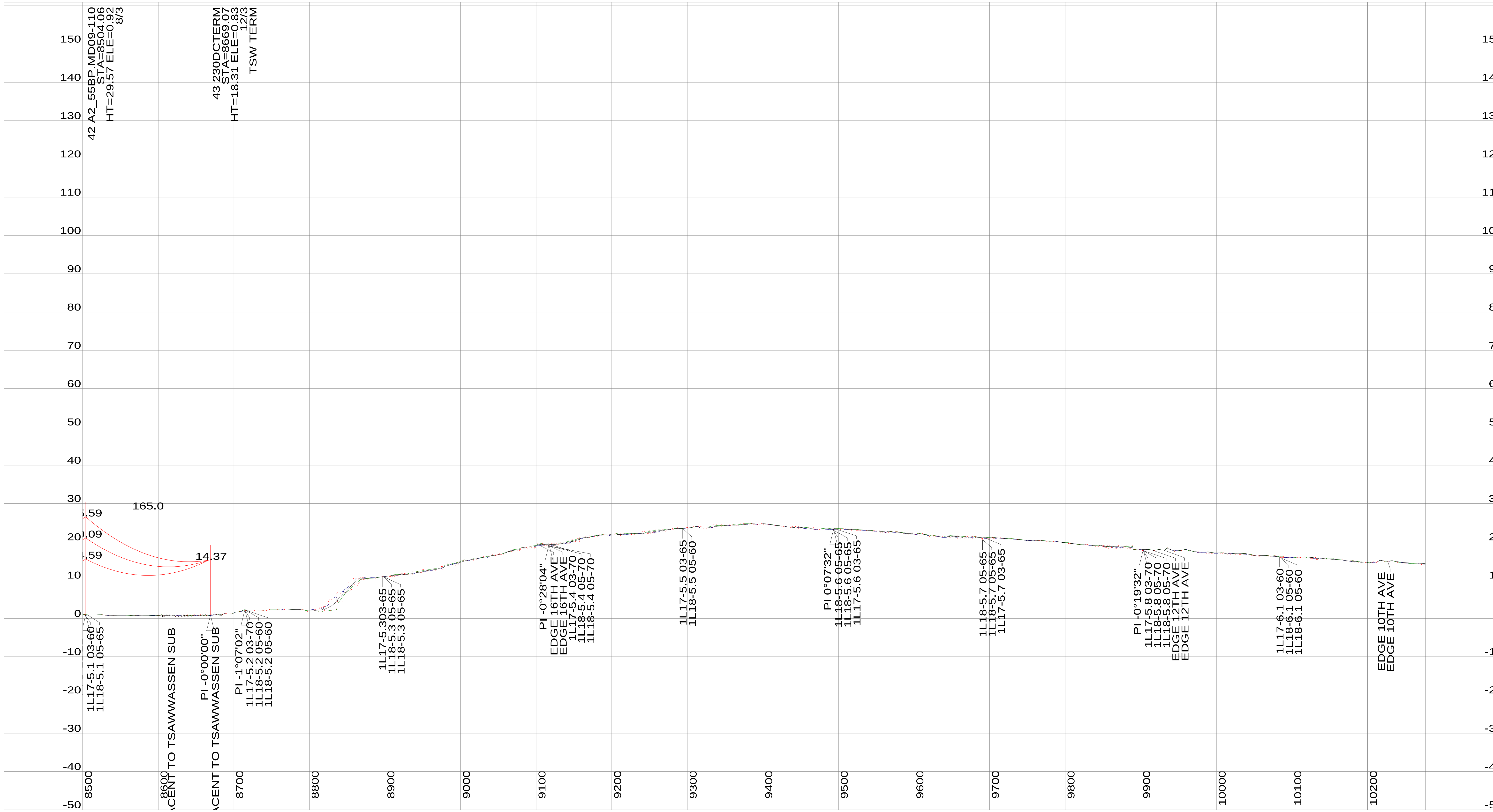
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 5 OF 25 — REV. A



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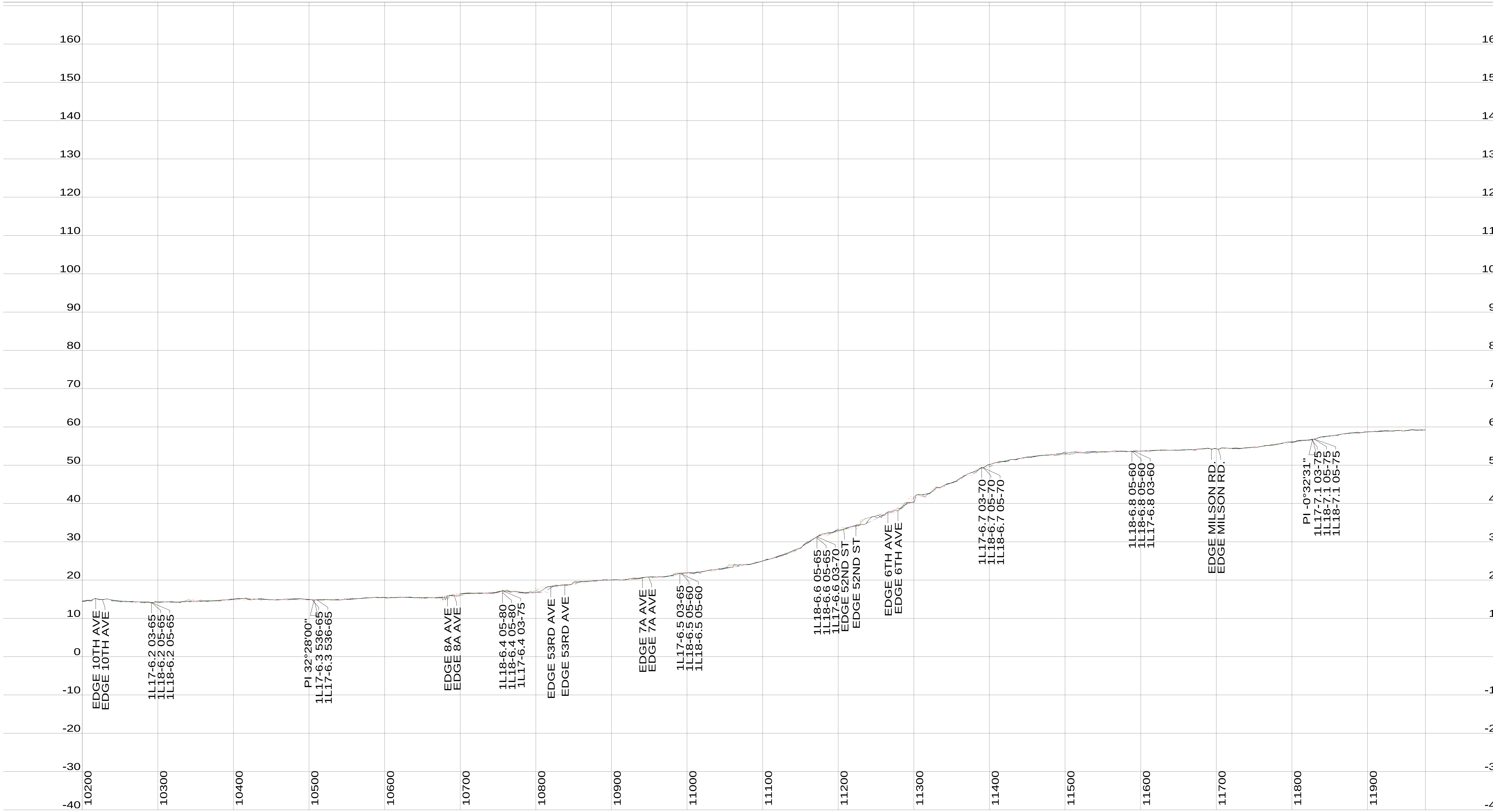
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 6 OF 25 — REV. A

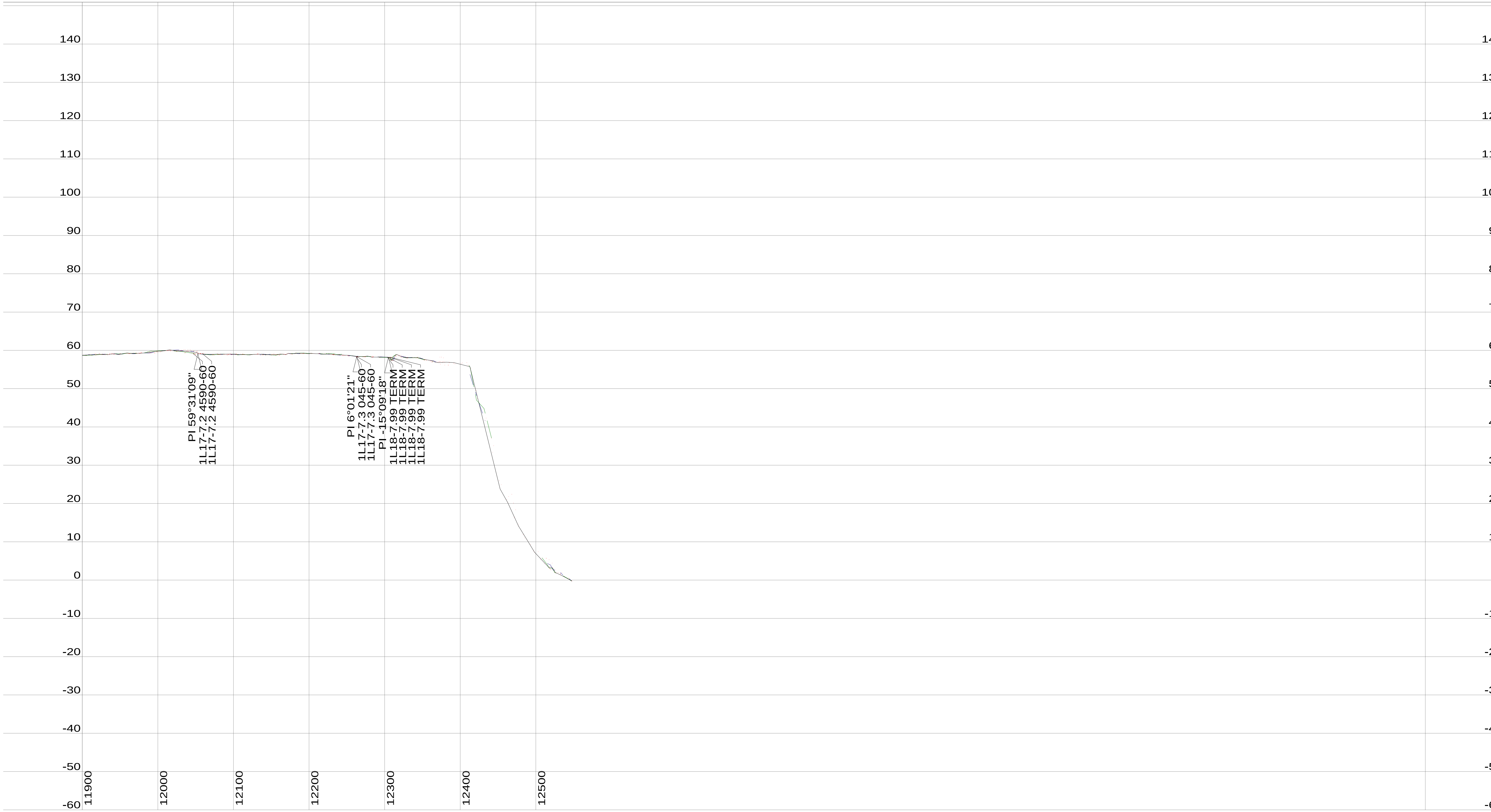


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 7 OF 25 — REV. A



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10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

