Index

THE CORPORATION OF THE CITY OF PENTICTON
MEMORANUM

TO: Jack Kler-Dir. of Corp. Services **FILE:** **REP:**
FROM: Terry Andreychuk-Elect. Utility-Gen. Mgr. **DATE:** Jun 4, 2007 **RES:**
SUBJECT: FortisBC –Okanagan

CAO COMMENTS:

RECOMMENDATION:

THAT the City of Penticton support the application by FORTISBC for the OKANAGAN TRANSMISSION REINFORCEMENT PROJECT.

IMPLICATION OF RECOMMENDATION:

Organizational: Positive impact on the City of Penticton - Electric Utility power supply and the on-going Voltage Conversion Project .
Financial: Rate increase to all FortisBC customers system wide
Policy:N/A
Strategic Plan: N/A - as the bulk of the project is outside City limits.
Communication Strategy: Letter of Support to FortisBC

REFERENCE: FortisBC Website @ http://www.fortisbc.com/otrproject.html.

BACKGROUND: FortisBC Website @ http://www.fortisbc.com/otrproject.html

This project will be of significant and similar benefit to the City of Penticton - Electric Utility and its customers as it provides us with the ability to supply future growth in our area, added system stability and reliability by way of redundancy and actual construction design.

ALTERNATIVES: N/A

DISCUSSION: N/A

Per:

Terry Andreychuk
Electric Utility- General Manager

June 11, 2007

Mr. Bob Gibney
FortisBC
1260 Commercial Way
Penticton, BC V2A 3H6

Dear Mr. Gibney:

Re: Okanagan Transmission Reinforcement Project

On behalf of Mayor and Council, I would like to thank you and Mr. Dufour for your informative presentation regarding the Okanagan Transmission Reinforcement Project at the May 22, 2007 Council meeting.

I can report that at the June 4, 2007 Council meeting, Council passed the following resolution:

LAND: FortisBC Transmission Reinforcement Project
Moved/Seconded:

331/2007 *THAT the staff memorandum dated June 4, 2007 regarding Okanagan Transmission Reinforcement Project be received;*

AND THAT FortisBC be advised that the City of Penticton support the proposed upgrade for the Okanagan Transmission Reinforcement Project;

AND THAT FortisBC be requested to consider relocating the transmission line, located in the south east sector of the City, adjacent to or outside City boundaries in order to minimize any impact on future developable lands.

AND FURTHER THAT the BC Utilities Commission be so advised.

CARRIED UNANIMOUSLY

Should you have any questions, please do not hesitate to contract the writer at 490-2412.

Yours truly,

THE CORPORATION OF THE CITY OF PENTICTON

Cathy Ingram, CMC
City Clerk

c: BC Utilities Commission

June 15, 2007

Mayor and Council
C/o Cathy Ingram, CMC
The City of Penticton
171 Main Street,
Penticton BC V2A 5A9

Dear Mayor and Council:

<u>Re: Letter of June 11, 2007 Okanagan Transmission Reinforcement Project</u>

Thank you for finding agenda time for the FortisBC OTR presentation and your subsequent letter of June 11, 2007.

Specific to your request to have FortisBC consider relocation of the transmission line currently located in the south east sector of the city, is the City of Penticton prepared to accept all incremental relocation costs?

If you have any questions regarding this matter please contact me directly at 1-250-490-5141.

Sincerely,

Bob Gibney
Manager BC Relations

C.c. Pierre Dufour

City Clerks Office
1435 Water Street
Kelowna, BC V1Y 1J4
Tel: (250) 469-8645
Fax: (250) 862-3315

City of Kelowna

Corporate Services

June 19, 2007

FortisBC Inc.
Mr. Bob Gibney
5th Floor, 1628 Dickson Avenue
Kelowna, BC V1Y 9X1

Dear Mr. Gibney:

Re: Pierre Dufour and Bob Gibney – Fortis BC Presentation to Council

This will confirm that Kelowna City Council considered your Presentation at a Regular Meeting held on June 18, 2007, and adopted the following resolution:

> THAT Council send a letter of support, in principle, to Fortis BC, for the need, proposed solution including the preferred route, and distribution of cost for the Okanagan Transmission Reinforcement Project.

I would be pleased to answer any inquires you may have.

Yours truly,

A.M. McClelland
Council Recording Secretary

/am

BRITISH COLUMBIA
Ministry of Agriculture and Lands

Integrated Land Management Bureau

File: 0255800

June 27, 2007

Fortis BC Inc.
5th Floor, 1628 Dickenson Avenue
Kelowna BC V1Y 9X1
Attention: Pierre Dufour, Manager

Dear Pierre Dufour:

Re: Okanagan Transmission Reinforcement Project

Thank you for meeting with me on June 25, 2007 to discuss this project. I understand from this meeting that Fortis' preference is to continue to use the existing powerline Right of Way (file 0255800) and you were also inquiring on an alternative upland route option across Crown Land.

It is our preference that the existing Right of Way be used in this powerline upgrading since this would have the least impact on the land base. We could consider an application on the alternate route, however, I would encourage you pursue all other options to use the existing Right of Way prior to proceeding with this.

If you wish to submit an application on the alternative Crown upland route the following factors should be considered prior to submitting this application through our Front Counter office in Kamloops:

1) There are several existing Grazing Leases which this route crosses, the written consent would be required prior to an application.
2) This route is within the Derenzy Bighorn Sheep Habitat Resource Management Zone of the Okanagan Shuswap Land Management Plan. The Ministry of Environment should be contacted for their input.
3) Discuss this proposal with the First Nations concerned.

If you have any questions or concerns in regards to this matter please contact me.

Yours truly,

Jerry Johnson,
Senior Land Officer
cc: Front Counter BC, Suite 210-301 Victoria St, Kamloops BC V2C 2A3

Integrated Land Management Bureau
Ministry of Agriculture and Lands

Regional Client Services Division
Southern Interior Region

Mailing/Location Address:
Floor 3
145 - 3rd Ave
Kamloops BC V2C 3M1

Telephone: 250-377-7027
Facsimile: 250-377-7036
Web Address:
http://www.al.gov.bc.ca

101 Martin Street, Penticton, British Columbia V2A 5J9
Tel: 250.492.0237 Fax: 250.492.0063
Toll Free: 877.610.3737
Email: info@rdos.bc.ca

REGIONAL DISTRICT
RDOS
OKANAGAN-SIMILKAMEEN

July 4, 2007

File No.: 5501.01

Via: E-mail

Bob Gibney
Fortis BC
1260 Commercial Way
Penticton, BC V2A 3H5

Dear Mr. Gibney:

Re: Proposed Changes to Transmission Lines

On behalf of the Board, I would like to thank you for attending the June 21, 2007 Corporate Issues Board meeting to address the proposed changes to the transmission lines through the South Okanagan.

After your presentation the Board passed the following resolution (B302/07)

> "That the Regional District Okanagan-Similkameen acknowledges and supports the need for upgrade power service for the Okanagan Valley;
>
> AND That the Regional District Okanagan-Similkameen does not support upgrading of the existing corridor and urges Fortis BC to relocate the line east of the existing site avoiding developed settlements;
>
> AND That the Regional District Okanagan-Similkameen move to register as an intervener in the matter of Fortis BC upgrade of the power upgrade in the south Okanagan from Oliver to Penticton. Carried"

Respectfully,

Dan Ashton
RDOS Board Chair

cc Readers File
J. Johnson, CAO

FORTISBC

July 6, 2007

Mr. Dan Ashton
RDOS Board Chair
Regional District Okanagan Similkameen
101 Martin Street,
Penticton, B.C. V2A 5J9

Dear Dan,

Thank you for allowing FortisBC the opportunity to present our proposed Okanagan Transmission Reinforcement (OTR) Project. As discussed, there is a pressing need to proceed with the project to ensure that FortisBC meets the electricity needs of the growing population in the south and central Okanagan.

Regarding your letter of July 4, 2007 supporting the OTR project need, is the Regional District Okanagan Similkameen (RDOS) prepared to reimburse FortisBC customers for all incremental costs required to relocate the existing line to a higher elevation route, and can you please explain why the RDOS would like to see the line relocated to a higher elevation.

Thank you for your time and consideration, if you have any questions please contact me directly at 490-5141.

Sincerely,

Bob Gibney

Bob Gibney
Manager, BC Relations

C.C. Pierre Dufour

PENTICTON
& WINE COUNTRY
CHAMBER
OF COMMERCE

"to be a catalyst in the community"

July 6, 2007

Bob Gibney
FortisBC Inc.
1260 Commercial Way
Penticton, BC V2A 3H5

Dear Mr. Gibney:

Re: Letter of Support

On behalf of the Penticton & Wine Country Chamber of Commerce, I am pleased to offer a letter of support for the FortisBC project that will see an upgrade to the transmission lines from Penticton to Oliver.

The presentation to the Chamber Board of Directors on June 27, made us realize that the project is crucial to the entire South Okanagan as the reliability of electricity could be compromised if the upgrade is not done.

While the Chamber initially supports keeping it on the existing route due to environmental footprint, cost, and time reasons, we would also support an alternate route if the stakeholders can provide one that can be secured in a timely and cost effective manner.

Please do not hesitate to call if you have any questions or concerns.

Yours truly,
PENTICTON & WINE COUNTRY CHAMBER OF COMMERCE

Chris Browne
President

FortisBC project

553 RAILWAY STREET, PENTICTON, BC, V2A 8S3
Ph: 250 492.4103 Fax: 250 492.6119 Email: admin@penticton.org Web: www.penticton.org

REGIONAL DISTRICT
of CENTRAL OKANAGAN

Office of the Administrator

1450 K.L.O. Road
Kelowna, B.C. V1W 3Z4

Telephone: (250) 763-4918
Fax: (250) 763-0606
www.regionaldistrict.com

July 12, 2007
File No: 0110-02

FortisBC
Pierre Dufour
Manager
Okanagan Transmission Reinforcement Project
5th Floor, 1628 Dickson Avenue
Kelowna, BC
V1Y 9X1

Dear Mr. Dufour:

I would like to take this opportunity to thank you on behalf of the Regional Board for attending the July 9th meeting and updating the Board on the Okanagan Transmission Reinforcement Project.

As requested and following your presentation and discussion, the Regional Board adopted the following resolution:

> "THAT the Regional Board of the Regional District of Central Okanagan supports in principle Fortis BC's Okanagan Transmission Reinforcement (OTR) Project."

Once again, thank you for addressing the Board.

Yours truly,

W. d'Easum
Chief Administrative Officer

July 23, 2007

FORTISBC
Manager of the Okanagan Transmission Reinforcement Project (OTR)
5th Floor, 1628 Dickson Avenue
Kelowna, B.C.
V1Y 9X1

ATTENTION: Pierre DuFour

Dear Sir,

RE: Results of meeting held with residents of McLean Creek Flats, Heritage Hills, Parsons Road Agricultural Bench & Lakeshore Highlands in Okanagan Falls

On June 26th, 2007, the COFAHVOL committee invited the residents of the four residential neighborhoods in Okanagan Falls that reside near the present Transmission line right of way to discuss your imminent application to the BCUC for a Certificate of Public Convenience and Necessity. A total of forty residents attended. One of the topics on the agenda was to gauge the consensus of the attendees willingness to pay an increase on their monthly electrical bills over the lifetime of the project to offset the additional costs that would be required to relocate the right of way to the east and to a higher elevation. The consensus of this group was in favour of paying a surcharge on their monthly electrical bills so long as the amount is not financially invasive in nature.

We propose that FortisBC submit with its application this information as well as some formula scenarios that can be presented to the residents of these neighbourhoods as well as those in the Evergreen area of Penticton , in the form of a survey of some kind, in an effort to gauge what amount would be acceptable and what method of payment would be most appropriate. As an example, during the last open house in May 2007 Gerry had mentioned that the additional costs involved in relocating the power corridor would translate to an addition of $.40 for every $100.00 realized on a household's monthly electrical statement.

Your consideration surrounding this issue is most appreciated.

Cordially,

Colin Harlingten/Robert Advocaat
COFAHVOL / SOCAG

cc: **B.C. UTILITIES COMMISSION**
ATTENTION: Commission Secretary
Box 250, 900 Howe Street
Sixth Floor
Vancouver, B.C.
V6Z 2N3

District of Summerland

"Building a Unique Community with Quality, Efficiency and Respect"

Office of the Mayor

Communities in Bloom / Collectivites en fleurs
National Winner 2006 Gagnant national

August 16, 2007

Mr. Bob Gibney
FortisBC Inc..
5th Floor
1628 Dixon Avenue
Kelowna, BC V1Y 9X1

Dear Mr. Gibney:

Re: Okanagan Transmission Reinforcement Project

Council discussed the Okanagan Transmission Reinforcement (OTR) project that is being proposed by FortisBC. Council agrees that the project is necessary to support the future power supply requirements of the South Okanagan. In your presentation, FortisBC presented two options for the route of the transmission line for the OTR project. Council supports using the existing transmission line right of way as this represents the lowest cost to the ratepayers for both the capital costs and the ongoing maintenance. The existing right of way is also the preferred route because it represents the lowest environmental impact to the area. Council is concerned that should the alternative route be selected, clearing of the new right of way will have a negative impact on native species and result in the further spread of invasive vegetation species such as knapweed.

We appreciate the opportunity to comment on this important project and look forward to seeing its successful completion. Should you have any questions regarding the foregoing or require any additional information, please do not hesitate to call.

Yours truly,

District of Summerland

David Gregory

David Gregory, Mayor

OSOYOOS INDIAN BAND

RR#3, SITE 25, COMP 1 PHONE: (250) 498-3444 ~ FAX: (250) 498-6577 OLIVER, BC V0H 1T0

August 20, 2007

FortisBC
Mr. Bob Gibney
Penticton

By Fax: 250-493-5869

RE: **Okanagan Transmission Reinforcement Program**

Sir:

The Osoyoos Indian Band is pleased to support the Okanagan Transmission Reinforcement Program. This will entail the upgrading to the existing transmission lines from 161 kV to 230 kV between Vaseaux Lake and Oliver, and Vaseaux Lake and OK Falls,(Penticton) and adding an additional 230 kV line to the north between Vaseaux Lake and OK Falls. (Penticton) Our support is subject to upgrades being performed within the existing Right of Way (Easement) that FortisBC has.

The Osoyoos Indian Band only speaks to the transmission line North to OK Falls as that is within our Traditional Territory. From OK Falls to Penticton is not something that we can address or speak to.

Yours truly

Steven Bryson

Steven Bryson
Lands & Taxation

Town of Oliver

35016 — 97th Street; PO Box 638; Oliver, BC; V0H 1T0
Telephone: (250) 485-6200; Fax: (250) 498-4466
Web site: www.oliver.ca General e-mail: admin@oliver.ca

Oliver, BC... "Wine Capital of Canada"

August 20, 2007

File Number: 5500-02

Bob Gibney
FortisBC
5th Floor, 1628 Dixon Avenue
Kelowna, BC V1Y 9X1
Email: bob.gibney@fortisbc.com

Dear Bob:

Re: Okanagan Transmission Reinforcement Project

At the July 23, 2007 Regular Open Council meeting, the following resolution was passed:

> *FortisBC Okanagan Transmission Reinforcement Project*
>
> *Bennest – Hampson*
>
> *That Council supports the Okanagan Transmission Reinforcement Project in a way that has the lowest cost to the user.*

I trust this is the information you require. Should you need anything further, please contact me at 250-485-6207 or amandziuk@oliver.ca.

Yours truly,

Alleson Mandziuk, BComm
Corporate Officer

W:\Engnrng and Public Works (5200-5799)\5500 Utilities\5500-02 Fortis (Electrical)\gibney-ltr-am-FortisBC OTR Project.doc

Kelowna Chamber OF COMMERCE

August 23, 2007

FortisBC Inc.
Attn: Pierre Dufour, Manager OTR
5th Floor, 1628 Dickson Avenue
Kelowna, BC V1Y 9X1

Dear Mr. Dufour,

In recent years the Okanagan has experienced significant growth in residential and commercial developments. This rapid pace of growth has placed increased stresses on existing power infrastructure in the Okanagan.

FortisBC has come forward with the Okanagan Transmission Reinforcement (OTR) Project. This is a major infrastructure project that will provide long-term, reliable power supply to accommodate residential and business growth in the Okanagan. Having undertaken a series of open houses, FortisBC has identified potential issues, concerns and opportunities in an effort to improve the project plan.

The OTR Project provides a viable long-term solution to the increasing demands currently placed upon the power infrastructure of the Okanagan. It is our hope that this project can move forward to address the increased strain on the power infrastructure in the Okanagan while balancing environmental, social and economic impacts.

Sincerely,

Laura

Laura A. Thurnheer, President
Kelowna Chamber of Commerce

BRITISH COLUMBIA

File: 230-01

Date: August 24, 2007

Pierre Dufour
FortisBC Inc.
5th Floor, 1628 Dickson Ave.
Kelowna, BC
V1Y 9X1

Dear Mr. Dufour:

Re: Okanagan Transmission Reinforcement Project

The Protection Branch of the Ministry of Forests and Range is supportive of FortisBC's current initiative which may better protect their assets from the risk of wildfires and simplify fire suppression efforts in and around these assets when they occur.

The Protection Branch hopes that the replacement of wooden structures with a more flame resistant structure will have a positive influence on our ability to control wildfires in these areas. According to the FortisBC discussion guide, it also may assist in the event of the simultaneous failure of power lines due to wildfire.

The Protection Branch of the Ministry of Forests and Range supports all corporate citizens who are working towards minimizing fire hazard and risk. In this regard, it appears that FortisBC is demonstrating a progressive approach to ensuring south Okanagan customer's electrical power needs are met while at the same time improving protection of their transmission assets from the risk of wildfires.

Yours truly,

Brian Simpson,
Acting Director Protection Branch

Ministry of Forests and Range Protection Program

Location:
2nd Floor 2957 Jutland Road
Victoria BC V8W 3E7

Mailing Address:
PO Box 9502 Stn Prov Govt
Victoria, BC V8W 9C1

Tel: (250) 387-5965
Fax: (250) 387-5685

Penticton Indian Band

R.R.#2, SITE 80, COMP.19
PENTICTON, BRITISH COLUMBIA
V2A 6J7

TELEPHONE 493-0048 FAX 493-2882

August 28, 2007

Our File: E5664-1

FORTISBC
Okanagan Transmission Reinforcement (OTR) Project
5th Floor, 1628 Dickson Avenue
Kelowna, BC
V1Y 9X1

Attention: Pierre Dufour
Manager

Dear Mr. Dufour:

RE: OKANAGAN TRANSMISSION REINFORCEMENT (OTR) PROJECT

Please be advised that this issue was discussed at length at the Penticton Indian Band Council meeting this date. As a result of our concerns with respect to a disturbance of the surrounding landscape in the event that the power line is relocated, the Penticton Indian Band Council would like to see the upgraded power transmission line remain on the existing right-of-way.

Please be advised that this opinion does not abrogate or derogate from the aboriginal rights and aboriginal title interests of the Penticton Indian Band/Okanagan Nation and in particular to the outstanding Band's specific claim – Penticton Indian Reserve No. 2 (Timber Claim).

Thank you for your attention to this matter.

Sincerely yours

Grand Chief Stewart Phillip

101 Martin Street, Penticton, British Columbia V2A 5J9
Tel: 250.492.0237 Fax: 250.492.0063
Toll Free: 877.610.3737
Email: info@rdos.bc.ca

REGIONAL DISTRICT
RDOS
OKANAGAN-SIMILKAMEEN

August 30, 2007

File No.: 5501.01

Bob Gibney
Fortis BC
1260 Commercial Way
Penticton, BC V2A 3H5

Dear Mr. Gibney:

Re: Okanagan Transmission Reinforcement Project

Please excuse the tardiness of my reply to your letter of July, 2007.

As discussed at the Board table the Directors are not in favour of reimbursing the costs associated with moving the lines of the proposed Okanagan Transmission Reinforcement Project.

Board members feel that the relocation is a good investment for Fortis as it will remove any of the health questions associated with the close proximately of high tension lines in subdivision areas. With the increased development in the valley, encroachment on a right-of-way which was previously far removed from residential areas has become a reality. Fortis also benefits from the addition of these new homes and the Board feels this is a good business case for Fortis to apply for a right-of-way in a higher elevation undeveloped area on crown land, therefore freeing up development land.

Once again please accept my apology for my tardiness in responding to your letter.

Respectfully,

Dan Ashton
RDOS Board Chair

cc British Columbia Utilities Commission
Readers File
J. Johnson, CAO

South Okanagan-Similkameen Invasive Plant Society

South Okanagan-Similkameen Invasive Plant Society

c/o 8703 Palmer Pl.
Summerland, B.C. V0H 1Z2

4 October 2007

FortisBC
5th Floor, 1628 Dickson Ave
Kelowna BC V1Y 9X1
Attn: Pierre Dufour, Project Manager

Re: Okanagan Transmission Reinforcement Project

Dear Mr. Dufour,

We are in receipt of your letter sent during the summer, as well as the more recent letter dated September 24, which was accompanied by a digital copy of the Environmental and Social Impact Assessment (ESIA).

Our Society, the South Okanagan-Similkameen Invasive Plant Society (SOSIPS), has been working to cooperatively reduce the threat of invasive plants and effectively manage priority infestations in the South Okanagan region since 1996. Your organization has been a key partner and contributor to the success of many of the coordinated invasive plant projects in our region. Most notably, SOSIPS has been working with stakeholders, including FortisBC, to coordinate invasive plant management in the Vaseux area for the past ten years. We hope that FortisBC will continue to partner with SOSIPS through the implementation of the Okanagan Transmission Reinforcement Project.

In reviewing the ESIA, we noted that various invasive plant mitigative measures have been proposed. Taking appropriate preventative and mitigative approaches throughout the planning and implementation phases of the Okanagan Transmission Reinforcement (OTR) Project will significantly reduce the time, cost and effort associated with invasive plant management.

We support the inclusion of a pre-construction treatment program, however we question how this may be implemented in 2008 in light of the fact that priority invasive species are not yet identified, nor have they been inventoried and mapped along the length of the transmission line. SOSIPS recommends that FortisBC conduct a detailed inventory on invasive plants during the 2008 field season. Due to the magnitude of this project, SOSIPS advises FortisBC to build on this baseline data and prepare an **Invasive Plant Management Plan** that documents the existing invasive plants occurring on the right-of-way, and provides clear guidelines, preventative and mitigative approaches, and performance measures to ensure that this project effectively addresses noxious and other harmful weeds.

We have concerns about the use of strictly native seed mixes used to re-vegetate disturbed soils. Our collective experience indicates that native seeds typically take longer to germinate and germination success with species such as bluebunch wheatgrass is inconsistent. Therefore, we advise FortisBC to use seed mixes that include non-invasive agronomic species. SOSIPS requests an opportunity to review the recommended seed mix prior to any revegetation efforts.

We also strongly encourage a long-term monitoring and post-construction treatment program as part of the OTR Project. However, we do not feel that the 3-year timeline for post-construction monitoring and control recommended in the ESIA is adequate. We recommend a minimum 5-year program be implemented.

Our Invasive Plant Program Coordinator, Lisa Scott, has already contacted you and has also spoken with your environmental consultant. She will continue to be available to help address invasive plant issues and concerns during this project. SOSIPS has collaborated with and assisted many landowners and agencies along the existing transmission line from Vaseux Lake to Penticton. Consequently, we would like to participate in future invasive plant planning and strategizing relating to the OTR Project.

We look forward to your response to our concerns as noted above. If you have any questions please contact Lisa Scott at (250) 404-0115 or sosips@shaw.ca

Sincerely,

Phil Rippin
President

cc. Maureen Grainger

BRITISH COLUMBIA
The Best Place on Earth

File No.: 2007SIP0633

October 31, 2007

FortisBC Inc.
5th Floor, 1628 Dickson Ave
Kelowna BC V1Y 9X1

Attention: Pierre Dufour

Re: Review of Environmental and Social Impact Assessment (Draft) for the Fortis BC Okanagan Transmission Reinforcement (OTR) Project

The Ecosystem Section of the Ministry of Environment (MOE) has reviewed the above mentioned report prepared by Elements September 2007. It appears, from the information provided, that an upgrade along the existing transmission corridor will have the lesser impacts on fish, wildlife and habitat values. The following comments are provided in response to proposed works being implemented at the preferred option sites (existing transmission corridor and benchland adjacent to Oliver) identified in the assessment report.

Due to the scope of this project, it is advisable to engage a qualified professional (QP) with a background in local fish and wildlife species, their habitat requirements, the general ecosystem types in the south Okanagan, and experience in environmentally sensitive project design and monitoring practices. Such services will provide a foundation to lessen the impacts of this development through the identification of on-site values through an appropriate means to reduce impacts that would be associated by this proposed upgrade.

Antelope-brush Ecosystem
Antelope-brush ecosystems are considered rare in BC with approximately 9% of the original area in a relatively undisturbed state. Wherever possible the project footprint should be kept to a minimum. Where natural ecosystems are compromised due to this proposal, it is possible to develop and implement a restoration plan.

There are several local knowledgeable people/organizations that could assist in a mitigation strategy. Long term monitoring of such works would assist the knowledge base. We would be able to put you in contact with organizations that would be willing to assist in the development of such a plan.

Fish and Fish Habitat
As per the federal *Fisheries Act*, any harmful alteration, disruption or destruction (HADD) of fish habitat will require authorization from Fisheries and Oceans Canada. Authorizations are not unconditional; they permit HADD to fish habitat only under carefully prescribed conditions. As necessary, compensation measures will be required to balance loss of fish habitat. It will be necessary for you to determine if fish values are present.

Hazard Tree Removal
Should you encounter trees that need to be felled for safety reasons, provincial *Best Management Practices (BMP) for Hazard Tree and Non-Hazard Tree Limbing, Topping or Removal* can be used to reduce the impacts of such actions.

Rare Plants
The alkaline flats to the east of Vaseux Lake are known to support several species of rare plants. To minimize the potential for ancillary activities impacting these plants, the areas should be fenced off (not flagged) to delineate 'no-work' zones. These areas should include a buffer surrounding individual occurrences. If rare plants are to be damaged due to safety or design constraints of the 230kV line installation, plants should be relocated or salvaged under direction of a QP.

Invasive Plants
A pre-emptive integrated invasive plant management strategy is highly recommended. The strategy should include recommendations for all disturbed ground resulting from the proposed works as well as potential plant salvage and relocation sites. Control efforts should be undertaken in 2008 prior to any project related ground disturbance or restoration/enhancement efforts with timing appropriate for the target weeds biology. Follow-up monitoring, and treatments, will be required.

Wildlife Relocation
The Ecosystem Section recommends that all wildlife relocation be conducted under the direction of the QP and/or local species specialists identified by the QP.
Detailed relocation measures are expected to be outlined in the Environmental Management Plan. This is especially important to ensure appropriate and proper handling of sensitive species. A *Wildlife Act* Permit will be required for all wildlife relocation activities. Additional permitting may be required for federally-listed species at risk under the *Species at Risk Act* (SARA). More information can be found at the SARA Public Registry (http://www.sararegistry.gc.ca/default_e.cfm) and MOE Permit and Authorization Bureau (http://www.env.gov.bc.ca/pasb/applications/process/wildlife.html#a11).

Birds
For the Okanagan Region, the province recommends a raptor 'Least Risk Window' between August 15th and January 30th. The anticipated project schedule outlined in Section 7 (pg 49) of the assessment indicates pole site preparation and installation occurring until Feb 28, 2009. This work window should be revised to match the provincial recommendations.

Under Section 34 of the *Wildlife Act*, a person commits an offence, if he/she possesses takes, injures, molests or destroys a bird or its egg, or a nest that is occupied by a bird or its egg. To ensure an offence is not committed, it is recommended that the QP inspect identified wildlife tree areas prior to any works occurring in their vicinity.

The proponent is encouraged to review and implement *BMP's for Raptor Conservation during Urban and Rural Land Development in British Columbia.* Table 6 (under BMP 2, Section 8) recommends species specific nest replacement or habitat enhancement options. These options are recommended as mitigation of any necessitated wildlife tree removal.

California Bighorn Sheep
Based on California Bighorn Sheep lambing data from the Ministry of Environment, Wildlife Section (Okanagan Region), a lambing 'no-work window' of March 15th – June 25th is recommended. This timeframe encompasses local population periods of lambing recognizance, birthing and initial rearing. The anticipated project schedule outlined in the assessment indicates line installation occurring during June 2008. The QP should contact Ministry staff to obtain more detailed information on known lambing sites in the area.

Furthermore, the Wildlife Section opens a limited hunting draw for California Bighorn Sheep during the month of September. To avoid disturbing key hunting areas during this time, contact Brian Harris, Wildlife Section (490-8254) for further discussion.

Reptiles
In accordance with *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (Section 4: Environmentally Valuable Resources)*, target buffer distances for snake hibernacula in undeveloped areas measure 150 meters from the den site. Mitigation measures outlined in the assessment indicate a 50 meter buffer for snake den sites. It is expected that this setback be extended to provincial standards. Detailed information for snakes will be released by Ministry staff to the QP.

To ensure no impacts to fish and wildlife or their habitats, the Ecosystem Section refers to provincial Standards and Best Practices. Fortis BC is encouraged to review and implement all relevant BMP's. BMP's can be found at:
http://www.env.gov.bc.ca/wld/BMP/bmpintro.html.
It is the proponent's responsibility to ensure their activities are in compliance with all legislation.

If you have any questions or require additional information please feel free to contact me. Lisa Tedesco, Ecosystem Biologist (490-8252). The Ecosystems Section will be available to provide comments on the finalized Environmental Management Plan.

Yours truly,

Lisa Tedesco
Ecosystems Biologist

LT/cl

OKANAGAN NATION ALLIANCE
3255 C Shannon Lake Road, Westbank, BC V4T 1V4
Phone: (250) 707-0095 Fax (250) 707-0166 www.syilx.org

November 5, 2007

Pierre Dufour, Manager
FortisBC
5th Floor, 1628 Dickson Avenue
Kelowna, BC
V1Y 9X1

Re: Okanagan Transmission Reinforcement (OTR) Project

Dear Mr. Dufour;

After reviewing the letters addressed to FortisBC from Penticton Indian Band and Osoyoos Indian Band, we are in concurrence on the Okanagan Transmission Reinforcement Program. This program will entail upgrading the existing transmission lines from 161 kV to 230 kV between Vaseux Lake and Oliver and Vaseux Lake and OK Falls. Our support is subject to upgrades being performed within FortisBC's existing Right of Way.

If an alternate route is proposed, the Okanagan Nation Alliance will be involved in all aspects of the review and part of the decision making process for acceptance, rejection, or modification of the proposal. Estimated timelines can be developed upon commencing research on an alternate proposal.

Please be advised that this opinion does not abrogate or derogate from the aboriginal rights and aboriginal title interests of the Okanagan Nation.

Sincerely,
OKANAGAN NATION ALLIANCE

endorsed by the Natural Resources Committee for Stewart Phillip's signature.

____
Chief Stewart Phillip
Chairman

cc: Bob Gibney, Executive Liaison First Nations-FortisBC

The Nature Trust of British Columbia
#260 - 1000 Roosevelt Crescent
North Vancouver, BC V7P 3R4
Phone: 604-924-9771
Fax: 604-924-9772
Toll Free: 1-866-288-7878

Email: info@naturetrust.bc.ca
Website: www.naturetrust.bc.ca

November 7, 2007

FortisBC Inc.
5th Floor, 1628 Dickson Ave
Kelowna BC
V1Y 9X1

ATTN: Pierre Dufour

Re: Review of Fortis BC Okanagan Transmission Reinforcement (OTR) Project upland route refinements

Dear Pierre Dufour:

Thank you for the opportunity to comment on the proposed refinement of the OTR project upland route. The Nature Trust of British Columbia's South Okanagan Conservation Land Manager, Carl MacNaughton, has reviewed the information provided in OTR project discussion papers, public open house sessions, and in personal discussion with you.

Based on this review and particularly the revised upland route proposal provided to us on October 17, 2007, we are not in a position to support the upland route option, given that this option would result in significant degradation of habitat to Nature Trust owned conservation lands. As you've stated, the revised upland route would lead to an additional 1.1 kilometers of right-of-way being created.

The Nature Trust of British Columbia has been involved in the South Okanagan for over 25 years. We have actively worked to implement a landscape level, partnership based approach to habitat conservation and management. These efforts have resulted in net holdings of over 100,000 acres in the South Okanagan, in both private and Crown land leases and licenses.

For our conservation efforts to be successful, it is critical that the integrity of our holdings be maintained for wildlife habitat values. Any further intrusions into these presently intact areas of high value habitat would be detrimental to our management goals for our conservation lands.

The existing transmission line right-of-way, as it passes through Nature Trust holdings, is in a degraded state, due to ongoing issues of invasive plant infestation, regular clearing of vegetation, and soil disturbance due to

The Nature Trust
of British Columbia

right-of-way access for maintenance, and unauthorized public access to the right-of-way. These issues have already posed difficulties in the management of our Okanagan Falls Biodiversity Ranch, due to increased management costs and reduced habitat integrity.

Any further rights-of-way, and associated construction activities, would only worsen these issues and compound the habitat degradation, thus limiting the viability of our conservation holdings as a working Biodiversity Ranch and as an important wildlife corridor.

For these reasons, The Nature Trust of British Columbia cannot support the proposed upland route across our conservation holdings, as detailed in your recent communications.

Regarding this issue, and the details of your draft Environmental and Social Impact Assessment, Carl MacNaughton is available to meet with you in person to discuss.

Yours in Conservation,
The Nature Trust of British Columbia

Doug Walker
Chief Executive Officer

cc: Drew Carmichael, Ministry of Environment
David Smith, Canadian Wildlife Service
Kathleen Moore, Canadian Wildlife Service
Carl MacNaughton; South Okanagan Land Conservation Manager
Bryn White, South Okanagan Similkameen Conservation Program

South Okanagan-Similkameen Invasive Plant Society

South Okanagan-Similkameen Invasive Plant Society

c/o 8703 Palmer Pl.
Summerland, B.C. V0H 1Z2

22 November 2007

FortisBC
5th Floor, 1628 Dickson Ave
Kelowna BC V1Y 9X1
Attn: Pierre Dufour, Project Manager

Re: Okanagan Transmission Reinforcement Project

Dear Mr. Dufour,

As a follow-up to your letter dated July 9, 2007 and your email dated November 1, 2007, this letter serves as a response to your request for written comment as to our Society's preference with regards to route selection for the Okanagan Transmission Reinforcement (OTR).

SOSIPS Board of Directors reviewed and discussed the two route options during a Board meeting held last Friday, November 16. We have concerns about existent invasive plant infestations on the existing corridor, which would potentially be exacerbated by the proposed upgrades. However, an entirely new upland route would additionally create new opportunities for weed invasion into locations where weeds presently do not exist. Therefore, SOSIPS does not feel that we are in a position to support one route over another based on our Society's goal "to cooperatively control, contain and reduce invasive plants in the region, and to encourage knowledge and partnership for an integrated, effective invasive plant control program."

As noted in our earlier letter, our Society's primary concern is to ensure that appropriate preventative and mitigative approaches are applied throughout the planning and implementation phases of the OTR Project. We have recommended that your agency prepare an Invasive Plant Management Plan that documents the existing invasive plants occurring on the right-of-way, and provides clear guidelines, preventative and mitigative approaches, and performance measures to ensure that this project effectively addresses noxious and other harmful weeds. We also strongly encourage a long-term monitoring and post-construction treatment program as part of the OTR Project.

We have enclosed a basic manual for integrated weed management in BC, entitled Seven Steps to Managing Your Weeds. We encourage FortisBC to consider the guidelines contained within this manual and adopt these standard practices, as it will help your agency to develop an efficient and cost-effective long-term solution to managing invasive plants on all your transmission and distribution rights-of-way. We are pleased to see that the FortisBC Rights-of-Way Vegetation Management Plan 2005-2010 includes a section that deals specifically with the objectives and steps for managing noxious and invasive weeds on FortisBC rights-of-way using the principles of IPM.

Please notify our Coordinator, Lisa Scott at (250) 404-0115 or sosips@shaw.ca when your next open house is scheduled.

Sincerely,

Phil Rippin
President

cc. Maureen Grainger

TABLE OF CONTENTS

1.1 PROJECT MANAGEMENT

1.1.1 Principles of Project Management

Project management is based on the following principles:

1. Quality, scope and cost control of the OTR Project will be the responsibility of the FortisBC OTR Project Manager;
2. Work which impacts the operational control points will be completed, where appropriate, by FortisBC staff. This includes: engineering management, and review, outage coordination, construction monitoring, and final commissioning;
3. Consultant and contract resources will be used for all major components of the Project through an Engineering, Procurement and Construction Management agreement with BC Hydro Engineering, similar to that used for the design and construction of the Vaseux Lake Terminal station;
4. Accountability for each OTR Project component (environment, engineering, construction, commissioning) will reside with FortisBC and will be actively managed by a FortisBC employee or representative;

Quality assurance, environmental and safety inspections will be performed throughout the OTR Project. An on-site construction supervisor will be dedicated for each of the line and station construction phases.

1.1.2 Environment, Health and Safety Management

Environment, Health and Safety (EH&S) values are of the highest priority to FortisBC. It is FortisBC's practice to identify, assess and control workplace hazards in a prudent and continually improving manner. The following elements will be addressed to the satisfaction of the OTR Project Manager for all workers, contractors and affected public:

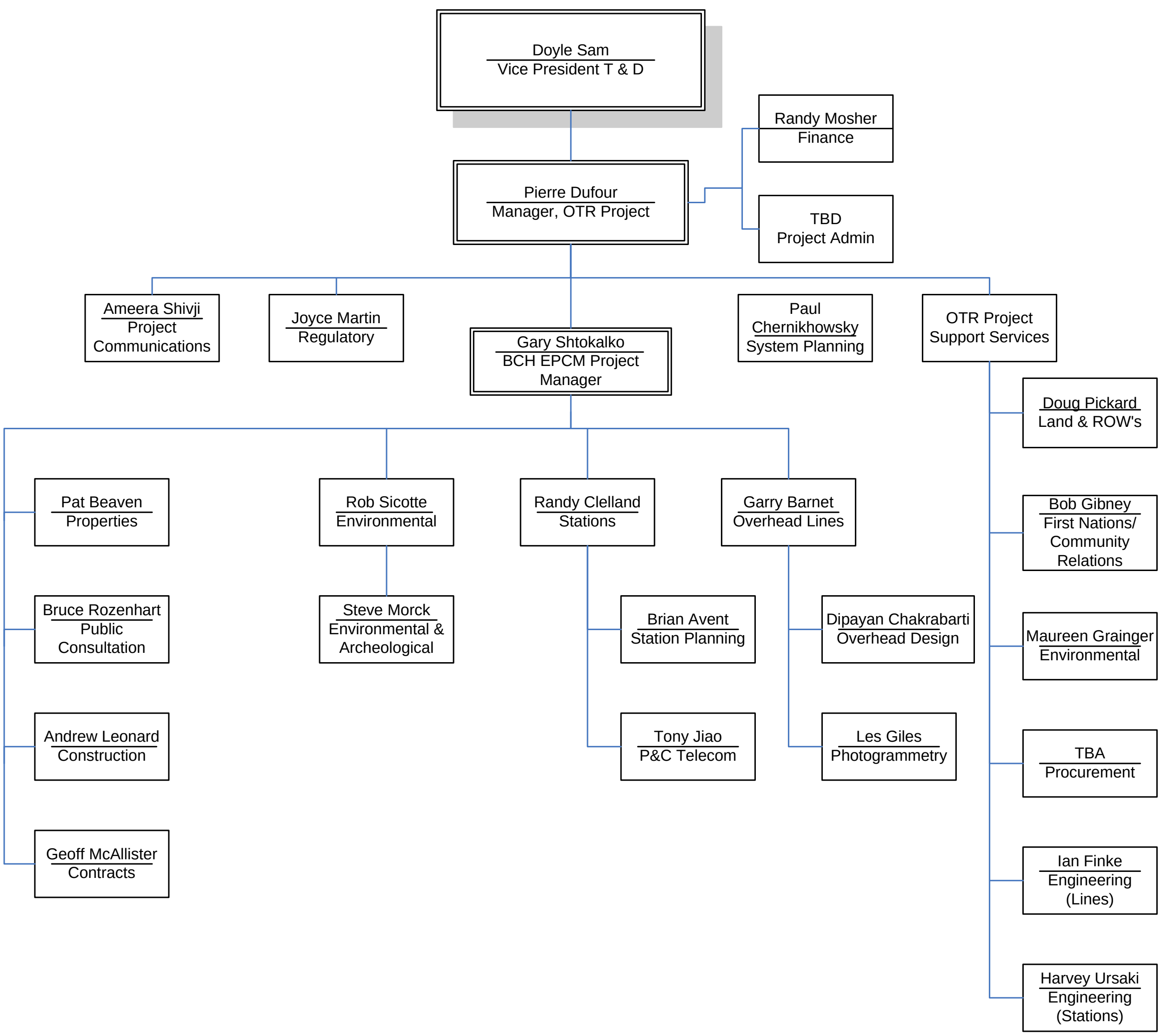
- Strict adherence to FortisBC's EH&S Policies and Procedures;
- Systematic analysis of EH&S hazards at work sites;
- Control measures to eliminate or reduce risks and hazards;

- Worker competency and safety training programs;
- Regular EH&S inspection requirements;
- Emergency response planning requirements;
- Incident reporting, investigation and remediation; and
- Program documentation, records maintenance and administration.