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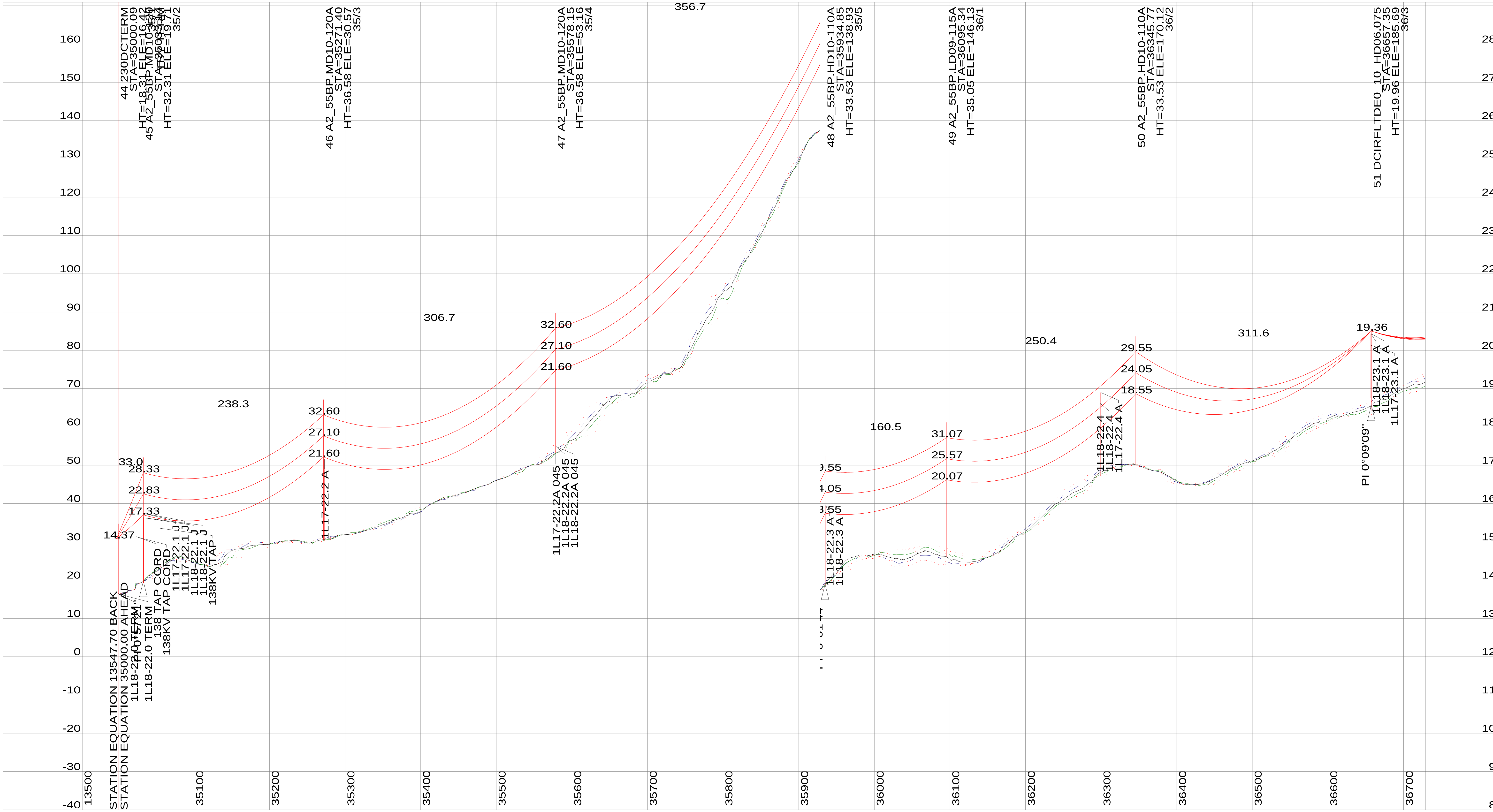
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 8 OF 25 — REV. A



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10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

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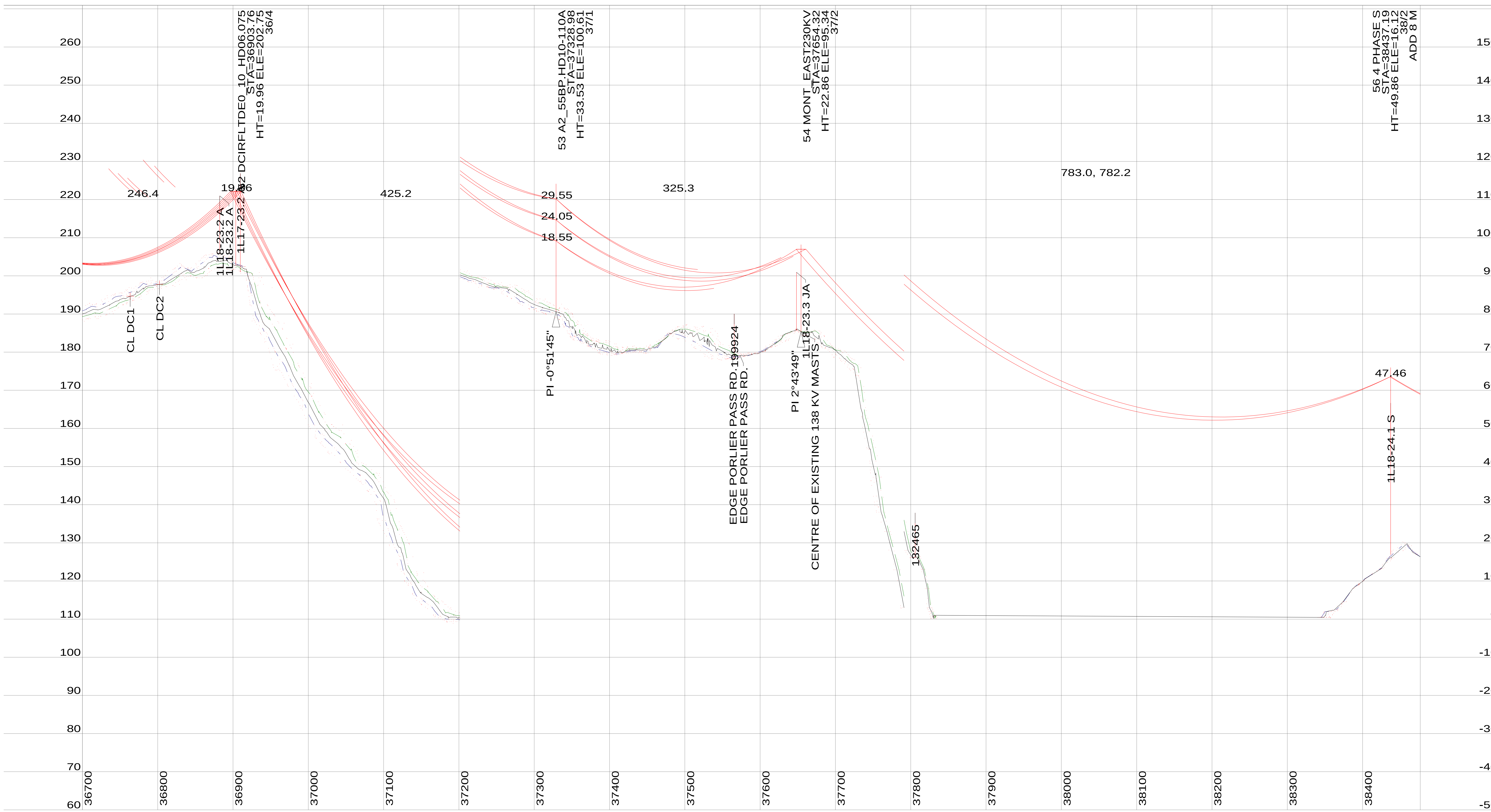
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 9 OF 25 — REV. A



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PLSFILE NO.:#3VI230_ARNXSAT_COMP

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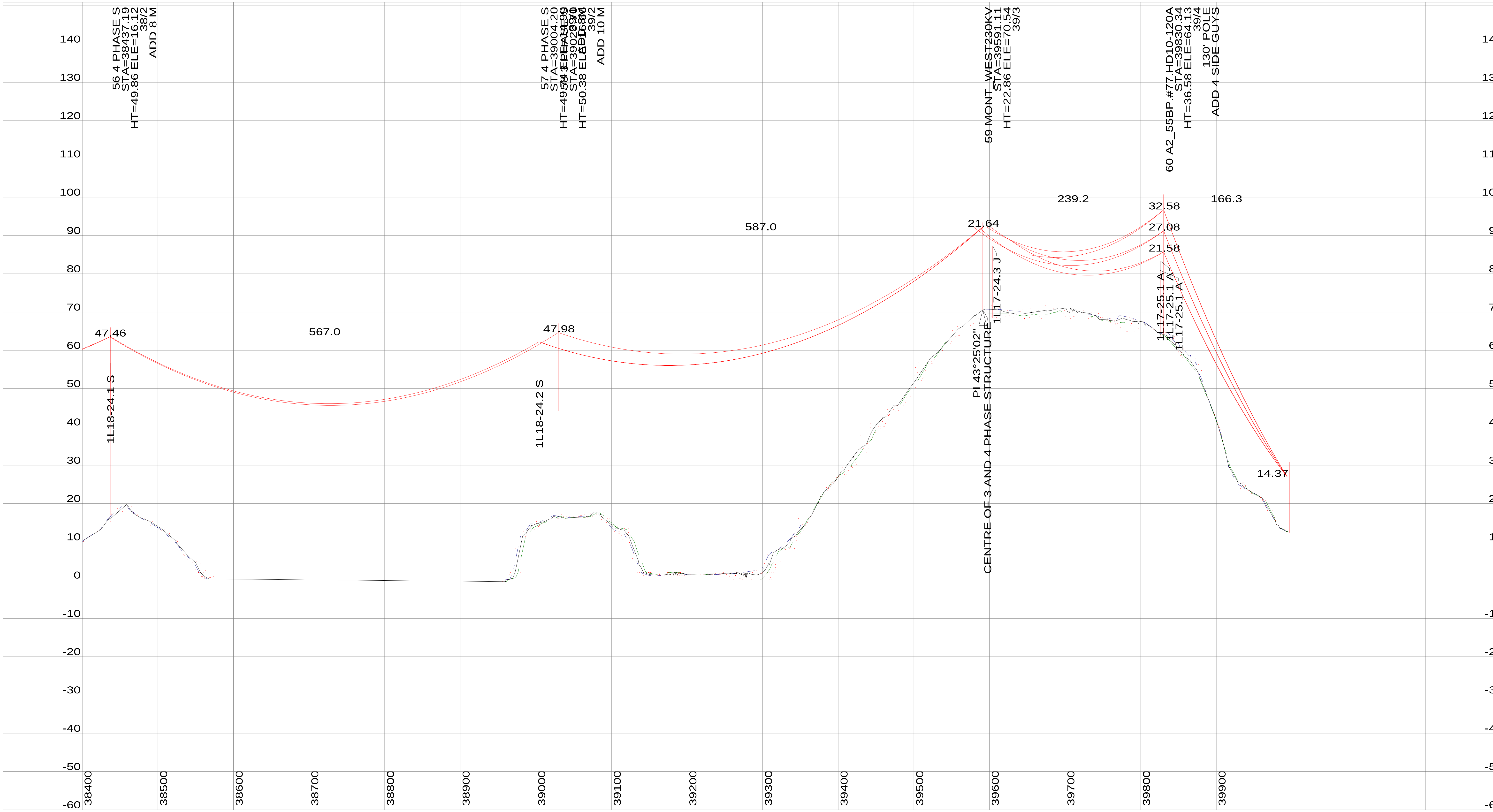
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 10 OF 25 — REV. A