1.1.3 OTR Project Team

The organization structure for the OTR Project is presented in Figure B-1 below.

Figure B-1: OTR Project Team



1.1.4 Key Roles and Responsibilities

1.1.4.1 FortisBC OTR Project Manager

The OTR Project Manager has overall responsibility for delivering the project on time and within budget, by meeting or exceeding the project scope requirements and doing so to the Planning and Operations departments' overall satisfaction. Primarily, the OTR Project Manager is responsible for:

- Overall management of the OTR Project including the key areas of: Scope, Budget, Reporting, Schedule, Resources, Risk, Quality, Environment, Health and Safety;
- Administration of the FortisBC – BC Hydro EPCM Agreement for provision of design, procurement and construction management services for the OTR Project;
- Coordination of review and approval by FortisBC of key deliverables from the EPCM and for OTR Project tasks being done by FortisBC directly;
- Regular communication about the OTR Project to all stakeholders as appropriate; and
- All aspects of the Project through the end of the Completion Phase and the subsequent Post-Implementation Review focusing on learning's from the experience of executing the Project.

1.1.4.2 FortisBC OTR Project Support Team

To ensure FortisBC system and local knowledge and needs are reflected in the work conducted by the EPCM contractor, a FortisBC OTR Project support team provides information, reviews, approval as well as the following tasks:

- Transmission system and operations planning;
- OTR Project communications and First Nations relations;
- Overall OTR Project financial and schedule control;

- Provision of FortisBC standards and review of EPCM engineering deliverables;
- Provide review and concurrence on major EPCM supply and installation contracts prior to tender, award or issuance of change orders;
- Communications systems design and commissioning;
- Protection and Control system final commissioning; and
- Strategic direction on land and regulatory issues.

1.1.4.3 EPCM Project Manager and BC Hydro Project Team

Reporting to the OTR Project Manager the BC Hydro EPCM Project Manager will via BC Hydro resources and sub-consultants provide the following services:

- Preliminary and detailed scoping, engineering and estimating;
- Develop, monitor and sustain a detailed project design, procurement and construction work plan;
- Construction tender packages and contract administration;
- Major equipment and material procurement and contract administration;
- Progress reporting and cost forecasting;
- Property support services for construction access;
- Public communications support service;
- Construction field engineering and support;
- Commissioning Plan development;
- Implement, monitor and ensure all applicable FortisBC Environment, Health and Safety policies and the OTR Project Environmental Management Plan requirements and standards are satisfied; and
- Ensure Quality Assurance standards are followed.

The OTR Project budgets and schedules will be re base-lined when Commission approval is received. The EPCM agreement uses a change control process between the parties to review and manage OTR Project costs, schedule and quality. This process was used by FortisBC and BC Hydro in the design and construction of the Vaseux Lake Terminal station in 2004 to 2005 with success.

It is planned that approximately 95% of the OTR Project supply and installation contracts will be directly publicly tendered or tendered via BC Hydro Stores Procurement. Some monitoring, construction or supply contracts maybe directly negotiated with First Nations where capacity exists or can be reasonably be developed.

Index of Project Engineering

FortisBC

OKANAGAN TRANSMISSION REINFORCEMENT PROJECT (OTR)

Transmission Line Preliminary Design Basis

Prepared for FortisBC by:

BC hydro
Engineering

July 2007

DISCLAIMER

This Report was prepared by BC Hydro Engineering for FortisBC solely for the Okanagan Transmission Reinforcement Project.

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[1] Based on Design Basis Template – Original 4 May 2007

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1. INTRODUCTION

1.1 PROJECT SCOPE

The project scope involves the definition phase for transmission reinforcement upgrades for FortisBC in the south Okanagan. The facility work included in this project involves replacing the existing 28 km long 161 kV transmission line from Vaseux Terminal Station to R.G. Anderson Terminal Station with two new 230 kV transmission lines, and replacing the existing 10 km long 161 kV transmission line from Vaseux Terminal Station to Oliver Terminal Station with a new 230 kV line. In addition, the facility work includes constructing a new Bentley Terminal Station located within 1 km of the Oliver Terminal Station and relocating some of the line terminations from the Oliver Terminal to the new Bentley Terminal. The transmission line from Vaseux Terminal Station to R.G. Anderson Terminal Station may be two single circuits or one double circuit, with wood/steel single circuit H-frame or steel double circuit pole structures, and will re-use some of the existing Right-of-Way. The transmission line from Vaseux Terminal Station to Bentley Terminal Station will be one single circuit, with wood/steel single circuit H-frame or steel single circuit pole structures, and will re-use the existing Right-of-Way. The project includes line terminations at the Vaseux and R.G. Anderson Terminal Stations, and the design and construction of capacitor banks in Kelowna Terminal Stations.

2. ROUTE

2.1 DESCRIPTION

<u>Vaseux Terminal Station (VAS) to R.G.Anderson Terminal Station (RGA)</u>

The proposed Okanagan Transmission Reinforcement (OTR) upgrades between VAS and RGA include two new 230 kV transmission lines, re-using some of the existing right-of-ways (R/W). The proposed transmission line between VAS and RGA will consist of two 230 kV single circuits and 230 kV double circuit AC transmission line construction.

There were three route alternatives considered for the new 230 kV lines:

- Circuit L76 161 kV “Existing Route” – VAS to RGA
- High level “Upland Route” – Shuttleworth Creek to RGA
- Mid level “Midland Route” – Shuttleworth Creek to RGA

Structure type and locations were considered based on objectives that would:

a) minimize disruption to current land use along the ROW;

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

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

d) improve aesthetic appearance of the ROW; and

e) improve line security relative to damage from wildfire.

Four alternatives for VAS to RGA using combinations of the two feasible routes and structure types were considered as follows:

Alternative #1A: Existing Route with primarily DCSP circuit configuration.

Alternative #1B: On existing Route with primarily H-Frame Double circuit steel pole configuration aligned on existing 40m ROW.

Alternative #2A: Upland Route Shuttleworth Creek to RGA with primarily DCSP circuit configuration requiring a new 40 m wide right of way.

Alternative #2B: Upland Route Shuttleworth Creek to RGA with primarily two single circuit steel pole H-frame configurations requiring new 52 m wide right of way.

Alternative #3: Combination of Existing and Upland Route Shuttleworth Creek to RGA with primarily one circuit steel pole H-frame configuration on each route with a new 40 m wide right of way required Upland.

Planning level financial and non-financial assessments identified Alternative #1A as being preferred. However from technical stand point of view, Alternatives #1B and #2B were detailed further by preliminary engineering and estimates. For Alternatives #2A & #3 the engineering and estimates remain at the planning level and would require additional work to refine details and create higher certainty estimates.

1. Existing Route

The existing circuit L76 route between VAS and RGA is 28.0 km in length. The existing R/W is typically 40 m wide, and the existing 161 kV alignment is offset approximately 12 m from the west edge of the R/W. The proposed R/W cross section for DCSP braced post construction would have the new 230 kV alignment centered in the R/W. This route has the lowest elevation, and reaches up to 675 m. The existing route crosses through some developed areas to the east of Skaha Lake. The existing route is lightly treed with significant amounts of rocky terrain. Some minor clearing will be required at the easterly side of the R/W.

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The strategy for locating new structures along the existing route would be to place all structures at approximately the same stationing as existing ones. There may be some opportunity to slightly minimize the total number of structures, but the terrain and local development will dictate the design. Near RGA, at least one structure will be removed. Property owners in the Allendale Road area have requested that investigations be done to assess whether structures could be located closer to property boundaries. Property owners in the Heritage Hills area have requested that investigations be done to assess whether structure L76-94 could be removed entirely.

The route is shown on 76L VAS-RGA Orthophoto Maps, Drawing 76L-T07-D2, Sheets 1 to 15.

2. Upland Route

The upland route from VAS to RGA follows the existing circuit L76 route from VAS to approximately the 8200 m station (measured from VAS), then diverts east through higher elevations until it re-joins the existing route just south of RGA. The upland route is 28.3 km in length. There is no existing R/W between the points where the upland route leaves from and returns to the existing L76 route. This portion of the line would pass through mostly areas of crown land. This route is heavily treed in many areas, and consists of very rocky terrain with quite rapid elevation changes at some locations. The upland route would require clearing of forested areas of land and acquisition of new R/W. The proposed R/W cross section for DCSP braced post construction would have the new 230 kV alignment centered in the R/W. This route has the highest elevation, and reaches up to 1225 m.

The strategy for locating structures along the upland route would be to optimize span lengths and utilize various structure types in order to minimize structure costs, minimize construction costs, and minimize environmental impacts. Rugged terrain will largely dictate the proposed structure locations and types. More dead end structures may be needed because of long spans and challenging terrain.

The route is shown on 76L VAS-RGA Orthophoto Maps, Drawing 76L-T07-D2, Sheets 1 to 5 and 16 to 25.

3. Midland Route

The midland route from VAS to RGA follows the existing circuit L76 route from VAS to approximately the 9600 m station (measured from VAS), then diverts east through moderate elevations and around developed areas until it re-joins the existing route just south of RGA. The midland route is approximately 28 km in length. This route has a moderate elevation, and reaches up to 1025 m. There is no existing R/W between the points where the midland route leaves from and returns to the existing route. The midland route would require some clearing of treed areas of land and acquisition of approximately a 40 m width of new R/W. The terrain is

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extremely rocky and the profile consists of a number of sharp peaks and valleys through the higher elevation mountainous sections of the route.

Upon further investigation of the midland route layout, this alternative is being set-aside due to unfavourable route access, excessive spans and challenging steep terrain.

Vaseux Terminal Station (VAS) to Bentley Terminal Station (BEN)

The proposed Okanagan Transmission Reinforcement (OTR) upgrades between VAS and BEN include one new 230 kV transmission line, re-using the existing right-of-way (R/W). The proposed transmission line between VAS and BEN will consist of one 230 kV single circuit AC transmission line.

The preliminary layout and design is being done assuming a single circuit wood pole (SCWP) or steel pole configuration. The existing route is the only alternative being considered for the new 230 kV line.

1. Existing Route

The existing circuit L40 route between VAS and OLI is approximately 10 km in length. The existing R/W is typically 40 m wide, and the existing 161 kV alignment is offset approximately 12 m from the west edge of the R/W. The proposed R/W cross section for SCWP construction would have the new 230 kV alignment centered in the R/W. Some clearing will be required at the easterly side of the R/W. This maximum elevation on this route is approximately 560 m.

The strategy for locating new structures along the existing route would be to place all structures at approximately the same stationing as existing ones.

The route is shown on 40L VAS-BEN-OLI Orthophoto Maps, Drawing 40L-T07-D3, Sheets 1 to 7.

The route alternatives are also shown on a map contained in Appendix A.

Vaseux Terminal Station (VAS) to Vaseux Tap Point

Two single circuit 230 kV lines were constructed east from VAS to connect 40L and 76L at 161 kV. The length of each of these taps is 1.5 km. The structures are numbered 1-40L thru 7-40L and 1-76L thru 7-76L. Construction consists of single circuit H-frame wood structures and single circuit steel pole structures with braced post insulators supporting “Drake” conductor. Size 9 overhead ground-wire is installed for 3 structures beyond VAS on both circuits. The circuits are adjacent to and overlap the BCTC Circuit 5L98 R/W. The 40L tap will connect to the new 230 kV construction to BEN. The 76L tap will connect to the easterly circuit of the 75L/76L double circuit to RGA. An additional single circuit line for 75L will be constructed to the north of the 76L tap. Structure data and profile information for the existing 76L and 40L Taps is shown on Dwg. 040-45603 (SDS – 40L), 076-45602 (SDS – 76L), 040-45602 (Profile – 40L), 076-

[1] Based on Design Basis Template – Original 4 May 2007

45601 (Profile – 76L) and 040-45601 (Plan and Sections – 40L, 76L and 5L98).

A third single circuit 230 kV line needs to be constructed east from VAS for the 75L circuit. It will exist from the north side of the VAS 230 kV yard, then turn east and parallel the existing 76L tap on the north side to the VAS tap point. In keeping with the existing taps, it will be located a minimum of 15.25 m north of 76L and be constructed in the same configuration and materials as the 76L and 40L taps. The length will be 1.7 km, 0.3 km longer than the existing taps due to the location of the terminal. A decision will need to be made whether to construct the tap with “Drake” or “Bunting” conductor. The spacing of the 40L/76L structures is sufficient for “Drake” but ampacity compatibility may suggest installing “Bunting” conductor.

2.2 LOADING ZONES

The ice and wind loading is the subject of BC Hydro Engineering Memo, 16 July 2007, which can be found in Appendix B. The 230 kV transmission line construction will be designed for a 1 in 100 year return period loading. The ice loading for the project is divided into two zones: elevations less than 1000 m and elevations greater than 1000 m. The wind loading for the project is divided into three zones: low elevation route running North-South, low elevation route running West-East, and high elevation route running North-South. The recommended 1 in 100 year return period loads are as follows:

- 300 Pa wind pressure and 12.5 mm radial ice for locations along existing route (VAS-BEN and VAS-RGA) oriented predominantly in a North-South direction.
- 400 Pa wind pressure and 12.5 mm radial ice for locations along existing route (VAS-BEN and VAS-RGA) oriented predominantly in a West-East direction.
- 400 Pa wind pressure and 12.5 mm radial ice for locations along upland route VAS-RGA.
- 12.5 mm ice (with no wind) for elevations less than 1000 m, and 19 mm ice (with no wind) for elevations greater than 1000m.

The following table outlines the proposed conductor and structure loading:

Condition	Loading (Design)	Remarks
Minimum Ice and Wind on Conductor and Groundwire	12.5 mm radial ice, 0.30 kN/m^2 wind pressure @ -20^{o}C conductor temp.	Equivalent to CSA Medium, glaze ice 9 kN/m^3 density
Maximum Ice and Wind on Conductor and Groundwire	12.5 mm radial ice, 0.40 kN/m^2 wind pressure @ -20^{o}C conductor temp.	Equivalent to CSA Heavy, glaze ice 9 kN/m^3 density

[1] Based on Design Basis Template – Original 4 May 2007

Condition	Loading (Design)	Remarks
Maximum Wind on Conductor and Groundwire	0.57 kN/m² wind @ -20°C conductor temperature	Maximum wind, bare conductor
Maximum Ice on Conductor and Groundwire (for elevations < 1000 m)	12.5 mm radial ice @ -20°C conductor temperature	Maximum ice (no wind) for elevations < 1000 m
Maximum Ice on Conductor and Groundwire (for elevations > 1000 m)	19 mm radial ice @ -20°C conductor temperature	Maximum ice (no wind) for elevations > 1000 m
Wind on Structure	1.5 x maximum wind or 0.90 kN/m²	
Ice on insulator assemblies	Bare mass x 1.5	
Ice/snow on structure	No allowance	

2.3 RIGHT- OF-WAY CROSS SECTION

The preliminary right-of-way cross sections are based on the estimate 90th percentile span length for each alternative, e.g. 10 percent of the spans will require additional right-of-way or widenings of the width shown on the cross-sections. The extra width of right-of-way is needed to capture the increased swing of the conductor, plus applicable CSA horizontal clearance requirements.

For 230 kV double circuit steel pole structures, with Bunting conductor, the CSA minimum requirements for centreline-to-R/W edge distance is 19.5 m, for spans along the upland route (taking into account the 90th percentile span length).

For 230 kV single circuit wood/steel pole H-frame configuration structures, the CSA minimum requirements for centreline-to-R/W edge distance is 18.0 m for spans along the upland route (taking into account the 90th percentile span length).

To minimize impacts on environment and land, it is proposed to utilize double circuit steel pole structures with stacked phase configuration wherever possible. The assessment of the proposed transmission line alignments will be provided by the Environmental, Geotechnical and Properties reviews.

Preliminary right-of-way cross section details for existing and proposed lines are shown in drawings 75L-T07-B1 to -B8 located in Appendix C. Also included are Vaseux Tap Plan and Sections shown on drawing 040-45601.

Additional right-of-way or guy easements will be required for any design employing guyed medium angle suspension or guyed dead-end structures. A preliminary list of potential guy easements required along the existing right-of-way is shown in the table below:

[1] Based on Design Basis Template – Original 4 May 2007

Existing Structure No.	Station (m)	Line Angle (deg.)	Structure Type	Comment
L76-38	2737	-7.7	d2_55bp.ld10	Guy ground contact 6.0m outside R/W edge.
L76-40	3449	-27.2	d2_55bp.ld10	Guy ground contact 0.6m outside R/W edge.
L76-57	8322	4.4	d2_55bp.ld10	Guy ground contact 1.7m outside R/W edge.
L76-83	15149	-12.5	d2_55bp.ld10	Guy ground contact 2.2m from R/W edge.
L76-104	20615	-11.0	d2_55bp.ld10	Guy ground contact 1.2m from R/W edge.
L76-108	21704	-7.2	d2_55bp.ld10	Guy ground contact 4.2m outside R/W. Guy easement on wrong side of R/W.
L76-110	22328	-9.8	d2_55bp.ld10	Guy ground contact 4.0m outside R/W. Guy easement on wrong side of R/W.
L76-114	23282	-13.7	d2_55bp.ld10	Guy ground contact 0.2m from R/W edge.

2.4 TERRAIN HAZARDS AND LINE SECURITY

Areas of possible terrain hazards will be identified in the Preliminary Geotechnical Report, located in Appendix D.

A review of the location of the major usable access roads and tracks to and along the route options being considered will be identified in the Access Overview Report, located in Appendix E.

2.5 INDIVIDUAL STRUCTURE REQUIREMENTS

<u>Specific Locations:</u>

For the existing route option, the strategy is to locate new structures at the same stationing as the existing L76 line 161 kV structures.

<u>No Structure Zones: Property Owners</u>

By spotting new structures at the same stationing as the existing L40/L76 line 161 kV structures, property owners that currently have a structure in their vicinity will receive a new structure as well.

Areas that have been specifically requested for structure relocations, by property owners, are as follows:

- L76 structure 94 site was requested to be removed, if possible.
- L76 structure 69 site was requested to be moved toward the property line, if possible.

<u>No Structure Zones: Environmental Issues</u>

The exclusion zone for structures or anchors will extend a minimum of 30 m back from Riparian Zones of the following Creek Crossings:

<u>VASxRGA</u>

[1] Based on Design Basis Template – Original 4 May 2007

Vaseux Creek
Irrigation Creek
Shuttleworth Creek
McLean Creek
Harkin Creek (existing route)
Thomas Creek (upland route)
Derenzy Creek (upland route)
Matheson Creek
Gillies Creek
Ellis Creek

VASxBEN
Vaseux Creek
Atizlack Creek
Wolfcub Creek

More specific constraints for structure locations near Riparian Zones will be determined on a site specific basis during detailed design.

2.6 CROSSING LIST AND SPECIAL REQUIREMENTS

Roads and Highways:

T/L Location or Other Reference	Station on Existing Route	Feature	Impact/ Likely Mitigation/ Comments
L76 Str. 47	5.2 km	McIntyre Creek FSR	Forest Service Road
L76 Str. 64	10.7 km	Weyerhaeuser Road	Local Road
L76 Str. 69	11.8 km	Allendale Road	Local Road
L76 Str. 71	12.1 km	McLean Creek Road	Local Road
L76 Str. 79	14.6 km	McLean Creek Road	Local Road
L76 Str. 92	17.2 km	Matheson Road	Local Road
L76 Str. 96	18.1 to 18.3 km	(New Construction)	Local Road
L76 Str. 97	18.7 km	Sunnybrook Drive	Residential Road
L76 Str. 122	25.6 km	Crow Place	Residential Road
L76 Str. 132	27.9 km	Carmi Avenue	Local Road

Dedicated Crown Deletions:

To be determined.

Pipeline Rights-of Way (P=Pipeline(s), R=Road, PL=Powerline):

A Terasen Gas, Southern Crossing gas pipeline R/W is spanned between existing Str. L76-118 and L76-120, as shown on Orthophoto Sheet 14.

Railways:

N/A

[1] Based on Design Basis Template – Original 4 May 2007

Airways and Airports:

N/A

NWPA:

To be determined.

Communication Facilities:

FortisBC and Shaw Communications have a facility sharing agreement for an existing fibre-optic communications cable under-strung on 76L from RGA to the Okanagan Falls area.

3. SURVEY

Input data for PLS-CADD modelling is based on a digital terrain model created using photogrammetric methods and aerial photos obtained by the BC Hydro Survey and Photogrammetry Department. The photography is dated September 2005 for the existing R/W and the north and south ends of the upland alternative route, and July 2006 for the centre section of the upland alternative route.

The coordinates were based on a NAD83 reference datum. The coordinate system for the project is UTM, Zone 11N.

4. CONDUCTOR, GROUNDWIRE & COMMUNICATION FIBRE

4.1 CONDUCTOR

The proposed 230 kV overhead conductors type for single circuit flat construction is 402.8 mm^2 26/7 “Drake” (795.0 kcmil) per phase.

The proposed 230 kV overhead conductor type for double circuit stacked configuration is 604.3 mm^2 45/7 “Bunting” (1192.7 kcmil) per phase.

4.1.1 Limiting Conditions

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 in accordance with BC Hydro’s

[1] Based on Design Basis Template – Original 4 May 2007

Transmission Technical Standards, Procedures and Guidelines, Manual 41E, Section 4, dated October 1988, and are as follows:

10% WDT (final & initial): -15°C
Mean annual temperature: 7.5 °C
Extreme cold (uplift) -30 °C

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (°C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.5	0.400	-20	Final	50	CSA Heavy
2	0	0	-15	Initial	26	10% Winter Design Temp. (WDI)
3	0	0	7.5	Final	19	Mean Annual
4	0	0	-15	Final	23	10% Winter Design Temp. (WDF)
5A	0	0	125	Final		Vert. Clearance (Drake) Max. Conductor Sag
5B	0	0	93	Final		Vert. Clearance (Bunting) Max. Conductor Sag
6	0	0.20	40	Final		Vert./Hor. Clearance – Swing, sidehills
7	0	0	40	Final		Horizontal Clearance – R/W edge dist., circuit-to-circuit separation
8	0	0	15	Final		Phase Spacing
9	12.5	0.20	-20	Final		Insulator Swing #1 – (0.9 m)
10	12.5	0.300	-20	Final		Insulator Swing #3 – CSA Medium
11	0	0	-30	Initial		Extreme Cold Temperature
12	0	0.574	-20	Final		Maximum Wind Bare Conductor
13	12.5	0	-20	Final		Unequal Ice

4.1.2 Mechanical Properties

The mechanical properties of “Drake” conductor are as follows:

Code Name:	“Drake”
Description:	26/7 ACSR (795.0 kcmil)
Aluminum Area:	402.8 mm^2
Area – Total:	468.4 mm^2
Stranding:	26 x 4.44 mm; 7 x 3.45 mm
Complete Diameter:	28.13 mm
Rated Tensile Strength:	139000 N
Modulus of elasticity ($N/mm^2 \times 10^3$):	74.46 (EFIN) 55.16 (EIL)

[1] Based on Design Basis Template – Original 4 May 2007

	46.88 (EIU)
Linear expansion coefficient (/^{o}C x 10^{-6}):	18.90 (AFIN)
	17.64 (AIL)
	17.19 (AIU)
Bare Mass:	1.623 kg/m

Loaded masses:

Loaded Masses				
Radial Ice* (mm)	Wind (kN/m2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.5	0.400	30.21	21.25	36.93
0	0.574	15.92	16.15	22.68
12.5	0.300	30.21	15.94	34.16
12.5	0.200	30.21	10.63	32.02
0	0.200	15.92	5.63	16.89
12.5	0	30.21	0.00	30.21
0	0	15.92	0.00	15.92

* - Density of 912.7 kg/m^3

The mechanical properties of “Bunting” conductor are as follows:

Code Name:	“Bunting”
Description:	45/7 ACSR (1192.7 kcmil)
Aluminum Area:	604.3 mm^2
Area – Total:	646.0 mm^2
Stranding:	45 x 4.135 mm; 7 x 2.756 mm
Complete Diameter:	33.08 mm
Rated Tensile Strength:	147459 N
Modulus of elasticity (N/mm^2 x 10^3):	65.50 (EFIN)
	53.09 (EIL)
	37.92 (EIU)
Linear expansion coefficient (/^{o}C x 10^{-6}):	20.88 (AFIN)
	20.34 (AIL)
	20.34 (AIU)
Bare Mass:	1.995 kg/m

Loaded masses:

Loaded Masses				
Radial Ice* (mm)	Wind (kN/m2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.5	0.400	35.60	23.23	42.51
0	0.574	19.57	18.99	27.27
12.5	0.300	35.60	17.42	39.63
12.5	0.200	35.60	11.62	37.45
0	0.200	19.57	6.62	20.66

[1] Based on Design Basis Template – Original 4 May 2007

Loaded Masses				
Radial Ice* (mm)	Wind (kN/m2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.5	0	35.60	0.00	35.60
0	0	19.57	0.00	19.57

* - Density of 912.7 kg/m^3

The BC Hydro standard PLS-CADD conductor files will be used for this project.

4.1.3 Electrical Capacity

Normal load of 745 amps for summer, or 1178 amps for winter
(Drake = 75 degree C)
(Bunting = 64 degree C summer; Bunting = 43 degree C winter).

Peak load of 904 amps for summer, or 1270 amps for winter
(Drake = 90 degree C)
(Bunting = 73 degree C summer; Bunting = 51 degree C winter).

Emergency load of 1175 amps for summer, or 1448 amps for winter
(Drake = 125 degree C)
(Bunting = 93 degree C summer; Bunting = 70 degree C winter).

Standard Conditions

Emissivity:	50%
Absorption:	50%
Wind:	2.194 km/h (2 ft/s) @ 90^o to line
Cloud/ Pollution:	2.0 factor (summer) or 4.0 factor (winter)
Elevation:	762 m (2500 ft)
Location:	49^{o}N, 118^{o}W
Summer ambient:	40^{o}C July 18:00 hrs
Winter Ambient:	0^{o}C December 18:00hrs

4.2 GROUNDWIRE

The proposed overhead groundwire is a size 9 7W Grade 1300 (3/8 GS-180).

At this time overhead groundwire for the terminations at Vaseux Terminal Station (VAS), R.G. Anderson Terminal Station (RGA) and Bentley Terminal Station (BEN) will be according to BC Hydro standards which require the groundwire to extend for a minimum of 3 structures out from the station terminal structure or 500 m, whichever provides the greatest length.

[1] Based on Design Basis Template – Original 4 May 2007

To aid in the determination of whether it is practical and effective to install continuous overhead shield wire, ground resistivity measurements should be taken at representative locations along the 230 kV corridor. The measurements will 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.

4.2.1 Limiting Conditions

The following conditions are for steel, galvanized groundwire:

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^oC)	Condition	Limiting Tension (%RTS)	Remarks
1	12.5	0.400	-20	Final	35	CSA Heavy
2	0	0.57	-20	Final	35	Maximum Wind Bare Conductor
3	0	0	-15	Initial	34	10% Winter Design Temp. (WDI)
4	0	0	7.5	Final	28	Mean Annual
5	0	0	-15	Final		10% Winter Design Temp. (WDF)
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.5	0.200	-20	Final		Insulator Swing #1 – (0.9 m)
8	12.5	0.300	-20	Final		Insulator Swing #3 – CSA Medium
9	12.5	0	-20	Final		Unequal Ice
10	0	0	40	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.

4.2.2 Mechanical Properties

Groundwire Data and Characteristics

[1] Based on Design Basis Template – Original 4 May 2007

Steel area:	51.10 mm^2
Stranding:	7 x 3.05 mm
Outside Diameter:	9.144 mm
Rated Tensile Strength:	60051 N
Modulus of elasticity ($N/mm^2 \times 10^3$):	189.16 (EFIN)
	186.16 (EIL)
	177.880 (EIU)
Linear expansion coefficient ($/^oC \times 10^{-6}$):	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)
12.5	0.400	11.55	13.66	17.89
0	0.574	3.94	5.25	6.56
12.5	0.300	11.55	10.24	15.44
12.5	0.200	11.55	6.83	13.42
0	0.200	3.94	1.83	4.35
12.5	0	11.55	0.00	11.55

* - Density of 912.7 kg/m^3

4.3 COMMUNICATION FIBRE

Details for an existing communication optical fibre to be strung as underbuild have not been confirmed at this time. Estimate allowances for the fibre to be transferred from the existing 40L/76L circuits to the new construction based on the use of the existing right of ways and structure locations hence spans being of similar length. If an alternate route is selected additional design and estimating will be required for new fibre. The facility sharing agreement between FortisBC and Shaw Communications contemplates some cost sharing for upgrades.

4.3.1 Limiting Conditions

The following conditions are for ALCOA AC0729C811CJ8 ADSS fibre:

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m^2)	Temp. (^oC)	Condition	Limiting Tension (%RTS)	Remarks

[1] Based on Design Basis Template – Original 4 May 2007

Loading Condition						
Load Case	Radial Ice (mm)	Wind (kN/m²)	Temp. (°C)	Condition	Limiting Tension (%RTS)	Remarks
1	12.5	0.400	-20	Final	31	Max. Design Loading
2	0	0.57	-20	Final	31	Maximum Wind Bare Conductor
3	0	0	-15	Initial		10% Winter Design Temp. (WDI)
4	0	0	7.5	Final	10	Mean Annual
5	0	0	-15	Final		10% Winter Design Temp. (WDF)
6	0	0	-30	Initial	35	Extreme Cold Temperature
7	12.5	0.200	-20	Final		Insulator Swing
8	12.5	0.300	-20	Final		Insulator Swing
9		0.200	-20	Final		Swing, sidehill clearance
11	12.5	0	-20	Final		Clearance to ground - Winter
12	0	0	40	Final		Max. Fibre Sag - Summer

Under the above conditions, the ADSS fibre shall not sag less than the conductor above it.

Under condition 11, the clearance between the ADSS and the ground shall not be less than pedestrian clearance per CAN/CSA 22.3 No.1-06.

4.3.2 Mechanical Properties

Communication Fibre Data and Characteristics

Name:	ALCOA AC0729C811CJ8
Outside Diameter:	21.4 mm
Stranding:	72 fibre
Rated Tensile Strength:	121,701 N
Modulus of elasticity (N/mm^2 /100°C):	20.7116 (EFIN)
Linear expansion coefficient (/100°C):	$6.19x10^{-5}$ (AFIN)
Bare Mass:	0.403 kg/m

Loaded masses:

Loaded Masses				
Radial Ice* (mm)	Wind (kN/m2)	Vertical Component (N/m)	Horizontal Component (N/m)	Resultant (N/m)
12.5	0.400	15.87	18.56	24.42
0	0.574	3.95	12.28	12.90
12.5	0	15.87	0.00	15.87
0	0	3.95	0.00	3.95

[1] Based on Design Basis Template – Original 4 May 2007

* - Density of 912.7 kg/m^3

5. STRUCTURES

5.1 STRUCTURES USED

Various structure geometries are available for 230 kV line designs. Their use is dictated by their availability and depends on the technical, environmental, property and stakeholder consultation constraints associated with the proposed route. 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.

The types of structures that are being utilized in the preliminary design are listed below.

5.1.1 H-Frame Single Circuit Wood/Steel Pole, 1 x 3 Arrangement

This mode of support comprises flat configuration 3-phase structures supported on two wood/steel 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.

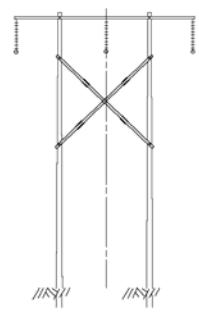
The span length or distance between structures approximately 225 m.

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 full length treated with chromium copper arsenic preservative (CCA). Wood timbers are pressure treated with CCA preservative. The poles are normally direct buried. Design of H-frame structures with

[1] Based on Design Basis Template – Original 4 May 2007

steel poles would be interchangeable. Steel poles are a viable alternative when in areas of concern for wild fire resistance.

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

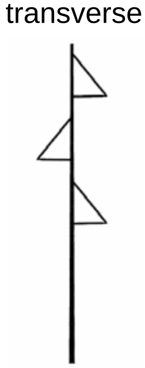


Standard right-of-way cross sections call for the edge of right-of-way to be off-set 15 m from the centre of the structure (centre phase) and in the case of two or more circuits, each circuit is separated by 21 m measured from the centre of the structure (centre phase). Two circuits will require a minimum right-of-way width totalling 51 m. These dimensions are valid for spans up to 300 m 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.

5.1.2 Braced Post Single Circuit "Narrow" Wood or Steel Pole

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 with respect to transverse wind loads and because of the attempt 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 size. Angle and dead-end poles can be un-guyed 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

[1] Based on Design Basis Template – Original 4 May 2007

measured from the centre of the structure. Two circuits will require a right-of-way width totalling 41 m.

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 larger conductor may be reduced to less than 200 m.

Poles over 100 ft for these structures have generally been supplied in galvanized steel. The advantage of the steel poles is they can be sectionalized for transportation and erected in sections by stacking the pole section one on top of each other.

5.1.3 Braced Post Single Circuit "Delta" Steel Pole

This delta configuration of conductor attachment points on braced post and vertical post insulators was developed as an alternative structure configuration for the existing route in the area of Heritage Hills. It utilizes braced post insulators for lower right and left side phases and 3.5" diameter core vertical post insulator for the centre phase.

Span lengths are generally shorter than possible with the flat two pole H-frame type because the structure is weaker with respect to transverse wind loads, and because the intent is to minimize pole heights with this configuration.

5.1.4 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

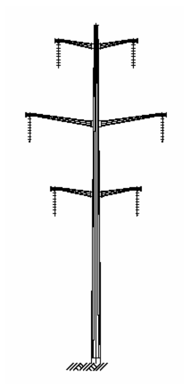
[1] Based on Design Basis Template – Original 4 May 2007

angle and dead-end structures can be set within a 0.9 m diameter direct buried galvanized steel culvert that improves stability.

This compact nature of this structure produces the least field affects and the least area impacts of all the types compared. The compact arrangement of he conductors requires the use of a larger diameter conductor, e.g. Bunting ACSR to meet RI requirements.

5.1.5 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.



Each level of crossarms is vertically separated by approximately 6.0 m. The upper and lower crossarms extend about 3.3 m out from the centre of the structure. The middle phase attachment is offset by 1.5 m to increase clearance between phases and minimize clashing. 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 in 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.

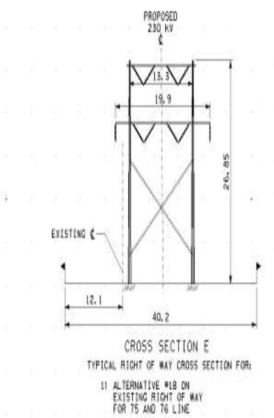
Foundations for this family of steel poles are large.

The attachment height of the lowest conductors on these types of structures will average 29 m which results in an overall structure height of 40 m. By reducing span length to reduce overall height will

[1] Based on Design Basis Template – Original 4 May 2007

in many cases double the number of structures significantly increasing the cost per km.

5.1.6 H-Frame Double Circuit Steel Pole, 'Delta' Arrangement



This configuration supports two circuits on H-frame steel pole. On suspension structures the conductor is attached to cross-arms with I-type and V-string suspension insulator strings approximately 2 m in length.

Each level of cross-arm is vertically separated by approximately 7.5 m. The lower cross-arm extends about 3.3 m out from the centre of both the pole structures. The middle phase attachment is offset by 1.5 m with respect top phase to increase clearance between phases and minimize clashing.

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The poles are normally direct buried. Design of H-frame structures with steel poles would be interchangeable. Steel poles are a viable alternative when in areas of concern for wild fire resistance.

The attachment height of the lowest conductors on these types of structures will average 19 m which results in an overall structure height of 27 m.

5.2 PLS-CADD STRUCTURE CODING

The proposed 230 kV structures can be categorized in the following structure series:

Tangent Structures

Also referred as small angle structures, tangent structures are only used in tangent applications where the line angle is at most 3 degrees. Tangent structures are usually designed to resist loads in their transverse axis with little strength in their longitudinal axis. This results in the lightest structure in the series and typically accounts for 70% of all line structures.

Long Span / Light Angle Structures

This structure series accounts for structures used in tangent applications where longitudinal strength is required, typically in long spans or in icing areas where unbalanced icing (i.e. unequal ice) exist between adjacent spans. The structure series is also used in locations where the line angle is up to 8-10 degrees. More long span structures would be present in the upland route layout due to the challenging terrain.

Medium Angle Structures

[1] Based on Design Basis Template – Original 4 May 2007

Medium angle structures are used where the line angle is at most 25-30 degrees, resulting in additional transverse load carrying capacity than light angle structures.

Strain Structures

Strain structures are light dead-end structures designed to withstand the load resulting from iced conductors on one side of the structure and bare conductors on the other. This unbalanced ice loading combined with a maximum line angle of 45 degrees results in a lighter structure than the dead-end towers. For stringing operations, the strain structures must be temporarily guyed if conductors are to be installed on only one side.

Dead-end Structures

Dead-end structures, or full dead-end structures, are structures capable of resisting ultimate ice on one side of the structure with no conductor attached to the other side. The structures can be used for line angles varying between 0 and 90 degrees. Dead-end structures are the heaviest structures used in a transmission line.

In addition to the different types, towers are also designated by their subtype. The standard BC Hydro structure type codes are given below:

Subtypes	Description
A	Tangent or small angle suspension structure (up to 3 degrees)
B	Tangent or small angle suspension structures (used when slight modifications are made to A structure loadings)
C	Light Angle and / or Long Span tangent suspension structures (up to 10 degrees)
D	Medium Angle Suspension Structures (up to 30 degrees)
G	Reserved for designating ground wire structures (e.g. AG)
H	Strain tower (up to 45 degrees)
J	Medium angle dead-end structure (0 to 45 degrees)
K	Heavy angle dead-end structure (45 to 90 degrees). Larger phase spacing than type J. Can also be used as long span crossing towers in tangent situations.
S or 2	Reserved for designating towers with snow legs, (e.g. SA; i.e. A tower with Snow legs)
T	Transposition tower
X	Special designs such as crossing structures

In general, structures models are named to indicate subtype and configuration, optional guying, pole class and structure height. The three character filename extension represents the pole length in feet.

For example, the filename **2a2d.hd10.090** represents:

- A double circuit tangent (2a) to medium angle (2d) configuration,
- A heavy duty (hd10) class steel pole,
- A 90 ft pole (090).

[1] Based on Design Basis Template – Original 4 May 2007

Structures shall be permanently numbered in the form of sequential structure numbering, commencing at Vaseux Terminal Station (VAS) and continuing through to R.G. Anderson Terminal Station (RGA) to the North, and continuing through to Bentley Terminal Station (BEN) to the South.

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 RGA from VAS.

back: refers to location back of a structure centre or point on centre-line when viewed from the source, e.g. VAS to RGA.

5.3 WOOD STRUCTURES

Structure Types

The 230 kV transmission structures used are designated by a sequence of numbers and letters corresponding to the structure configuration, subtype, pole class and height, as shown in the table below. Sample drawings of wood pole structures types are provided in Appendix F.

Type	Reference Dwg.	Description	Approx. Line Angle Range (°)	PLS-CADD Code
A	40L-T08-D34	Light angle suspension H-frame with steel crossarms, optional guying	0-5	A_1.055 to A_1.095
D	40L-T08-D35	Medium angle suspension 3-pole guyed structure	5-30	D_1.055 to D_1.095
J	40L-T08-D32	Light angle dead end 3-pole guyed structure	0-20	J10_H2.055 to J10_H2.095
J	40L-T08-D33	Medium to heavy angle dead end 3-pole guyed structure	20-60	J60_H2.055 to J60_H2.095

Design Parameters

Presently, the preliminary layout for Transmission Alternatives with single circuit H-frame structures is based on PLS-CADD W-Frame structure models. It is intended that the final layout be based on PLS-CADD PLS-Pole models.

[1] Based on Design Basis Template – Original 4 May 2007

The following represents the load factors and design stresses for PLS-Pole models.

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 and DG)
	1.5	dead-end structures (Types J, JG, 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 will be 1.5 x 0.385 kN/m^2 = 0.57 kN/m^2 (referencing Design Criteria provided in Section 8).
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 above grade based on unfactored loads.

Pole Dimension and Class

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

[1] Based on Design Basis Template – Original 4 May 2007

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)
WRC-H2-50	4242500	WRC	H2	15.24	78.7	144.8	2.1
WRC-1-50	4242501	WRC	1	15.24	68.6	128.3	2.1
WRC-2-50	4242502	WRC	2	15.24	63.5	120.7	2.1
WRC-H2-55	4242550	WRC	H2	16.76	78.7	149.9	2.3
WRC-1-55	4242551	WRC	1	16.76	68.6	133.4	2.3
WRC-2-55	4242552	WRC	2	16.76	63.5	124.5	2.3
WRC-H2-60	4242600	WRC	H2	18.29	78.7	154.9	2.4
WRC-1-60	4242601	WRC	1	18.29	68.6	138.4	2.4
WRC-2-60	4242602	WRC	2	18.29	63.5	129.5	2.4
WRC-H2-65	4242650	WRC	H2	19.81	78.7	160.0	2.6
WRC-1-65	4242651	WRC	1	19.81	68.6	142.2	2.6
WRC-2-65	4242652	WRC	2	19.81	63.5	133.4	2.6
WRC-H2-70	4242700	WRC	H2	21.34	78.7	165.1	2.7
WRC-1-70	4242701	WRC	1	21.34	68.6	147.3	2.7
WRC-H2-75	4242750	WRC	H2	22.86	78.7	170.2	2.9
WRC-1-75	4242751	WRC	1	22.86	68.6	151.1	2.9
WRC-2-75	4242752	WRC	2	22.86	63.5	141.0	2.9
WRC-H2-80	4242800	WRC	H2	24.38	78.7	174.0	3.1
WRC-1-80	4242801	WRC	1	24.38	68.6	154.9	3.1
WRC-2-80	4242802	WRC	2	24.38	63.5	144.8	3.1
WRC-H2-85	4242850	WRC	H2	25.91	78.7	177.8	3.2
WRC-1-85	4242851	WRC	1	25.91	68.6	158.8	3.2
WRC-2-85	4242852	WRC	2	25.91	63.5	148.6	3.2
WRC-H2-90	4242900	WRC	H2	27.43	78.7	182.9	3.4
WRC-1-90	4242901	WRC	1	27.43	68.6	162.6	3.4
WRC-2-90	4242902	WRC	2	27.43	63.5	152.4	3.4
WRC-H2-95	4242950	WRC	H2	28.96	78.7	185.4	3.4
WRC-1-95	4242951	WRC	1	28.96	68.6	165.1	3.4
WRC-2-95	4242952	WRC	2	28.96	63.5	154.9	3.4

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.

Design stresses

a) Poles

[1] Based on Design Basis Template – Original 4 May 2007

All poles shall be Western Red Cedar (WRC) full length treated and butt gained, 12' from the butt.

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) Crossarms and Timbers

Steel crossarms shall be used on Type A 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:

$F_b = 0.75\ F_y$ where F_b = allowable bending stress, and
F_y = steel yield stress.

It follows that for HT steel (F_y = 350 Mpa) and A36 steel (F_y = 252 Mpa), the allowable bending stress values are:

HT Steel: F_b = 262 MPa

A36 Steel: F_b = 189 MPa

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:

[1] Based on Design Basis Template – Original 4 May 2007

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 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

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.

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.

Guy Properties

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 1300 (1/2" Grade 180) to
	Size 16 Grade 1500 (5/8" Grade 220)

b) 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

[1] Based on Design Basis Template – Original 4 May 2007

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 & 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

c) Guy Loads (GL)

The maximum allowable guy load, is determined as follows:

GL_{max} = 0.85 RBL where GL_{max} = maximum allowable guy load, and
RBL = rated breaking load (minimum breaking load specified in CSA CAN3-G12-92).

The guy load determined by PLS-CADD analysis must be less than GL_{max}. For design values see the table below.

	Metric	Imperial
Strand Size	12 mm	1/2 in
Grade	1300	180
Minimum Breaking Load	120 kN	25,500 lb
Area, A	97.0 mm^2	0.150 in^2
Modulus, E	189,606 N/mm^2	27,500,000 psi
EA	18,300 kN	4,114,000 lb

	Metric	Imperial
Strand Size	16 mm	5/8 in
Stranding	19 strand	19 strand
Grade	1500	220
Minimum Breaking Load	205 kN	46,100 lb
Area, A	151.6 mm^2	0.235 in^2
Modulus, E	189,606 N/mm^2	27,500,000 psi
EA	28,750 kN	6,462,500 lb

d) 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.

[1] Based on Design Basis Template – Original 4 May 2007

5.4 STEEL STRUCTURES

Structure Types

The 230 kV transmission structures used are designated by a sequence of numbers and letters corresponding to the structure configuration, subtype, pole class and height, as shown in the table below. Sample drawings of structures types are provided in Appendix F.

Type	Reference Dwg.	Description	Approx. Line Angle Range (°)	PLS-CADD Code
A	75L-T08-B26	Double circuit steel pole suspension tangent structure, braced post insulators, optional guys, 5.5 m phase spacing	0-4	a2_55bp.ld10-090 to a2_55bp.hd10-120
D	75L-T08-B28	Double circuit steel 2-pole medium angle guyed suspension structure, braced post or suspension insulators, 5.5 m phase spacing, poles off-set 3.0 m from C/L	4-30	d2_55bp.ld10-090 to d2_55bp.ld10-120
D	75L-T08-B27	Double circuit steel pole suspension long span/light angle structure, steel davit arms, suspension insulators, no guys, 6.1 m phase spacing	0-8	2a2d.hd10-090 to 2a2d.hd10-180
J	75L-T08-B31	Double circuit guyed two steel pole medium angle dead end structure, post insulators, 5.5 m phase spacing, poles off-set 4.0 m from C/L	30-60	j2_55bp.ld10-090 to j2_55bp.ld10-120
J	75L-T08-B32	Double circuit two steel pole medium angle dead end structure, self-supporting, post insulators, 5.5 m phase spacing, poles off-set 4.0 m from C/L	30-60	j2_55ss.hd10-090 to j2_55ss.hd10-120
K	75L-T08-B33	Double circuit guyed two steel pole heavy angle dead end structure, post insulators, 5.5 m phase spacing, poles off-set 4.0 m from C/L	60-90	k2_55bp.ld10-090 to k2_55bp.ld10-120

Design Parameters

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) 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

[1] Based on Design Basis Template – Original 4 May 2007

Live loads	1.20	tangent structures (Types A2, A2G, A2GT)
	1.30	angle structures (Types D2 and D2G)
	1.50	dead-end structures (Types J2, J2G, K2, K2G & 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 8 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/m^2 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/m^2 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 above grade based on unfactored loads.

Pole Dimension and Class

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. Light Duty (LD) series based on a 3/16” wall thickness; Medium Duty (MD) series based on a 5/16” wall thickness; Heavy Duty (HD) series 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.

[1] Based on Design Basis Template – Original 4 May 2007

Steel Pole Property Label	Length (m)	Default Embedded Length (m)	Base Plate (mm)	Shape	Tip Diameter (mm)	Base Diameter (mm)
Poles Set on Embedded 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
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

Design stresses

a) Poles

Design stresses for steel poles used in PLS-CADD shall be as follows:

Type: Steel Pole	Default Values	
Yield Stress	448 MPa	65,000 psi
Modulus E	200,000 MPa	29,000,000 psi

b) Crossarms

Design stresses for tubular davit arms used in PLS-CADD are as follows:

Type: Steel Pole	Default Values

[1] Based on Design Basis Template – Original 4 May 2007

Yield Stress	345 MPa	50,000 psi
Modulus E	200,000 MPa	29,000,000 psi

The successful steel pole designer/supplier will determine the yield stress of the steel used for the poles and davit arms.

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.

Guy Properties

a) Guy Size

Standard and optional guys for different structure types shall be as follows and as specified on the appropriate structure erection drawing:

Type A2 and A2G steel pole structures: Size 12

Type A2A steel pole structure: Size 12

Type D2 and D2G steel pole structures(1): Size 12 or 16

Type J2 and J2G steel pole structures(2)(3): Size 12, 16 or 25

Type K2 and K2G steel pole structures(2)(3): Size 12, 16 or 25

Notes:

1. Size 12 for steel pole H-frame (wood pole equivalent) structures, Size 12 for tie guys between poles of double circuit structures and Size 12 or 16 for side guys of double circuit steel pole structures depending on site specific load.

2. Size 16 for conductor support on steel pole H-frame (wood pole equivalent) structures and Size 25 for double circuit steel pole dead-end structures.

3. Size 12 for groundwire support on steel pole H-frame (wood pole equivalent) structures and Size 16 for groundwire support on double circuit steel pole dead-end structures.

[1] Based on Design Basis Template – Original 4 May 2007

b) 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 & Light angle structures	30^o minimum, 45^o maximum
Medium angle structures	30^o minimum, 45^o maximum
Dead-end structures	30^o minimum to 45^o maximum longitudinal guys; 30^o side guys

Guyed double circuit two-pole dead-ends shall have a guy angle of 30^o. It will be necessary to increase the height of the outer pole to ensure adequate clearance is provided under the outer pole conductors by the inner pole guys.

c) Guy Loads (GL)

The maximum allowable guy load, is determined as follows:

GL_{max} = 0.85 RBL where GL_{max} = maximum allowable guy load, and RBL = rated breaking load (minimum breaking load specified in CSA CAN3-G12-92).

The guy load determined by PLS-CADD analysis must be less than GL_{max}. For design values see the table below.

	Metric	Imperial
Strand Size	12 mm	½ in
Grade	1300	180
Minimum Breaking Load	120 kN	25,500 lb
Area, A	97.0 mm^2	0.150 in^2
Modulus, E	189,606 N/mm^2	27,500,000 psi
EA	18,300 kN	4,114,000 lb

	Metric	Imperial
Strand Size	16 mm	5/8 in
Stranding	19 strand	19 strand
Grade	1500	220
Minimum Breaking Load	205 kN	46,100 lb
Area, A	151.6 mm^2	0.235 in^2
Modulus, E	189,606 N/mm^2	27,500,000 psi
EA	28,750 kN	6,462,500 lb

[1] Based on Design Basis Template – Original 4 May 2007

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.

5.5 INSULATOR PROPERTIES

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.

Insulation

Insulators and insulation for the project, based on a minimum equivalent of 12 suspension insulator units, are outlined in the sections that follow. For double circuit structure configurations, differential insulation shall be provided such that one circuit has an equivalent of 12 suspension insulator units and the other circuit has an equivalent of 15 suspension insulator units.

The insulators listed below are sample types only and may be adjusted for detailed design and construction. The conductor hardware listed below are sample types only and will be adjusted for "Drake" and "Bunting" conductor, and as needed to suit detailed design and construction requirements.

Sample drawings of insulators can be found in Appendix G.

a) Composite Types

Suspension type

Application: 230 kV suspension strings & jumper suspension strings

Mfg.Cat. No.: NGK 251-SS580-YE-08, c/w corona ring

Creepage distance: 4974 mm
Colour: Light grey
Type: 111 kN
Length: 2061 mm
Mass: 8.6 kg

Mfg.Cat. No.: NGK 251-SS700-YE-08, c/w corona ring

Creepage distance: 6003 mm

[1] Based on Design Basis Template – Original 4 May 2007

Colour:	Light grey
Type:	111 kN
Length:	2421 mm
Mass:	9.6 kg

Dead-end type

Application:	230 kV dead-ends Drake / Bunting conductor
Ball & Socket:	Type K
Colour:	Light grey
M & E Rating:	160 kN
Length:	2505 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-SN491-1S*1 / NGK L2-SN591-1S*1 (Polymer line post, tongue end)

Colour:	Light grey
Length:	2156 mm / 2531 mm (horizontal)
Mass:	28 kg / 32.1 kg

Mfg.Cat. No.: NGK L3-SN491-13 / NGK L3-SN591-13 (Polymer line post, tongue end)

Colour:	Light grey
Length:	2113 mm / 2472 mm (vertical angle 17^{o})
Mass:	52.2 kg / 57.9 kg

Mfg.Cat. No.: NGK L3-SN491-23-W / NGK L3-SN591-23-W

[1] Based on Design Basis Template – Original 4 May 2007

	(Polymer line post, c/w corona ring, trunnion end)
Colour:	Light grey
Length:	2111 mm / 2740 mm (vertical angle 17^o)
Mass:	54.1 kg / 59.8 kg

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 G of this Design Brief for suspension and dead-end insulator hardware assembly reference drawings. Sample drawings showing conductor and insulator hardware for "Lapwing" conductor will be adjusted for the associated hardware for "Bunting" or "Drake" conductor during detailed design and construction.

a) Suspension Insulator Hardware Assemblies

Loaded weight or mass is bare weight or mass x 1.5 and represents an iced assembly. Suspension string length is measured 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 / 140 kN
insulators per string:	12 for one circuit; 15 for other circuit
number of strings:	1
bare weight:	55 kg (540 N)
loaded weight:	82.5 kg (810 N)
length of assembly (swing):	1945 mm

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):	2172 mm

[1] Based on Design Basis Template – Original 4 May 2007

b) 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.

<u>Composite Insulator for Lapwing Conductor on Dead-end Structures (Full Tension)</u>

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

<u>Composite Insulator for Lapwing Conductor on Dead-end Structures (Slack Span)</u>

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

<u>Composite Insulator Alternative for Dead-end Structure in Uplift</u>
Dead-end insulator strings shall be reversed for positive conductor dip.

<u>Braced Fixed Post Insulator (Polymer) Hardware Assemblies</u>
(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)

[1] Based on Design Basis Template – Original 4 May 2007

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})

Note: use armour rod specified for conductor size.

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. If required conductor vibration dampers should be installed in accordance with manufacturer instruction. The need for vibration dampers

[1] Based on Design Basis Template – Original 4 May 2007

shall be considered after a vibration analysis is completed by Transmission Design using Dolmison software package.

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. FOUNDATIONS

6.1 GUY ANCHORS

Standard wood pole guy anchors are as per BC Hydro Transmission Engineering Standard Drawing G-T08-D462, "Standard Guy Anchor Systems for Wood Pole Structures." The maximum working tension to maintain appropriate safety factors is 33.34 kN horizontal load at 45^{o} guy angle.

For guy loads in excess of the above earth setting steel channel guy anchors with concrete (Types 21, 22, 23 & 24) or pipe type (Type 31) or grouted 25 or 31 mm "Dywidag temcor" rods in rock (Types 40 and 41) shall be used. The types are listed below:

Type 21/22 with 25 mm OD rod – for use with single Size 16 guy stand based on 30^{o} guy angle

Type 31 with 25 mm OD rod – for use with single Size 16 guy stand based on 30^{o} guy angle

Type 23/24 with 31 mm OD rod – for use with single Size 25 guy stand based on 30^{o} guy angle

Type 40 – 25 mm OD rod for use with single Size 16 guy stand based on 30^{o} guy angle

Type 41 – 31 mm OD rod for use with single Size 25 guy stand based on 30^{o} guy angle.

[1] Based on Design Basis Template – Original 4 May 2007

6.2 POLE SETTING

It is anticipated that rock foundations will be utilized for steel poles in a double circuit configuration. A family of rock foundations, including light, medium and heavy, would be needed to address variations in foundation loads. Shallow square foundations in earth may also be required for double circuit steel poles in some soil conditions. Preliminary proposed foundation types are listed in the table below. Sample drawings of preliminary details in Appendix H.

Type	Reference Dwg.	Description
HR MR LR	75L-T08-B15 75L-T08-B16 75L-T08-B18	Heavy, medium and light rock foundations for steel pole structures.
LC MC HC	75L-T08-B19 75L-T08-B20 75L-T08-B21	Light, medium and heavy concrete foundations for steel pole structures. Shallow square foundations in earth.

For wood or steel pole H-frame structures, it is likely that the poles would be direct embedded, due to the amount of rock and perceived competant soil in the area. Poles set in earth for this project will be set to the standard design depth of 10% of the total pole length pulus an additional 0.6 m. For poles set in rock, embedment depths will be as per BC Hydro Transmission Engineering Standard Drawing G-T08-B459, “Standard Pole Setting Depths for Wood Pole Structures.”

7. CLEARANCES

7.1 GROUND CLEARANCES

The 230 kV conductor to ground clearances used for this project are as shown in BC Hydro’s Transmission Technical Standards, Procedures and Guidelines, Manual 41K, Section 1, Table J, dated November 1988 (Appendix I).

The table below summarizes the minimum 230 kV ground clearances (which indicate tolerances to allow for inaccuracies in terrain data and construction):

230 kV Crossing Over	Clearance + Tolerance (metres)
Land accessible to vehicles and equipment	6.1 + 1.3
Land accessible to pedestrians only	6.0 + 1.3
Roads, Minor roads & Highways	7.9 + 1.3
Roads, Logging & Mining	11.1 + 1.3
Railways	9.3 + 1.3
Water Crossings	Determined in accordance with Table 3 of CAN/CSA C22.3 – No. 1-01

[1] Based on Design Basis Template – Original 4 May 2007

230 kV Crossing Over	Clearance + Tolerance (metres)
Pipelines	9.6 + 1.3

Tolerances are in accordance with Vertical Clearances for Overhead Lines BC Hydro Transmission Engineering Standards, Manual 41K, Section 1.2 and include tolerance allowance for: survey, layout, structure installation (steel pole on engineered foundation or direct embedment wood and steel poles) and stringing.

For elevation in excess of 1000 m, increase clearances by 1% for each additional 100 m.

7.2 HORIZONTAL CIRCUIT TO CIRCUIT CLEARANCES

For 230 kV single and double circuit steel pole structures, the CSA minimum requirements for circuits supported on the same structure is outlined on Table 17 of CAN/CSA C22.3 No. 1-01 for spans up to 450 m in length. For spans greater than 450 m the horizontal separation shall not be less than that required for a 450 m span.

7.3 VERTICAL SEPARATION

The required clearances between 230 kV conductors crossing over other conductors or structures are as shown in BC Hydro's Transmission Technical Standards, Procedures and Guidelines, Manual 41K, Section 1, Table J dated November 1988.

The table below summarizes the minimum 230 kV clearances (which indicate tolerances to allow for inaccuracies in terrain data and construction) crossing over other conductors or structures:

230 kV Crossing Over	Clearance + Tolerance (metres)
0 – 69 kV Wires	2.6 + 1.3
0 – 69 kV Structures	2.6 + 1.3
138 kV Wires	2.1 + 1.3
138 kV Structures	2.9 + 1.3
230 kV Wires	2.4 + 1.3
230 kV Structures	2.8 + 1.3

Note: See Section 7.1 for a reference and explanation of tolerances.

[1] Based on Design Basis Template – Original 4 May 2007

7.4 CLEARANCE TO THE STRUCTURE

The required clearance between the conductor and the structure used for this project are as shown in BC Hydro's Transmission Technical Standards, Procedures and Guidelines, Manual 41K, Section 1.3, Table 2 dated November 1988. At 230 kV, the minimum design clearance from the conductor to the structure is 1.372 m. For long term exposure e.g. fixed post insulator to guy, the minimum clearance shall not be less than 1.8 m.

8. DESIGN CRITERIA

8.1 MAXIMUM DESIGN WEATHER LOADINGS

For the proposed VASxRGA circuit, the transmission line will be designed to survive a climatic load event based on a return period of 1-in-100 years. In other words, the transmission line will be designed to provide service continuity for major climatic load events with an annual probability of exceedance of 1%.

The Design Criteria for the transmission line from VAS to RGA are included in Appendix B. For the lower elevation existing route, climatic load requirements for the 1-in-100 year return period event would be consistent with CSA Medium loading (300 Pa wind and 12.5 mm ice) for combined wind and ice effects for transmission line sections running predominantly in the North-South direction, and with CSA Heavy loading (400 Pa wind and 12.5 mm ice) for combined wind and ice effects for transmission line sections running predominantly in the West-East direction. For the higher elevation upland route alternative, climatic load requirements for the 1-in-100 year return period event would be consistent with CSA Heavy loading (400 Pa wind and 12.5 mm ice) for combined wind and ice effects. At higher elevations, there is a greater probability of in-cloud icing and snow loading. Consequently, for elevations greater than 1000 m, 19 mm ice loading (bare, no wind) will also need to be considered.

This would mean that, for the existing route option from VAS to RGA and VAS to BEN, the layout and design for the transmission line would be done with 300 Pa wind and 12.5 mm ice loading along all sections except for the West-East sections originating from BEN Terminal and VAS terminal to the tap point. For these West-East orientated sections, the layout and design for the transmission line would be done with 400 Pa wind and 12.5 mm ice loading. For a higher elevation upland route alternative from VAS to RGA, the layout and design for the transmission line would be done with 400 Pa wind and 12.5 mm ice loading, and a maximum ice thickness of 19 mm (with no wind).

8.2 WEATHER LOADINGS

The conductor weather loading conditions used for this project are shown in the table below.

[1] Based on Design Basis Template – Original 4 May 2007

Radial Ice (mm)	Wind (kN/m^2)	Temperature (°C)	Remarks	Conductor Condition
19	0	-20	3/4 ice	Final
12.5	0.574	-20	Crossing Heavy	Final
12.5	0.400	-20	CSA Heavy	Initial / Final
12.5	0.300	-20	CSA Medium	Final
12.5	0.200	-20	1/2 4lb	
0	0	-15	10% winter design	
0	0.574	-20	bare 12 lb wind	
0	0	7.5	Mean Annual	
0	0.120	7.5	Mean Annual w/30mph	
0	0	10	bare 10 deg	
0	0	15	bare 15 deg	
0	0	30	bare 30 deg	
0	0	40	bare 40 deg	
12.5	0.200	-20	swing #1 0.9m	
0	0.400	-20	swing #2 0.3 8lb	
0	0.574	-20	swing #3 0.3 12lb	
0	0	60	Hot 60 deg	
0	0	93	Hot 93 deg (Bunting)	
0	0	100	Hot 100 deg	
0	0	125	Hot 125 deg (Drake)	
0	0	125	Clearance 0 Drake conductor	Final
0	0.050	40	Clearance 1	Final
0	0.100	40	Clearance 2	Final
0	0.150	40	Clearance 3	Final
0	0.200	40	Clearance 4	Final
0	0	-30	uplift	
12.5	0	-20	1/2 ice no wind	
0	0	-20	-18	
0	0	30	Ambient	
0	0.200	40	hot swing	
0	0	0	32(deg F)	

The ice density used with the above values is 8.954 kN/m^3.

8.3 LIMITING CONDUCTOR TENSIONS

The limiting conductor tensions used for this project are derived from the BC Hydro's Transmission Technical Standards, Procedures and Guidelines, Manual 41E, Section 4, Table 1, Page 29 dated October 1988. The maximum conductor tension limits are based on insulator strength requirements.

Condition	State	Maximum Conductor Tension

[1] Based on Design Basis Template – Original 4 May 2007

		(% RTS)	DRAKE (kN)	BUNTING (kN)
Design Load	Final	50	69.5	73.7
10% Winter Design	Initial	26	36.1	38.3
Mean Annual	Final	19	26.4	28.0
10% Winter Design	Final	23	32.0	33.9

9. PLS-CADD FILES

The following design files were used for preliminary layout and design for all routes and transmission line alternatives:

Route	Transmission Alternative	Filename
Existing (76L) VASxRGA	Double Circuit Steel Pole	alt_dem_vas_rga_bunting.bak
Upland VASxRGA	Double Circuit Steel Pole	alt1_dem_vas_rga_upland3_bunting.bak
Existing (76L) & Upland VASxRGA	1x Single Circuit H-frame each route	alt_dem_vas_rga_scwp h-frame.bak
Upland VASxRGA	2x Single Circuit H-frame	alt_dem_vas_rga_upland3_scwp h-frame.bak
Existing (40L)	1x Single Circuit H-frame	alt_dem_vas_ben_scwp h-frame.XYZ

10. PHASING

For a single circuit structure, the flat configuration typically results in a horizontal phase arrangement of 1 x 3 (i.e. one row of 3 phases).

Another option is to utilize a “stacked” configuration with a 3 x 1 phase arrangement. Using this configuration would results in significantly taller towers that the single circuit flat configuration, but a much narrower right-of-way requirement which would minimize the land disturbance.

When land-use constraints are more serious, a viable option is to double circuit the transmission lines, resulting in single tower structures supporting 6 phases. The optimum design is to have a “stacked” 3 x 2 phase arrangement. Using this configuration would results in significantly taller towers that the single circuit flat configuration. However, using double circuiting would have the most impact to minimize the land disturbance and lower the EMF levels due to the cancelling effect created by the double circuit arrangement.

It is suggested that opposing phasing be utilized to further reduced EMF levels in a double circuit configuration.

Refer to Appendix J for Phasing Diagram 040-44604 for phasing of 76L, VAS x RGA and 40L from VAS to BEN/OLV.

[1] Based on Design Basis Template – Original 4 May 2007

11. SAGGING

Sagging tolerances for construction are as follows:

i. 2-Conductor Bundle

The difference is sag between the sub-conductors shall not be more than 30 cm.

The difference between the specified sag and the actual sag shall not exceed plus or minus 150 mm for all spans.

ii. Single Conductor or Groundwire

The difference between the specified sag and the actual sag shall not exceed plus or minus 150 mm for all spans.

12. SPECIAL DESIGN CONSIDERATIONS

- Shielding/armoring around structures to be determined.

13. REFERENCES

References for the design and construction specifications for the VAS Terminal Station to RGA Terminal Station, and the VAS Terminal Station to BEN Terminal Station, 230 kV Transmission Reinforcement Project are contained in the following documents:

- OTR Project Preliminary Route Briefing, January 2006.
- Design Wind and Ice Loads, BC Hydro Engineering Memo
- Preliminary Geotechnical Report, BC Hydro Engineering Report
- Preliminary Access Assessment for R/W Preparation, BC Hydro Engineering Report
- Preliminary Vegetation Assessment for R/W Preparation, BC Hydro Engineering Report
- Environmental & Social Impact Assessment Screening Report, BC Hydro Engineering Report
- Planning Level Cost Estimates, BC Hydro Engineering Report
- 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)

[1] Based on Design Basis Template – Original 4 May 2007

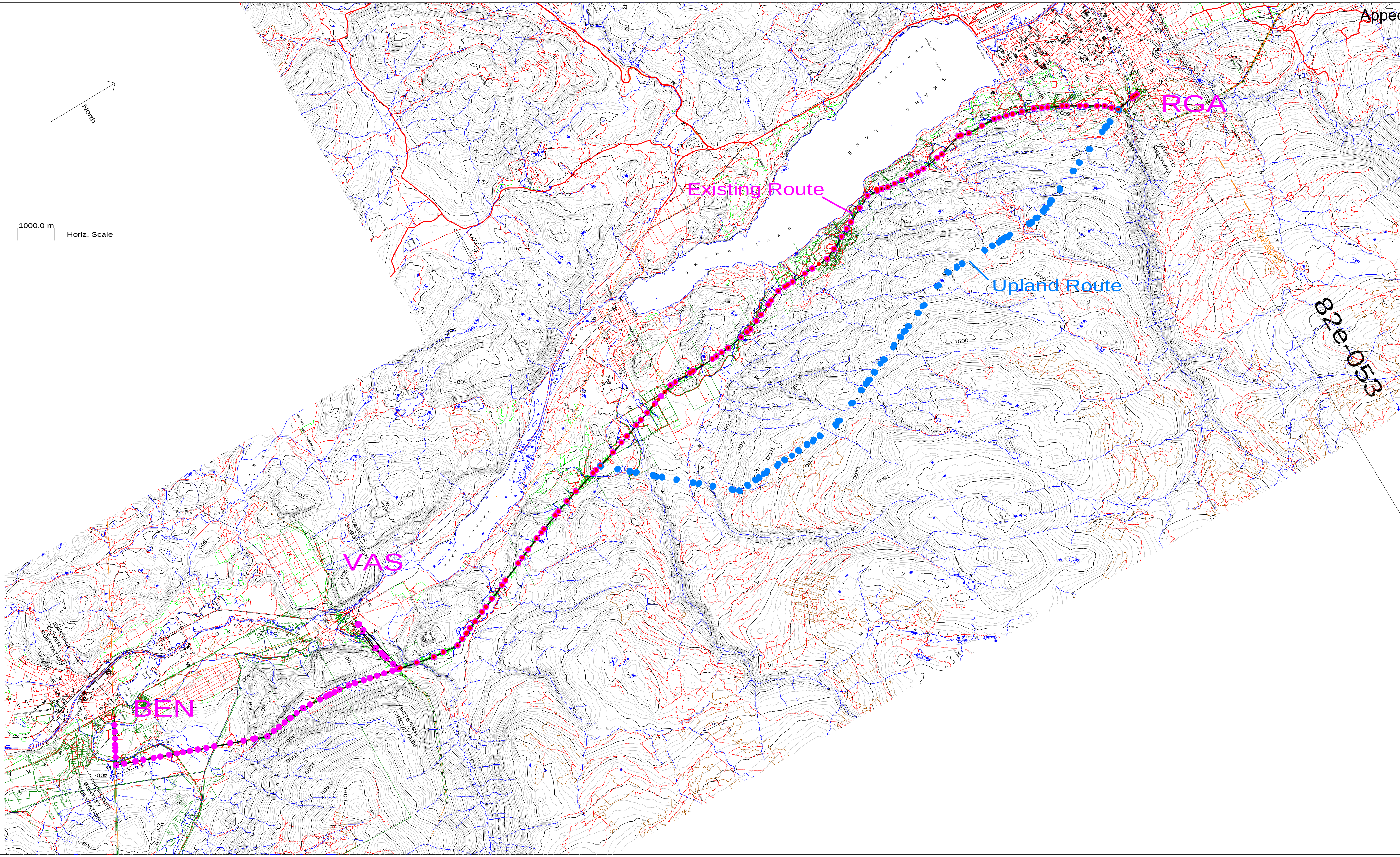
- CSA/CAN3-G12-92, Zinc Coated Steel Wire Strand
- Design Guide (Draft), Wood Pole Structures (Draft), A. Zolotoochin, BC Hydro.
- Handbook of Steel Construction, Canadian Institute of Steel Construction
- ASCE (1990) Guide for Design of Steel Transmission Pole Structures
- ANSI/ASCE (1991), Design of 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

[1] Based on Design Basis Template – Original 4 May 2007

APPENDIX A: MAP OF ROUTE ALTERNATIVES

Appendix C

FILE MAP FOR ALTERNATE ROUTES_05DEC2007.xyz PLOTTED 2007-12-05



REF#	DRAWING NUMBER	TITLE	REF#	DRAWING NUMBER	TITLE
REFERENCE DRAWINGS			REFERENCE DRAWINGS		

NO	REMARKS	DATE	DESIGNED	INDEP CHKD	DFTG	DFTG CHKD	INSPD	REV	ACPT
REVISIONS									

DSGN
INDEP CHKD
DFTG
DFTG CHKD
INSPD
REV
ACPT

BChydro ENGINEERING

FORTIS BC
OKANAGAN TRANSMISSION REINFOR.

BENxVASxRGA - 230 kV Alternate Routes

PLAN VIEW

DATE 2007-12-05 DISTR DWG NO CAD SH 1 OF 1 R R0

APPENDIX B: DESIGN CRITERIA

[1] Based on Design Basis Template – Original 4 May 2007

BC hydro

reliable power,
at low cost,
for generations

Inter-office memo

To:	Roslyn Bubela	July 16, 2007
From:	Barry C. Anderson	File: Fortis – Ben-Vas-RGA – Weather Loads
CC:	Ola Onifade	
Subject:	Fortis BC Okanagan Transmission Reinforcement – Climatic Loadings	

Roslyn, based on BCTC/BC Hydro's performance criteria for different voltage classes, we would recommend that this line be designed to withstand weather loadings that have a return period of 1 in 100 years: See Sketch 1 attached which shows the Existing Route and the possible Upland Route and Transmission Line Nodes A, B, C, D, E, and F used to differentiate climatic loading areas. Relevant information for this line is:

1) Snow depth: Reference data from other lines indicates a maximum snow depth of 1.0 metre at about 1100 metres.

2) Bare Ice (Ice with no wind). Ice data from freezing rain interpretation at Penticton Airport for a 50 year return period is only 3.3 mm. Equal ice loadings for both 1 in 50 and 1 in 100 year loadings would be less than the CSA minimum of 12.5 mm ice. **For elevations less than 1000 metres, the CSA minimum of 12.5 mm ice is recommended for the ice with no wind at -18 degrees Celcius.** Above 1000 m, we have seen significant fog icing and wet snow accumulations on some of BC Hydro lines such as at Mile 286 of Circuit 5L96 recently and **would recommend that 19 mm ice with no wind, at -18 degrees Celcius, be used for the heavy ice condition for structures located above 1000 metres elevation.**

3) Combined Wind with Ice Loadings. For lines running along the valley bottom in a north-south direction, the fact that the prevailing wind direction is not perpendicular, but at some angle to the line, we are recommending **300 kPa wind with 12.5 mm ice at -18 degree celcius (CSA Medium) for Nodes B – C, C – E, and E - F (existing lower elevation route)**

The exception to this is for the following 2 cases

-the first case is when the transmission line runs perpendicular to the predominant wind up and down the valley such as between nodes A (Bentley Sub) and B (the ninety degree PI) and C (Vaseux Tap) and D (Vaseux Sub). For these areas**, we recommend a wind of 400 kPa and 12.5 mm ice at -18 degrees (CSA Heavy).**

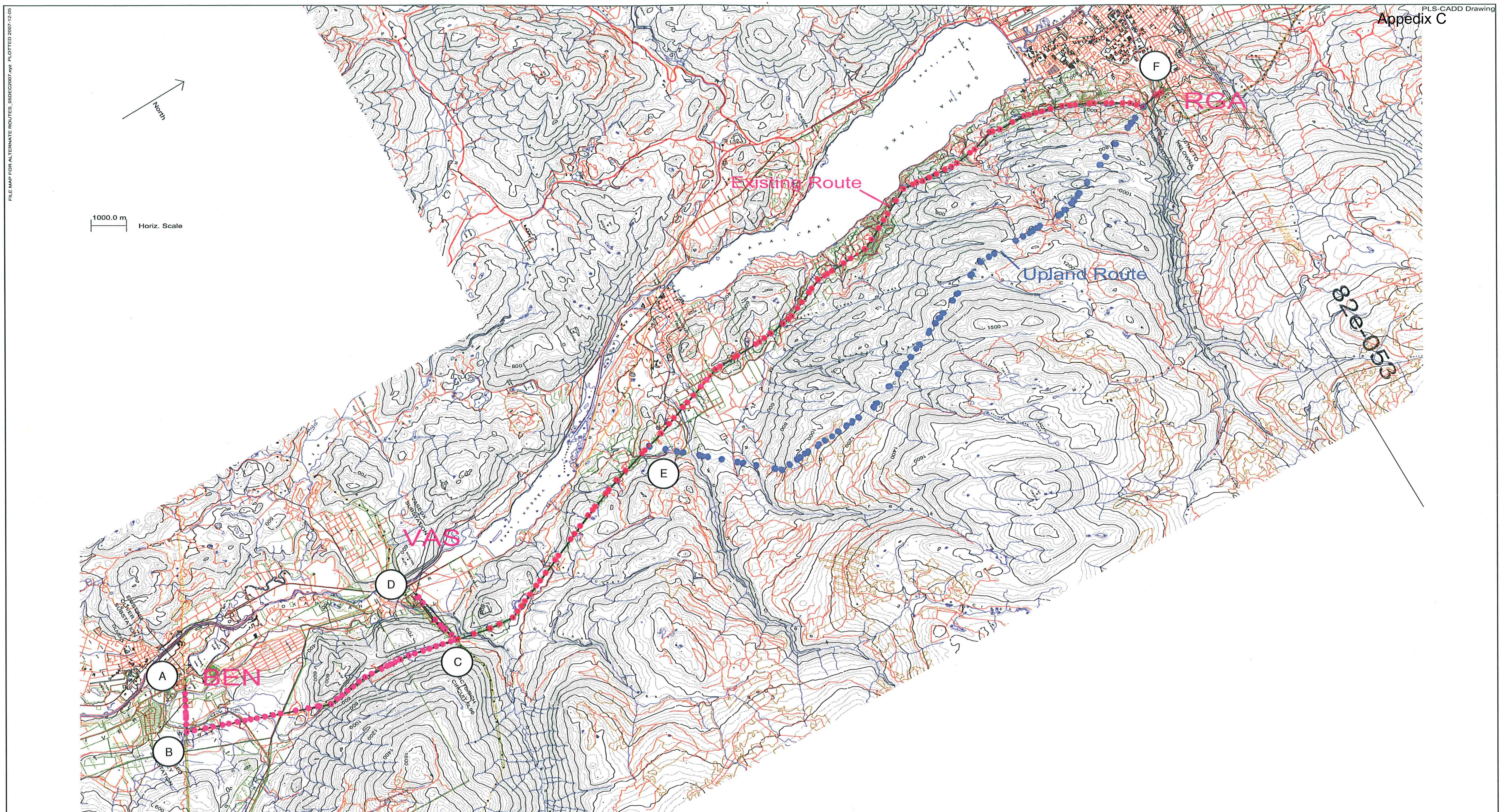
- the second case is when the wind is higher up on the ridge such as the upland route, the wind speed is increased by the ridge effects with the air trying to funnel over the top. For this upland route we recommend a wind of **400 kPa and 12.5 mm ice at -18 degrees celcius (CSA Heavy).**

Please use the above recommendations in your design for this line and let me know if you need any more information.

Barry C Anderson, P.Eng.

Appendix C

PLS-CADD Drawing



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

BC hydro ENGINEERING

FORTIS BC
OKANAGAN TRANSMISSION REINFOR.