PLS-CADD DRAWING



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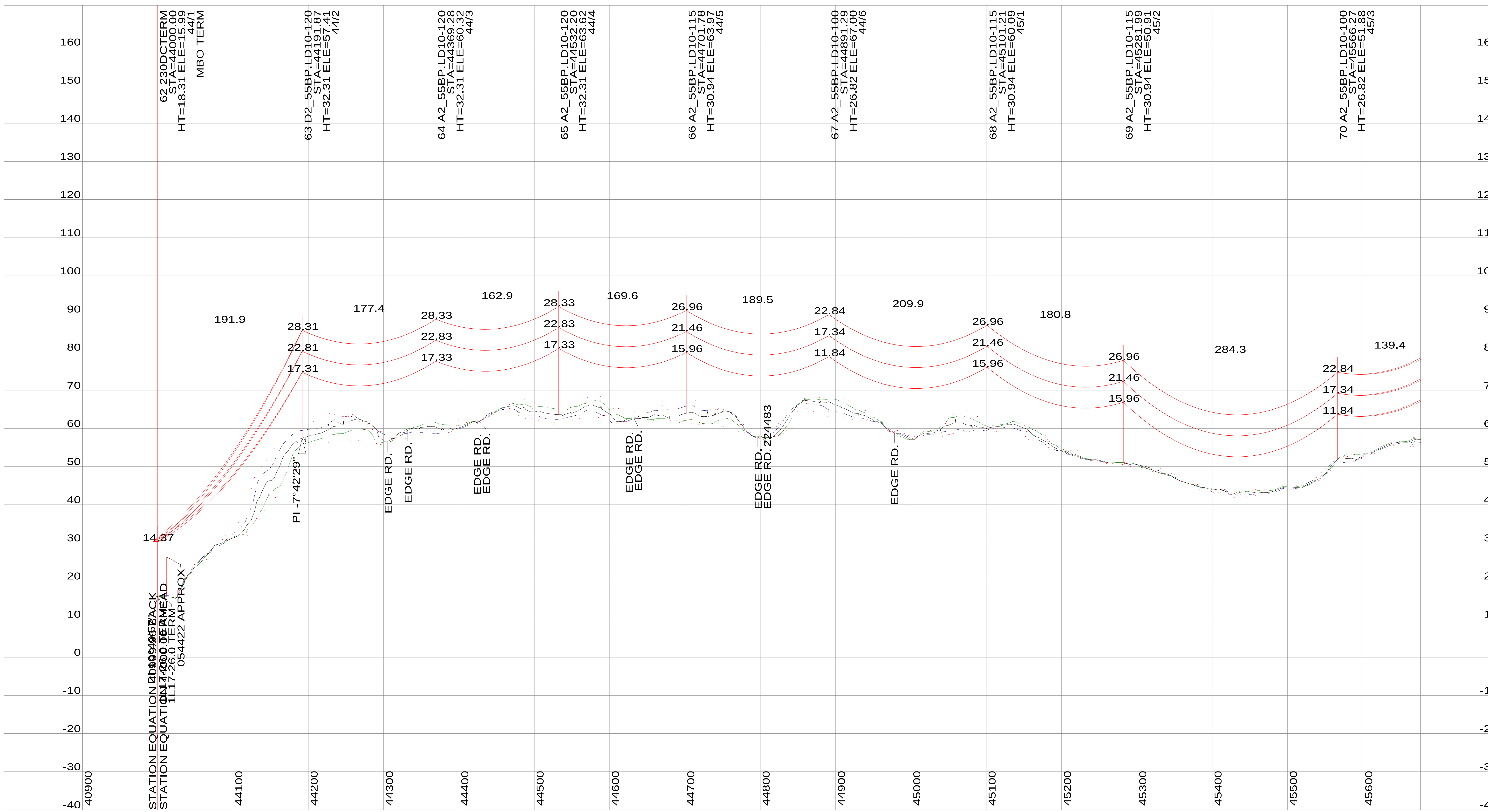
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 11 OF 25 — REV. A

PLS-CADD DRAWING



50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

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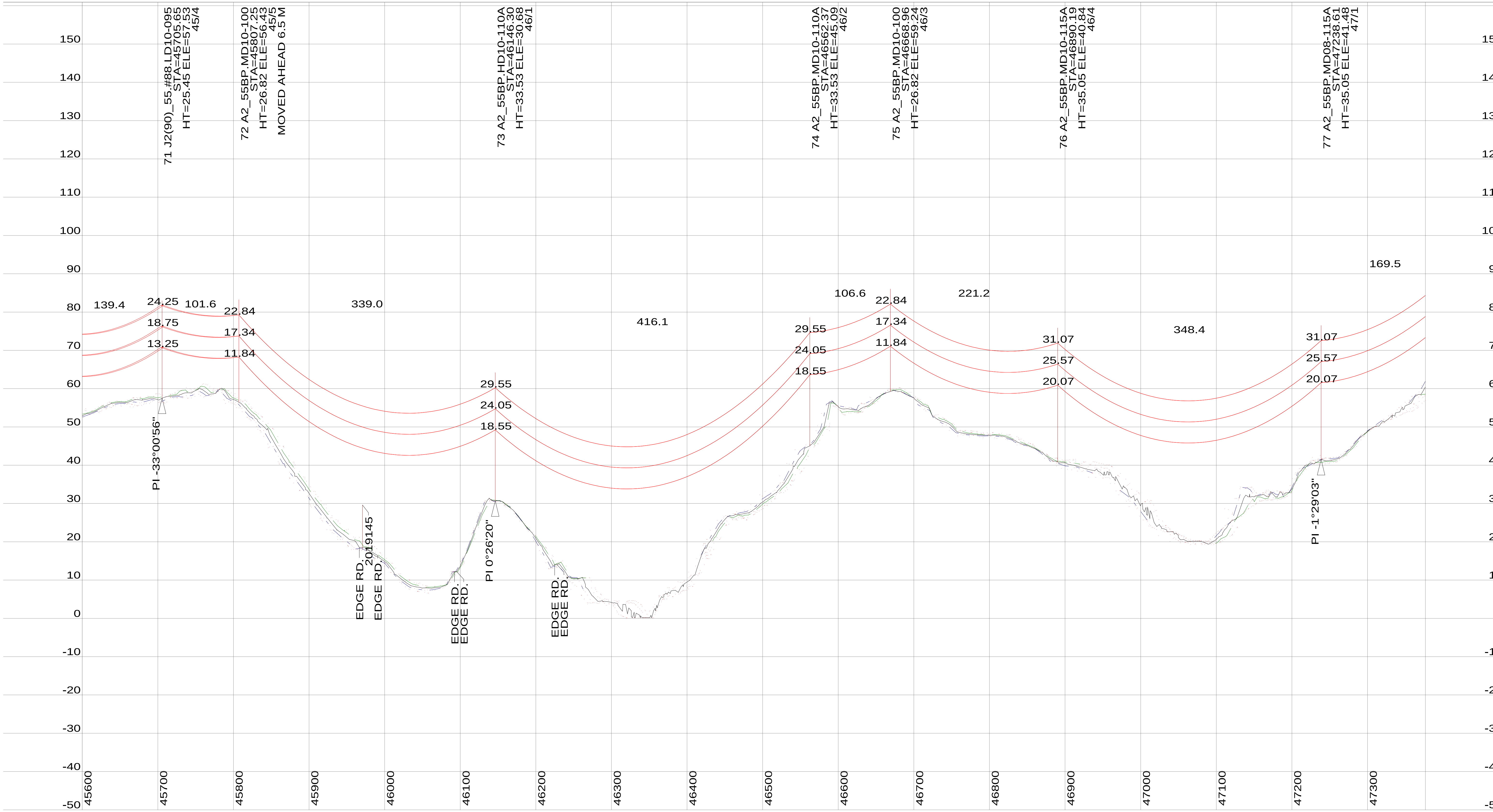
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 12 OF 25 — REV. A

PLS-CADD DRAWING



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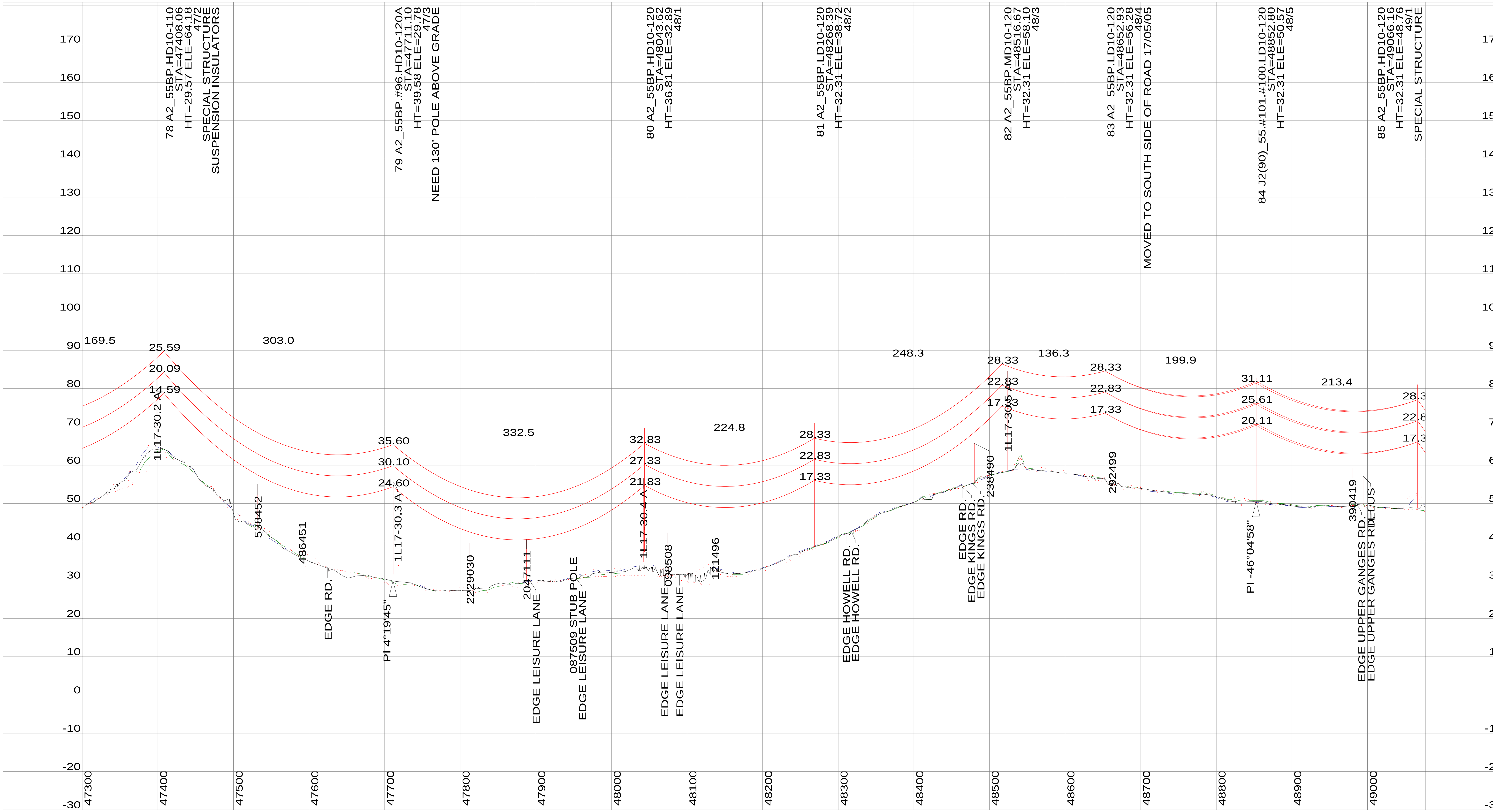
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 13 OF 25 — REV. A