BENxVASxRGA - 230 kV Alternate Routes

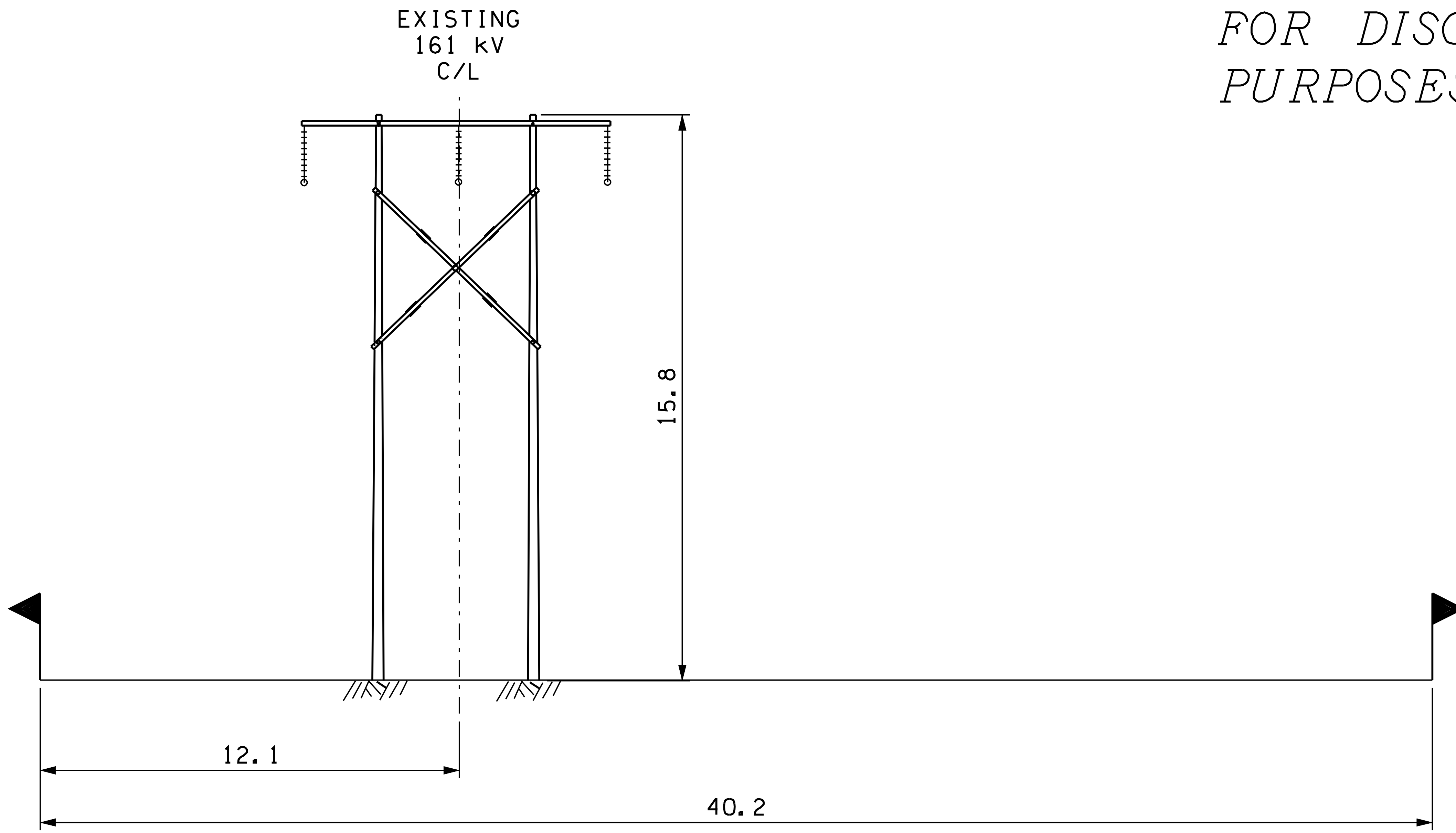
PLAN VIEW

DATE 2007-12-05 DISTR DWG NO CAD R0

APPENDIX C: RIGHT-OF-WAY CROSS SECTIONS

PRELIMINARY

FOR DISCUSSION PURPOSES ONLY



TYPICAL EXISTING R/W
OLIVER X RGA
40L & 76L
VIEW NORTH

REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

REVISIONS

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DESIGNED BY		
CHECKED BY		
APPROVED BY		

FORTISBC

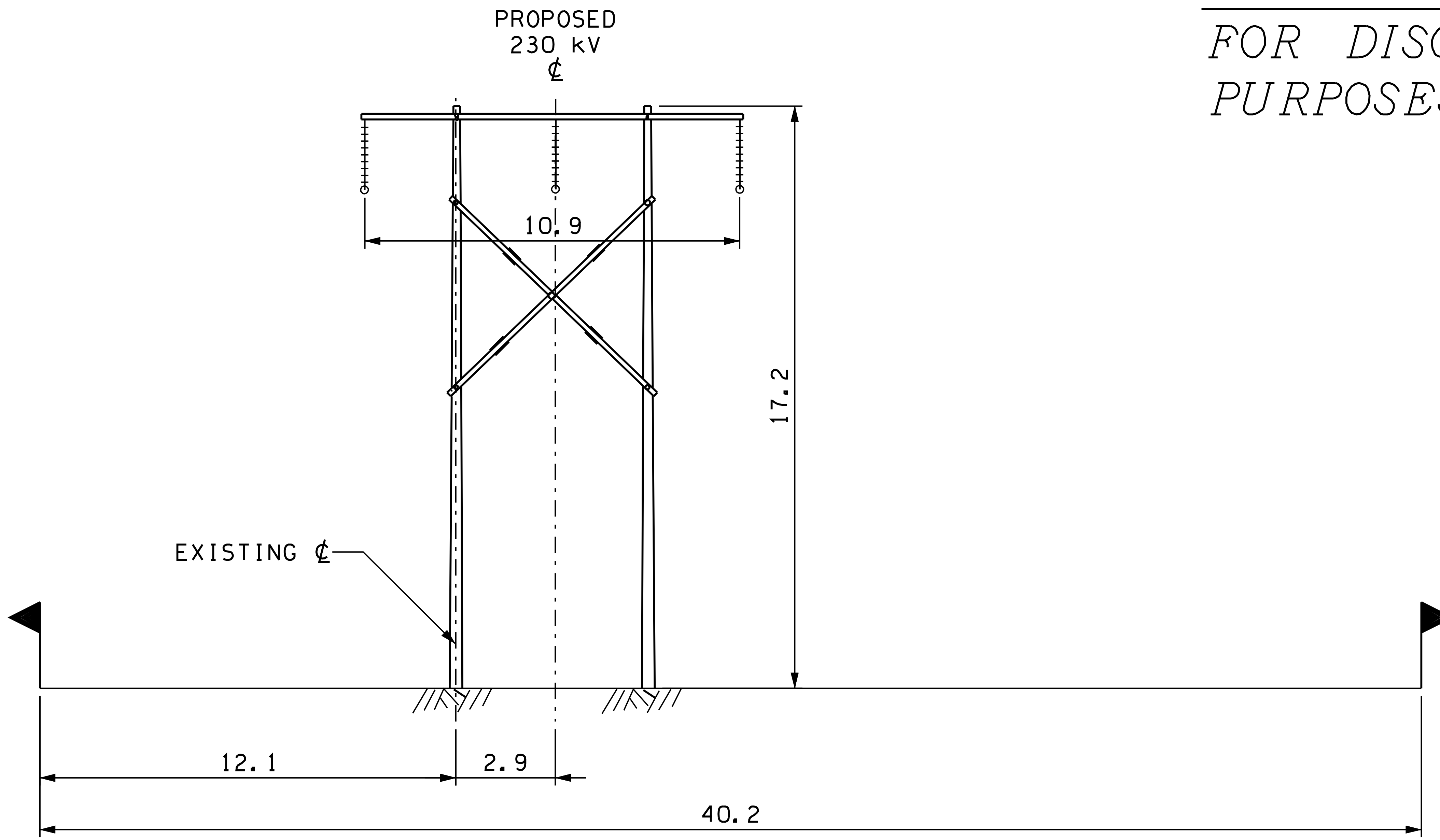
FORTISBC
PROPOSED VAS x BEN 230 kV
EXISTING 161 kV

RIGHT-OF-WAY CROSS SECTION

DRAWING NUMBER	REV
75L-T07-B2	

PRELIMINARY

FOR DISCUSSION PURPOSES ONLY



TYPICAL EXISTING R/W
BENTLEY X VAS TAP
AS SCWP 230
VIEW NORTH

REVISIONS								
							DRAWN BY	
							DESIGNED BY	
							CHECKED BY	
							APPROVED BY	
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE		

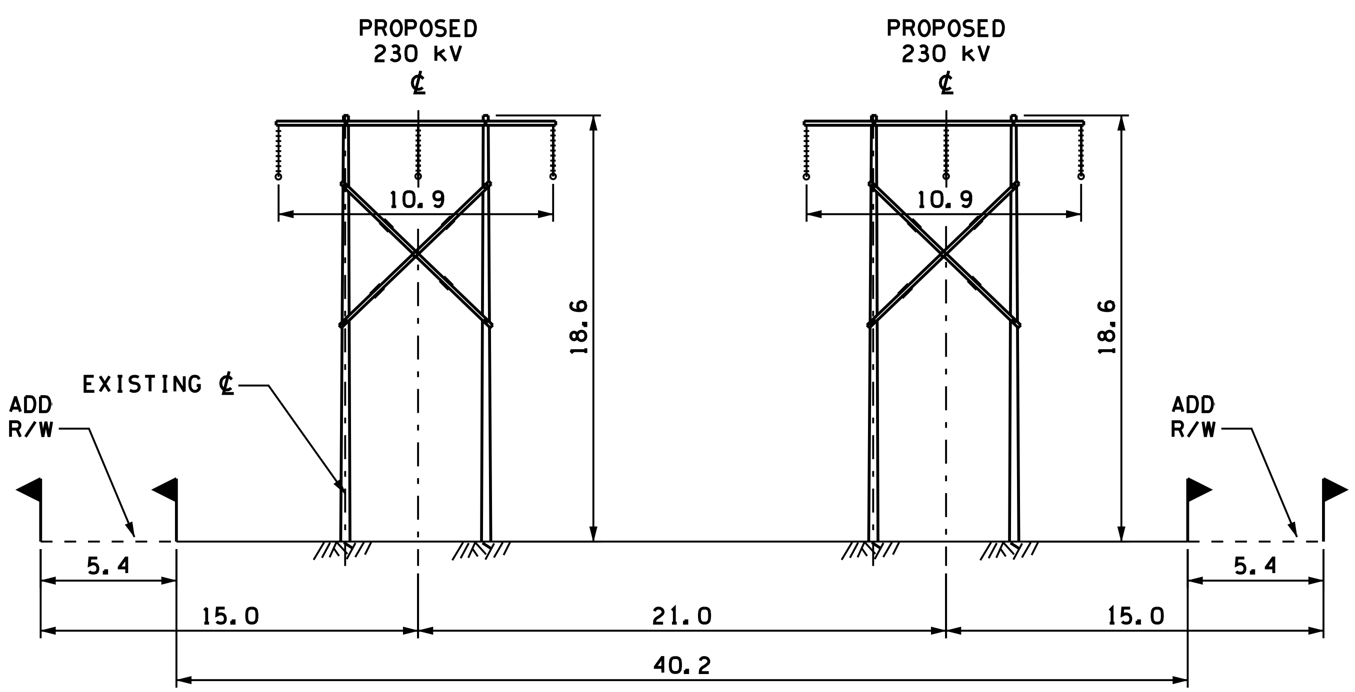
FORTISBC

FORTISBC
PROPOSED VAS x BEN 230 kV
1 X SCWP ALTERNATIVE

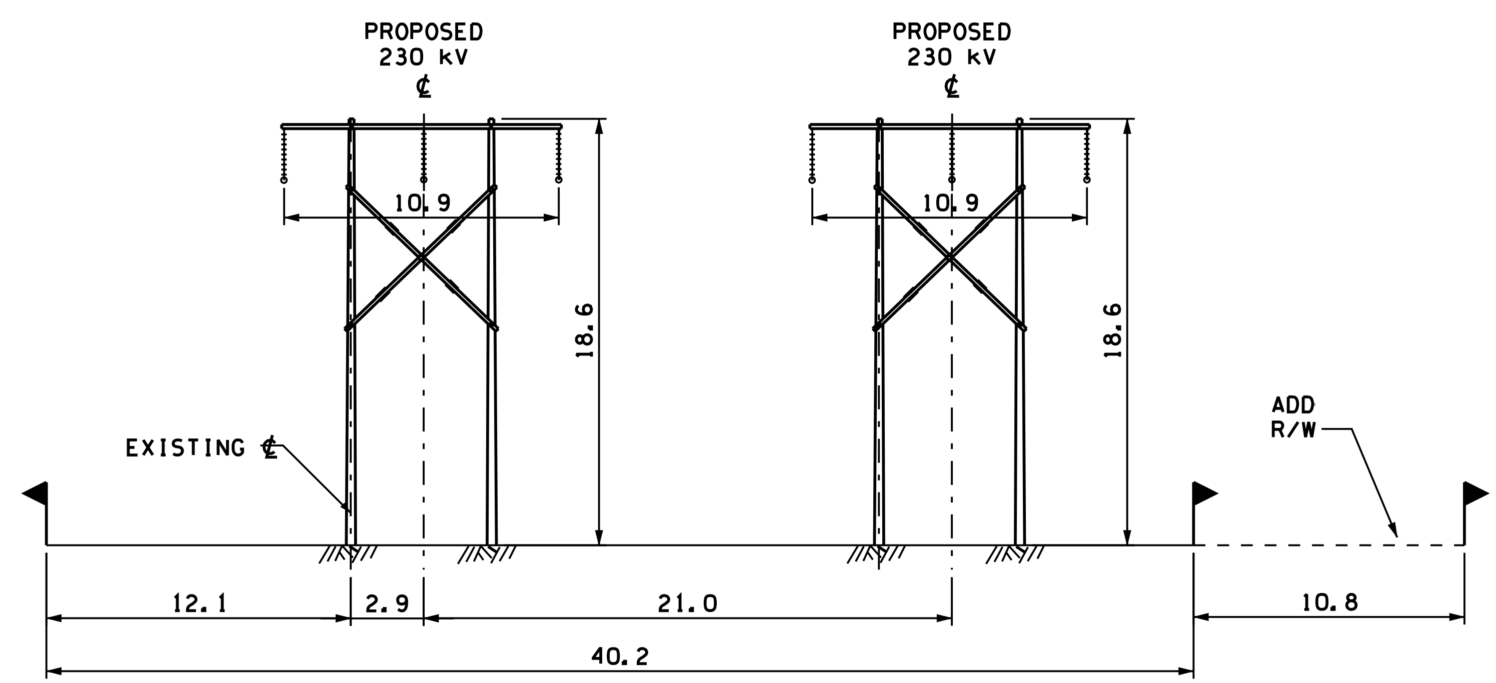
RIGHT-OF-WAY CROSS SECTION

DRAWING NUMBER	REV
75L-T07-B3	

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY



TYPICAL EXISTING R/W
ADD R/W EACH SIDE
VAS X RGA
w/2 x SCWP/SCSP 230 KV
VIEW NORTH
ALTERNATE 1
(OPTION 2B)



TYPICAL EXISTING R/W WITH ADDITION
VAS X RGA
w/ 2 x SCWP/SCSP 230
VIEW NORTH
ALTERNATE 2
(OPTION 2B)

NOTES:

1. TYPICAL SHORTER SPANS, 225-300 M
2. ALLOWS STAGED CONSTRUCTION.

REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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DESIGNED BY
CHECKED BY
APPROVED BY

FORTISBC

FORTISBC
PROPOSED VAS x RGA 230 kV
2 X SCWP ALTERNATIVES

RIGHT-OF-WAY CROSS SECTION

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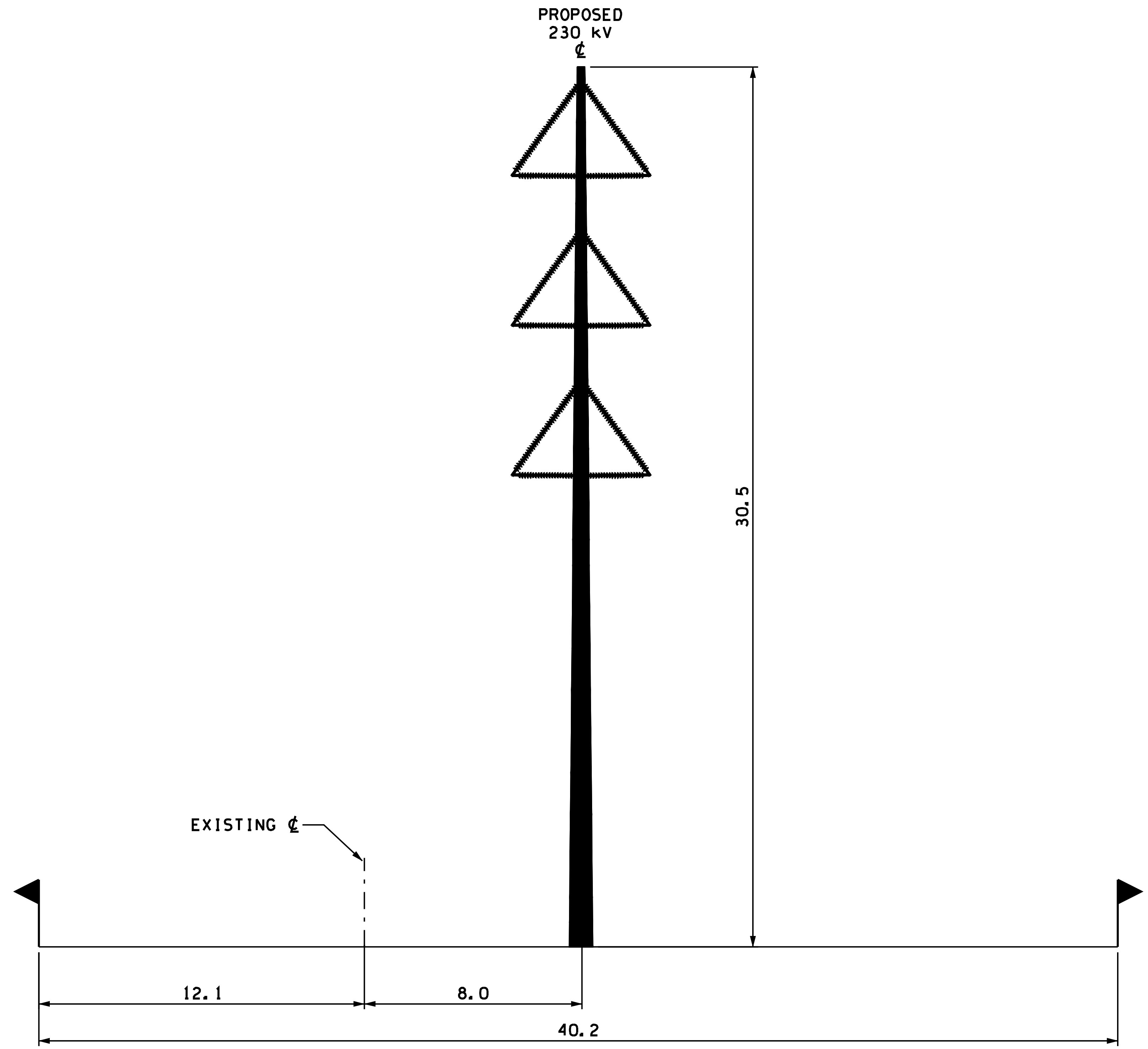
75L-T07-B4	

PRELIMINARY
FOR DISCUSSION
PURPOSES ONLY



TYPICAL EXISTING R/W
VAS X RGA
W/ 230 kV DCSP BRACED POST
VIEW NORTH

NOTES:

1. TYPICAL SHORTER SPANS - 225 M
2. REQUIRES LARGER DIA. CONDUCTOR, E.G. BUNTING ACSR

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APPROVED BY	

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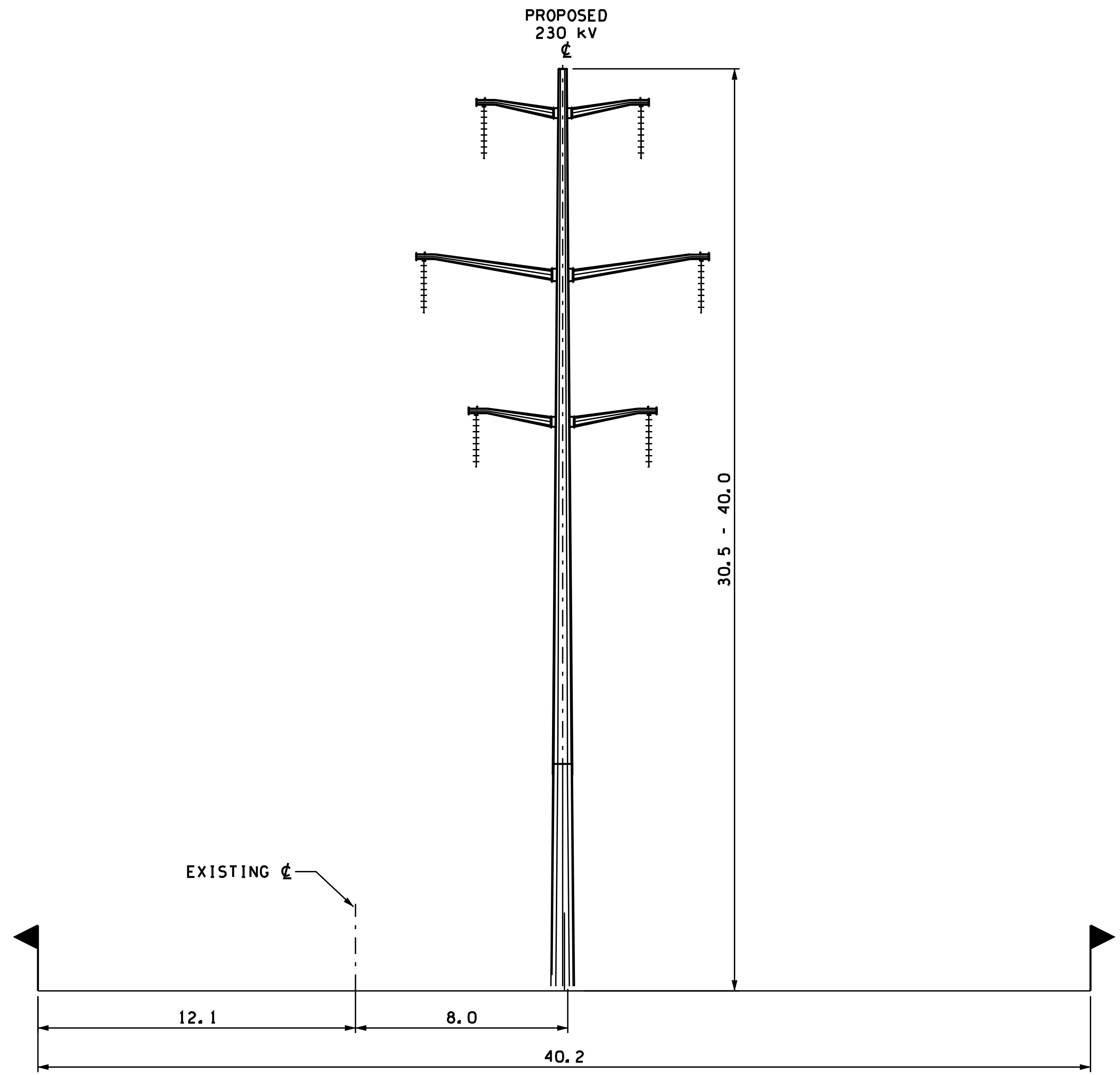
FORTISBC
PROPOSED VAS x RGA 230 kV
DCSP BRACED POST ALTERNATIVE

RIGHT-OF-WAY CROSS SECTION

DRAWING NUMBER	REV
75L-T07-B5	

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY



TYPICAL EXISTING R/W
VAS X RGA
W/ 230 kV DCSP DAVIT ARM
VIEW NORTH

NOTES:

1. TYPICAL LONGER SPANS - 400 M
2. LARGE FOUNDATIONS.

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							DESIGNED BY	
							CHECKED BY	
							APPROVED BY	
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FORTISBC

FORTISBC
PROPOSED VAS x RGA 230 kV
DCSP DAVIT ARM ALTERNATIVE

RIGHT-OF-WAY CROSS SECTION

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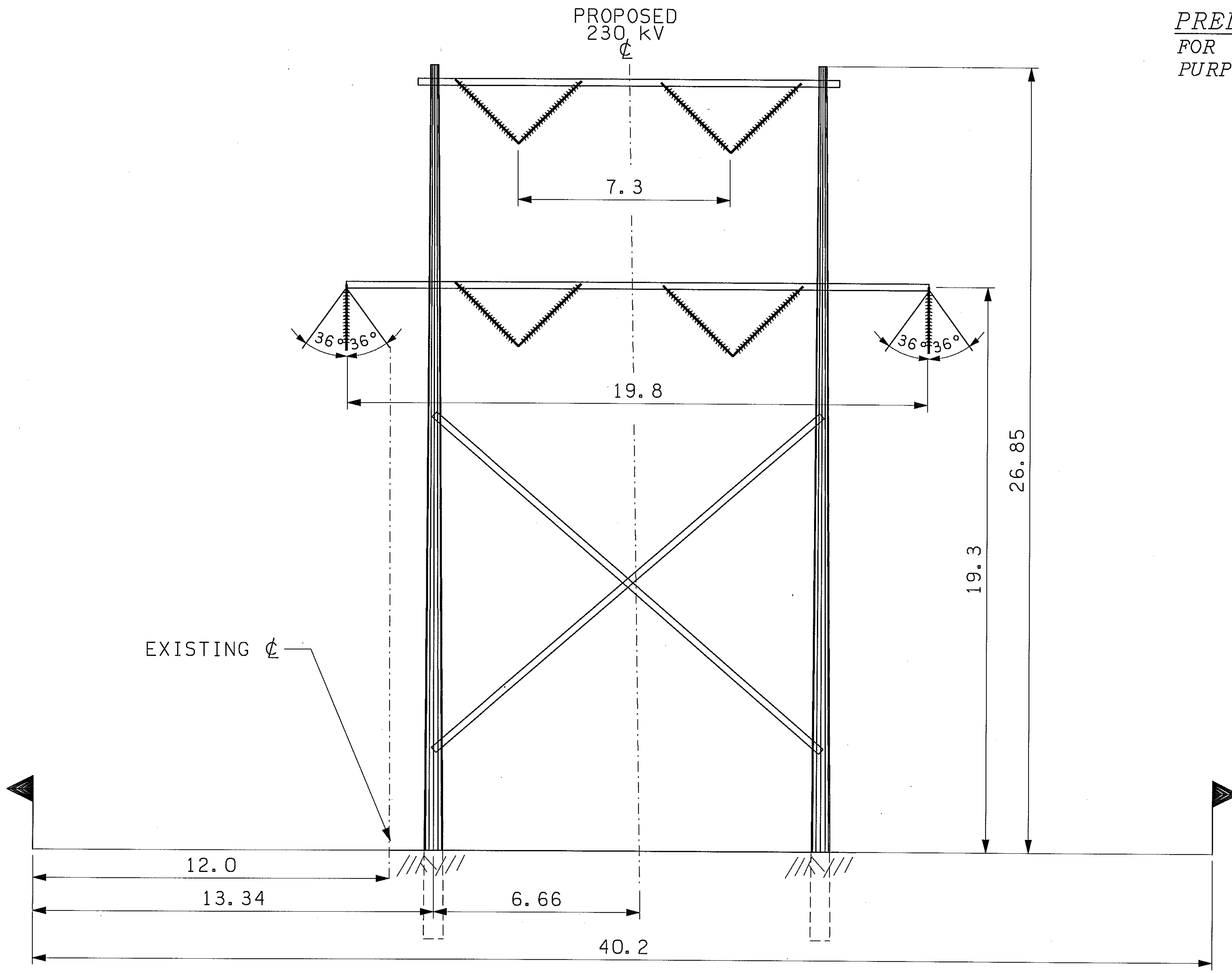
75L-T07-B6	

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY



TYPICAL EXISTING R/W
VASxRGA
W/230kV H-FRAME TANGENT

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2. FOR POLE EMBEDMENT SEE DWG. 75L-T08-B35.

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DESIGNED BY	
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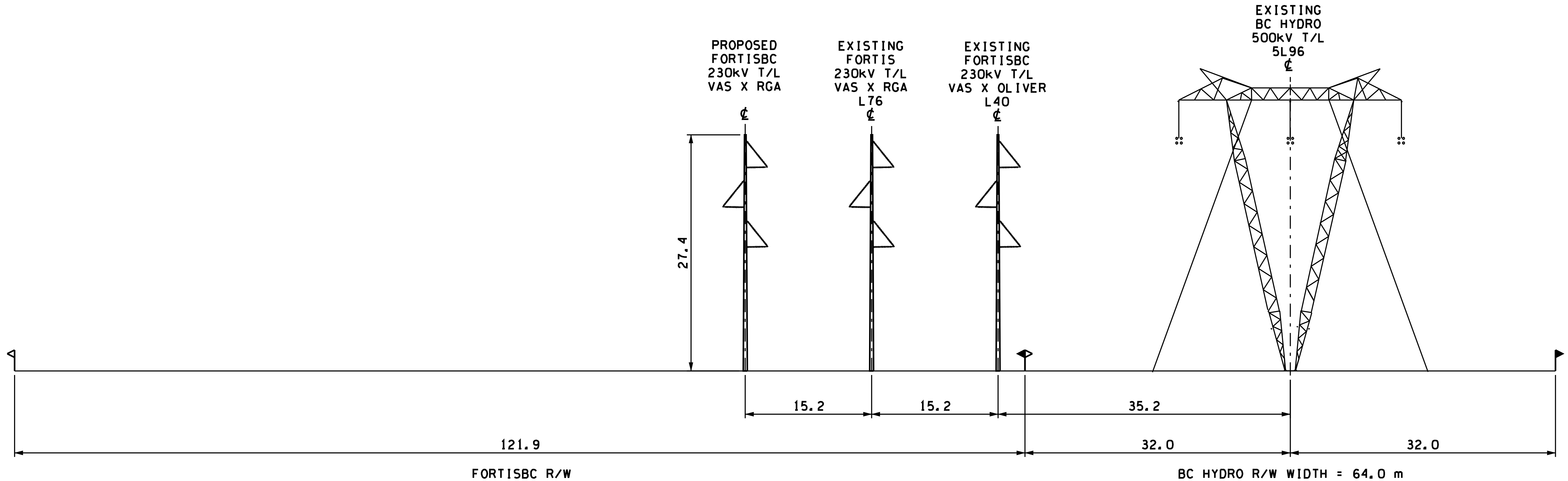
APPROVED BY	

FORTIS BC
PROPOSED VASxRGA
230kV DOUBLE CIRCUIT H-FRAME
SUSPENSION STRUCTURE

DRAWING NUMBER	REV
75L-T07-B9	0

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY



LEGEND
- BC HYDRO R/W BOUNDARY
- FORTISBC R/W BOUNDARY

TYPICAL HORIZONTAL CROSS-SECTION
OF EXISTING BC HYDRO 500 kV T/L
AND EXISTING/ PROPOSED FORTISBC
230 kV T/Ls ADJACENT TO BCTC/BCH CIRCUIT 5L96

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

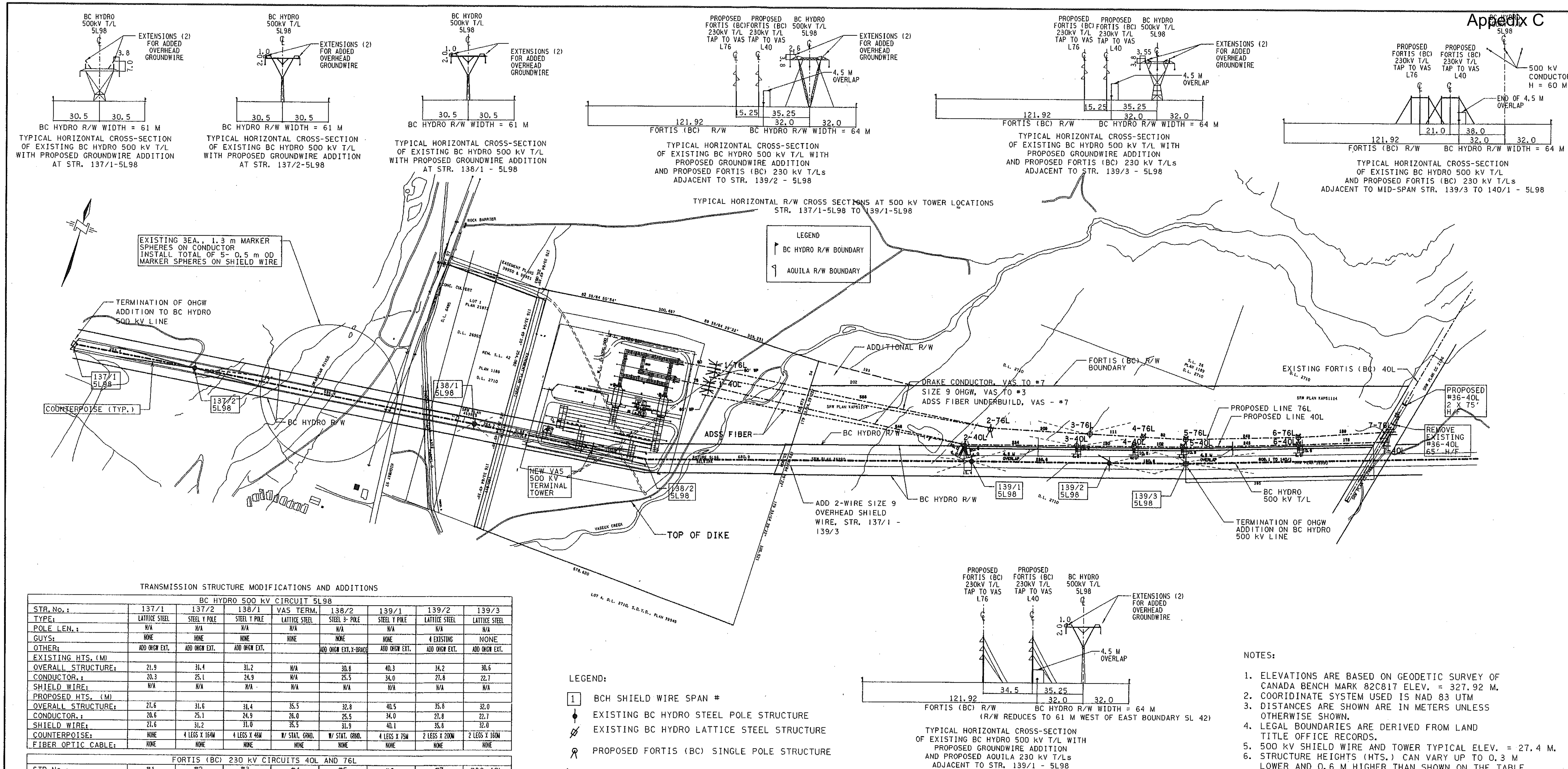
DRAWN BY
DESIGNED BY
CHECKED BY
APPROVED BY

FORTISBC

FORTISBC
VAS 230kV TAPS
EXISTING AND PROPOSED
RIGHT-OF-WAY SECTION

DRAWING NUMBER	REV
75L-T07-B8	

Appendix C



TRANSMISSION STRUCTURE MODIFICATIONS AND ADDITIONS

BC HYDRO 500 kV CIRCUIT 5L98								
STR. No.:	137/1	137/2	138/1	VAS TERM.	138/2	139/1	139/2	139/3
TYPE:	LATTICE STEEL	STEEL Y POLE	STEEL Y POLE	LATTICE STEEL	STEEL 3- POLE	STEEL Y POLE	LATTICE STEEL	LATTICE STEEL
POLE LEN.:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GUYS:	NONE	NONE	NONE	NONE	NONE	NONE	4 EXISTING	NONE
OTHER:	ADD OHGW EXT.	ADD OHGW EXT.	ADD OHGW EXT.		ADD OHGW EXT. X-BRACE	ADD OHGW EXT.	ADD OHGW EXT.	ADD OHGW EXT.
EXISTING HTS. (M)								
OVERALL STRUCTURE:	21.9	31.4	31.2	N/A	30.8	40.3	34.2	30.6
CONDUCTOR.:	20.3	25.1	24.9	N/A	25.5	34.0	27.8	22.7
SHIELD WIRE:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PROPOSED HTS. (M)								
OVERALL STRUCTURE:	27.6	31.6	31.4	35.5	32.8	40.5	35.8	32.0
CONDUCTOR.:	20.6	25.1	24.9	26.0	25.5	34.0	27.8	22.7
SHIELD WIRE:	27.6	31.2	31.0	35.5	31.9	40.1	35.8	32.0
COUNTERPOISE:	NONE	4 LEGS X 164M	4 LEGS X 46M	W/ STAT. GRND.	W/ STAT. GRND.	4 LEGS X 75M	2 LEGS X 200M	2 LEGS X 160M
FIBER OPTIC CABLE:	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

FORTIS (BC) 230 kV CIRCUITS 40L AND 76L								
STR. No.:	#1	#2	#3	#4	#5	#6	#7	#36-40L
TYPE:	3-WOOD POLE	1-STEEL POLE	1-STEEL POLE	1-STEEL POLE	1-STEEL POLE	1-STEEL POLE	3-WOOD POLE	2-WOOD POLE
POLE LEN.:	80'/65'/80'	120'	90'	80'	80'	80'	3X75'/3X70'	75'/75'
GUYS:	14 EA.	6 EA.	3 EA.		1 EA.	1 EA.	6 EA.	
EXISTING HTS. (M)								
STRUCTURE:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.6
COND.:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.6
OHGW:	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NONE
PROPOSED HTS. (M)								
STRUCTURE:	22	32	24	21.5	21.5	21.5	16/16.5	19
COND.:	15.7	16 TO 28	12 TO 20	10.5 TO 18.5	10.5 TO 18.5	10.5 TO 18.5	15.5/17.5	16
OHGW:	20.8	31.8	23.8	NONE	NONE	NONE	NONE	NONE
COUNTERPOISE:	NONE	2 LEGS X 50M EA	2 LEGS X 100M EA	NONE	NONE	NONE	NONE	NONE
FIBER OPTIC CABLE:	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD	ADSS UNDERBUILD

LEGEND:

- [1] BCH SHIELD WIRE SPAN #
- EXISTING BC HYDRO STEEL POLE STRUCTURE
- EXISTING BC HYDRO LATTICE STEEL STRUCTURE
- PROPOSED FORTIS (BC) SINGLE POLE STRUCTURE
- PROPOSED FORTIS (BC) MULTI POLE STRUCTURE
- --- PROPOSED BURIED COUNTERPOISE WIRE

NOTES:

1. ELEVATIONS ARE BASED ON GEODETIC SURVEY OF CANADA BENCH MARK 82C817 ELEV. = 327.92 M.
2. COORIDINATE SYSTEM USED IS NAD 83 UTM
3. DISTANCES ARE SHOWN ARE IN METERS UNLESS OTHERWISE SHOWN.
4. LEGAL BOUNDARIES ARE DERIVED FROM LAND TITLE OFFICE RECORDS.
5. 500 kV SHIELD WIRE AND TOWER TYPICAL ELEV. = 27.4 M.
6. STRUCTURE HEIGHTS (HTS.) CAN VARY UP TO 0.3 M LOWER AND 0.6 M HIGHER THAN SHOWN ON THE TABLE.
7. COUNTERPOISE LENTHS ARE ESTIMATES BASED ON READINGS TAKEN ON 5L98 AT THE TIME OF IT'S CONSTRUCTION IN 1982. AS-BUILT LENGTHS WILL VARY BASED UPON FINAL MEASUREMENTS TAKEN AFTER ESTIMATED LENGTH IS INSTALLED.

SCALE 100 0 100 200 300 METRES

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION
				0	GSB		RO ISSUE
				B	GSB	13/12/03	ADD EASEMENTS ON BCH R/W
				A	GSB	30/09/03	ADD FIBER TO 230 KV

DRAWN BY GSB
CHECKED BY
APPROVED BY

FORTISBC

BChydro

BC HYDRO DWG NO. 304D-T07-D3 R

VASEUX LAKE TERMINAL STATION PLAN OF PROPOSED BC HYDRO AND FORTIS (BC) TRANSMISSION LINE MODIFICATIONS AND ADDITIONS

DRAWING NUMBER	REV
040-45601	

APPENDIX D: GEOTECHNICAL OVERVIEW

FORTISBC

OKANAGAN TRANSMISSION REINFORCEMENT PROJECT (OTR)

Geotechnical Overview

Prepared for FortisBC by:

BC hydro

Engineering

25 June 2007

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1. INTRODUCTION

This report provides a summary of preliminary concerns and evaluations of geotechnical concerns with regard to various route alternatives for the OTR 230 kV upgrade project between Oliver and Penticton in the southern Okanagan area.

This review has concentrated on two aspects of the geotechnical concerns, namely; a preliminary assessment of hazards along the route and a preliminary summary of foundations requirements for the various route options. The work completed as part of the assessment of this route has included review of:

- previous geotechnical reports on the area,
- the library of still photographs of the routes and existing transmission structures in the area;
- satellite and aerial photograph coverage of segments of the routes; and
- overview of the routes by helicopter.

The following sections summarize these reviews and provide conclusions based on these reviews.