50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

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CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
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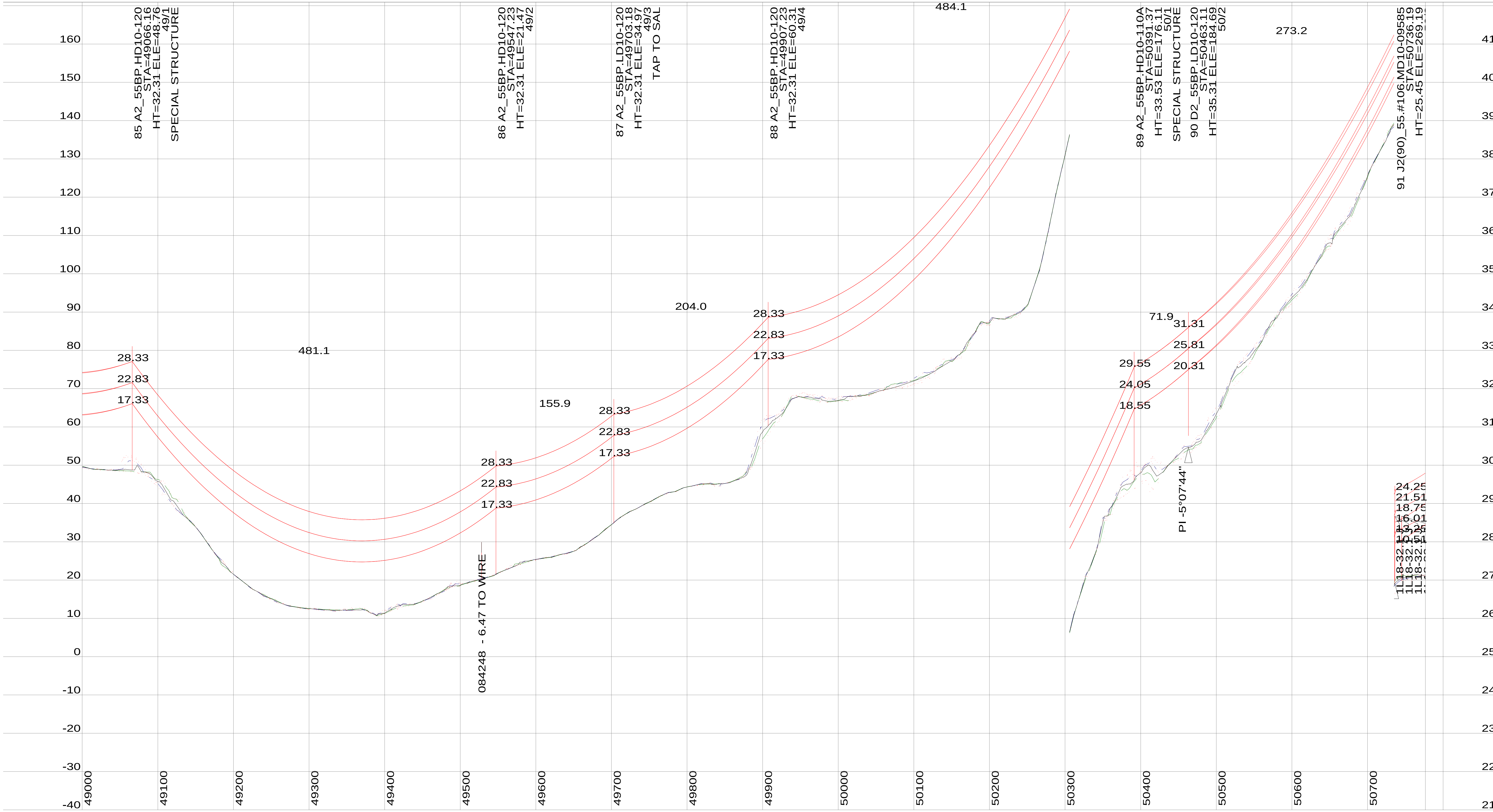
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 14 OF 25 — REV. A

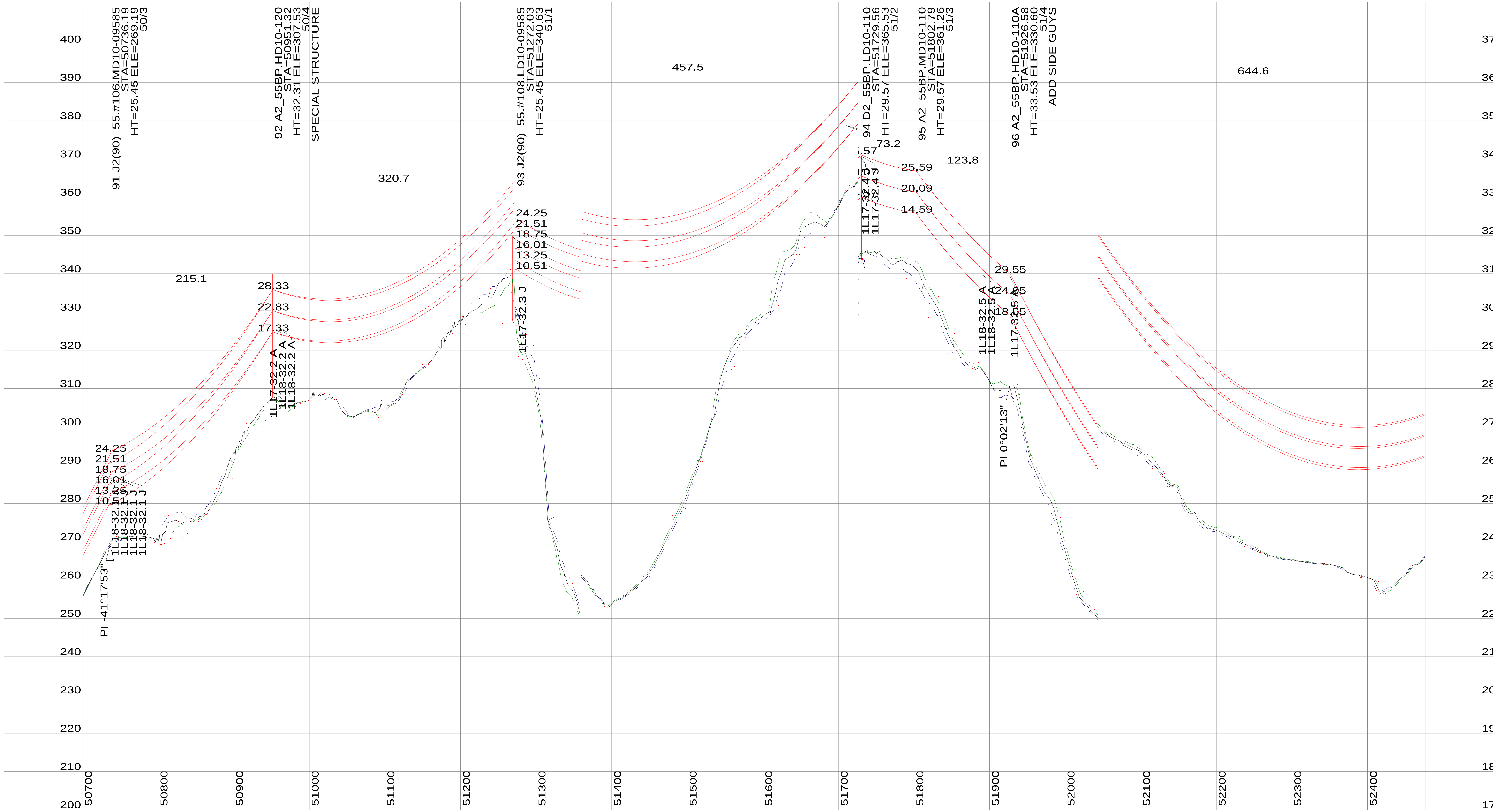


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 15 OF 25 — REV. A

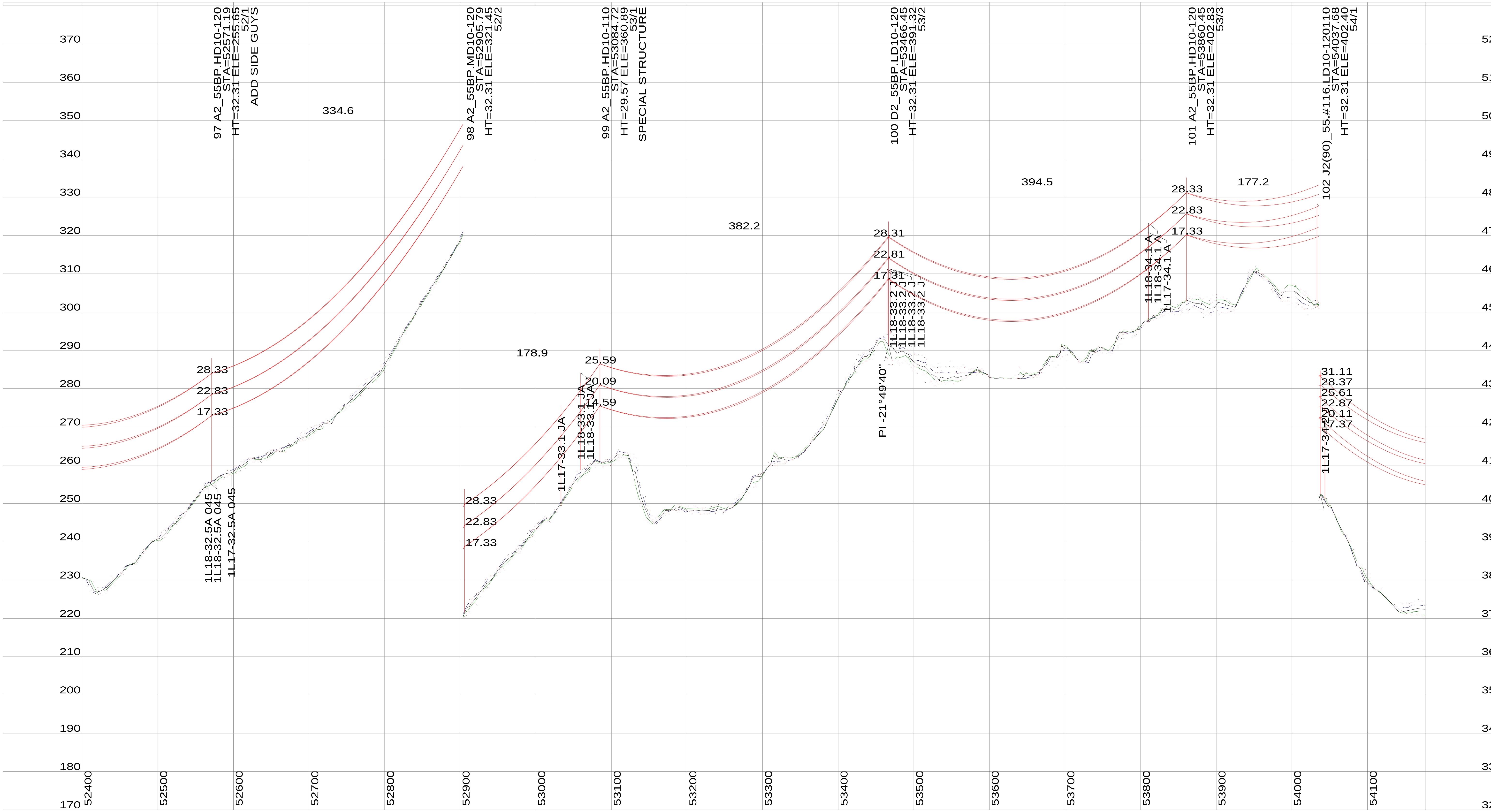


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 16 OF 25 — REV. A



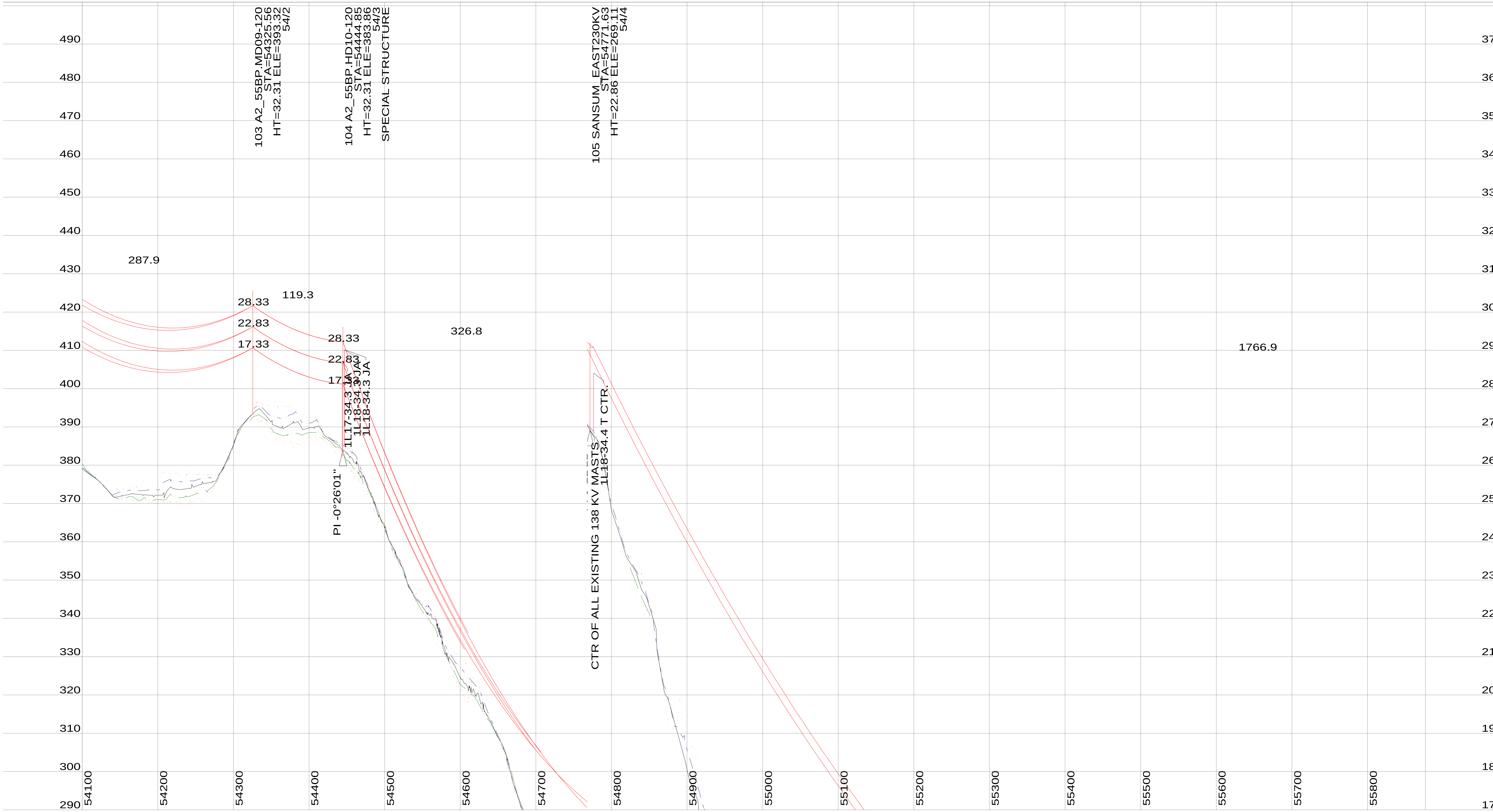
50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BChydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT
ACCEPTED BY:	PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 17 OF 25 — REV. A

PLS-CADD DRAWING

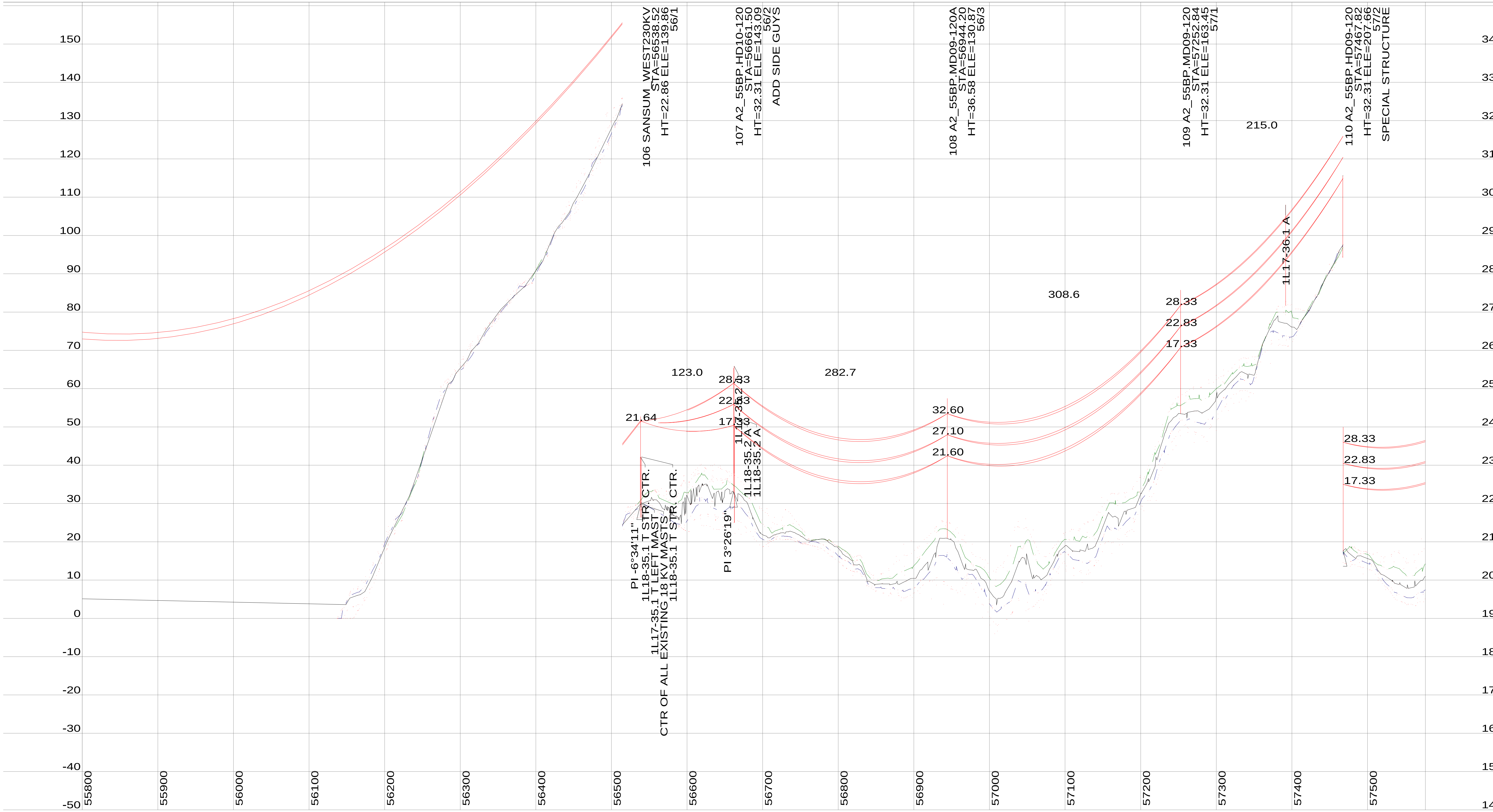


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 18 OF 25 — REV. A



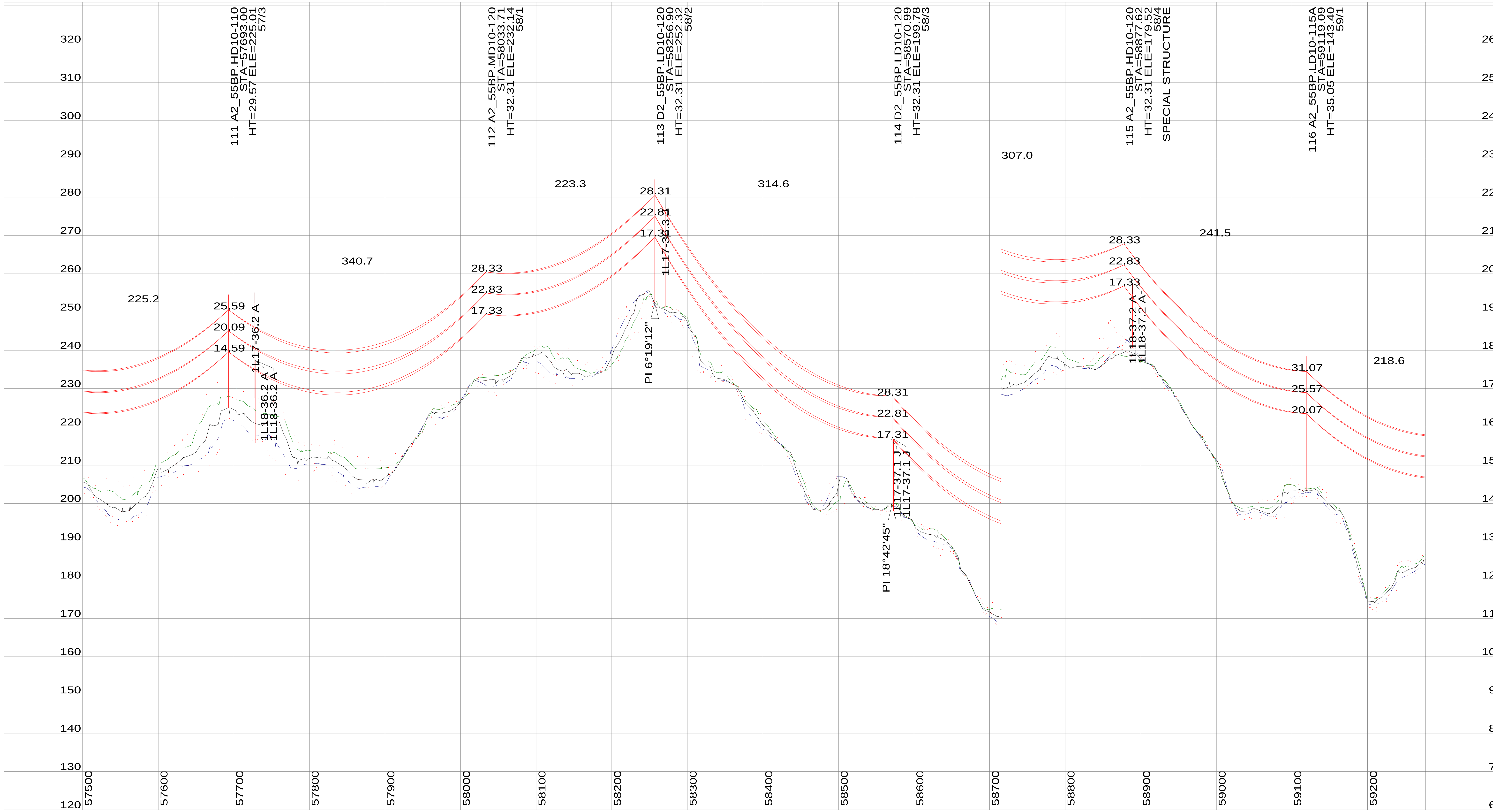
50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 19 OF 25 — REV. A