It is important to note that this assessment is should be considered an overview report and that the Design / Implementation Phase assessment will require a more thorough review including ground review and subsurface geotechnical exploration in critical areas to "ground proof" portions of the assessed conditions. In addition, foundation conditions will vary along the route. This is particularly true in areas of shallow bedrock since minor variations of the depth of the rock surface will mean the difference between using a rock or soil foundation and will mean a different design especially for the steel pole option. Hence, estimates contained here in must be considered to be approximate and it will be necessary to include a contingency for modifying foundations.

2. Limitations

This assessment has been limited to a surficial review of the site. Depths of fills and other subsurface stratigraphy are inferred from cuts and highway geometry in adjacent areas and have not been confirmed by subsurface investigations. This review is limited to geotechnical concerns with respect to physical development and security of the structures.

3. Route Options Reviewed

Two basic route options have been reviewed. These consisted of the existing Fortis Circuit L40 and L76 routes and an upper route branching east from L76 from a point just south of Shuttleworth Creek near structure L76/57 and traverses the mid slope of the undeveloped mountain side adjacent to Skaha Lake into RG Anderson Substation.

It is also understood that options of double circuit steel pole and single circuit wood pole are being considered for either or a combination of both the routes discussed above.

4. Geological Environment

The proposed transmission alignments are located on the east side of the Okanagan valley near the west edge of the Columbia Highlands physiographic region. The alignments pass through areas of a variety geologic bedrock formations ranging from volcanic to metamorphic to intrusive. As a result the bedrock along the proposed routes is variable ranging from very strong massive rock to highly weathered densely fractured zones.

The area has been glaciated and the soil deposits are post glacial in origin. The area of the south end of the alignments are located primarily on outwash terraces of sandy silts. The soils elsewhere tend to be relatively thin overlaying shallow bedrock deposits.

5. General Hazard Discussion

The hazards are limited by the near desert climate of the area. Drainages may be prone to infrequent storm floods and such flood channels should be avoided. The proposed alignments also traverse areas of steeply sloping bedrock and rock falls and rolling boulders can be a hazard especially during winter and early spring when freeze – thaw cycles can result in jacking action to loosen rock slabs. Specific areas of concern are summarized in Tables 1A and 1B included below.

As indicated in Table 1A there are several areas of potential rock fall hazard. The majority of these are judged to be moderate to low in risk. The only section where there is considered to be a potentially high hazard is between L40-15 and L40-21. Protection in the form of a gabion wall deflector should be considered for these structures. The requirement or design of such deflectors should be confirmed at the time of the final location of these structures. Other hazards can be mitigated by careful location of the structures. Again review should be completed when structure locations are finalized.

TABLE 1A SITE REVIEW COMMENTS - EXISTING ALIGNMENT

	STR #	COMMENT
1	0	Proposed Bentley substation – soils foundations to structure 48
2	L40-15	Rock fall Hazard start – moderate to high primarily from east
3	L40-21	Rock fall hazard end – moderate to high both sides but primarily from east side.
4	L76-37	Vaseaux Canyon – Rock Moderate to strong, blasting required
5	L76-45	Soil over shallow rock – Rock fall hazard – moderate to low
6	L76-48	Start of Strong rock – soil (sand and gravel back on line)
7	L76-49	Rock, moderate to weak - blasting still likely required continues back on line
8	L76-57	Rock, moderately strong, platy – blasting required continues back on line
9	L76-59	Forest fire area ends
10	L76-61	Weathered rock (possibly diggable) – shallow rock back online
11	L76-64	Soil silty sand and gravel back on line
12	L76-76	Poor rock expected to be shallow and back on line
13	L76-88	Rock is highly weathered and likely can be dug by machine – with difficulty.
14	L76-103	Rock fall hazard ahead on line low hazard
15	L76-105A	End of rock fall Hazard
16	L76-114	On Rock expect soil (silty sand and gravel) back on line
17	L76-119	On Rock expect shallow rock back on line
18	L76-123	Rock out crop expect shallow rock back on line; sand and gravel ahead on line
19	L76-131	Rock exposed on south bank below substation
20	L76-133	RG Anderson Substation

TABLE 1B SITE REVIEW COMMENTS - ALTERNATE ALIGNMENT (km 0 at str L76-56)

	KM #	COMMENT
1	0 to 1.5	Predominantly soil with local rock outcrops
2	1.5 to 3.0	60% rock more at high points
3	3.0 to 7.0	Soil (likely granular – easily erodible)
4	7.0 to 14.2	Predominantly Rock some shallow soil cover in low areas
5	14.2 to 15.2	Shallow soil cover – Gillies Creek Valley
6	15.2 to 18.0	Predominantly Rock with local shallow soil cover
7	18.0 to PGA Sub	Soils with local shallow rock

6. General Foundation Discussion

The soils are considered to be adequate to support poles designed on standard foundations. These would consist of normal direct buried depths for wood poles and concrete spread foundations for the double circuit steel poles. There were no areas noted where deep foundations were considered necessary.

Structures located on exposed and very shallow rock (less than 1 m) can be placed in blasted holes for wood poles and on anchored block foundations for double circuit steel poles. Areas where rock and soil foundations are likely required are indicated as follows in Tables 2A and 2B.

TABLE 2A ESTIMATED FOUNDATIONS - EXISTING ALIGNMENT

	From	To	ESTIMATED FOUNDATIONS
1	L40-01	L76-48	48 structures on mainly soils foundations
2	L76-49	L76-61	12 structures on mainly rock foundations
3	L76-62	L76-64	3 structures on mainly soils foundations
4	L76-65	L76-88	23 structures on poor rock (possibly soils fdns)
5	L76-89	L76-114	23 structures on mixed – shallow rock
6	L76-115	L76-123	8 structures on mainly rock or shallow rock
7	L76-124	L76-133 end	9 structures on mainly soils foundations

TABLE 2B ESTIMATED FOUNDATIONS - ALTERNATE ALIGNMENT

	From	To	TYPE OF FOUNDATIONS
1	L76-56	7 km	Mainly on soils foundations
2	7 km	14.2 km	Mainly on rock foundations
3	14.2 km	15.2 km	Mainly on soils foundations
4	15.2 km	18 km	Mainly on rock foundations
5	18 km	RGA sub	Mainly on soils foundations

7. CONCLUSIONS

The discussions provided in this report must be considered as preliminary and as overview in nature for preliminary ball part estimation purposes. The alignments reviewed were generally considered to be stable and the majority of natural hazards can be mitigated by careful location of structures. The upper alignment is much more remote and access will likely be limited. Hence, hazards such as from forest fire will be difficult to combat. There are a few structures which may require rock fall protection. Such a requirement should be assessed at the time of locating the structures.

The foundation estimates attached must also be considered to be very approximate. Approximately 1/3 of the structures are expected to need to be supported on rock foundations. The remainder will be on competent soils and no deep foundations (soft soil foundations) are considered to be required. Once an alignment is closer to finalization, review of specific sites is recommended to allow more accurate assessment of foundation requirements.

APPENDIX E: ACCESS OVERVIEW

[1] Based on Design Basis Template – Original 4 May 2007

FORTISBC

OKANAGAN TRANSMISSION REINFORCEMENT PROJECT (OTR)

Access Overview – Route Options

Prepared for FortisBC by:

BC hydro

Engineering

22 May 2007

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List of Abbreviations

FSR	FSR means forest service road
kV	kV means kilovolt (1000 volts)
MOFR	MOFR means Ministry of Forestry and Range
O/H	Overhead
RoW	RoW means right(s)-of-way
T/L	T/L means transmission line
Twr	Twr means tower

Executive Summary

FortisBC electric transmission line supply to Penticton, BC and Oliver, BC is rapidly reaching capacity. It has been determined that Penticton requires two 230kV transmission lines to replace an existing 161kV line and Oliver requires one 230kV transmission line to replace an existing 161kV line.

The Okanagan Transmission Reinforcement (OTR) project refers to a FortisBC initiative to examine the options to fulfill the need for additional electric transmission line capacity in the Penticton/Oliver areas.

The FortisBC Vaseux Substation, located approximately 30km south of Penticton and 10km north of Oliver, is the current source of the 161kV single circuit woodpole O/H transmission line (L76) to R.G.Anderson Substation in Penticton and a similar transmission line (L40) to Oliver Substation in Oliver. Vaseux Substation, which is connected to a BCHydro 500kV transmission line, will also be the source of additional electric transmission line supply.

The intent of this Access Overview is assist in preparing cost estimates and to show the location of the major usable access roads and tracks, via the maps in Appendix A, to and along the route options being considered by the OTR Project. It can be used as a discussion document with landowners to discuss access options. It is to also save time and effort of those not familiar with the lines and proposed routing during the project review and construction phases.

This report is not intended to be a detailed description of the condition of the access to and along the right-of-way because the review was restricted to public roads and a helicopter overview. Therefore road condition comments remain general in nature.

Orthophoto maps, at a larger scale (1:2500), can be used to view more detail of existing access along the right-of-way. The report is also not a detailed plan for developing access where owner consultation or professional design expertise would be required for new water crossings or sections along unstable slopes. These items are generally

considered as part of a subsequent detailed access assessment report when the final routing is determined.

1.0 Introduction

FortisBC electric transmission line supply to Penticton and Oliver in the BC Okanagan area is rapidly reaching capacity. It has been determined that Penticton requires two 230kV transmission lines to replace an existing 161kV line and Oliver requires one 230kV transmission line to replace an existing 161kV line.

Route options for two new 230 kV transmission lines to Penticton start at the FortisBC Vaseux Substation, located 30km south of Penticton, and end at R.G.Anderson Substation on the east side of Penticton

The current project is examining

(i) 2-230kV circuits to Penticton via double circuit steel poles along the existing route (see Photo 1); or

Photo 1 – Example of 230kV Double Circuit Steel pole structure (not necessarily OTR design)

(ii) 2-230kV circuits to Penticton via double circuit steel poles along the first 7km of the existing route and then along a higher elevation route; or

(iii) 2-230kV circuits to Penticton via double circuit steel poles along the first 7km of the existing route and then 2-230kV single circuits along a higher elevation route; and

(iv) 1-230kV circuit to a proposed new Bentley Substation in Oliver via a single circuit woodpole along the existing route.

The terrain in the Okanagan valley varies from gently rolling desert in the Oliver area to hilly, agricultural range or crop lands interspersed with steep and rocky terrain and incised creek valleys in the Okanagan Falls/Penticton area. Therefore access along much of the existing and proposed routes is discontinuous and many accesses to the right-of-way are required. Many of the roads and access tracks in the vicinity of the existing transmission lines, which were developed during construction, are often private, gated and locked preventing public access to the line. The incised creek valleys, along the existing lines, means access along the right-of-way is discontinuous and therefore many accesses to the right-of-way are required.

The existing 161 kV circuits to Penticton and Oliver were built in the 1960’s and roads to and along the right-of-way are generally well established. However the high cost of developing access in steep, rocky terrain during construction and the evolution of private land boundaries since construction has precluded the addition and maintenance of some access to or along the right-of-way. While some roads have been maintained, roads on private land or used infrequently have deteriorated and are often overgrown or converted to cow paths.

Proposed double-circuit, steel poles in place of the L76 line and the proposed single-circuit woodpoles in place of the L40 line will carry the new circuit conductors with span lengths similar to the existing lines so much of the access to existing poles can be used and developing access to new pole locations will be minimized.

Options for the new transmission line routings have been identified. This access overview describes access to these route options separately. This overview is primarily referenced to the maps at 1:40,000 or 1:25,000 (approximate scale).included with this report in Appendix A showing the route options.

2.0 Purpose

There are numerous roads in the vicinity of the existing transmission lines between Oliver and Penticton but many do not lead to the right-of-way, are private, or gated and locked preventing access to the line. The intent of this Access Overview is to assist in preparing cost estimates and provide a brief description and location of access to the route options to save time and effort by those not familiar with the existing and proposed routings for the lines during the project review and construction phases. It can also be used as a discussion document with landowners to discuss access options. The report describes only the major usable access roads to route options including those along the existing transmission lines of L76 to Penticton and L40 to Oliver. The access roads leading to various points along the route options are shown on the maps contained in Appendix A. These maps show the main access points to various sections along the existing lines and route options and are the primary product of the report. The maps have been kept to 11”x17” paper size to facilitate use in the field. The text in this report is to supply supplementary information to the maps.

This Access Overview also provides information to promote safety and highlight the hazards encountered when accessing transmission line rights-of-way. It may also be used for consideration in the development of suitable and properly engineered access, which will facilitate construction and on-going maintenance activities.

This report is not intended to be a detailed description of the condition of access to and along the right-of-way but some general comments on road conditions are included. Access along the right-of-way is very discontinuous. Orthophoto maps at a larger scale (1:2500) are available as part of the project and show more detail on existing track locations. They can be used to determine detailed access alignments along the right-of-way in a particular area which is beyond the scope of this report. This report is also not a detailed plan for developing new access where owner consultation or professional design expertise would be required for new alignments, water crossings or sections along unstable slopes. A more detailed description of access to and along the right-of-way and requirements for additional access for construction is usually described in a subsequent access assessment report that is prepared when a final routing is determined. Detailed measurements of access requirements are then determined during the centerline survey and preliminary line design phases of the project for tendering purposes prior to construction activity.

In general, access design for a new transmission line continues to be refined in consultation with project stakeholders, such as landowners and government agencies, in accordance with project and environmental requirements. Actual access construction generally includes main and spur roads, ditching, culvert and bridge installation, gravel work, gating, etc. These activities may take place during timber harvesting and clearing in accordance with specifications in the contracts, or during line construction after the right-of-way has been cleared.

3.0 General

The field review for this Access Overview took place in April, 2007. The weather remained dry during this time and although most of the access to the right-of-way described in this report is unaffected by wet conditions some sections may deteriorate during the wet season. The alternate upland route to Penticton is at substantially higher elevation than the existing L76 line and subject to heavy snowfall, which is therefore impassable during much of the winter.

There is an access system associated with most of the existing L76 and L40 transmission lines. However, there are several rock gullies and creek ravines precluding continuous access along the right-of-way so numerous roads must be used for access to the transmission lines. Also, access along the right-of-way is generally slow where speed is often limited to 10 kmh or less. Therefore this overview report and the maps contained in Appendix A, are provided to show the most expeditious route to access the right-of-way or a particular site along the right-of-way and for establishing cost estimates for construction.

Specific concerns regarding terrain, fisheries, wildlife, forestry, land use and heritage values are not discussed but will likely be addressed when a detailed road location plan is prepared based on an approved centerline alignment.

Section 4.0 describes the major access to the route options under study by the OTR project. For ease of describing access locations existing transmission line labeling is used when available.

Section 5.0 describes the major access to route options not described in Section 4.0:

3.1 FortisBC's Existing Overhead Transmission Lines L76 & L40

FortisBC's transmission lines L76 and L40 were both built in the 1960's time frame.

The poles on FortisBC's existing transmission line L76 to Penticton are numbered consecutively starting at Pole 29 outside Vaseux Substation, located 30km south of Penticton, and increase as it heads north to Pole 133 outside R.G.Anderson Substation on the east side of Penticton.

The poles on FortisBC's existing transmission line L40 to Oliver are numbered consecutively starting at Pole A outside Oliver Substation, located 10km south of Vaseux Substation, and increase as the line heads east to Pole J at Camp McKinney Road, where it turns north to Pole 1 and increases to Pole 42 outside Vaseux Substation.

3.2 Transmission Line Driving Safety

Access to the transmission line right-of-way is often along existing good quality gravel or dirt roads such as the McIntyre Creek FSR to Poles 37 – 58 shown here in Photo 1. However driving on Forest Service Roads or Industrial roads such as Weyerhaeuser's R201 east of Okanagan Falls requires extreme vigilance. Logging trucks use a radio communication system to report their location on the road. The radio frequency is posted at the beginning of the road. In this way empty trucks can pull off when a loaded truck is coming. Vehicles without radios cannot communicate their location and run the risk of being hit by a truck. Always have lights on when traveling along these roads or use a radio when mandatory during certain hours. Additional care is also needed to avoid "sweepers" which are the long logs that overhang the truck bed and sweep through the on-coming lane around corners.

Photo 2 – McIntyre Creek FSR to Poles 37 - 58

Access to the existing transmission lines has sometimes deteriorated where sidecuts have sloughed in such as the access off Lakeside Road to Poles 100 – 102 shown in Photo 2 where use could lead to a rollover if the track is not widened. This access is restricted by the owner, Nature's Trust.

Photo 3 – Un-maintained access off Lakeside Road to Poles 100 - 102

Wildlife, such as bears attracted by the low growing vegetation and snakes attracted by sun-drenched rocks, are often found along the transmission line right-of-way such as in Photo 5. Appropriate training and procedures are required to ensure personnel safety when traveling along the right-of-way.

Photo 4 – Wildlife along T/L RoW

3.3 Access to the Right-of-Way

Access is, or was, available to most sections of the existing transmission lines. However, where the access is across private land, as is generally the case, the track has been blocked and reduced to remnants of the former track. An example of this is the track off McIntyre Creek FSR to Poles 51 – 54 which has been reduced to a cow path as shown in Photo 4.

Photo 5 – Un-maintained access off McIntyre FSR to Poles 51 - 54

Existing access to the upland route option is via Weyerhaeuser's R201 Road, remnants of a track off Allendale Road east of the dump, remnants of a track along Gillies Creek, or a track off Wiltse Blvd in Penticton. None of the latter three tracks could be reviewed in the field.

The main access to the existing lines and the optional routes are shown on the maps in Appendix A at 1:40,000 or 1:25,000 (approximate scale).

3.4 Access along the Right-of-Way

A detailed field review of access along the right-of-way was beyond the scope of this. Therefore the condition of existing access along the right-of-way is discussed in general terms only based on a cursory field review from public roads and airphotos. When a new transmission line follows an existing transmission line alignment access along the right-of-way has been developed and maintained for the existing lines where possible and cost effective. If existing vehicle access to, or along, the right-of-way cannot be used or new access cannot be developed then helicopter access will be required.

In some instances access to the right-of-way is precluded by terrain, such as Vaseux Canyon, or private use, such as vineyards as shown in Photo 4. Helicopter access is, or may be, required in these areas.

Photo 6 – Access to Pole 92 in vineyard off Matheson Road

The access along the existing transmission lines is generally over poor to good quality gravel or dirt tracks. However, when these roads are across low lying land or steep terrain they tend to deteriorate with heavy use or under wet conditions. Many tracks that were used during construction have become overgrown with vegetation through lack of use such that only remnants of the track remain as in Photo 5 showing a track off Weyerhaeuser R201 Road east of Okanagan Falls. Deadfall will also occur on access tracks when they run outside the cleared right-of-way through timbered areas and will have to be removed. Some sections of the existing access roads are significantly steep and when combined with loose rock surfaces, are extremely difficult to travel such that vehicle direction has to be restricted to “down only”.

Photo 7 – Remnants of access track to Poles 59 – 64 along the right-of way off Weyerhaeuser R201 Road

Much of the access along the right-of-way of the existing transmission line L76 is discontinuous. In some cases the access track meanders on and off the right-of-way in accordance with terrain and may not always pass close to tower sites. Under these circumstances short spur roads are developed across the right-of-way to connect the main access track to structure sites or work areas.

The access along the right-of-way of the existing transmission line L40 is continuous from Vaseux Canyon south to near Camp McKinney road but from here to the proposed Bentley Substation the access along the right-of-way becomes discontinuous.

There is no access along the proposed upland route option for L76 and is likely to be discontinuous if built because of numerous rock ridges.

3.5 Properties

The existing transmission lines, and thus associated access to and along the lines, often crosses through private property that is owned and controlled by the owner. Private owner concerns and requirements for access to and along all route options must be determined before construction tenders are issued. Owners may have specific requirements regarding livestock, irrigation, weed control etc. Specific concerns and requirements of additional private owners occurring outside of these areas, not readily apparent during field assessments, must also be determined during landowner discussions.

The Ministry of Forests and Range (MOFR) and timber licensees using forest service roads (FSR) consider construction of a transmission line an industrial use and thus must be advised of any intent to use roads for construction access.

Site specific requirements for access and permits/approvals for any development or upgrading of access or water crossings are usually determined and obtained prior to the clearing and construction stages on the approved route. Where existing or proposed access lies outside the statutory right-of-way on private land, site specific access arrangements are usually required.

4.0 Access to Existing Lines

4.1 L 76 - Vaseux Substation to RGAnderson Substation

The existing L76 transmission line follows the east side of Vaseux and Skaha Lakes approximately 300 to 400m above lake level and generally above development although some residential and agricultural areas have surrounded the line since its construction in the 1960's. The line heads east from Vaseux Substation, near the Okanagan River and the south end of Vaseux Lake, for 1.5km, then turns and heads north for about 27km to R.G.Anderson Substation on the east side of Penticton.
The majority of the line crosses agricultural areas that support vineyards, orchards and open rangeland but some sections are predominantly rock.
The existing access to the poles along the L76 transmission line is as follows although design differences for a new transmission line may require additional or alternate access or access method during construction and subsequent maintenance.

a) **Hwy 97 – Vaseux Substation & Pole 29 -** the area around Vaseux Substation and Pole 29 is private FortisBC land and is accessed by a driveway off the east side of Hwy 97 approximately 8km north of Oliver,BC;
b) **Helicopter - Poles 30 to 34 –** these poles cross Crown land and are on a rocky cliff on the south side of Vaseux Creek. There are no signs of vehicle tracks and presumably the area is only accessed by helicopter;
c) **Camp McKinney Road - Poles 35,36 –** vehicle access to these poles is available by following a dirt track off Camp McKinney Road approximately 6km south of the poles and heading north across Osoyoos Indian Reserve IR 1**;**

Photo 8 – Entrance to Osoyoos IR 1 off Camp McKinney Road

d) **Helicopter - Poles 37 to 43 –** these poles are on the north side of Vaseux Creek across open range with Poles 37 to 39 on Crown land and Poles 40 to 43 on private land. There are no signs of access tracks in the area. While there is a private road off the McIntyre Creek FSR crossing the transmission line near Pole 44 and the terrain does not preclude access construction it is understood access is restricted by the owner to prevent invasive weeds from spreading and access is by helicopter;

e) **Helicopter - Poles 44 to 47 –** these poles are across open range on private land. There are remnants of a vehicle track heading north along the line off the private road from McIntyre Creek FSR in this section but it is understood access is restricted by the owner to prevent invasive weeds from spreading and access is by helicopter;

f) **Helicopter - Poles 48 to 48A –** these poles are across open range on private land. There are remnants of a track heading north through a stretch gate off the McIntyre Creek FSR under the line in this section, but it is understood access is restricted by the owner to prevent invasive weeds from spreading and access is by helicopter;

g) **Helicopter - Poles 49, 50 –** these poles are across open range with Pole 49 on private land and Pole 50 on Crown land. There are no signs of a vehicle track in this section and while the terrain does not preclude access construction it is understood access is restricted by the owner to prevent invasive weeds from spreading and access is by helicopter;

h) **McIntyre Creek FSR – Poles 51 to 54 -** these poles are across open range on Crown land. There are remnants of a vehicle track along the line in this section which can be accessed via an overgrown, primitive track off McIntyre Creek FSR located 700 metres to the east where it is blocked by boulders;

Photo 9 – Segment of McIntyre Creek FSR near track leading to Poles 51 to 54.

i) **McIntyre Creek FSR - Poles 55 to 58 –** these poles are across open range with Poles 54 to 57 on Crown land and Pole 58 on private land of Nature's Trust. There are remnants of a track along the line in this section which can be accessed via an overgrown, primitive track off McIntyre Creek FSR located 1.5km east or from a track across private property off Allendale Road to the north;

Photo 10 – Primitive track to Poles 55 -58 from McIntyre FSR

j) **Weyerhaeuser R201 Road - Poles 59 to 64 –** these poles are across open range on private land of Nature's Trust. There are remnants of a track along the line in this section which can be accessed via a ranch track off Weyerhaeuser R201 Road located 1km east or by installing a gate and establishing access from R201 where it passes under the line between Pole 64 and 66 (Pole 65 missing) on the south side of Shuttleworth Creek (see Photo 7);

k) **Chapman Road – Poles 66, 67 –** these poles cross private cultivated land and it appears they can be accessed via ranch tracks across private property off the south end of Chapman Road located 450 metres east of the line;

l) **McLean Creek Road – Pole 68 –** this pole is on private cultivated land and it appears it is accessed via a ranch track across private property off McLean Creek Road located about 200 metres west of the line;

m) **Allendale Road – Poles 69, 70 –** Pole 69 is on private cultivated land and can be accessed via a gate under the line on the south side of Allendale Road. Pole 70 is also on private cultivated land and can be accessed from Allendale Road located 100 metres south if a gate is installed in the fence or from a private driveway located 150 metres north off McLean Creek Road**;**

Photo 11 – Looking south at Pole 70 off McLean Creek Road

n) **McLean Creek Road – Pole 71 –** Pole 71 is on a 4m elevated mound of private land and can be accessed from McLean Creek Road or from a private driveway off McLean Creek Road south of the pole;
o) **McLean Creek Road – Poles 72,73 –** these poles cross open range on Crown land and it appears there are remnants of vehicle tracks to the poles and along the line off McLean Creek Road thru a stretch gate about 80 metres north of Pole 71. These poles can also be accessed from the north along the line.
p) **McLean Creek Road – Poles 74 to 79 –** Poles 74 to 79 cross open range with Poles 74 & 75 on Crown land and Poles 76 to 79 on private land of Nature's Trust. There is a good, gravel track to this section from McLean Creek Road located 400 metres west of the line mid-span between Poles 75 & 76. From this track there is a vehicle track running along or close to the line with tracks to the poles throughout this section;
q) **McLean Creek Road – Pole 81 –** Pole 81 is on private, open land adjacent to the owner's driveway for access;

Photo 12 – Looking north at Pole 81 next to private driveway off McLean Creek Road

r) **Helicopter – Poles 82, 83 –** these poles are on the open private land of two different owners. There are no signs of vehicle track in the area of the line and although terrain does not preclude access construction it is assumed access by helicopter;

s) **McLean Creek Road – Pole 84 –** Pole 84 is located in a private vineyard where it appears vehicle access is available by following the owner's private driveway and a track through the vineyard;

t) **McLean Creek Road – Poles 85 to 90 –** these poles cross open private land. There are remnants of a vehicle track along the line in this section that can be accessed from a private driveway off McLean Creek Road in the south or perhaps a private drive off Matheson Road to the north;

u) **Helicopter – Pole 91 –** Pole 91 is in the middle of a private orchard or vineyard. The nearest vehicle track in the vicinity of the line is about 30 metres away which appears to be off Matheson Road or helicopter access may be necessary;

v) **Helicopter – Pole 92 –** Pole 92 is on the edge of a private vineyard at the base of a 10m high slope off Matheson Road. There is a vehicle track in the vineyard along the base of the slope that could connect with Matheson Road if a gate was installed approximately 120 metres north or helicopter access may be necessary;

w) **Helicopter – Pole 93 –** Pole 93 is on open, sloping private land. There are no signs of a vehicle track in the vicinity of the line. It appears helicopter access will be necessary;

x) **Parsons Road – Pole 94 –** Pole 94 is in a vineyard on the edge of a private driveway off of Parson Road approximately 300 metres west and downhill. The driveway appears to provide optimal access to the pole;

y) **Heritage Blvd – Poles 95 to 97–** Poles 95 to 97 are on private, vacant residential lots at the top of Heritage Hills Subdivision. With a minor amount of access development each site can have vehicle access off of different sections of Heritage Blvd. While vehicle access may be prepared at this time, ongoing area development may preclude vehicle access in the future;

z) **Helicopter – Poles 98, 99 –** Poles 98 and 99 are on private, sloping land isolated by residential housing on all sides. There are no signs of vehicle tracks in the vicinity of the line and helicopter access is likely necessary;

aa) **Eastside Road – Poles 100 to 108 –** Poles 100 to 108 are on open, sloping and rocky terrain where Poles 100 to 104 are on private land of Nature's Trust, Poles 105 to 106 are on private land and Poles 107, 108 are on Crown land. There are signs of a vehicle track to each pole from a good quality vehicle track along the line throughout this section which can be accessed from Eastside Road in the south via a private driveway or unnamed, gated track east of Pole 101 and in the north via a dirt track along Gillies Creek off Smythe Drive. At the north end there also appears to be an alternate dirt track off Smythe Drive which crosses Gillies Creek on the west of the line and crosses over private to intersect the longer track up Gillies Creek;

bb) **Valleyview Road – Poles 109, 110 –** Poles 109 & 110 are on open, private land. There are remnants of a vehicle track to each of these poles from a track off the south end of Valleyview Road located 600 metres northwest near the parking lot of a Rock Climbing Facility.

Note Valleyview Road is labeled as a primitive road within 1 km of the climbing facility because it becomes a narrow and rutted dirt track;

cc) **Evergreen Drive – Poles 112 to 119 –** Poles 112 to 119 are on open, rocky private land. There are signs of a vehicle track to each pole from a a good quality vehicle track along the line throughout this section which is accessed through a locked gate at the south end of Evergreen Road;

dd) **Crow Place (Evergreen Drive) – Poles 120 to 122 –** Poles 120 to 122 are on open, rocky private land. There is a good quality vehicle track along the line throughout this section which is accessed from the north through a locked gate on Crow Place at the south end of Evergreen Road. Alternatively these poles can be accessed from the north through a locked gate off the east end of Wiltse Blvd;

ee) **Crow Place (Evergreen Drive) & Wiltse Blvd – Poles 123 to 130 –** Poles 123 to 130 are on open, undeveloped private land adjacent to a new and growing residential subdivision. There are signs of a vehicle track to each pole from a good quality vehicle track along the line throughout this section, which is accessed from the south through a locked gate on Crow Place at the south end of Evergreen Road. Alternatively these poles can be accessed from the north through a locked gate off the east end of Wiltse Blvd;

ff) **Carmi Road – Poles 131-132 –** these poles are located on the north bank of Ellis Creek. There is a good quality gravel track off Carmi Road to Pole 131 and Pole 132 is next to Carmi Road.

4.2 L40 Vaseux Substation to Proposed Bentley Substation

The existing L40 transmission line follows the east side of Okanagan River approximately 100 to 200m above the valley with most of the line traversing desert-like grazing land across Osoyoos Indian Reserve IR 1. The area has changed little since its construction in the 1960's. The line heads east from Vaseux Substation, near the Okanagan River and the south end of Vaseux Lake, for 1.5km, then turns and heads south for about 8km where it turns west for 1.5km to proposed Bentley Substation on a plateau above the Nk'Mip Canyon Desert Golf Course east of Oliver. The desert conditions and level nature of the terrain in the area tends to preserve the access. The existing access to the poles along the L40 transmission line is as follows although design differences for a new transmission line may require additional or alternate access or access method during construction and subsequent maintenance.

a) **Hwy 97 – Vaseux Substation & Pole 42 -** the area around Vaseux Substation and Pole 29 is private FortisBC land and is accessed by a driveway off the east side of Hwy 97 approximately 8km north of Oliver,BC;
b) **Helicopter - Poles 41 to 37 –** these poles cross Crown land and are on a rocky cliff on the south side of Vaseux Creek. There are no signs of vehicle tracks and presumably the area is only accessed by helicopter;
c) **Camp McKinney Road - Poles 36 to 17–** vehicle access to these poles is available by following a dirt track off Camp McKinney Road approximately 6km south of Pole 36 that heads north across Osoyoos Indian Reserve IR 1. The road appears to be a good quality dirt road with little elevation difference throughout its length (see Photo 8);
d) **Camp McKinney Road – Poles 16 to 13 –** vehicle access to these poles is off a dirt track about 2.5km north of where it leaves Camp McKinney Road. Poles 16 and 15 are at a slightly higher elevation but the track appears to be in good shape**;**

Photo 13 – Looking north from Camp McKinney road at Poles 13 – 16

e) **Camp McKinney Road – Poles 12 to 10 –** vehicle access to these poles is via a gas pipeline access track off Camp McKinney Road. If there is a suitable access crossing over the pipeline these poles could be accessed from the section with Poles 13 – 16;

f) **Camp McKinney Road – Poles 9 to 7 –** vehicle access to these poles is directly off Camp McKinney Road and along the right-of-way;

Photo 14 – Looking west off Camp McKinney Road at track to Pole 7

g) **Camp McKinney Road – Poles 6 to 4 –** vehicle access to these poles is from a track off Camp McKinney Road about 400 metres east of the line crossing over Camp McKinney Road to Pole 6 and then along the right-of-way;

h) **Camp McKinney Road – Poles 3 to 2 –** vehicle access to these poles is via a private driveway from Camp Mckinney Road to Pole 2 and then along the right-of-way to Pole 2;

i) **Camp McKinney Road – Pole 1 –** there is no obvious track to this pole but there is easy vehicle access directly off Camp McKinney Road;

j) **Camp McKinney Road – Pole J –** vehicle access to this pole is along an established track off Camp McKinney Road;

k) **Camp McKinney Road – Poles J to C –** vehicle access is available to these poles by using a private drive to Cherry Grove Vineyards off Camp McKinney Road about 100 metres north of the line crossing over Camp McKinney Road. The private drive is a good quality 2-lane road with a combination cattleguard/bridge/gate over Atsiklak Creek near Camp McKinney Road. Pole C is opposite the location of the proposed Bentley Substation**;**

Photo 15 – Looking at private driveway to Cherry Grove Vineyards and Poles J - C

5.0 Access to Alternate Route Option

5.1 Vaseux Substation to RGAnderson Substation - Upland Route

This route option uses the existing L76 transmission line from Vaseux Substation, north above Vaseux Lake to approximately Pole 57 approximately 8 km north of Vaseux Substation. Access to this part of the route would thus be the same as that described in Section 4.1, up to Subsection (i). From the existing Pole 57 the route turns northeast and climbs across vacant Crown land from km 0 to km 5 until the 1000 metre elevation.

Photo 16 – Looking northeast from Weyerhaeuser R201 Road at upland route option km 2 – 3.

At km 5 the route then turns again and follows the 1000 metre elevation north, at 500 to 600 metres above the existing line, for the next 16 km across vacant Crown land to near R.G.Anderson Substation on the east side of Penticton. The terrain on this route option is very rugged with numerous rock outcrops and although there are remnants of selective logging near 5 km there are no other signs of activity along the route**.**

Photo 17 – Looking north at upland route option and Penticton

Mature pine, spruce and larch dominate the south third of the route while the remainder is scattered conifers, much of which has been burned. The existing access to the upland route option is as follows using kilometers from Pole 57 as a reference:

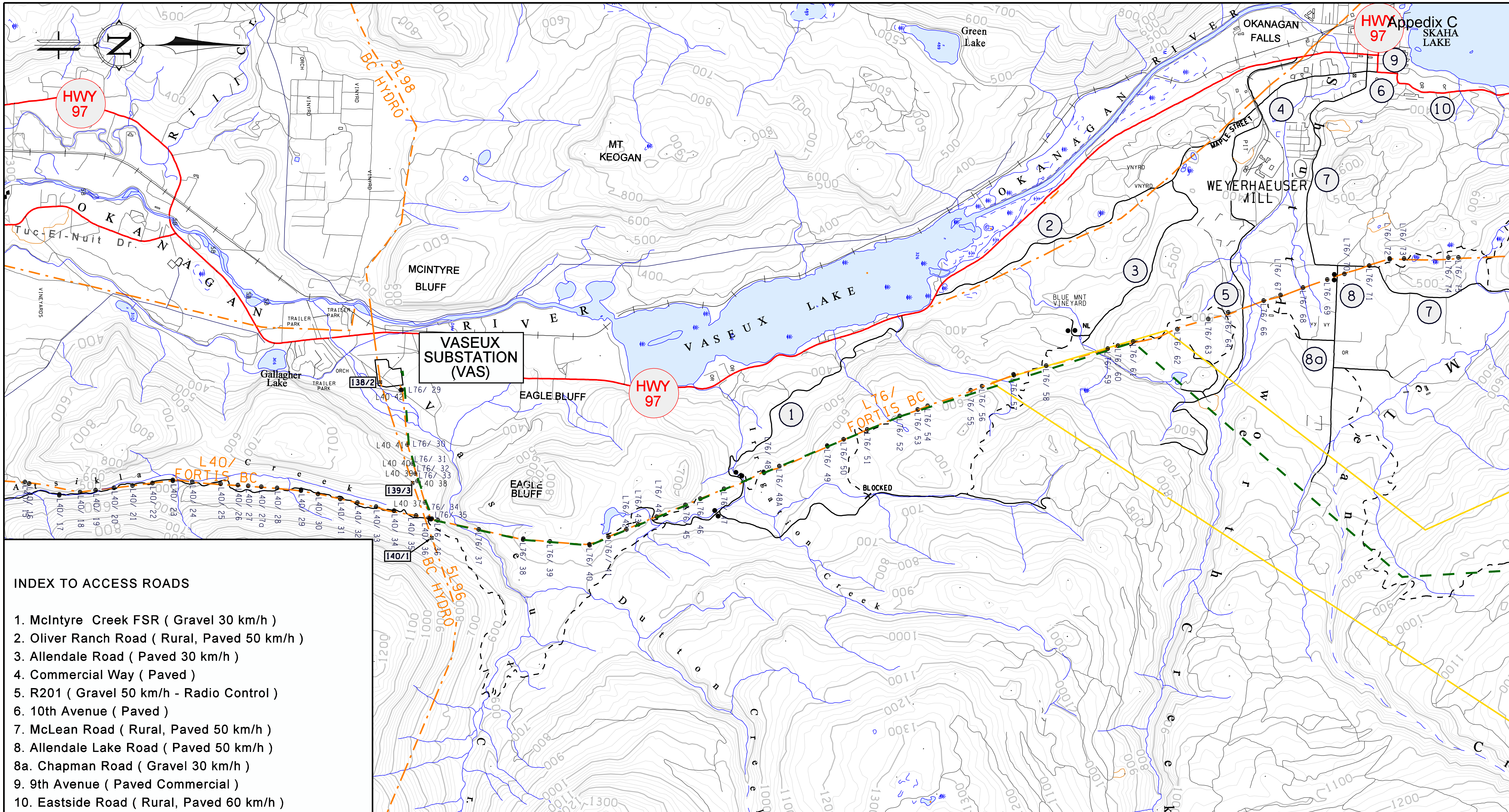
a) **Weyerhaeuser R201 Road – km 2 –** there is vehicle access to this part of the route option via the good quality, gravel Weyerhaeuser R201 Road east of Okanagan Falls;
b) **Allendale Road – km 3.5 –** it appears there are remnants of vehicle access to this part of the route from the west off the east end of Allendale Road past the dump;
c) **Un-named road – km 4 –** there are remnants of vehicle access switchbacking up the hill to this part of the route off a private road from Allendale Road to the west of the route;
d) **Un-named road – km 16 –** there are remnants of vehicle access off the end of Smythe Drive and Lakeside Road that follows Gillies Creek to this part of the route;

e) **Un-named road – km 19 –** there are remnants of vehicle access through the locked gate off the east end of Wiltse Blvd to this part of the route.

The upland route option then joins the existing L76 transmission line and access to the route is again the same as that to the existing line as described in Section 4.1, Subsections (ee) & (ff).