PLS-CADD DRAWING



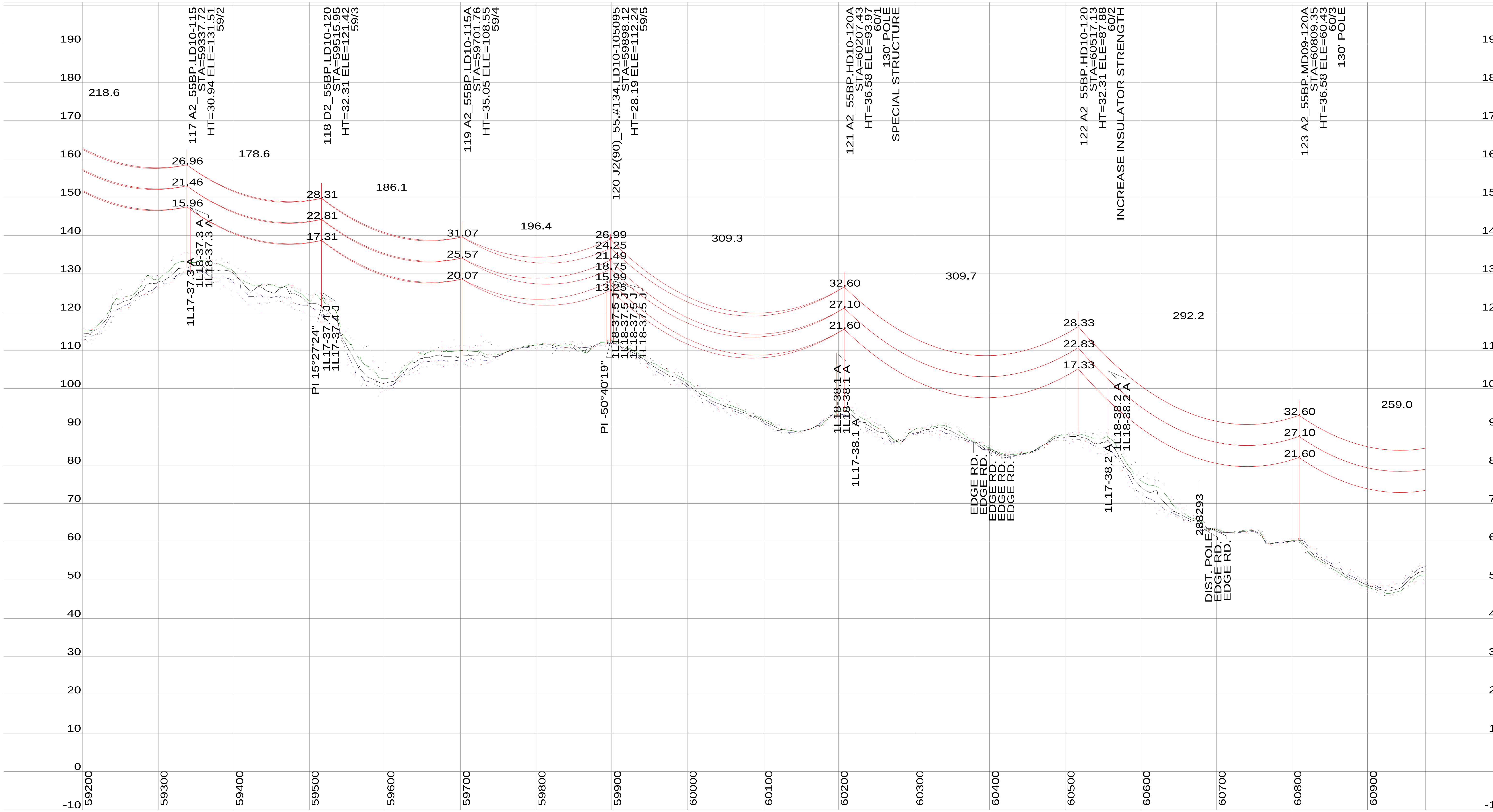
50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 20 OF 25 — REV. A

PLS-CADD DRAWING

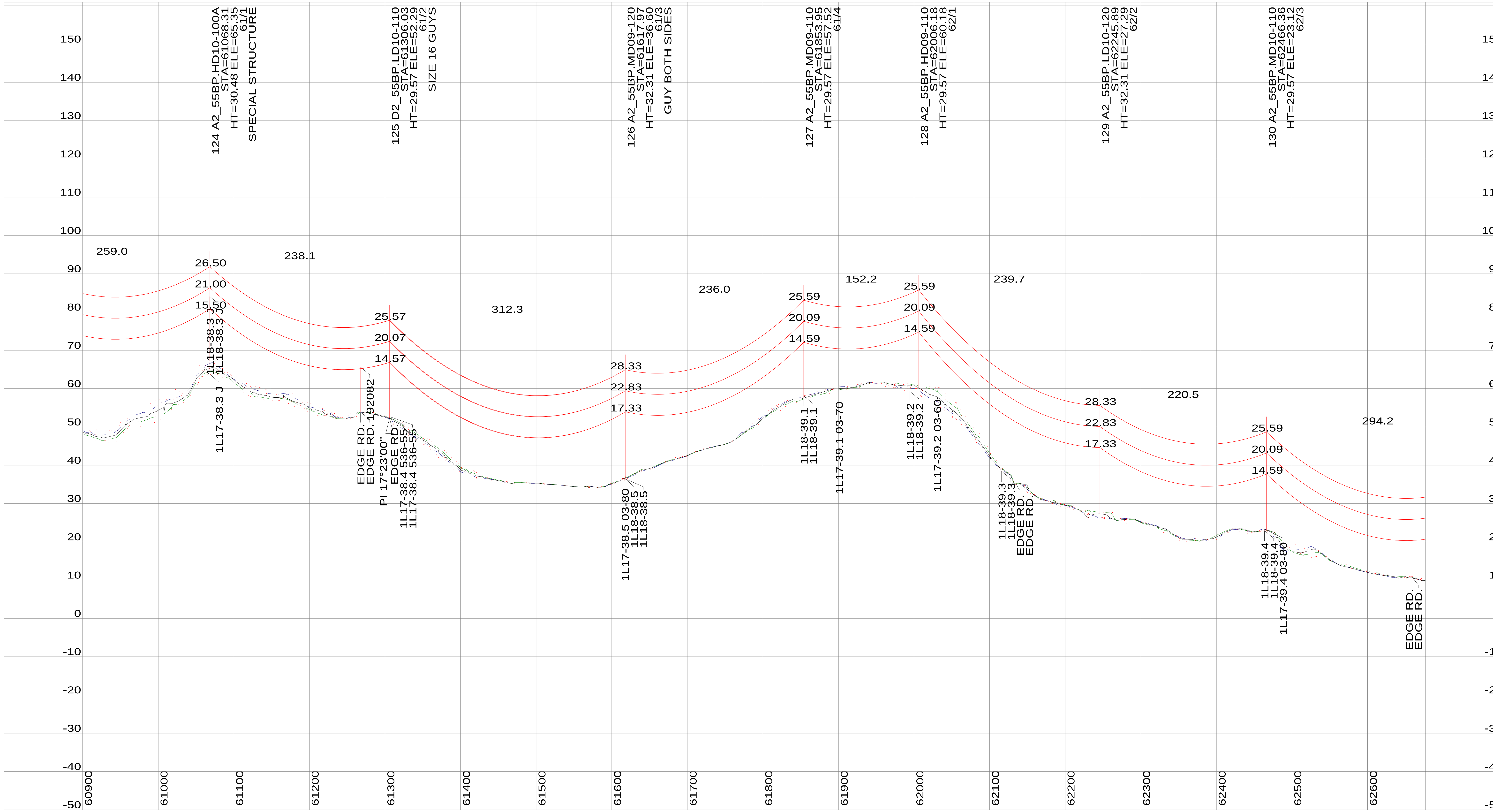


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BChydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 21 OF 25 — REV. A

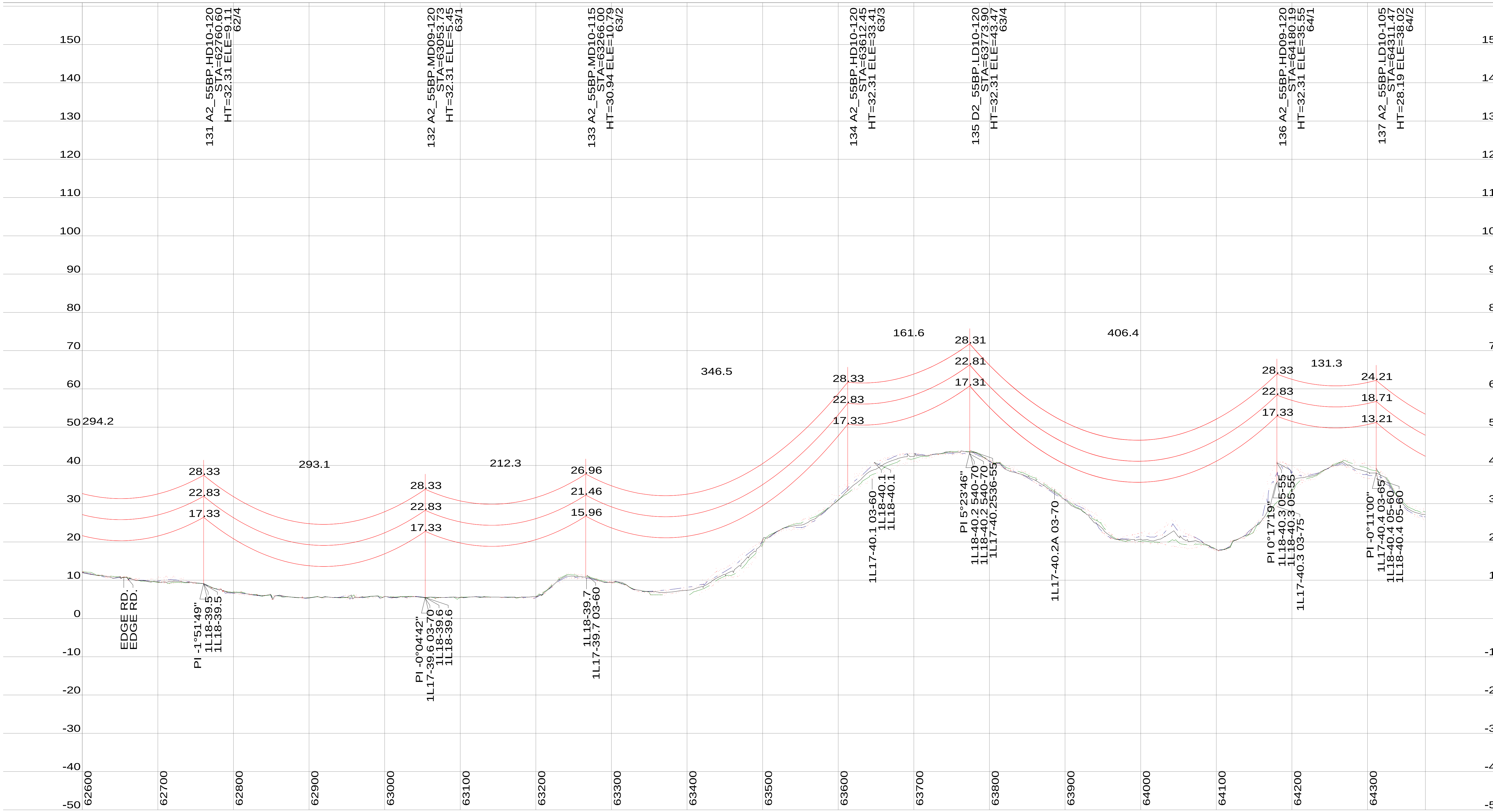


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BChydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 22 OF 25 — REV. A

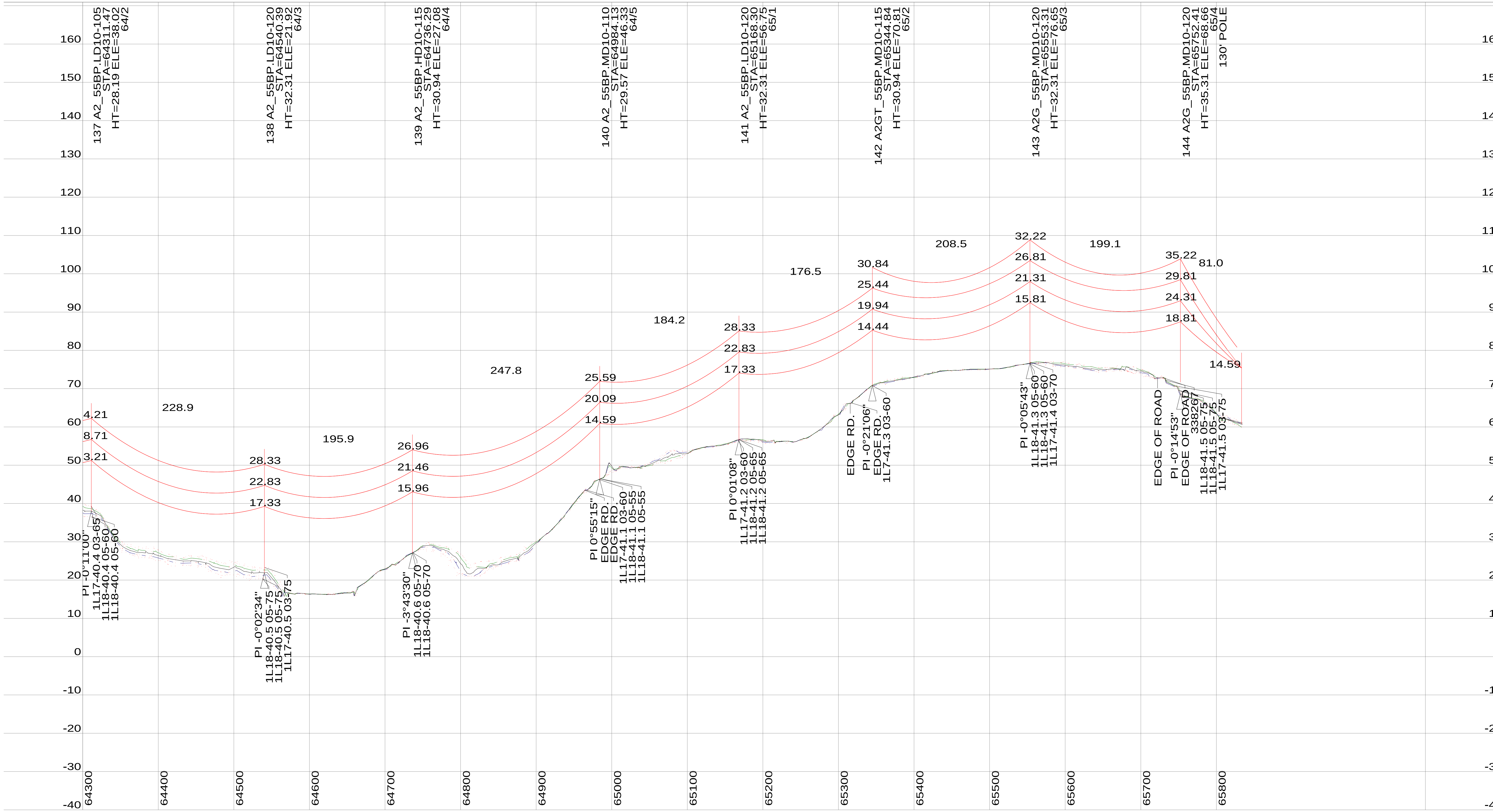


50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BC hydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 23 OF 25 — REV. A



PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BChydro ENGINEERING	
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE	
ACCEPTED BY:		
DATE: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 24 OF 25	REV. A

50.0 M HORIZ. SCALE

10.0 M VERT. SCALE

PLSFILE NO.:#3VI230_ARNXSAT_COMP

DESIGNED BY: GSB	BChydro ENGINEERING
CHECKED BY:	VI230DEF PROJECT PROPOSED REPLACEMENT AND UPGRADING OF EXISTING 138 KV TO 230 KV PROFILE
ACCEPTED BY:	
DATE:: 6/30/2005	BC HYDRO DWG. NO. 2L129-T07-B4 SHT. 25 OF 25 — REV. A

Str. Number	Station (m)	X Easting (m)	Y Northing (m)	Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Comment
ARN Term	-0.3	496859	5437795	1.6	28.05		230dcterm	
0/1	27.8	496831	5437796	1.6	134.81		type j2g_55.#2.ld10-110100	
0/2	162.7	496830	5437661	2.0	142.38		type a2g-brac\55ps\516w\a2g_55bp.md10-110	
0/3	305.1	496829	5437519	1.6	196.56		type a2g-brac\55ps\516w\a2gt_55bp.md10-115	
0/4	501.7	496827	5437322	1.4	191.10	-0.3157	type a2-brac\55ps\a2_55bp.ld10-110	
0/5	692.8	496826	5437131	2.0	214.81		type a2-brac\55ps\a2_55bp.ld09-110	
0/6	907.6	496826	5436917	2.0	259.76		type a2-brac\55ps\516w\a2_55bp.md09-120	
1/1	1167.3	496825	5436657	1.4	245.41		type a2-brac\55ps\516w\a2_55bp.md10-120	
1/2	1412.7	496824	5436411	0.9	235.49		type a2-brac\55ps\516w\a2_55bp.md09-115	
1/3	1648.2	496823	5436176	1.0	247.55		type a2-brac\55ps\516w\a2_55bp.md09-115	
1/4	1895.8	496822	5435928	1.2	247.56		type a2-brac\55ps\516w\a2_55bp.md10-120	
2/1	2143.3	496821	5435681	1.1	223.40		type a2-brac\55ps\516w\a2_55bp.md09-115	
2/2	2366.7	496821	5435457	0.9	193.22		type a2-brac\55ps\a2_55bp.ld10-110	
2/3	2560.0	496820	5435264	1.0	230.34		type a2-brac\55ps\a2_55bp.ld10-115	
2/4	2790.3	496819	5435034	1.1	246.96		type a2-brac\55ps\516w\a2_55bp.md09-115	
3/1	3037.3	496819	5434787	1.6	253.43		type a2-brac\55ps\516w\a2_55bp.md10-120	
3/2	3290.7	496818	5434533	1.1	200.98		type a2_55bp.#17.#20.#20.hd09-115	
3/3	3491.7	496807	5434333	0.9	178.38	-2.7746	dcirfltde0_10_hd06.#18.065	
3/4	3670.1	496806	5434154	1.1	207.70		dcirfltde90_hd06.#19.065	
3/5	3877.9	496599	5434170	1.2	234.12	-3.7674	type a2_55bp.#20.#20.hd09-115	
4/1	4112.0	496365	5434172	1.0	257.42		type a2-brac\55ps\516w\a2_55bp.md10-120	
4/2	4369.5	496108	5434174	1.2	248.25		type a2-brac\55ps\516w\a2_55bp.md09-120	
4/3	4617.7	495859	5434176	1.4	233.21		type a2-brac\55ps\516w\a2_55bp.md10-120	140' POLE
4/4	4850.9	495626	5434178	1.3	234.48		type a2-brac\55ps\516w\a2_55bp.md09-120	135' POLE
5/1	5085.4	495392	5434180	1.5	184.52		type a2-brac\55ps\a2_55bp.ld09-110	
5/2	5269.9	495207	5434182	1.1	207.73		type a2-brac\55ps\a2_55bp.ld09-110	
5/3	5477.6	495000	5434184	0.8	207.73		type a2-brac\55ps\516w\a2_55bp.md08-110	
5/4	5685.4	494792	5434186	0.5	252.79		type a2-brac\55ps\516w\a2_55bp.md10-120	
5/5	5939.2	494539	5434187	0.8	157.39		dend\j2(90l)_55.hd10-09585	
6/1	6096.6	494539	5434029	0.9	131.53		type a2-brac\55ps\a2_55bp.ld08-120	
6/2	6228.1	494539	5433898	0.8	242.16		type a2-brac\55ps\a2_55bp.ld09-120	
6/3	6470.3	494539	5433656	0.7	229.15		type a2-brac\55ps\516w\a2_55bp.md09-120	
6/4	6699.4	494539	5433427	0.7	230.86		type a2-brac\55ps\516w\a2_55bp.md10-120	
6/5	6930.3	494539	5433196	0.9	257.23		type a2-brac\55ps\516w\a2_55bp.md10-120	
7/1	7187.5	494539	5432938	1.2	242.76		type a2-brac\55ps\38w\a2_55bp.hd08-120	
7/2	7430.3	494539	5432696	1.1	211.94		type a2-brac\55ps\516w\a2_55bp.md09-115	
7/3	7642.2	494539	5432484	1.3	222.61		type a2-brac\55ps\a2_55bp.ld10-110	
7/4	7864.8	494539	5432261	1.2	272.57	-0.3918	type a2-brac\55ps\38w\a2_55bp.hd10-120	125' POLE, SIDE GUY
8/1	8137.3	494539	5431989	0.7	154.24	-6.7518	type d\d2_55bp.ld10-120	125' POLES
8/2	8291.4	494560	5431836	0.9	212.91	8.3729	type d\d2_55bp.ld10-115	
8/3	8504.3	494555	5431623	0.9	210.54	0.2561	type a2-brac\55ps\516w\a2_55bp.md09-110	
8/4	8714.8	494550	5431413	2.3	183.12	-1.1173	type a2-brac\55ps\a2_55bp.ld10-115	
8/5	8897.9	494549	5431229	10.9	219.31		type a2-brac\55ps\516w\a2_55bp.md08-115	
9/1	9117.2	494547	5431010	19.3	178.17	-0.4677	type a2-brac\55ps\516w\a2_55bp.md09-120	
9/2	9295.4	494548	5430832	23.5	198.34		type a2-brac\55ps\516w\a2_55bp.md08-115	
9/3	9493.7	494548	5430634	23.3	197.88	0.1255	type a2-brac\55ps\516w\a2_55bp.md08-120	
9/4	9691.6	494548	5430436	21.0	211.85		type a2-brac\55ps\516w\a2_55bp.md08-115	
9/5	9903.5	494548	5430224	18.0	182.25	-0.3256	type a2-brac\55ps\a2_55bp.ld10-115	
10/1	10085.7	494549	5430042	16.0	207.20		type a2-brac\55ps\516w\a2_55bp.md08-110	
10/2	10292.9	494550	5429834	14.1	214.01		type a2-brac\55ps\a2_55bp.ld10-115	
10/3	10506.9	494551	5429620	14.8	250.91	32.4667	type j2(90)_55.#51.ld10-105	TIE GUYS & SIDE GUYS
10/4	10757.8	494417	5429408	17.1	233.63		type a2-brac\55ps\516w\a2_55bp.md09-120	
10/5	10991.5	494293	5429210	21.8	180.77		type a2-brac\55ps\a2_55bp.ld10-120	
11/1	11172.2	494197	5429057	31.4	219.67		type a2-brac\55ps\a2_55bp.ld09-115	