Appendix A

Access Overview Sheets



INDEX TO ACCESS ROADS

1. McIntyre Creek FSR (Gravel 30 km/h)
2. Oliver Ranch Road (Rural, Paved 50 km/h)
3. Allendale Road (Paved 30 km/h)
4. Commercial Way (Paved)
5. R201 (Gravel 50 km/h - Radio Control)
6. 10th Avenue (Paved)
7. McLean Road (Rural, Paved 50 km/h)
8. Allendale Lake Road (Paved 50 km/h)
8a. Chapman Road (Gravel 30 km/h)
9. 9th Avenue (Paved Commercial)
10. Eastside Road (Rural, Paved 60 km/h)

LEGEND

ALIGNMENT OPTIONS	
EXISTING TRANSMISSION LINE(S)	
MAIN ROAD / SECONDARY ROAD	
MAIN ACCESS ROAD	
ACCESS TRACK	
GATE	
UNLOCKED GATE	N.O.
LOCKED GATE	N.L.
FOREST SERVICE ROAD	FSR
BC HYDRO TOWER NUMBER	140/1
STUDY CORRIDOR	

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL METRIC MAP
CONTOUR INTERVAL 100 m
UTM ZONE 10, NAD83
BCGS REFERENCE: 82 E / L, 92 G / H / I / J
BASE MAP DERIVED FROM PROVINCIAL TRIM MAPPING

1500 0 1500 3000m
SCALE AS SHOWN

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY		
								DRAWN BY	DU	16.06.07
								CHECKED BY		
				b	DU	4.12.07	Revised Highland Option	APPROVED BY		

BChydro ENGINEERING

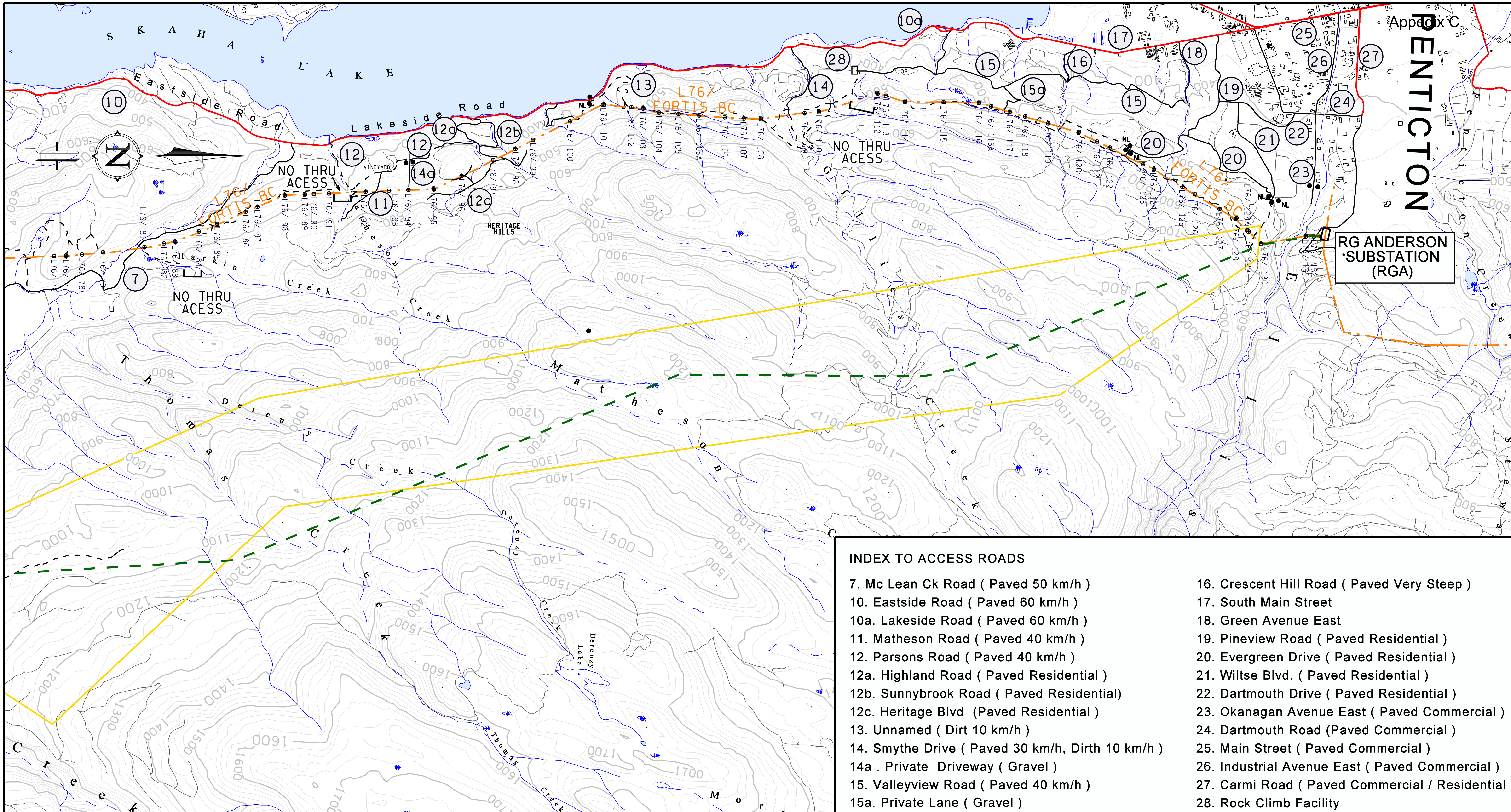
BC HYDRO DWG NO. L76-T07 - B1 R B

FORTISBC

FORTIS TRANSMISSION REINFORCEMENT
VASEUX SUB to R.G. ANDERSON SUB
ACCESS OVERVIEW

SHEET 1 OF 2

DRAWING NUMBER L76-T07 - B1 REV b



INDEX TO ACCESS ROADS

7. Mc Lean Ck Road (Paved 50 km/h)
10. Eastside Road (Paved 60 km/h)
10a. Lakeside Road (Paved 60 km/h)
11. Matheson Road (Paved 40 km/h)
12. Parsons Road (Paved 40 km/h)
12a. Highland Road (Paved Residential)
12b. Sunnybrook Road (Paved Residential)
12c. Heritage Blvd (Paved Residential)
13. Unnamed (Dirt 10 km/h)
14. Smythe Drive (Paved 30 km/h, Dirth 10 km/h)
14a . Private Driveway (Gravel)
15. Valleyview Road (Paved 40 km/h)
15a. Private Lane (Gravel)
16. Crescent Hill Road (Paved Very Steep)
17. South Main Street
18. Green Avenue East
19. Pineview Road (Paved Residential)
20. Evergreen Drive (Paved Residential)
21. Wiltse Blvd. (Paved Residential)
22. Dartmouth Drive (Paved Residential)
23. Okanagan Avenue East (Paved Commercial)
24. Dartmouth Road (Paved Commercial)
25. Main Street (Paved Commercial)
26. Industrial Avenue East (Paved Commercial)
27. Carmi Road (Paved Commercial / Residential)
28. Rock Climb Facility

LEGEND

ALIGNMENT OPTIONS	
EXISTING TRANSMISSION LINE(S)	
MAIN ROAD / SECONDARY ROAD	
MAIN ACCESS ROAD	
ACCESS TRACK	
GATE	
UNLOCKED GATE	N.O.
LOCKED GATE	N.L.
FOREST SERVICE ROAD	FSR
BC HYDRO TOWER NUMBER	140/1
STUDY CORRIDOR	

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL METRIC MAP
CONTOUR INTERVAL 100 m
UTM ZONE 10, NAD83
BCGS REFERENCE: 82 E / L, 92 G / H / I / J
BASE MAP DERIVED FROM PROVINCIAL TRIM MAPPING

1500 0 1500 3000m
SCALE AS SHOWN

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION		
								DESIGNED BY	
								DRAWN BY	DU 16.06.07
								CHECKED BY	
				b	DU	4.12.07	Revised Highland Option	APPROVED BY	

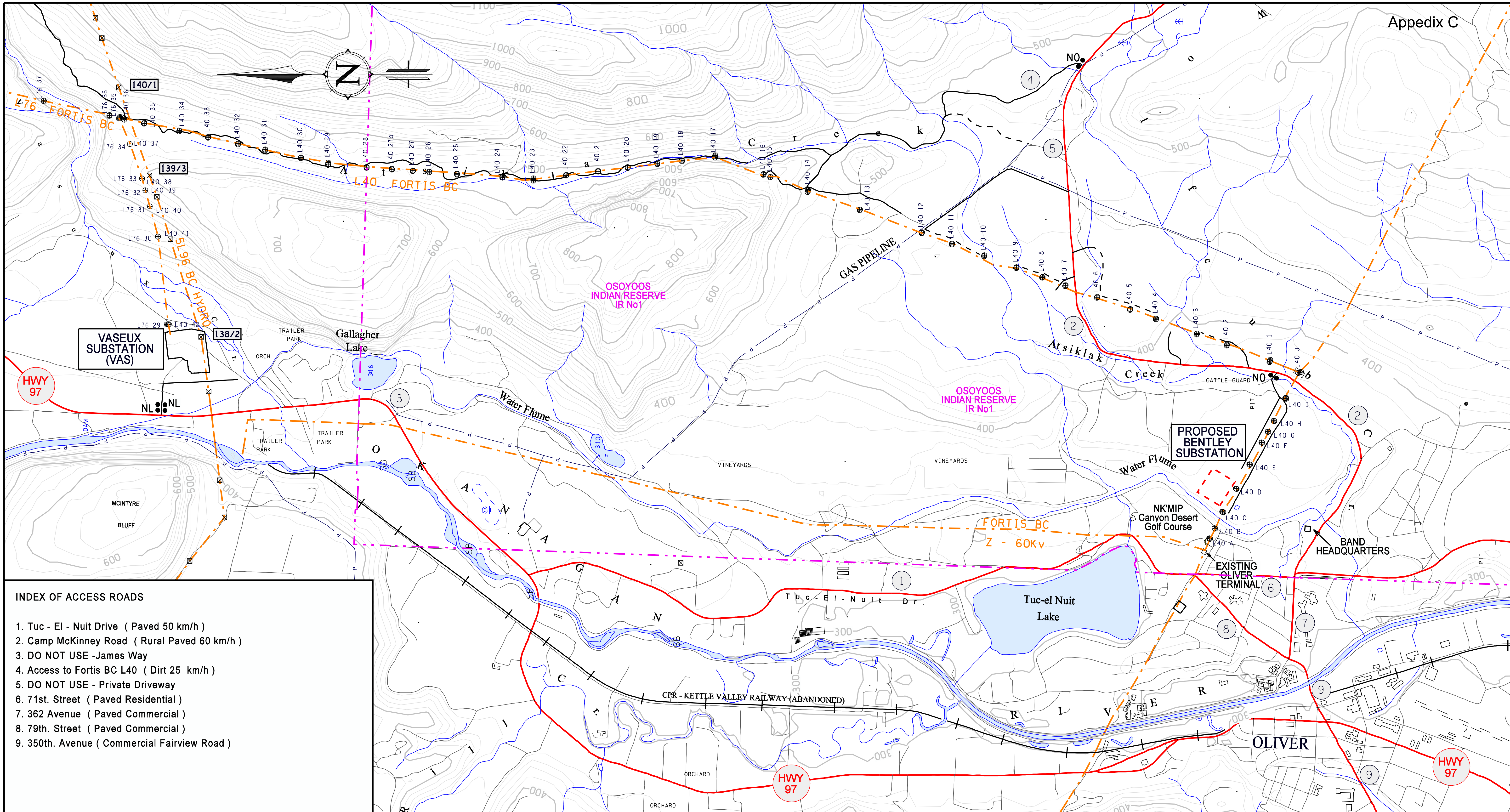
BChydro ENGINEERING
BC HYDRO DWG NO. L76-T07 - B1 R B

FORTISBC

FORTIS TRANSMISSION REINFORCEMENT
VASEUX SUB to R.G. ANDERSON SUB
ACCESS OVERVIEW

SHEET 2 OF 2

DRAWING NUMBER L76-T07 - B1 REV b



INDEX OF ACCESS ROADS

1. Tuc - El - Nuit Drive (Paved 50 km/h)
2. Camp McKinney Road (Rural Paved 60 km/h)
3. DO NOT USE -James Way
4. Access to Fortis BC L40 (Dirt 25 km/h)
5. DO NOT USE - Private Driveway
6. 71st. Street (Paved Residential)
7. 362 Avenue (Paved Commercial)
8. 79th. Street (Paved Commercial)
9. 350th. Avenue (Commercial Fairview Road)

LEGEND

ALIGNMENT OPTIONS	
EXISTING TRANSMISSION LINE(S)	
INDIAN RESERVE BOUNDARY	
MAIN ROAD / SECONDARY ROAD	
MAIN ACCESS ROAD	
ACCESS TRACK	
GATE	
UNLOCKED GATE	N.O.
LOCKED GATE	N.L.
FOREST SERVICE ROAD	FSR
BC HYDRO TOWER NUMBER	140/1
WOOD LOT	WL
UNSURVEYED CROWN LAND	UCL

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL METRIC MAP
CONTOUR INTERVAL 100 m
UTM ZONE 10, NAD83
BCGS REFERENCE: 82 E / L, 92 G / H / I / J
BASE MAP DERIVED FROM PROVINCIAL TRIM MAPPING

SCALE AS SHOWN

1000 0 1000 2000m

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION

DESIGNED BY		
DRAWN BY	DU	16.06.07
CHECKED BY		
APPROVED BY		

FORTISBC

BChydro ENGINEERING

BC HYDRO DWG NO. L40 - T07 - B1 R 1

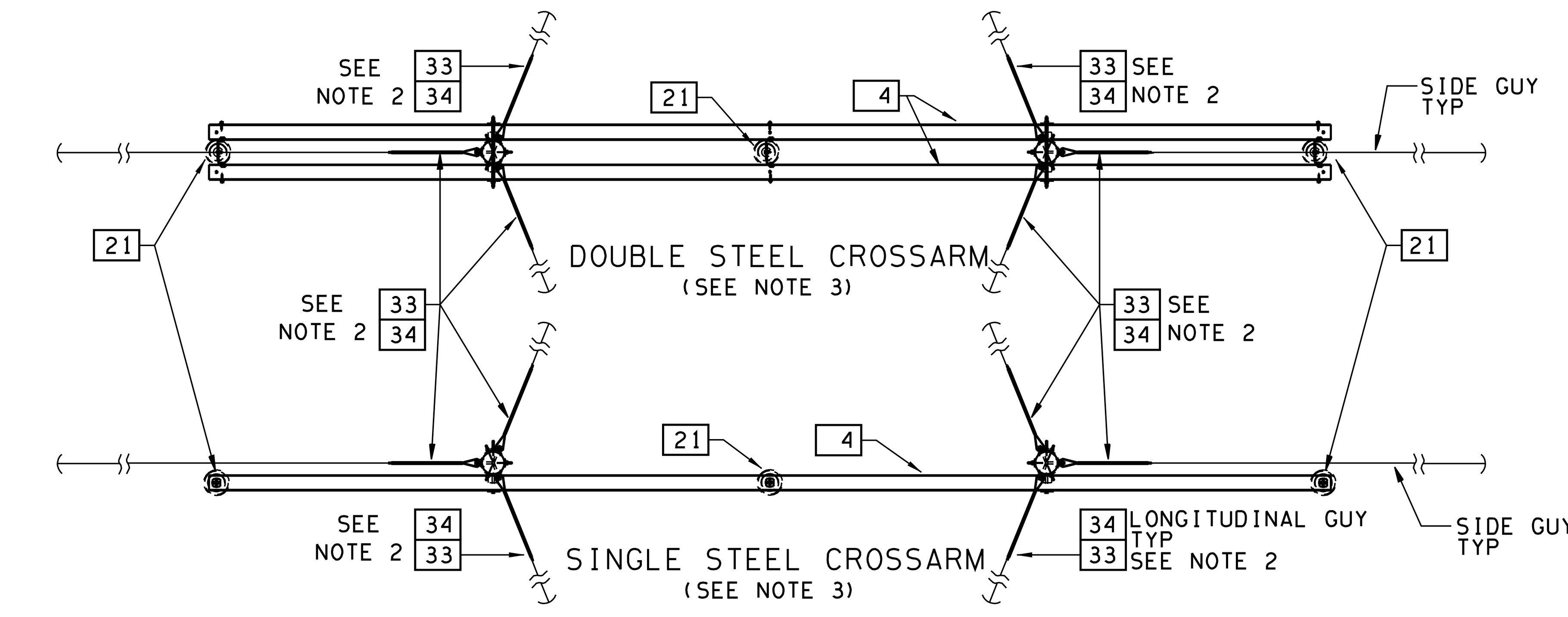
FORTIS TRANSMISSION REINFORCEMENT

ACCESS OVERVIEW

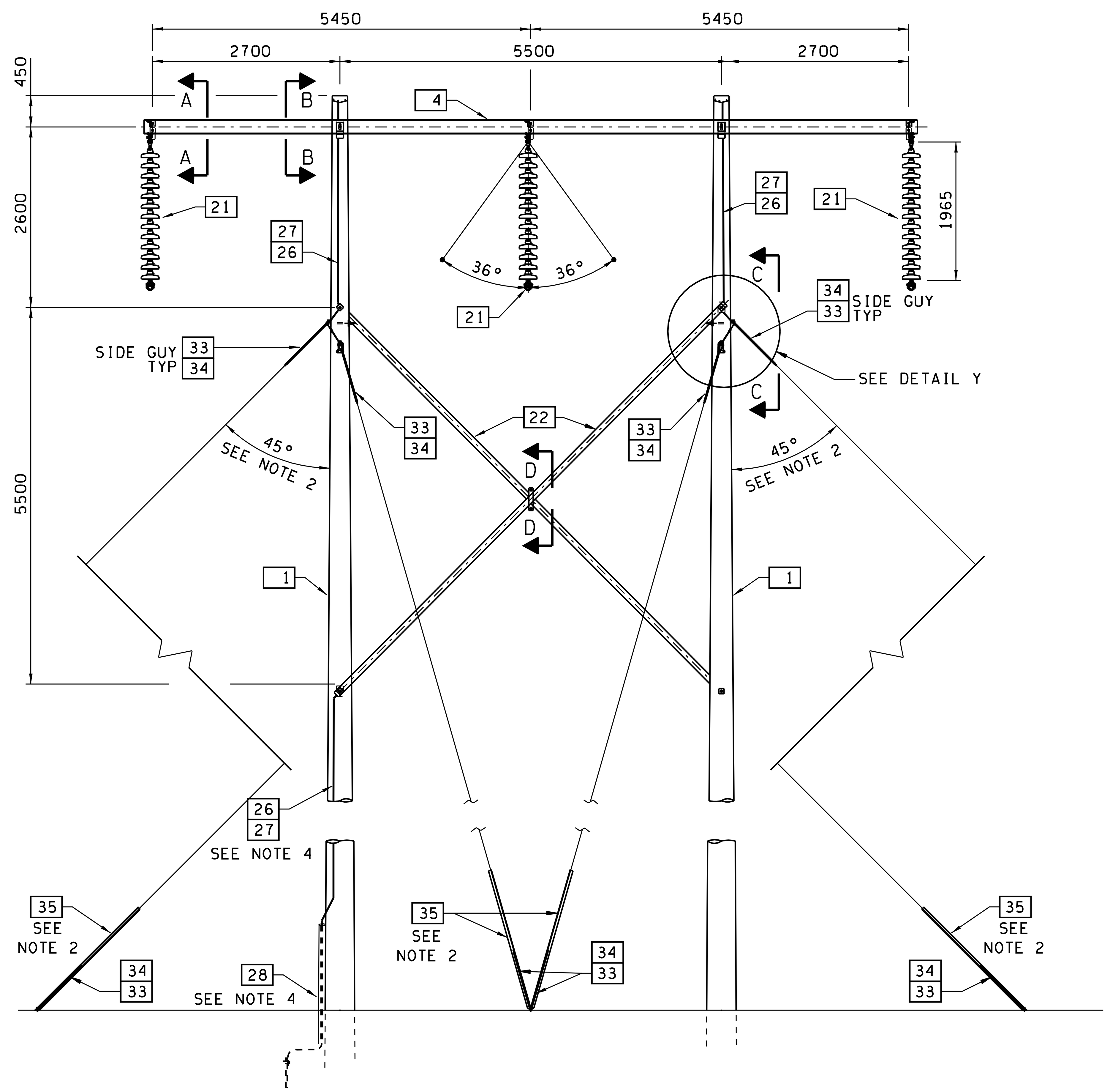
SHEET 1 OF 1

DRAWING NUMBER L40 - T07 - B1 REV a

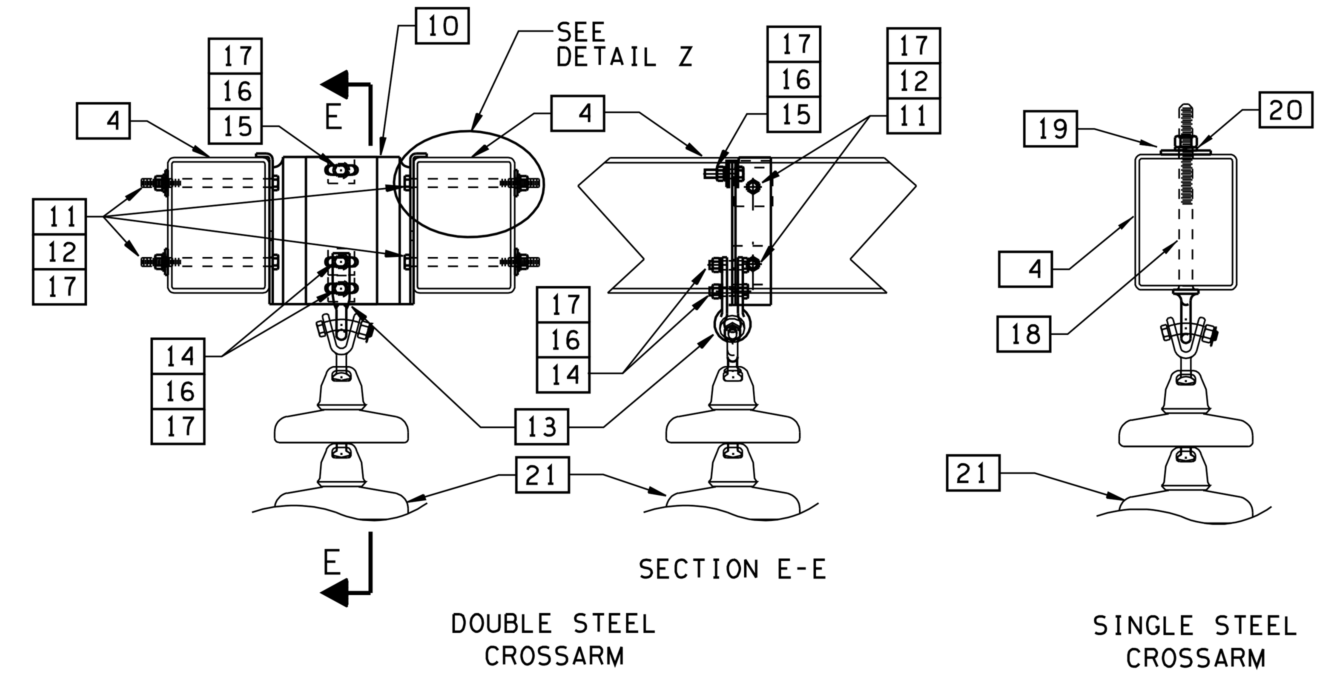
APPENDIX F: STRUCTURE TYPES



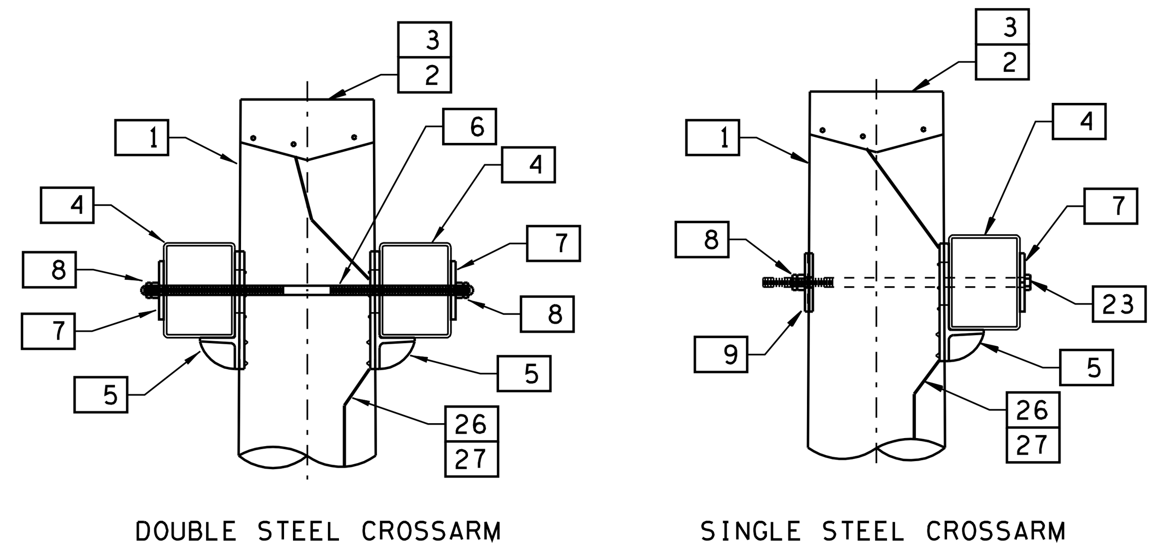
PLAN



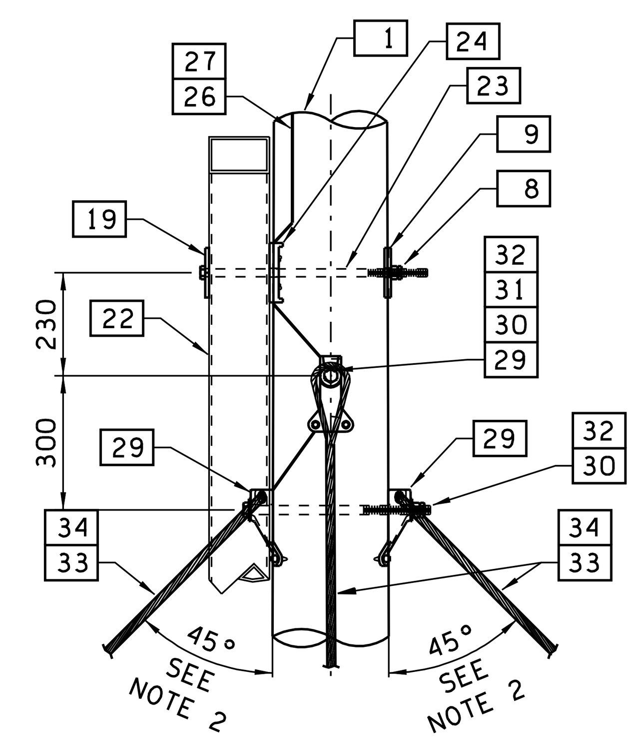
ELEVATION



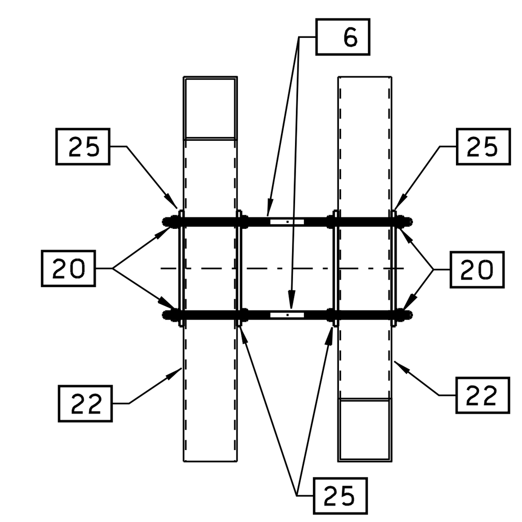
SECTION A-A



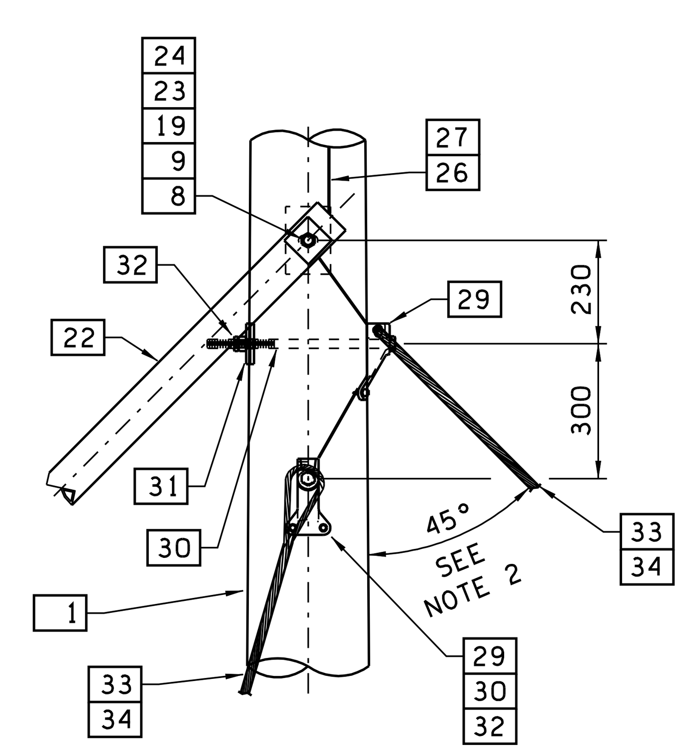
SECTION B-B



VIEW C-C



SECTION D-D



DETAIL Y

BILL OF MATERIAL FOR ONE STRUCTURE

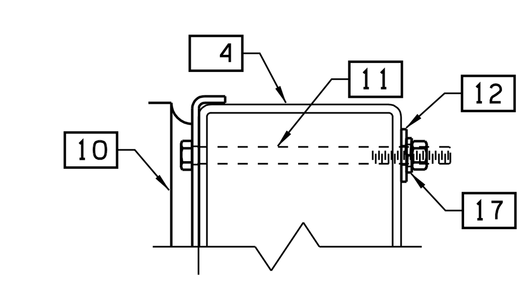
ITEM	QTY SINGLE X-ARM	QTY DOUBLE X-ARM	HU	BCH STOCK No. /DWG. No.	DESCRIPTION
1	2	2	EA	424-	POLE, WOOD, WRC, FULL LENGTH TREATED (SEE GENERAL CONSTRUCTION NOTES)
2	2	2	EA	421-0540	CAP, RAIN PROTECTIVE ALUMINUM
3	16	16	EA	-	NAIL, COMMON, WIRE, GALV, 3" LONG
4	1	2	EA	96002166	CROSSARM, STEEL, GALVANIZED, 8" X 6" X 1/4" X 11.15m LG, HSS
5	2	4	EA	421-0295	GAIN, CROSSARM SHELF, 4"x13", 1 1/16"Ø HOLE, SPIKED CURVED SIDE
6	2	4	EA	420-1333	BOLT, DOUBLE ARMING, 3/4"Ø x 28", c/w 4 NUTS
7	2	4	EA	420-1531	WASHER, FLAT, 4" x 5", FOR 3/4"Ø BOLT
8	6	8	EA	102-1153	NUT, PAL, FOR 3/4"Ø BOLT
9	6	4	EA	420-1576	WASHER, CURVED, 4" x 5", FOR 3/4"Ø BOLT
10	-	3	EA	421-0277	PLATE SET, ADJUSTABLE TIE, 1/4" THICK, FOR 5/8"Ø BOLT, 70 KN
11	-	12	EA	100-2081	BOLT, MACHINE, 5/8"Ø x 8", MIN. THREAD 4", c/w NUT
12	-	12	EA	420-1524	WASHER, FLAT, 3" x 3", FOR 5/8"Ø BOLT
13	-	3	EA	421-0279	LOOP, WIDE, 14 OPEN, FOR 5/8"Ø BOLT, 70 KN
14	-	6	EA	100-2357	BOLT, MACHINE, 5/8"Ø x 2 1/2", c/w NUT
15	-	3	EA	100-2355	BOLT, MACHINE, 5/8"Ø x 2", c/w NUT
16	-	9	EA	420-1521	WASHER, FLAT, 2" x 2", FOR 5/8"Ø BOLT
17	-	21	EA	102-4158	WASHER, HELICAL SPRING, FOR 5/8"Ø BOLT
18	3	-	EA	420-1183	BOLT, SHOULDER EYE, 3/4" Ø x 10", c/w NUT
19	7	-	EA	420-1525	WASHER, FLAT, 3" X 3", FOR 3/4"Ø BOLT
20	7	4	EA	102-4160	WASHER, HELICAL SPRING, FOR 3/4"Ø BOLT
21	3	3	EA	2LGS-T08-B638	230 kV SUSPENSION HARDWARE ASSEMBLY
22	2	2	EA	96002167	CROSSBRACE, STEEL, GALVANIZED, 3 1/2" X 3 1/2" X 3/16" X 7.95m LG, HSS
23	6	4	EA	100-2147	BOLT, MACHINE, 3/4"Ø x 20", MIN. THREAD 6", c/w NUT
24	4	4	EA	421-0200	GAIN, GRID, 4"x 6" FOR 3/4"Ø BOLT, SPIKED CURVED SIDE
25	2	2	SETS	421-0570	STRAP, SET, CROSSBRACE, (2) 330 X 65, FOR 3/4"Ø BOLT
26	6	6	m	380-0061	WIRE, BARE, SOLID, COPPER #6 AWG
27	1	1	PKG	103-0224	STAPLES, GALVANIZED, 38mm X 9.5mm (50 per PKG)

OPTIONAL COMPONENTS FOR BONDING (SEE NOTE 4)

ITEM	QTY	HU	BCH STOCK No. / DWG. No	DESCRIPTION
26	AS REQ'D	m	380-0061	WIRE, BARE, SOLID, COPPER #6 AWG
27	1	PKG	103-0224	STAPLES, GALVANIZED, 38mm X 9.5mm (50 per PKG)
28	1	EA	2LGS-T08-B647	GROUNDING DETAILS

OPTIONAL COMPONENTS FOR GUY ASSEMBLIES (SEE NOTE 2)

ITEM	QTY SINGLE SIDE GUY	QTY DOUBLE SIDE GUY	QTY DOUBLE IN-LINE GUY	HU	BCH STOCK No.	DESCRIPTION
29	1	2	4	EA	420-0769	HOOK, GUY, THIMBLE TYPE, FOR 7/8"Ø BOLT, 230 KN
30	1	2	2	EA	100-7402	BOLT, MACHINE, 7/8"Ø x 16", GRADE 5, MIN. THREAD 6", c/w NUT
31	1	2	-	EA	420-1577	WASHER, CURVED, 5" x 5", FOR 7/8"Ø BOLT
32	1	2	2	EA	102-1154	NUT, PAL, FOR 7/8"Ø BOLT
33	2	4	8	EA	420-0975	GRIP, GUY, SIZE 10
34	AS REQ'D	AS REQ'D	AS REQ'D	m	382-4235	WIRE, GUY, SIZE 10, GRADE 1300
35	AS REQ'D	AS REQ'D	AS REQ'D	EA	420-0910	GUARD, GUY, POLYETHYLENE TUBING



DETAIL Z

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL CONSTRUCTION NOTES SEE 2LGS-T08-B636.
3. INSTALL SINGLE (SA) OR DOUBLE (DA) CROSSARMS AS SPECIFIED ON STRUCTURE DATA SHEETS.
4. GROUNDING AND ADDITIONAL BONDING TO BE INSTALLED WHEN GUYS ARE NOT REQUIRED.
5. STRUCTURE TYPE DESIGNATION CODE: HFLAST

G-T08-B459	POLE SETTING DEPTHS FOR WOOD POLE STRUCTURES
G-T08-D462	STANDARD GUY ANCHOR SYSTEMS FOR WOOD POLE STRUCTURES
2LGS-T08-B636	GENERAL CONSTRUCTION NOTES
2LGS-T08-B638	SINGLE 70 kN INSULATOR STRING SUSPENSION HARDWARE ASSEMBLY FOR WOOD POLE STRUCTURES
2LGS-T08-B647	STANDARD GROUNDING DETAILS
2LGS-T08-B661	STEEL CROSSARM AND CROSSBRACE DETAILS

REVISIONS

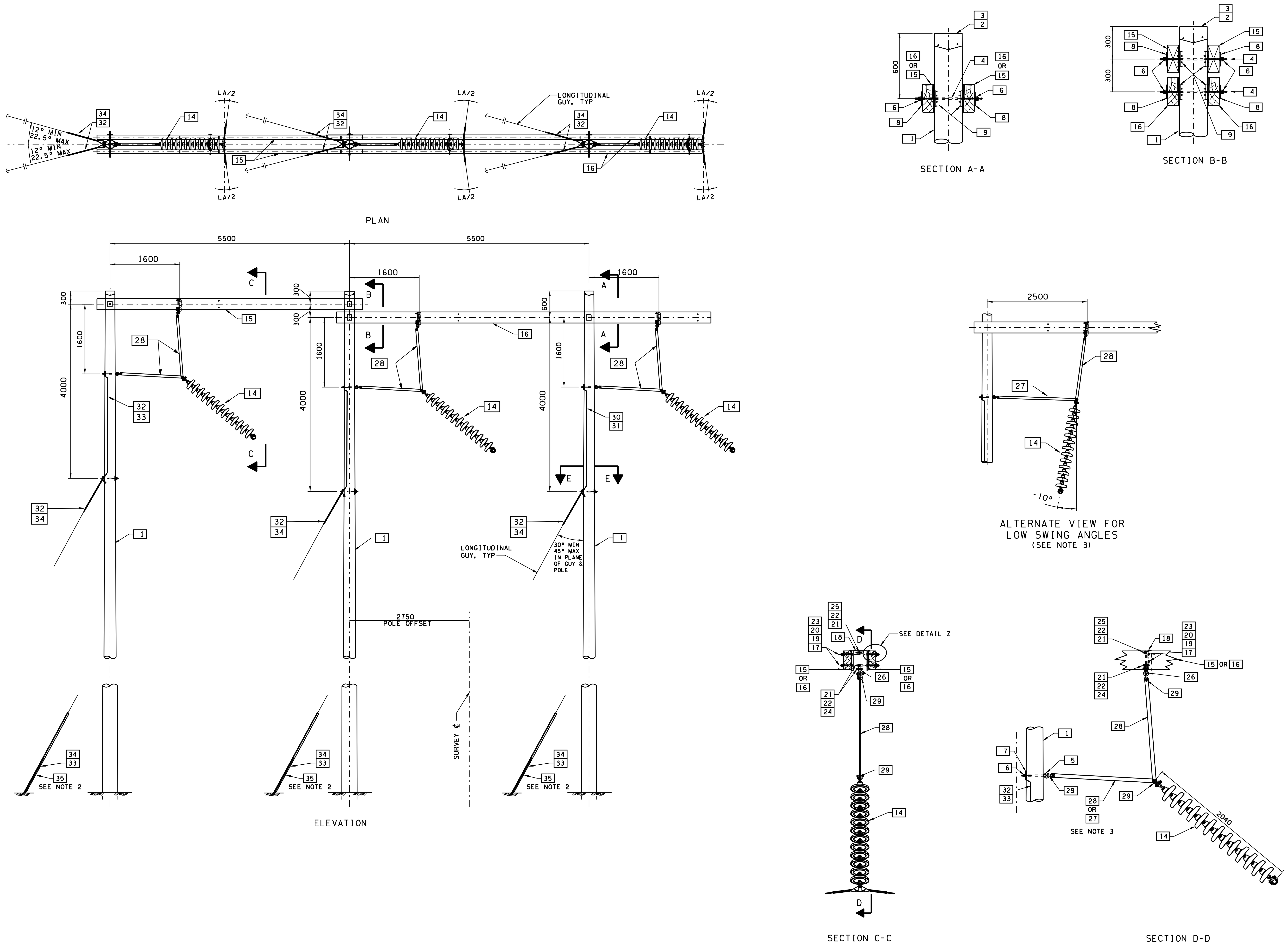
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE

DRAWN BY:
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

FORTISBC

DIVISION	FORTISBC
DEPARTMENT	SUSPENSION LIGHT ANGLE STRUCTURE
LOCATION	H-FRAME WITH STEEL CROSSARMS
TITLE	STRUCTURE ERECTION DRAWING

SCALE: | SCALE FACTOR:
DRAWING NUMBER: 40L-T08-D34
REVISION:



BILL OF MATERIAL FOR ONE STRUCTURE

ITEM	QTY	HU	BCH STOCK No. /BCH DWG No.	DESCRIPTION
1	3	EA	424-	POLE, WOOD, WRC, FULL LENGTH TREATED (SEE GENERAL CONSTRUCTION NOTES)
2	3	EA	421-0540	CAP, RAIN PROTECTIVE ALUMINUM
3	24	EA	-	NAIL, COMMON, WIRE, GALV, 3" LONG
4	4	EA	420-1331	BOLT, DOUBLE ARMING, ¾"Ø x 24", c/w 4 NUTS
5	3	EA	420-1186	BOLT, SHOULDER EYE, ¾"Ø x 14", c/w NUT
6	11	EA	102-1153	NUT, PAL, FOR ¾"Ø BOLT
7	3	EA	420-1576	WASHER, CURVED, 4" x 5", FOR ¾"Ø BOLT
8	8	EA	420-1531	WASHER, FLAT, 4" x 5", FOR ¾"Ø BOLT
9	8	EA	421-0204	GAIN, GRID, 3"x 6" FOR ¾"Ø BOLT, ONE SIDE CURVED, BOTH SPIKED
10	3	EA	420-0769	HOOK, GUY, THIMBLE TYPE, FOR ⅞"Ø BOLT, 230 KN
11	3	EA	100-7402	BOLT, MACHINE, ⅞"Ø x 16", GRADE 5, MIN. THREAD 6", c/w NUT
12	3	EA	102-1154	NUT, PAL, FOR ⅞"Ø BOLT
13	3	EA	420-1577	WASHER, CURVED, 5" x 5", FOR ⅞"Ø BOLT
14	3	EA	2LGS-T08-B638	230 kV SUSPENSION HARDWARE INSULATOR ASSEMBLY
15	2	EA	211-0616	CROSSARM, TIMBER, TREATED, 4" X 10" X 6.1m LG
16	2	EA	211-0615	CROSSARM, TIMBER, TREATED, 4" X 10" X 8.4m LG
17	12	EA	100-2077	BOLT, MACHINE, ⅝"Ø x 6", MIN. THREAD 3", c/w NUT
18	3	EA	421-0277	PLATE SET, ADJUSTABLE TIE, ¼" THICK, FOR ⅝"Ø BOLT, 70 KN
19	12	EA	420-1524	WASHER, FLAT, 3" x 3", FOR ⅝"Ø BOLT
20	12	EA	102-1152	NUT, PAL, FOR ⅝"Ø BOLT
21	9	EA	102-4158	WASHER, HELICAL SPRING, FOR ⅝"Ø BOLT
22	9	EA	420-1521	WASHER, FLAT, 2" x 2", FOR ⅝"Ø BOLT
23	12	EA	421-0209	CONNECTOR, TIMBER, 2½"Ø, FOR ⅝"Ø BOLT, SPIKED ONE SIDE
24	6	EA	100-2357	BOLT, MACHINE, ⅝"Ø x 2 ½", c/w NUT
25	3	EA	100-2355	BOLT, MACHINE, ⅝"Ø x 2", c/w NUT
26	3	EA	421-0279	LOOP, WIDE, 14 OPEN, FOR ⅝"Ø BOLT, 70 KN
27	AS REQ'D	EA	421-0585	PLATE, EXTENSION, 1870 LG, FOR ¾"Ø BOLT, 70 KN (SEE NOTE 3)
28	6	EA	421-0584	PLATE, EXTENSION, 1470 LG, FOR ¾"Ø BOLT, 70 KN
29	9	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
30	5	m	380-0061	WIRE, BARE, SOLID, COPPER #6 AWG
31	1	PKG	103-0224	STAPLES, GALVANIZED, 38mm X 9.5mm (50 per PKG)
32	6	EA	420-0972	GRIP, GUY, SIZE 10, COMPACT LOOP DESIGN
33	6	EA	420-0975	GRIP, GUY, SIZE 10
34	AS REQ'D	m	382-4235	WIRE, GUY, SIZE 10, GRADE 1300
35	AS REQ'D	EA	420-0910	GUARD, GUY, POLYETHELENE TUBING (SEE GENERAL CONSTRUCTION NOTES)

G-T08-B459	POLE SETTING DEPTHS FOR WOOD POLE STRUCTURES
G-T08-D462	STANDARD GUY ANCHOR SYSTEMS FOR WOOD POLE STRUCTURES
2LGS-T08-B636	GENERAL CONSTRUCTION NOTES
2LGS-T08-B638	SINGLE 70 kN INSULATOR STRING SUSPENSION HARDWARE ASSEMBLY FOR WOOD POLE STRUCTURES
2LGS-T08-B663	SUSPENSION MEDIUM ANGLE STRUCTURE 3 POLE (5°-30°) CROSSARM DETAILS

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL CONSTRUCTION NOTES SEE DWG No. 2LGS-T08-B636.
3. USE ITEM 27 AS SPECIFIED ON STRUCTURE DATA SHEETS.
4. STRUCTURE TYPE DESIGNATION CODE: 3PMA

REVISIONS					
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE

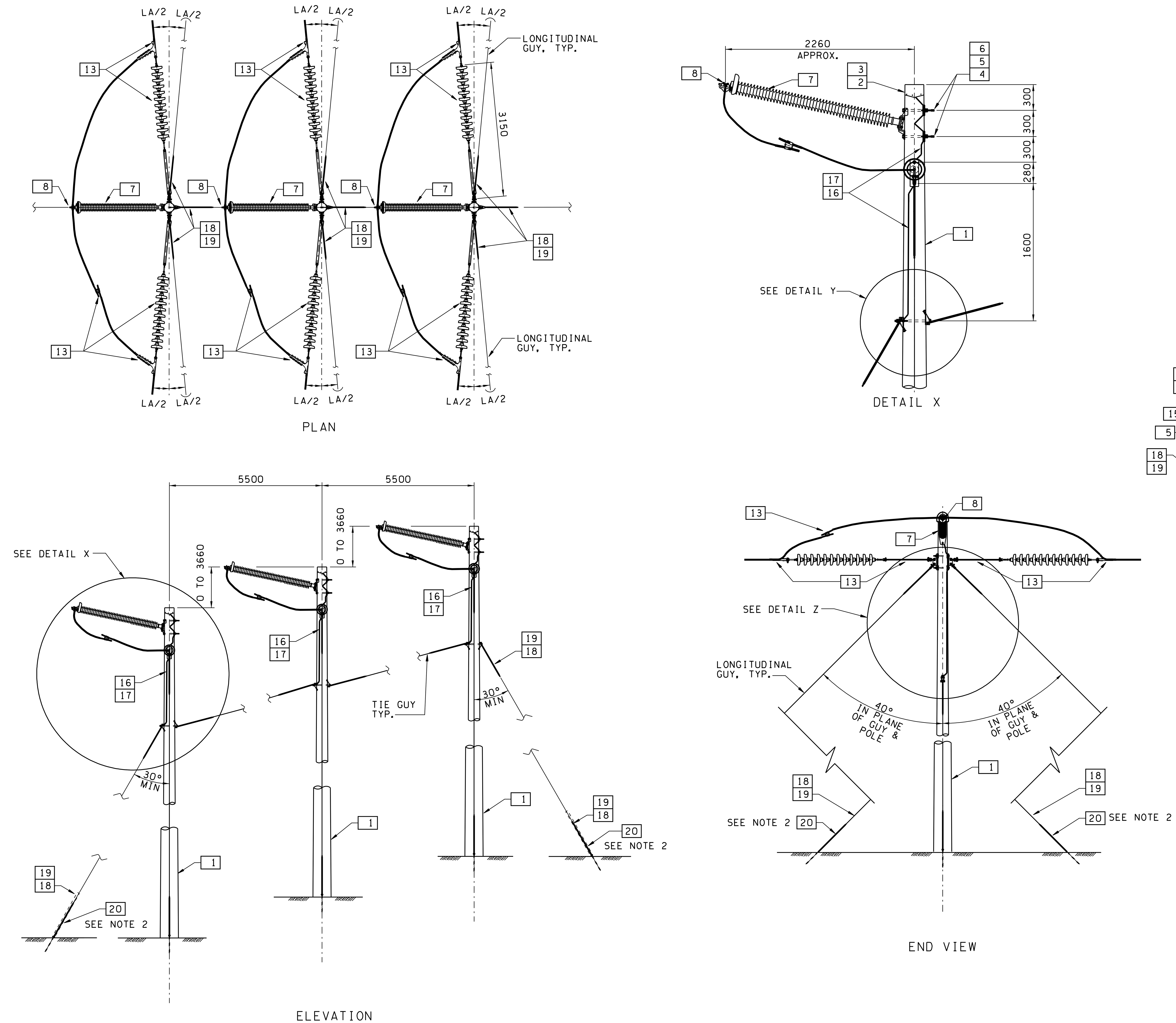
DRAWN BY:
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

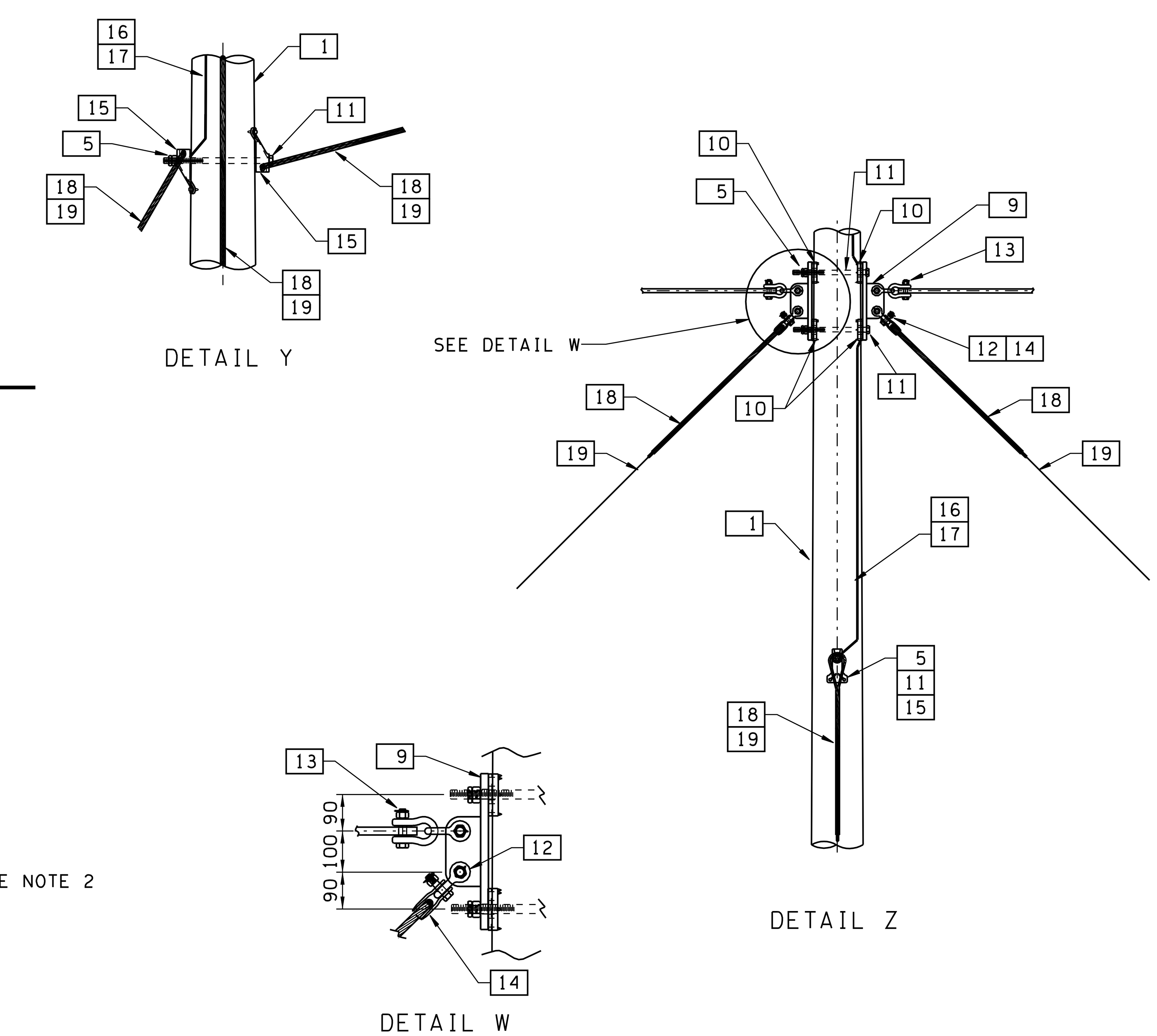
FORTISBC

DIVISION	FORTISBC
DEPARTMENT	SUSPENSION MEDIUM ANGLE STRUCTURE
LOCATION	3 POLE (5°-30°)
TITLE	STRUCTURE ERECTION DRAWING

SCALE: SCALE FACTOR:

DRAWING NUMBER	REVISION
40L-T08-D35	





BILL OF MATERIAL FOR ONE STRUCTURE				
ITEM	QTY	HU	BCH STOCK No./ BCH DWG No.	DESCRIPTION
1	3	EA	424-	POLE, WOOD, WRC, FULL LENGTH TREATED (SEE GENERAL CONSTRUCTION NOTES)
2	3	EA	421-0540	CAP, RAIN PROTECTIVE ALUMINUM
3	24	EA	-	NAIL, COMMON WIRE, GALVANIZED, 3" Lg
4	6	EA	100-7401	BOLT, MACHINE, 7/8"Ø x 14", GRADE 5, MIN. THREAD 6", c/w NUT
5	15	EA	102-1154	NUT, PAL FOR 7/8" BOLT
6	6	EA	420-1577	WASHER, CURVED, 5" x 5", FOR 7/8"Ø BOLT
7	3	EA	408-0408	INSULATOR, LINE POST, POLYMER, c/w CORONA RING
8	3	EA	413-	CLAMP, TRUNNION (SEE DWG No. G-T08-B460)
9	6	EA	96001366	TEE, GUYING, DEAD END, 120 KN, FOR 2 -7/8"Ø BOLTS
10	12	EA	421-0206	GAIN,GRID, 4"x 4" FOR 7/8"Ø BOLT, SPIKED CURVED SIDE
11	9	EA	100-7402	BOLT, MACHINE, 7/8"Ø x 16", GRADE 5, MIN. THREAD 6", c/w NUT
12	6	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, 3/4"Ø BOLT, 120 kN
13	6	EA	2LGS-T08-B640	SINGLE 120 kN INSULATOR STRING DEAD END HARDWARE ASSEMBLY
14	6	EA	413-0518	CLEVIS, DEAD END, 19 OPEN, 5/8"Ø BOLT, 120 kN
15	6	EA	420-0769	HOOK, GUY (H.D. THIMBLE TYPE) 230 KN
16	8	m	380-0061	WIRE, BARE, SOLID, COPPER #6 AWG
17	1	PKG	103-0224	STAPLES, GALVANIZED, 38mm X 9.5mm (50 per PKG)
18	20	EA	420-0976	GRIP, GUY, SIZE 12
19	AS REQ'D	m	382-4247	WIRE, GUY, SIZE 12, GRADE 1300
20	AS REQ'D	EA	420-0910	GUARD, GUY, POLYETHYLENE TUBING (SEE NOTE 2)

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL CONSTRUCTION NOTES SEE 2LGS-T08-B636.
3. STRUCTURE TYPE DESIGNATION CODE: 3PDE20

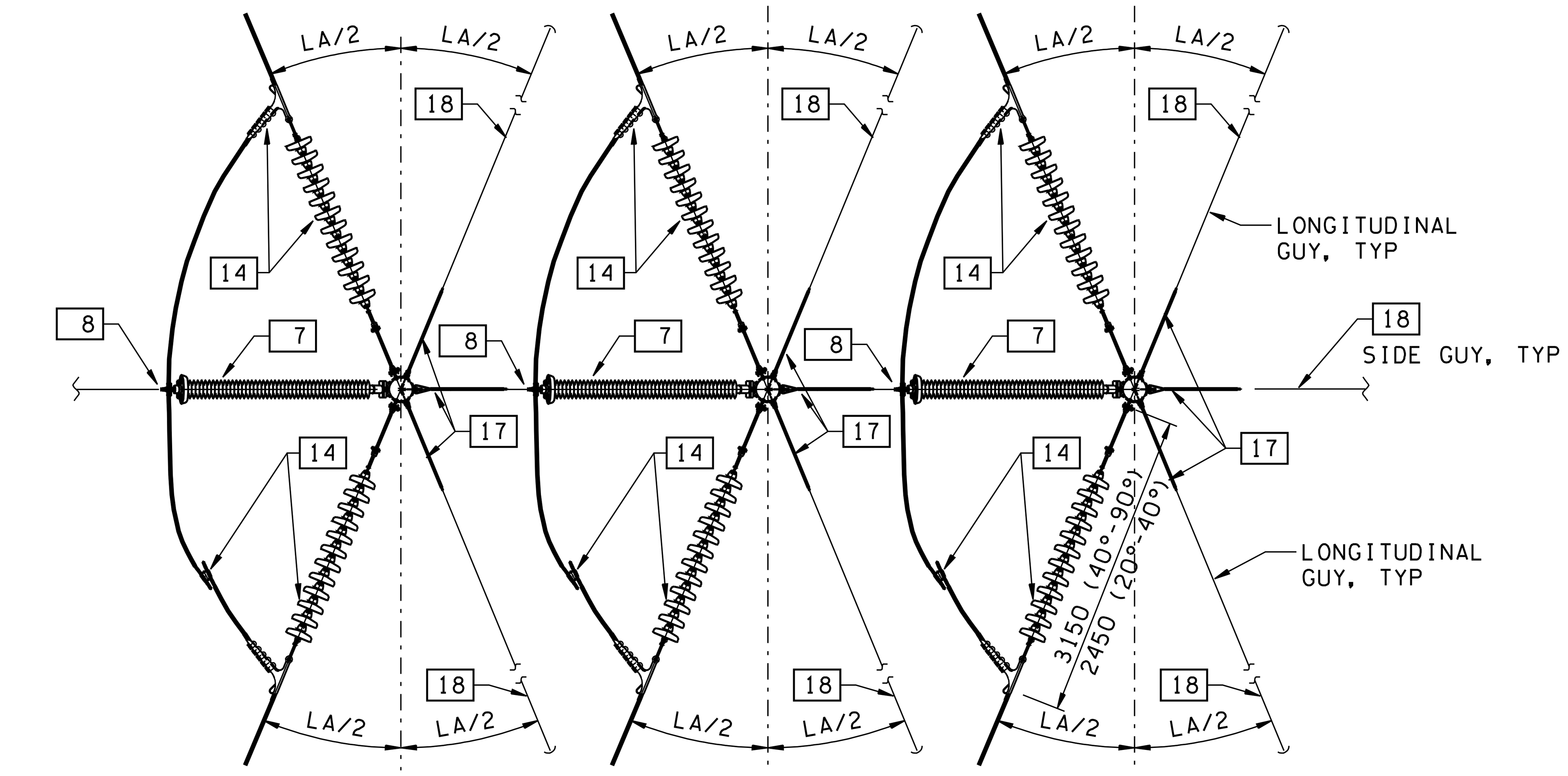
REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE

DRAWN BY:
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

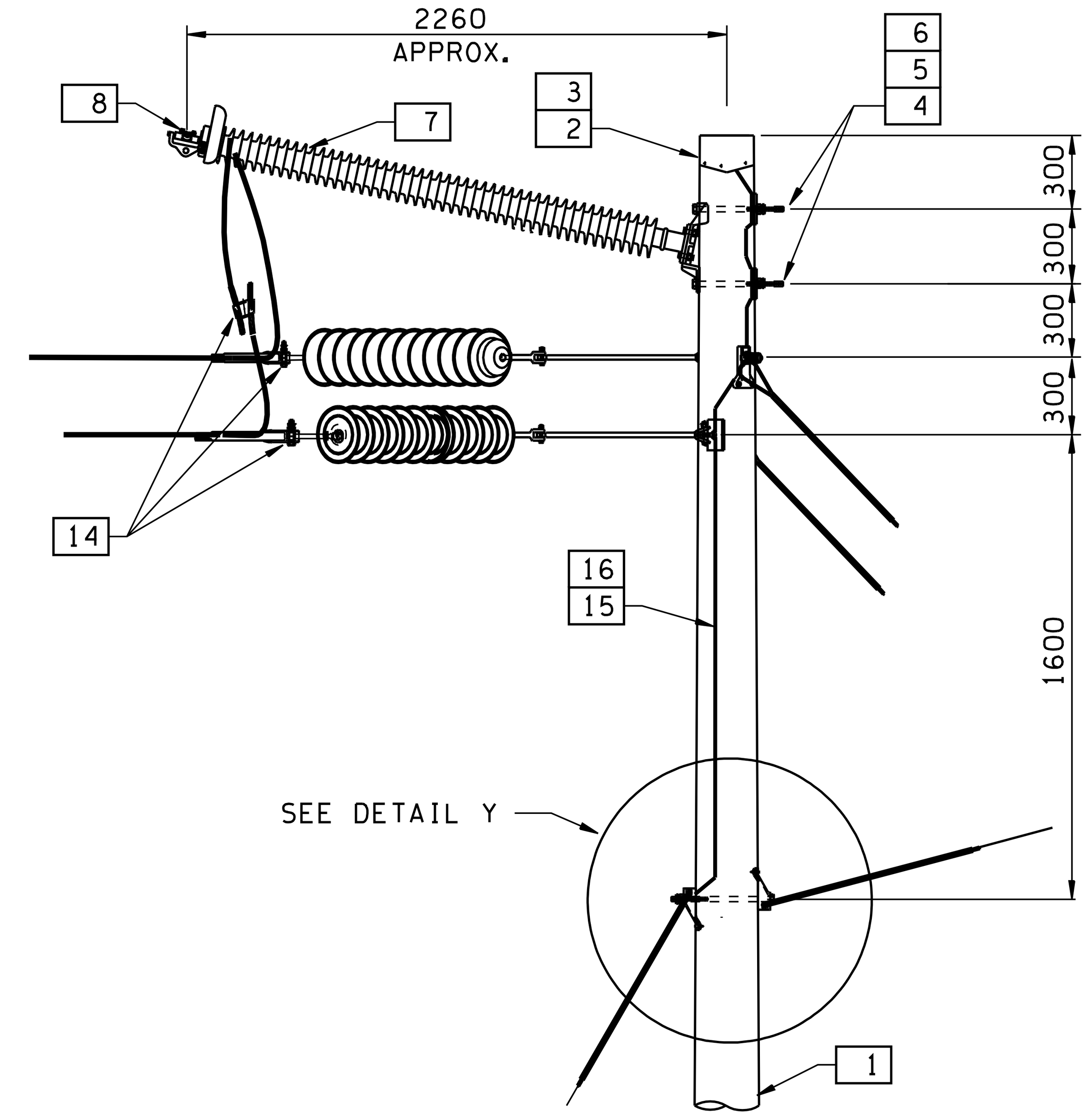
FORTISBC

DIVISION	FORTISBC
DEPARTMENT	DEAD END LIGHT ANGLE STRUCTURE
LOCATION	3-POLE (0° - 20°)
TITLE	STRUCTURE ERECTION DRAWING

SCALE: | SCALE FACTOR:
DRAWING NUMBER: 40L-T08-D32
REVISION:

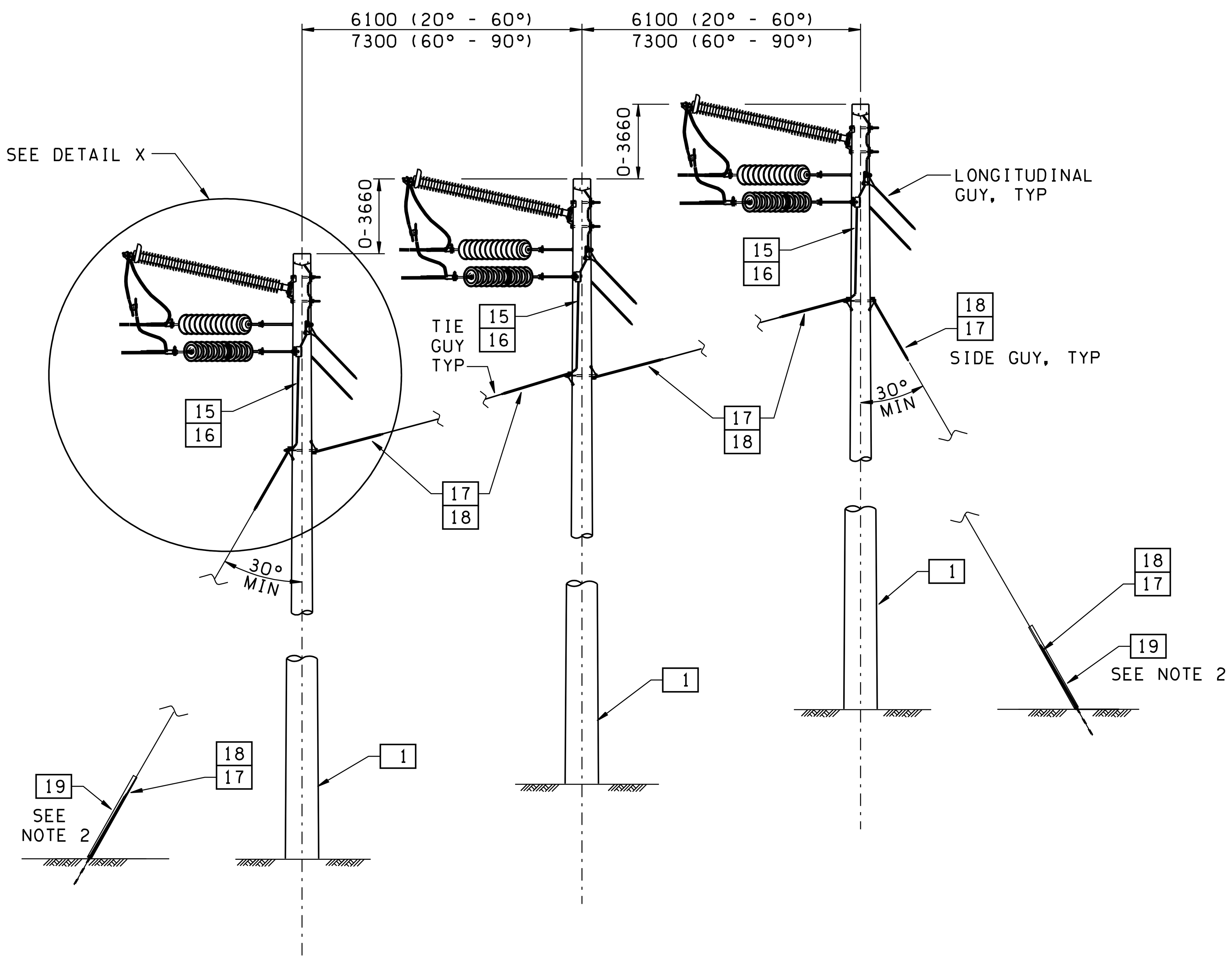


PLAN

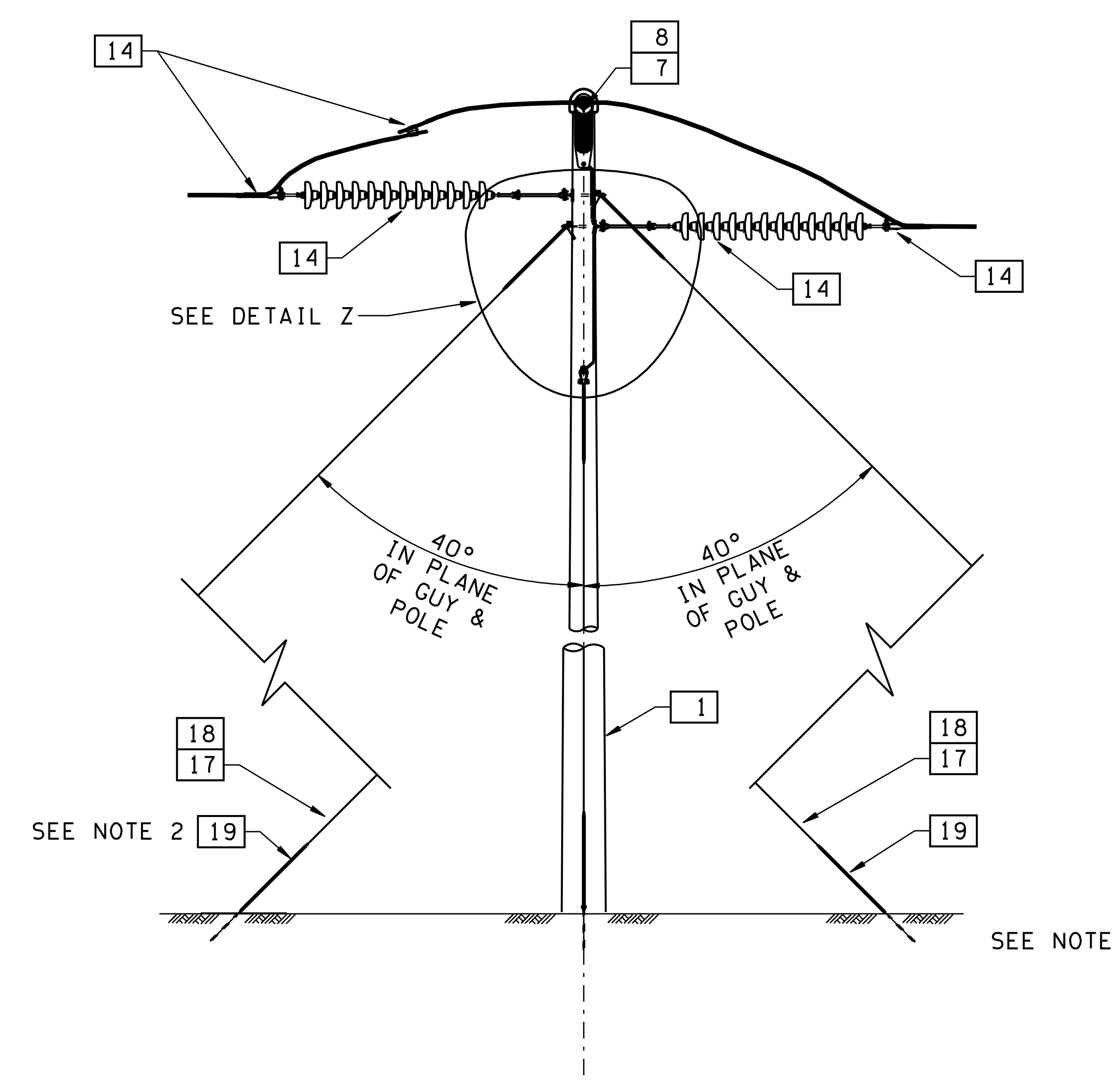


DETAIL X

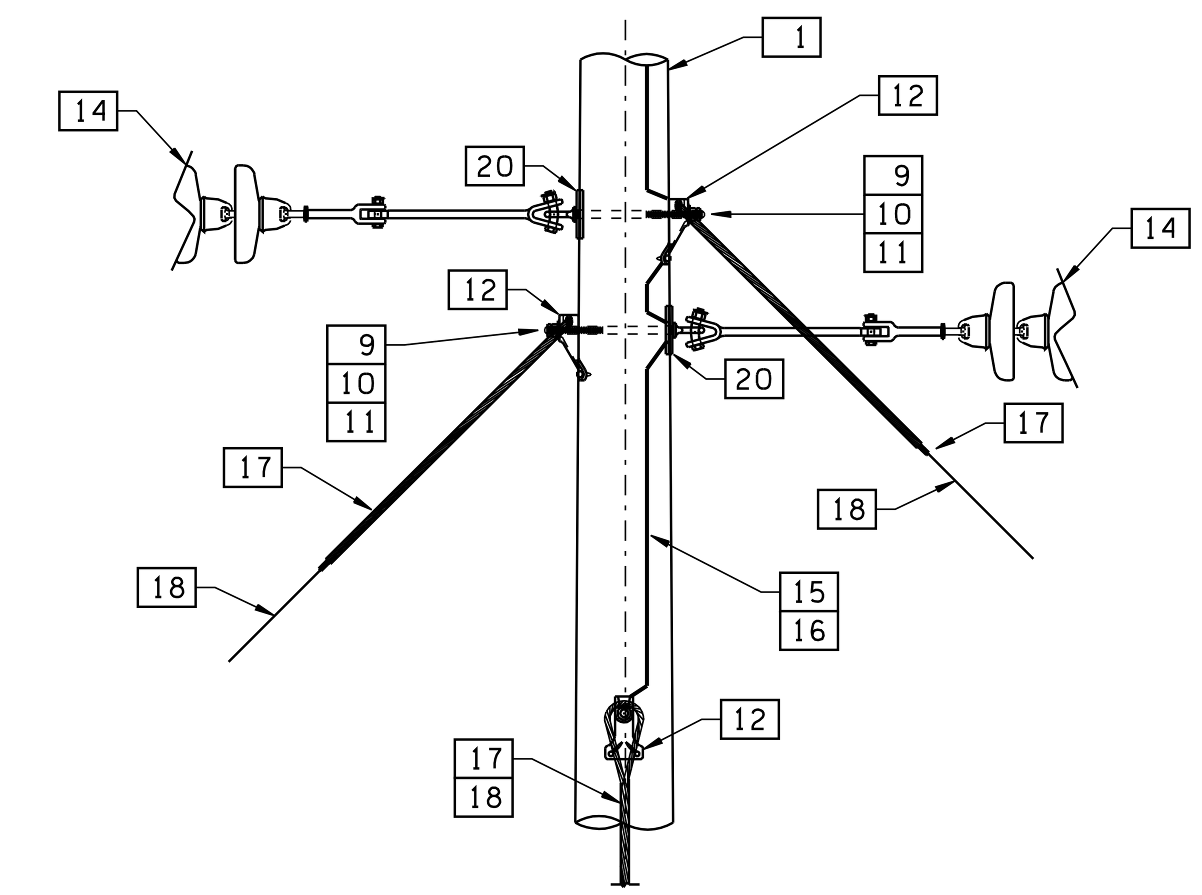
BILL OF MATERIAL FOR ONE STRUCTURE				
ITEM	QTY	HU	BCH STOCK No. / BCH DWG No.	DESCRIPTION
1	3	EA	424-	POLE, WOOD, WRC, FULL LENGTH TREATED (SEE GENERAL CONSTRUCTION NOTES)
2	3	EA	421-0540	CAP, RAIN PROTECTIVE ALUMINUM
3	24	EA	-	NAIL, COMMON WIRE, GALVANIZED, 3" Lg
4	6	EA	100-7401	BOLT, MACHINE, 7/8"Ø x 14", GRADE 5, MIN. THREAD 6", c/w NUT
5	9	EA	102-1154	NUT, PAL FOR 7/8" BOLT
6	6	EA	420-1577	WASHER, CURVED, 5" x 5", FOR 7/8"Ø BOLT
7	3	EA	408-0408	INSULATOR, LINE POST, POLYMER, c/w CORONA RING
8	3	EA	413-	CLAMP, TRUNNION (SEE DWG No. G-T08-B460)
9	6	EA	102-3045	WASHER, FLAT, ROUND, 2" O.D., FOR 3/4"Ø BOLT
10	6	EA	420-1186	BOLT, SHOULDER EYE, 3/4"Ø x 14", c/w NUT
11	6	EA	102-1153	NUT, PAL, FOR 3/4"Ø BOLT
12	12	EA	420-0769	HOOK, GUY (H.D. THIMBLE TYPE) 230 KN
13	3	EA	100-7402	BOLT, MACHINE, 7/8"Ø x 16", GRADE 5, MIN. THREAD 6", c/w NUT
14	6	EA	2LGS-T08-B640	SINGLE 120 kN INSULATOR STRING DEAD END HARDWARE ASSEMBLY
15	8	m	380-0061	WIRE, BARE, SOLID, COPPER #6 AWG
16	1	PKG	103-0224	STAPLES, GALVANIZED, 38mm X 9.5mm (50 per PKG)
17	20	EA	420-0976	GRIP, GUY, SIZE 12
18	AS REQ'D	m	382-4247	WIRE, GUY, SIZE 12, GRADE 1300
19	AS REQ'D	EA	420-0910	GUARD, GUY, POLYETHYLENE TUBING
20	6	EA	420-1576	WASHER, CURVED, 4" x 5", FOR 3/4"Ø BOLT



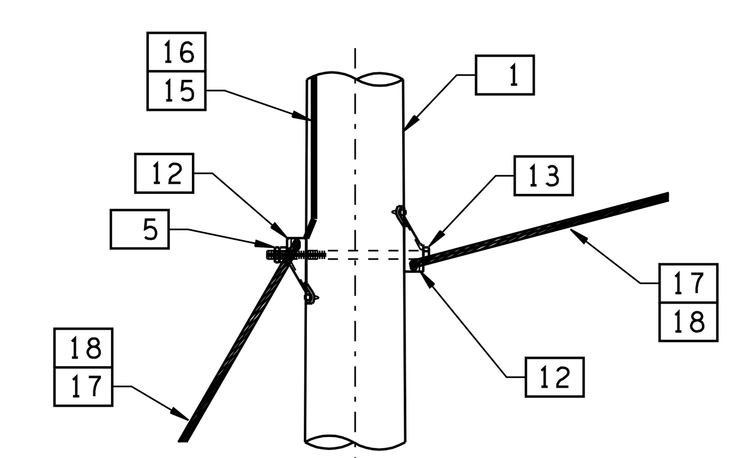
ELEVATION



END VIEW



DETAIL Z



DETAIL Y

2LGS-T08-B636	GENERAL CONSTRUCTION NOTES
2LGS-T08-B640	SINGLE 120 kN INSULATOR STRING DEAD END HARDWARE ASSEMBLY FOR WOOD POLE STRUCTURES
G-T08-B459	STANDARD POLE SETTING DEPTHS FOR WOOD POLE STRUCTURES
G-T08-B460	CONDUCTOR HARDWARE TABLE
G-T08-B462	STANDARD GUY ANCHOR SYSTEMS FOR WOOD POLE STRUCTURES

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. FOR GENERAL CONSTRUCTION NOTES SEE 2LGS-T08-B636.
3. STRUCTURE DESIGNATION CODE: 3PDE90

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE

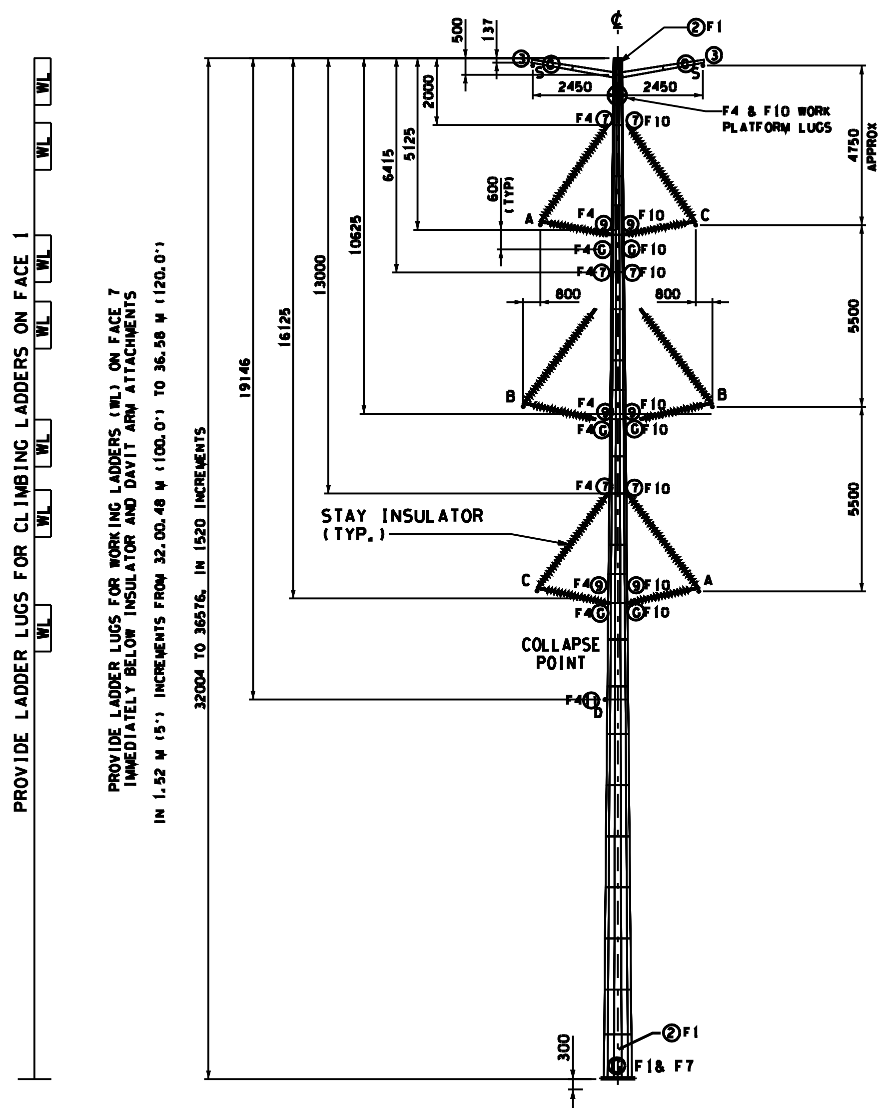
DRAWN BY:
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

FORTISBC

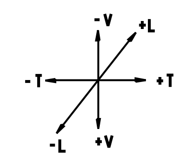
DIVISION	FORTISBC
DEPARTMENT	DEAD END MEDIUM TO HEAVY ANGLE STRUCTURE
LOCATION	3-POLE (20° - 90°)
TITLE	STRUCTURE ERECTION DRAWING

SCALE: SCALE FACTOR:
DRAWING NUMBER: 40L-T08-D33
REVISION:

STRUCTURE TYPE CONDUCTOR PHASE, GROUNDWIRE AND ADSS FIBRE LOADS



TRANSVERSE ELEVATION



LOAD DIRECTIONS TYPICAL FOR ALL SUPPORT POINTS SEE TABLE 1

TABLE 1 - TYPE 2A2PG (MD)

	ULTIMATE LOADS IN kN					
	CONDUCTOR			GROUNDWIRE		
CASE	V	T	L	V	T	L
1a	32.0	-9.0		10.0	-5.0	
1b	32.0	9.0		10.0	-5.0	
2a	20.0	-8.5		3.0	-2.0	
2b	20.0	8.5		3.0	+/-2.0	
3	20.0	+/-1.0		3.0	+/-0.2	
4a	20.0	-2.2		3.0	-0.2	
4b	20.0	2.2		3.0	0.2	
5	33.3	+/-1.7	+/-6.6	10.0	+/-0.3	+/-3.0
6	16.7	+/-6.8		2.5	+/-1.1	

	ULTIMATE LOADS IN kN		
	ADSS FIBRE		
CASE	V	T	L
1a	8.9	-5.2	
1b	8.9	5.2	
2a	1.6	-3.1	
2b	1.6	3.0	
3	1.6	+/-0.1	
4a	1.6	-0.7	
4b	1.6	0.7	
5	8.9	+/-0.2	+/-1.5
6	1.3	+/-0.6	

V = VERTICAL, PHASE/ WIRE LOAD
T = TRANSVERSE, PHASE/ WIRE LOAD
L = LONGITUDINAL, PHASE/WIRE LOAD

SPECIFIC SPECIFICATION NOTES:

1. CONDUCTOR, GROUNDWIRE AND ADSS FIBRE LOAD CASES

   CASES 1 TO 6 IN TABLE 1 ARE BASED ON THE FOLLOWING:

   CASE 1 - MAX. COMBINED WIND AND ICE, 0.385 kN/m2 WIND. 12.7 mm ICE, -18°C, w/ LF = 1.2
   CASE 2 - HIGH WIND, 0.57 kN/m2 WIND, NO ICE, -18°C, w/ LF = 1.2
   CASE 3 - COLD, NO WIND, NO ICE, -18°C, w/ LF = 1.2
   CASE 4 - EVERYDAY LOAD, 0.12 kN/m2, NO ICE, 10°C, w/LF = 1.2
   CASE 5 - UNEOUAL ICE, 12.7 mm ICE, NO WIND, -18°C, w/LF = 1.2.
   CASE 6 - EARTHOUAKE LOAD, NO ICE, NO WIND, -18°C, w/LF = 1.0

   "a" IS WITH THE WIND BLOWING NORMAL TO THE LEFT (in direction of face 10 to 4).
   "b" IS WITH THE WIND BLOWING NORMAL TO THE RIGHT (in direction of face 4 to 10).