Str. Number	Station (m)	X Easting (m)	Y Northing (m)	Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Comment
11/2	11391.9	494080	5428871	49.4	197.68		type a2-brac\55ps\516w\a2_55bp.md09-115	
11/3	11589.6	493975	5428704	53.6	238.12		type a2-brac\55ps\516w\a2_55bp.md09-115	
11/4	11827.7	493848	5428502	56.8	225.51	-0.542	type a2-brac\55ps\516w\a2_55bp.md10-120	
12/1	12053.2	493730	5428310	59.1	210.20	59.5192	type j2(90)_55.#58.ld10-100	TIE & SIDE GUYS
12/2	12263.4	493519	5428315	58.4	41.84	6.0226	type a2-brac\55ps\38w\a2_55bp.hd10-115	
12/3	12305.3	493478	5428320	58.2		-15.155	230dcterm	EBT Term
35/1	35000.1	473500	5417005	16.4	33.05		230dcterm	TBY Term
35/2	35033.1	473469	5416993	19.7	238.26	0.9557	type a2-brac\55ps\516w\a2_55bp.md10-120	
35/3	35271.4	473246	5416911	30.6	306.75		type a2-brac\55ps\516w\a2_55bp.md10-120a	
35/4	35578.2	472958	5416804	53.2	356.70		type a2-brac\55ps\516w\a2_55bp.md10-120a	
35/5	35934.8	472624	5416680	138.9	160.49	-0.0288	type a2-brac\55ps\38w\a2_55bp.hd10-110a	
36/1	36095.3	472473	5416624	146.1	250.43		type a2-brac\55ps\a2_55bp.ld09-115a	
36/2	36345.8	472238	5416537	170.1	311.58		type a2-brac\55ps\38w\a2_55bp.hd10-110a	
36/3	36657.4	471946	5416429	185.7	246.41	0.1525	dcirfltde0_10_hd06.075	
36/4	36903.8	471715	5416344	202.7	425.23		dcirfltde0_10_hd06.075	
37/1	37329.0	471316	5416197	100.6	325.33	-0.8624	type a2-brac\55ps\38w\a2_55bp.hd10-110a	
37/2	37654.3	471012	5416080	95.3	782.95	2.7302	special\mont_east230kv	
38/1	38436.4	470265	5415850	16.1	593.34		cspecial\3phase\3 phase s	add 8 m
38/2	38437.2	470273	5415823	16.1	567.01		special\4phase\4 phase s	add 8 m
39/1	39004.2	469735	5415644	14.9	587.02		special\4phase\4 phase s	add 8m
39/2	39029.7	469702	5415661	16.7	561.62		special\3phase\3 phase s	add 10 m
39/3	39591.1	469174	5415470	70.5	239.23	43.4173	special\mont_west230kv	
39/4	39830.3	468957	5415571	64.1	166.32		type a2-brac\55ps\38w\a2_55bp.#77.hd10-120a	130' POLE
39/5	39996.7	468807	5415642	12.5			230dcterm	MTG Term
44/1	44000.0	466814	5412360	16.0	191.87	10.8324	230dcterm	MBO Term
44/2	44191.9	466646	5412453	57.4	177.41	-7.7079	type d\d2_55bp.ld10-120	
44/3	44369.3	466480	5412517	60.3	162.92		type a2-brac\55ps\a2_55bp.ld10-120	
44/4	44532.2	466329	5412576	63.6	169.57		type a2-brac\55ps\a2_55bp.ld10-120	
44/5	44701.8	466170	5412637	64.0	189.51		type a2-brac\55ps\a2_55bp.ld10-115	
44/6	44891.3	465994	5412705	67.0	209.92		type a2-brac\55ps\a2_55bp.ld10-100	
45/1	45101.2	465798	5412781	60.1	180.78		type a2-brac\55ps\a2_55bp.ld10-115	
45/2	45282.0	465629	5412846	50.9	284.28		type a2-brac\55ps\a2_55bp.ld10-115	
45/3	45566.3	465364	5412949	51.9	139.38		type a2-brac\55ps\a2_55bp.ld10-100	
45/4	45705.6	465234	5412999	57.5	96.10	-33.0156	type j2(90)_55.#88.ld10-095	
45/5	45801.8	465140	5412980	57.0	344.55		type a2-brac\55ps\516w\a2_55bp.md10-100	
46/1	46146.3	464803	5412909	30.7	416.07	0.4389	type a2-brac\55ps\38w\a2_55bp.hd10-110a	
46/2	46562.4	464395	5412826	45.1	106.59		type a2-brac\55ps\516w\a2_55bp.md10-110a	
46/3	46669.0	464291	5412805	59.2	221.23		type a2-brac\55ps\516w\a2_55bp.md10-100	
46/4	46890.2	464074	5412761	40.8	348.42		type a2-brac\55ps\516w\a2_55bp.md10-115a	
47/1	47238.6	463732	5412693	41.5	169.49	0.0252	type a2-brac\55ps\516w\a2_55bp.md08-115a	
47/2	47408.1	463566	5412659	64.2	339.62	0.6682	type a2-brac\55ps\38w\a2_55bp.hd10-110a	SPECIAL STRUCTURE
47/3	47747.7	463232	5412596	27.5	295.40	-0.1756	type a2-brac\55ps\516w\a2_55bp.md10-120a	NEED 150' POLE
48/1	48043.1	462942	5412540	32.9	258.36	2.5585	type a2-brac\55ps\38w\a2_55bp.hd10-120	
48/2	48301.5	462687	5412502	41.5	182.31		type a2-brac\55ps\a2_55bp.ld10-120	
48/3	48483.8	462506	5412476	56.6	187.94	-0.9089	type a2-brac\55ps\516w\a2_55bp.md10-120	
48/4	48671.7	462321	5412446	55.1	180.45		type a2-brac\55ps\a2_55bp.ld10-120	
48/5	48852.2	462143	5412417	50.6	213.36	-45.4049	type j2(90)_55.#101.#100.ld10-120	
49/1	49065.5	462019	5412243	48.8	481.07		type a2-brac\55ps\38w\a2_55bp.hd10-120	special structure
49/2	49546.6	461741	5411850	21.5	360.01		type a2-brac\55ps\38w\a2_55bp.hd10-120	
49/3	49906.6	461533	5411557	60.3	484.14		type a2-brac\55ps\38w\a2_55bp.hd10-120	REQUIRE SPECIAL POLE
50/1	50390.7	461253	5411162	176.1	71.89		type a2-brac\55ps\38w\a2_55bp.hd10-110a	SPECIAL STRUCTURE

Str. Number	Station (m)	X Easting (m)	Y Northing (m)	Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Comment
50/2	50462.5	461209	5411105	184.7	273.20	-5.1289	type d\d2_55bp.ld10-120	
50/3	50735.6	461074	5410867	269.2	215.13	-41.2981	type j2(90)_55.#106.md10-09585	
50/4	50950.7	461115	5410656	307.5	320.71		type a2-brac\55ps\38w\a2_55bp.hd10-120	SPECIAL STRUCTURE
51/1	51271.4	461177	5410341	340.6	457.53	54.8364	type 2(90)_55.#108.ld10-09585	
51/2	51728.9	460860	5410011	365.5	73.23	10.9555	type d\d2_55bp.ld10-110	
51/3	51802.2	460801	5409969	361.3	123.79		type a2-brac\55ps\516w\a2_55bp.md10-110	
51/4	51925.9	460700	5409897	330.6	644.61	0.037	type a2-brac\55ps\38w\a2_55bp.hd10-110a	ADD SIDE GUYS
52/1	52570.6	460173	5409525	255.6	334.60		type a2-brac\55ps\38w\a2_55bp.hd10-120	ADD SIDE GUYS
52/2	52905.2	459900	5409332	321.5	178.93		type a2-brac\55ps\516w\a2_55bp.md10-120	
53/1	53084.1	459754	5409229	360.9	382.19		type a2-brac\55ps\38w\a2_55bp.hd10-110	SPECIAL STRUCTURE
53/2	53465.8	459440	5409010	391.3	394.45	-21.8278	type d\d2_55bp.ld10-120	
53/3	53859.8	459228	5408678	402.8	177.23		type a2-brac\55ps\38w\a2_55bp.hd10-120	
54/1	54037.0	459132	5408529	402.4	287.88	53.4386	type j2(90)_55.#116.ld10-120110	
54/2	54324.9	458844	5408511	393.3	119.29		type a2-brac\55ps\516w\a2_55bp.md09-120	
54/3	54444.2	458725	5408503	383.9	326.78	-0.4337	type a2-brac\55ps\38w\a2_55bp.hd10-120	SPECIAL STRUCTURE
54/4	54771.0	458399	5408480	269.1	1,766.90	0.3697	special\sansum_east230kv	
56/1	56537.9	456636	5408366	139.9	122.98	-6.5697	special\sansum_west230kv	
56/2	56660.9	456515	5408344	143.1	282.69	3.4386	type a2-brac\55ps\38w\a2_55bp.hd10-120	ADD SIDE GUYS
56/3	56943.6	456234	5408310	130.9	308.64		type a2-brac\55ps\516w\a2_55bp.md09-120a	
57/1	57252.2	455928	5408273	163.4	214.98		type a2-brac\55ps\516w\a2_55bp.md09-120	
57/2	57467.2	455715	5408248	207.7	225.18	0.4121	type a2-brac\55ps\38w\a2_55bp.hd09-120	SPECIAL STRUCTURE
57/3	57692.4	455491	5408222	225.0	340.71		type a2-brac\55ps\38w\a2_55bp.hd10-110	
58/1	58033.1	455152	5408184	232.1	223.34		type a2-brac\55ps\516w\a2_55bp.md10-120	
58/2	58256.3	454931	5408157	252.3	314.61	6.3199	type d\d2_55bp.ld10-120	
58/3	58570.4	454616	5408156	199.8	307.03	18.7125	type d\d2_55bp.ld10-120	
58/4	58877.0	454326	5408257	179.5	241.47		type a2-brac\55ps\38w\a2_55bp.hd10-120	SPECIAL STRUCTURE
59/1	59118.5	454097	5408334	143.4	218.64		type a2-brac\55ps\a2_55bp.ld10-115a	
59/2	59337.1	453890	5408403	131.5	178.57		type a2-brac\55ps\a2_55bp.ld10-115	
59/3	59515.3	453720	5408458	121.4	186.14	15.4567	type d\d2_55bp.ld10-120	
59/4	59701.1	453567	5408564	108.6	196.37		type a2-brac\55ps\a2_55bp.ld10-115a	
59/5	59897.5	453404	5408674	112.2	309.31	-50.6718	type j2(90)_55.#134.ld10-105095	
60/1	60206.8	453108	5408586	94.0	309.70		type a2-brac\55ps\38w\a2_55bp.hd10-120a	130' POLE, SPECIAL
60/2	60516.5	452811	5408497	87.9	292.22		type a2-brac\55ps\38w\a2_55bp.hd10-120	SPECIAL INSULATORS
60/3	60808.7	452531	5408414	60.4	258.97		type a2-brac\55ps\516w\a2_55bp.md09-120a	130' POLE
61/1	61067.7	452283	5408340	65.3	238.10		type a2-brac\55ps\38w\a2_55bp.hd10-100a	SPECIAL STRUCTURE
61/2	61305.4	452055	5408269	52.3	312.31	17.3832	type d\d2_55bp.ld10-110	SIZE 16 GUYS
61/3	61617.3	451743	5408276	36.6	235.98		type a2-brac\55ps\516w\a2_55bp.md09-120	GUY BOTH SIDES
61/4	61853.3	451507	5408279	57.5	152.23		type a2-brac\55ps\516w\a2_55bp.md09-110	
62/1	62005.6	451355	5408281	60.2	239.71		type a2-brac\55ps\38w\a2_55bp.hd09-110	
62/2	62245.3	451115	5408285	27.3	220.46		type a2-brac\55ps\a2_55bp.ld10-120	
62/3	62465.7	450895	5408288	23.1	294.25		type a2-brac\55ps\516w\a2_55bp.md10-110	
62/4	62760.0	450601	5408292	9.1	293.12	-1.8636	type a2-brac\55ps\38w\a2_55bp.hd10-120	
63/1	63053.1	450307	5408286	5.4	212.27	-0.0784	type a2-brac\55ps\516w\a2_55bp.md09-120	
63/2	63265.4	450095	5408282	10.8	346.45		type a2-brac\55ps\516w\a2_55bp.md10-115	
63/3	63611.8	449749	5408275	33.4	161.58		type a2-brac\55ps\38w\a2_55bp.hd10-120	

Str. Number	Station (m)	X Easting (m)	Y Northing (m)	Z Elevation (m)	Ahead Span (m)	Line Angle (deg)	Structure Name	Structure Comment
63/4	63773.3	449587	5408269	43.5	406.42	5.396	type d\d2_55bp.ld10-120	
64/1	64179.6	449182	5408301	35.6	131.28	0.2887	type a2-brac\55ps\38w\a2_55bp.hd09-120	
64/2	64310.8	449051	5408312	38.0	228.92	-0.1833	type a2-brac\55ps\a2_55bp.ld10-105	
64/3	64539.8	448823	5408329	21.9	195.91	-0.0427	type a2-brac\55ps\a2_55bp.ld10-120	
64/4	64735.7	448628	5408344	27.1	247.83	-3.7251	type a2-brac\55ps\38w\a2_55bp.hd10-115	
64/5	64983.5	448380	5408346	46.3	184.17	0.9208	type a2-brac\55ps\516w\a2_55bp.md10-110	
65/1	65167.7	448196	5408351	56.7	176.54	0.0188	type a2-brac\55ps\a2_55bp.ld10-120	
65/2	65344.2	448019	5408355	70.8	208.47	-0.3517	type a2g-brac\55ps\516w\a2gt_55bp.md10-115	
65/3	65552.7	447811	5408360	76.7	199.20	-0.0953	type a2g-brac\55ps\516w\a2g_55bp.md10-120	
65/4	65751.9	447612	5408363	68.7	190.70		type a2g-brac\55ps\516w\a2g_55bp.md10-120	130' POLE
65/5	65942.6	447421	5408366	58.6			230dcterm	VIT Term