   LOAD FACTORS SHOWN ABOVE ARE INCLUDED IN THE ULTIMATE LOADS.

   EACH STRUCTURE, INCLUDING FOUNDATIONS SHALL BE ABLE TO WITHSTAND THE ULTIMATE WIND LOAD OF 0.77 kN/M2 ON THE STRUCTURE WITHOUT ANY GUYS, CONDUCTOR OR ADSS FIBRE ATTACHED.

2. PHASE AND GROUNDWIRE LOAD COMBINATIONS

   LOADS T AND/OR L ARE REVERSIBLE WHERE SHOWN (+/-).
   "-" IS LOAD ACTING TO THE LEFT, BACK OR UPWARD, "+" IS ACTING TO THE RIGHT, AHEAD OR DOWNWARD.

   a) FOR CONDUCTOR LOAD CASE 1 TO 4 APPLY PHASE LOADS V, T AND L AT ANY ONE, ANY TWO OR ALL THREE PHASE POINTS ON ONE SIDE OF THE POLE (ONE CIRCUIT) WITH THE OTHER SIDE OF THE POLE UNLOADED. APPLY CORRESPONDING LOAD CASE FOR GROUNDWIRE AT ONE AND BOTH ATTACHMENTS AND ADSS FIBRE, THEN APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR ALL THREE PHASE POINTS ON THE SIDE OF THE POLE FOR THE SECOND CIRCUIT WITH THE LOADS OF ALL THREE PHASE POINTS OF THE FIRST CIRCUIT APPLIED.
   b) FOR LOAD CASE 5 APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR THREE PHASE POINTS AT THE SAME TIME APPLY CASE 3 LOADS ON THE REMAINING ATTACHMENTS INCL. GROUNDWIRE AND ADSS FIBRE

   PHASE LOADS INCLUDE THE MASS OF INSULATOR HARDWARE ASSEMBLIES AND ICE.

3. WIND LOAD ON STRUCTURE

   FOR LOAD CASE 1 APPLY A WIND LOAD OF 0.9 kN/m^2 ON THE PROJECTED AREA OF THE STRUCTURE IN THE SAME DIRECTION AS THE RESULTANT OF THE TRANSVERSE AND LONGITUDINAL PHASE LOADS.
   WIND LOADS ASSUMES A COEFFICIENT OF DRAG Co = 1.2 FOR A CIRCULAR CYLINDER. FOR A BOX OR OTHER FLAT SECTIONS MODIFY THE WIND LOAD FOR A Co = 2.4.

4. EARTHOUAKE LOADS

   SEE DWG. 2L129-T08-B6, NOTE 6.

5. SNUBBING LOADS

   SNUBBING OF CONDUCTOR AND GROUNDWIRE IS NOT PERMITTED.

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS, SEE DWG. 2L129-T08-B7.
3. SYMBOL LEGEND:
   - • PHASE CONDUCTOR (A, B, C)
   - • GROUNDWIRE (S)
   - • ADSS FIBRE (D)
   - G GROUND LUG
   - 1 ATTACHMENT DETAIL NUMBER, SEE DWG. 2L129-T08-B7.
   - F3 POLE FACE FOR ATTACHMENT (F3 = FACE 3)
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
5. PHASE CONDUCTORS, GROUNDWIRE AND FIBRE.
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM, RTS = 194,832 N, BARE MASS = 26.0087 N/M.
   GROUNDWIRE: SIZE 9 7W GRADE 1300, 9.14 MM OD., RTS = 60,000, BARE MASS = 3.94 N/M
   ADSS FIBRE: AT-3BE27DT-048-TPBE-Z(ADSS), BARE MASS = 2.15 N/M.
6. FOR GUY ASSEMBLY HARDWARE DETAILS, SEE DWG: 2L129-T08-B29 (SIZE 12 GUYS).

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

REFERENCE DWG.

2L129-T08-B6 - GENERAL SPECIFICATIONS
2L129-T08-B7 - ATTACHMENT DETAILS
2L129-T08-B33 - INSULATOR HARDWARE ASSEMBLY

REVISIONS								
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE		

DRAWN BY
DESIGNED BY
CHECKED BY
APPROVED BY

FORTISBC

TYPE 2A2PG DOUBLE CIRCUIT SUSPENSION W/ OHGW SPECIFICATION DRAWING

DRAWING NUMBER	REV
75L-T08-B26	

SPECIFIC SPECIFICATION NOTES:

1. CONDUCTOR AND ADSS FIBRE LOAD CASES

CASES 1 TO 6 IN TABLE 1 ARE BASED ON THE FOLLOWING:

CASE 1 - MAX. COMBINED WIND AND ICE. 0.385 kN/m2 WIND. 12.7 mm ICE. -18°C. w/ LF = 1.2
CASE 2 - HIGH WIND. 0.57 kN/m2 WIND. NO ICE. -18°C. w/ LF = 1.3
CASE 3 - COLD. NO WIND. NO ICE. -18°C. w/ LF = 1.3
CASE 4 - EVERYDAY LOAD. 0.12 kN/m2. NO ICE. 10°C. w/LF = 1.3
CASE 5 - UNEQUAL ICE. 12.7 mm ICE. NO WIND. -18°C. w/LF = 1.3
CASE 6 - EARTHQUAKE LOAD. NO ICE. NO WIND. -18°C. w/LF = 1.0

"a" IS WITH THE WIND BLOWING NORMAL TO THE LEFT (in direction of face 10 to 4).
"b" IS WITH THE WIND BLOWING NORMAL TO THE RIGHT (in direction of face 4 to 10).

LOAD FACTORS SHOWN ABOVE ARE INCLUDED IN THE ULTIMATE LOADS.

EACH STRUCTURE, INCLUDING FOUNDATIONS SHALL BE ABLE TO WITHSTAND THE ULTIMATE WIND LOAD OF 0.77 kN/M2 ON THE STRUCTURE WITHOUT ANY GUYS, CONDUCTOR OR ADSS FIBRE ATTACHED.

2. PHASE AND GROUNDWIRE LOAD COMBINATIONS

LOADS T AND/OR L ARE REVERSIBLE WHERE SHOWN (+/-). "-" IS LOAD ACTING TO THE LEFT, BACK OR UPWARD, "+" IS ACTING TO THE RIGHT, AHEAD OR DOWNWARD.

a) FOR CONDUCTOR LOAD CASE 1 TO 4 APPLY PHASE LOADS V, T AND L AT ANY ONE, ANY TWO OR ALL THREE PHASE POINTS ON ONE SIDE OF THE POLE (ONE CIRCUIT) WITH THE OTHER SIDE OF THE POLE UNLOADED. APPLY CORRESPONDING LOAD CASE FOR ADSS FIBRE. THEN APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR ALL THREE PHASE POINTS ON THE SIDE OF THE POLE FOR THE SECOND CIRCUIT WITH THE LOADS OF ALL THREE PHASE POINTS OF THE FIRST CIRCUIT APPLIED.

b) FOR LOAD CASE 5 APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR THREE PHASE POINTS AT THE SAME TIME APPLY CASE 3 LOADS ON THE REMAINING ATTACHMENTS INCL. GROUNDWIRE AND ADSS FIBRE

PHASE LOADS INCLUDE THE MASS OF INSULATOR HARDWARE ASSEMBLIES AND ICE.

3. WIND LOAD ON STRUCTURE

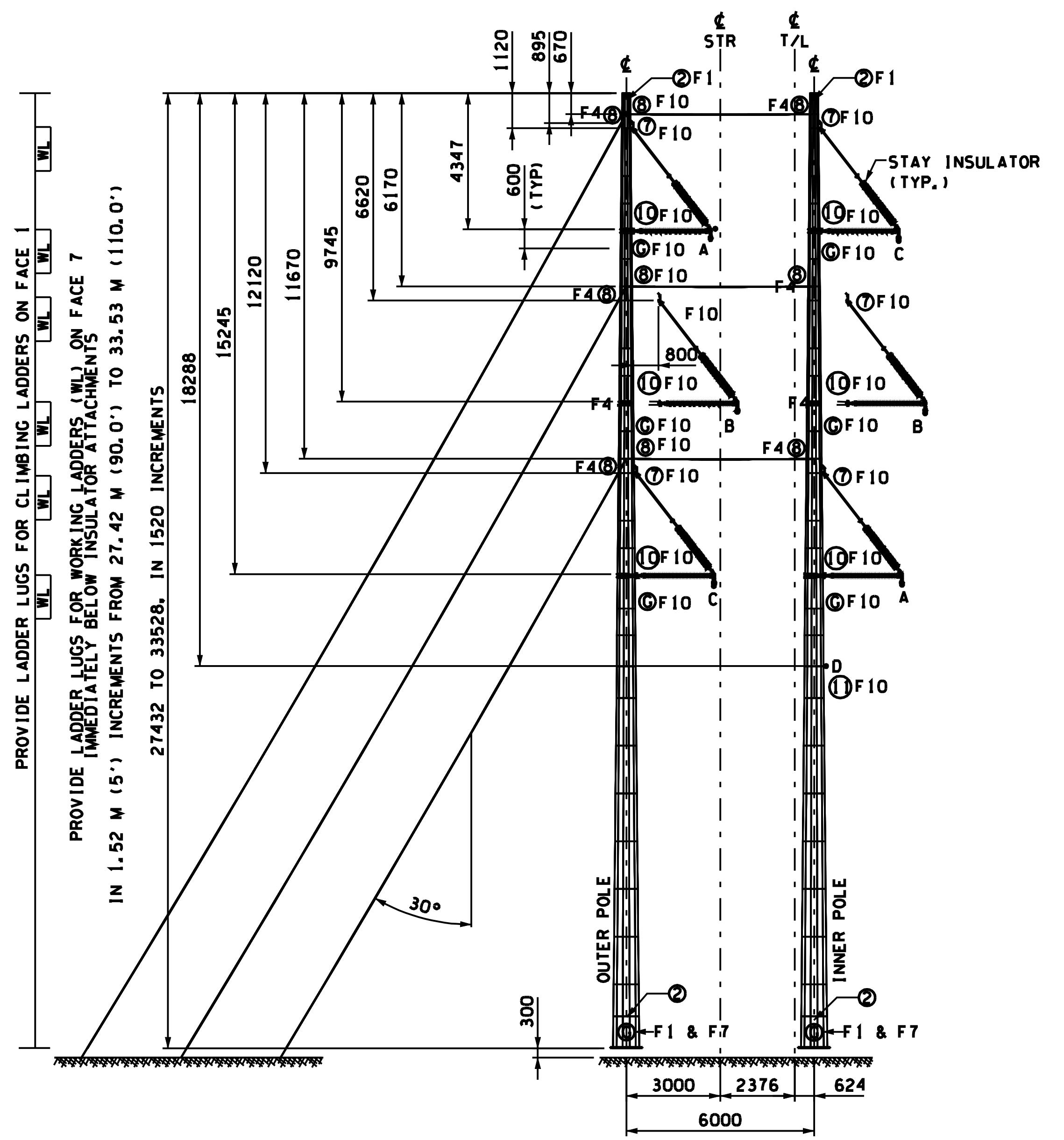
FOR LOAD CASE 1 APPLY A WIND LOAD OF 0.9 kN/m² ON THE PROJECTED AREA OF THE STRUCTURE IN THE SAME DIRECTION AS THE RESULTANT OF THE TRANSVERSE AND LONGITUDINAL PHASE LOADS.
WIND LOADS ASSUMES A COEFFICIENT OF DRAG Co = 1.2 FOR A CIRCULAR CYLINDER. FOR A BOX OR OTHER FLAT SECTIONS MODIFY THE WIND LOAD FOR A Co = 2.4.

4. EARTHQUAKE LOADS

SEE DWG. 2L129-T08-B6, NOTE 6.

5.0 SNUBBING ANGLE

SNUBBING OF CONDUCTOR IS NOT PERMITTED.



TRANSVERSE ELEVATION

REFERENCE DWG.

2L129-T08-B6 - GENERAL SPECIFICATIONS
2L129-T08-B7 - ATTACHMENT DETAILS
2L129-T08-B35 - INSULATOR HARDWARE ASSEMBLY

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

STRUCTURE TYPE CONDUCTOR PHASE AND ADSS FIBRE LOADS

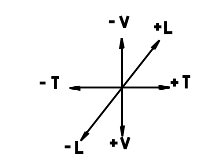
TABLE 1 - TYPE 2GD2V

ULTIMATE LOADS IN kN — CONDUCTOR

CASE	V	T	L
1a	40.0	3.0	
1b	40.0	52.0	
2a	25.0	3.0	
2b	25.0	50.0	
3	25.0	29.0	
4a	24.0	3.0	
4b	24.0	22.0	
5	40.0	38.0	+/-6.6
6	18.5	29.5	

ULTIMATE LOADS IN kN — ADSS FIBRE

CASE	V	T	L
1a	11.0	-4.0	
1b	11.0	15.0	
2a	2.0	-2.5	
2b	2.0	9.0	
3	2.0	1.0	
4a	2.0	-0.5	
4b	2.0	2.5	
5	11.0	5.0	+/-1.5
6	1.5	1.4	



LOAD DIRECTIONS TYPICAL FOR ALL SUPPORT POINTS SEE TABLE 1

V = VERTICAL, PHASE/ WIRE LOAD
T = TRANSVERSE, PHASE/ WIRE LOAD
L = LONGITUDINAL, PHASE/WIRE LOAD

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS, SEE DWG. 2L129-T08-B7.
3. SYMBOL LEGEND:
   - ● PHASE CONDUCTOR (A, B, C)
   - ● GROUNDWIRE (S)
   - ● ADSS FIBRE (D)
   - Ⓖ GROUND LUG
   - ① ATTACHMENT DETAIL NUMBER, SEE DWG. 2L129-T08-B7.
   - F3 POLE FACE FOR ATTACHMENT (F3 = FACE 3)
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
5. PHASE CONDUCTORS AND FIBRE.
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM, RTS = 194,832 N, BARE MASS = 26.0087 N/M.
   ADSS FIBRE: AT-3BE27DT-048-TPBE-Z(ADSS), BARE MASS = 2.15 N/M.
6. FOR GUY ASSEMBLY HARDWARE DETAILS, SEE DWG: 2L129-T08-B6, NOTE 13.

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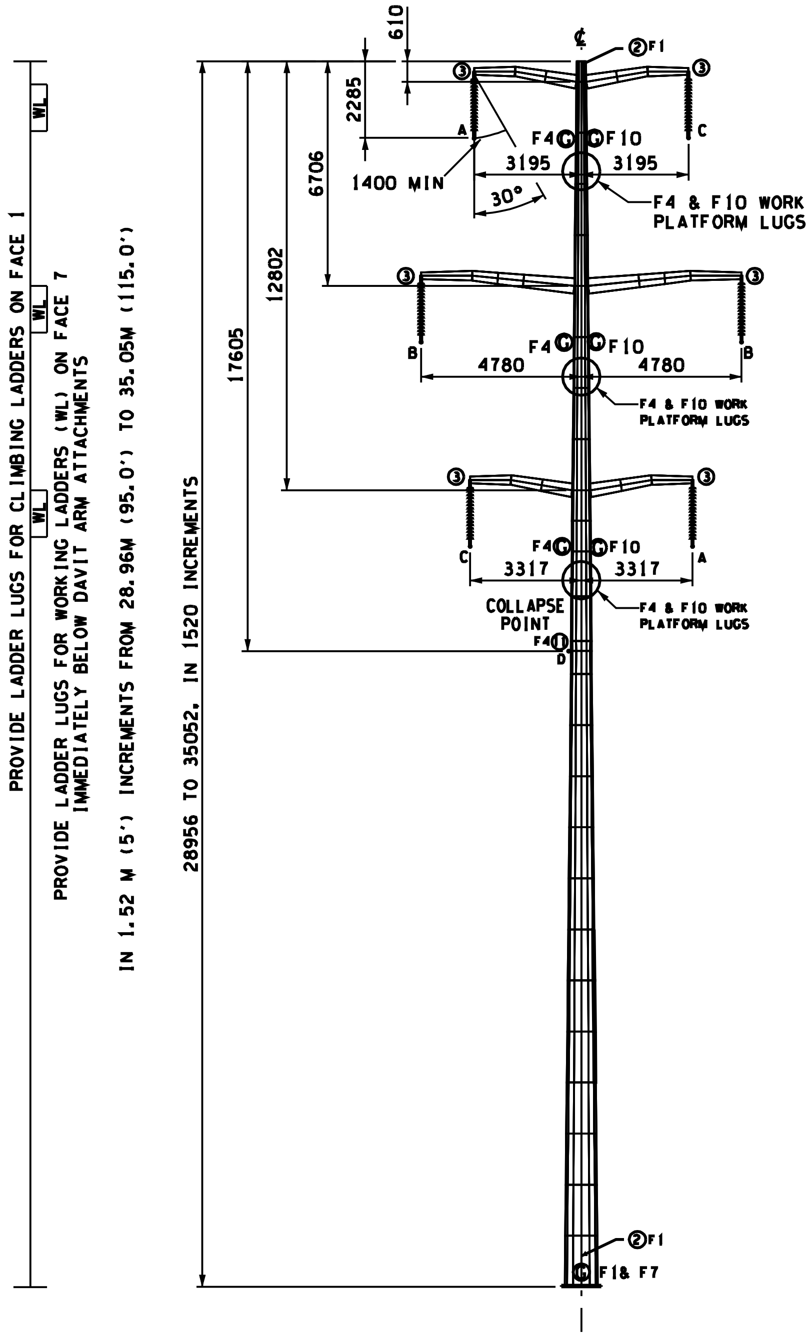
TYPE 2GD2V DOUBLE CIRCUIT MEDIUM ANGLE GUYED SUSPENSION SPECIFICATION DRAWING

DRAWING NUMBER	REV
75L-T08-B28	



TRANSVERSE ELEVATION

SPECIFIC SPECIFICATION NOTES:

1. CONDUCTOR AND ADSS FIBRE LOAD CASES

CASES 1 TO 7 IN TABLE 1 ARE BASED ON THE FOLLOWING:

CASE 1 - MAX. COMBINED WIND AND ICE, 0.385 kN/m2 WIND. 12.7 mm ICE, -18°C, w/ LF = 1.2
CASE 2 - HIGH WIND, 0.57 kN/m2 WIND, NO ICE, -18°C, w/ LF = 1.2
CASE 3 - COLD, NO WIND, NO ICE, -18°C, w/ LF = 1.2
CASE 4 - EVERYDAY LOAD, 0.12 kN/m2, NO ICE, 10°C, w/LF = 1.2
CASE 5 - UNEOUAL ICE, 12.7 mm ICE, NO WIND, -18°C, w/LF = 1.2.
CASE 6 - EARTHOUAKE LOAD, NO ICE, NO WIND, -18°C, w/LF = 1.0
CASE 7 - SNUBBING LOAD, COLD, NO WIND, NO ICE, -18°C, w/ LF = 2.0

"a" IS WITH THE WIND BLOWING NORMAL TO THE LEFT (in direction of face 10 to 4).
"b" IS WITH THE WIND BLOWING NORMAL TO THE RIGHT (in direction of face 4 to 10).

LOAD FACTORS SHOWN ABOVE ARE INCLUDED IN THE ULTIMATE LOADS.

EACH STRUCTURE, INCLUDING FOUNDATIONS SHALL BE ABLE TO WITHSTAND THE ULTIMATE WIND LOAD OF 0.77 kN/M2 ON THE STRUCTURE WITHOUT ANY GUYS, CONDUCTOR OR ADSS FIBRE ATTACHED.

2. PHASE AND GROUNDWIRE LOAD COMBINATIONS

LOADS T AND/OR L ARE REVERSIBLE WHERE SHOWN (+/-).
"-" IS LOAD ACTING TO THE LEFT, BACK OR UPWARD, "+" IS ACTING TO THE RIGHT, AHEAD OR DOWNWARD.

a) FOR CONDUCTOR LOAD CASE 1 TO 4 AND 7 APPLY PHASE LOADS V, T AND L AT ANY ONE, ANY TWO OR ALL THREE PHASE POINTS ON ONE SIDE OF THE POLE (ONE CIRCUIT) WITH THE OTHER SIDE OF THE POLE UNLOADED. APPLY CORRESPONDING LOAD CASE FOR ADSS FIBRE, THEN APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR ALL THREE PHASE POINTS ON THE SIDE OF THE POLE FOR THE SECOND CIRCUIT WITH THE LOADS OF ALL THREE PHASE POINTS OF THE FIRST CIRCUIT APPLIED.

b) FOR LOAD CASE 5 APPLY PHASE LOADS V, T AND L AT ANY ONE, TWO OR THREE PHASE POINTS AT THE SAME TIME APPLY CASE 3 LOADS ON THE REMAINING ATTACHMENTS INCL. ADSS FIBRE

PHASE LOADS INCLUDE THE MASS OF INSULATOR HARDWARE ASSEMBLIES AND ICE.

3. WIND LOAD ON STRUCTURE

FOR LOAD CASE 1 APPLY A WIND LOAD OF 0.9 kN/m^2 ON THE PROJECTED AREA OF THE STRUCTURE IN THE SAME DIRECTION AS THE RESULTANT OF THE TRANSVERSE AND LONGITUDINAL PHASE LOADS.
WIND LOADS ASSUMES A COEFFICIENT OF DRAG Co = 1.2 FOR A CIRCULAR CYLINDER. FOR A BOX OR OTHER FLAT SECTIONS MODIFY THE WIND LOAD FOR A Co = 2.4.

4. EARTHOUAKE LOADS

SEE DWG. 2L129-T08-B6, NOTE 6.

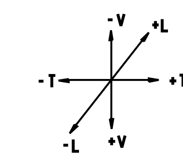
5. SNUBBING ANGLE

THE SNUBBING ANGLE SHALL NOT EXCEED 20° MEASURED FROM HORIZONTAL.

STRUCTURE TYPE CONDUCTOR PHASE AND ADSS FIBRE LOADS

TABLE 1 - TYPE 2A2D

ULTIMATE LOADS IN kN				ULTIMATE LOADS IN kN			
CONDUCTOR				ADSS FIBRE			
CASE	V	T	L	CASE	V	T	L
1a	32.0	-12.0		1a	8.4	-7.5	
1b	32.0	12.0		1b	8.4	7.5	
2a	20.0	-11.0		2a	1.6	-4.5	
2b	20.0	11.0		2b	1.6	4.5	
3	20.0	+/-1.0		3	1.6	+/-0.1	
4a	20.0	-2.2		4a	1.6	-1.0	
4b	20.0	2.2		4b	1.6	1.0	
5	32.0	-1.0	+/-6.6	5	8.4	+/-0.1	+/-1.5
6	16.7	+/-6.8		6	1.3	+/-0.6	
7	33.3	+/-1.7	+/-4.0	7	2.7	+/-0.2	+/-0.2



LOAD DIRECTIONS TYPICAL FOR ALL SUPPORT POINTS SEE TABLE 1

V = VERTICAL, PHASE/ WIRE LOAD
T = TRANSVERSE, PHASE/ WIRE LOAD
L = LONGITUDINAL, PHASE/WIRE LOAD

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS, SEE DWG. 2L129-T08-B7.
3. SYMBOL LEGEND:
   - ● PHASE CONDUCTOR (A, B, C)
   - ● GROUNDWIRE (S)
   - ● ADSS FIBRE (D)
   - (G) GROUND LUG
   - (1) ATTACHMENT DETAIL NUMBER, SEE DWG. 2L129-T08-B7.
   - F3 POLE FACE FOR ATTACHMENT (F3 = FACE 3)
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
5. PHASE CONDUCTORS AND FIBRE.
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM, RTS = 194,832 N, BARE MASS = 26.0087 N/M.
   ADSS FIBRE: AT-3BE27DT-048-TPBE-Z(ADSS), BARE MASS = 2.15 N/M.

REFERENCE DWG.

2L129-T08-B6 - GENERAL SPECIFICATIONS
2L129-T08-B7 - ATTACHMENT DETAILS

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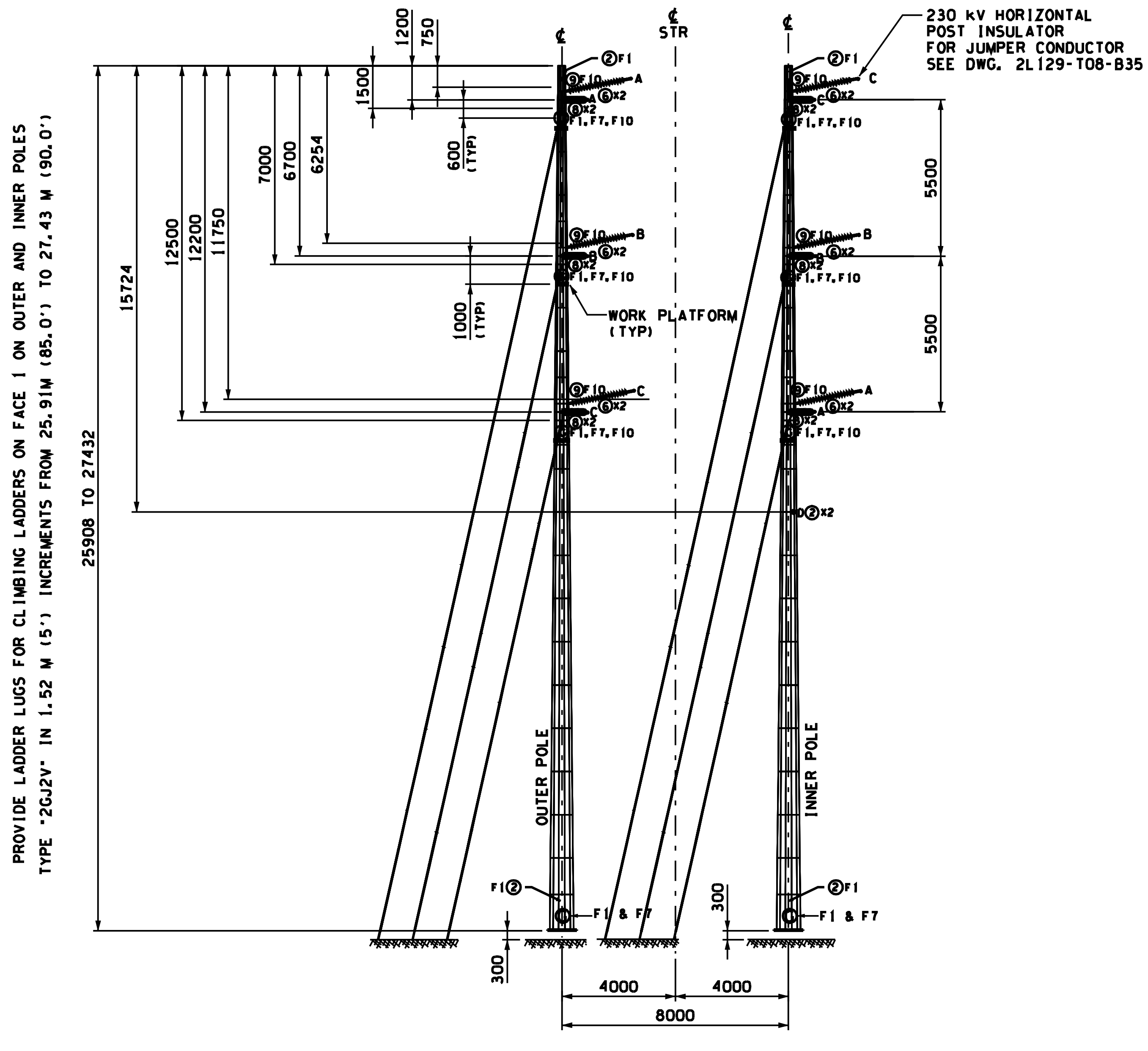
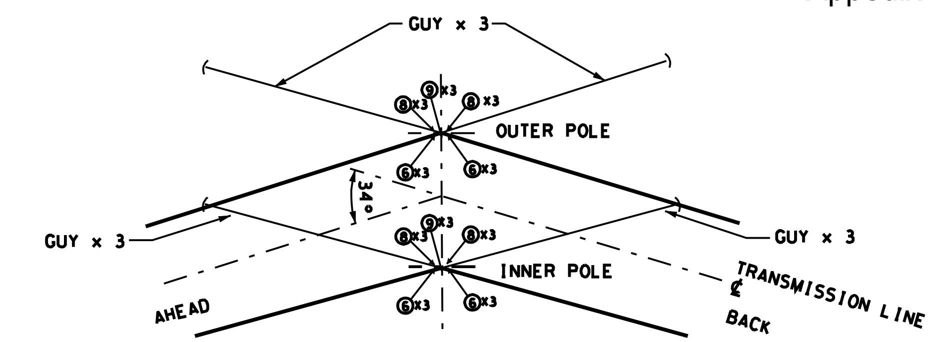
FORTISBC

FORTISBC
TYPE 2A2D DOUBLE CIRCUIT SUSPENSION SPECIFICATION DRAWING

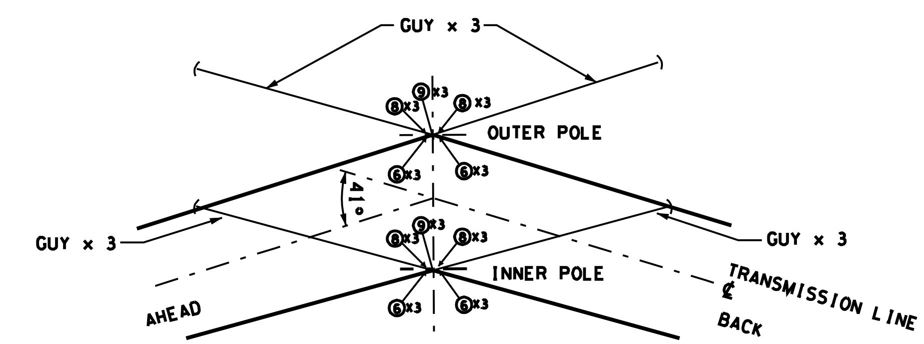
DRAWING NUMBER	REV
75L-T08-B27	



TRANSVERSE ELEVATION



PLAN STR. 45/4
(TRUE LA = 33° LEFT)



PLAN STR. 50/3
(TRUE LA = 41° LEFT)

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS, SEE DWG. 2L129-T08-B7.
3. SYMBOL LEGEND:
   - • PHASE CONDUCTOR (A, B, C)
   - • GROUNDWIRE (S)
   - • ADSS FIBRE (D)
   - Ⓖ GROUND LUG
   - ① ATTACHMENT DETAIL NUMBER, SEE DWG. 2L129-T08-B7.
   - F3 POLE FACE FOR ATTACHMENT (F3 = FACE 3)
   - (—— GUY
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
5. PHASE CONDUCTOR AND FIBRE:
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM,
   RTS = 194,832 N, BARE MASS = 26.0087 N/M.
   ADSS FIBRE: AT-3BE27DT-048-TPBE-Z(ADSS), BARE MASS = 2.15 N/M.
6. FOR GUY ASSEMBLY HARDWARE DETAILS, SEE DWG: 2L129-T08-B6, NOTE 13.

REFERENCE DWG.

2L129-T08-B6 - GENERAL SPECIFICATIONS
2L129-T08-B7 - ATTACHMENT DETAILS
2L129-T08-B35 - HORIZONTAL POST INSULATOR (JUMPER)

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FOR DISCUSSION PURPOSES ONLY

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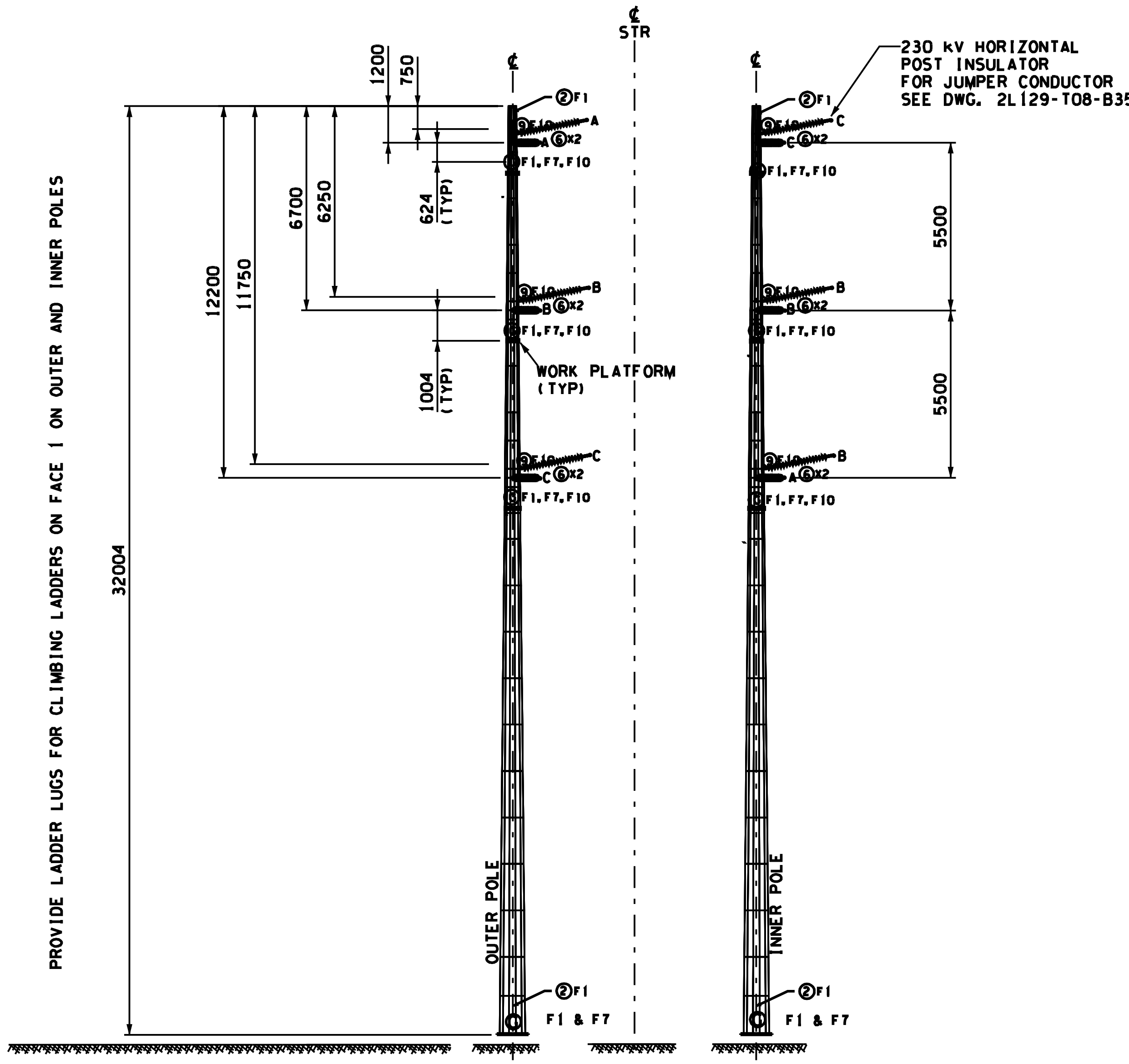
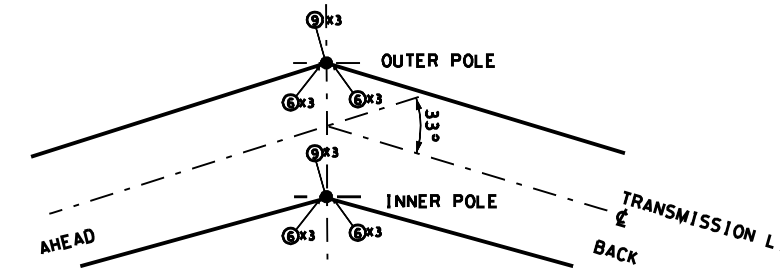
FORTISBC

FORTISBC
TYPE 2GJ2V DOUBLE CIRCUIT
GUYED MEDIUM ANGLE DEAD-END
SPECIFICATION DRAWING-
SHEET 1 OF 2

DRAWING NUMBER	REV
75L-T08-B31-1	



TRANSVERSE ELEVATION



PLAN STR. 10/3
(TRUE LA = 33° RIGHT)

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS, SEE DWG. 2L129-T08-B7.
3. SYMBOL LEGEND:
   - • PHASE CONDUCTOR (A, B, C)
   - • GROUNDWIRE (S)
   - Ⓖ GROUND LUG
   - ① ATTACHMENT DETAIL NUMBER, SEE DWG. 2L129-T08-B7..
   - F3 POLE FACE FOR ATTACHMENT (F3 = FACE 3)
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.
5. PHASE CONDUCTOR:
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM, RTS = 194,832 N, BARE MASS = 26.0087 N/M.

PRELIMINARY
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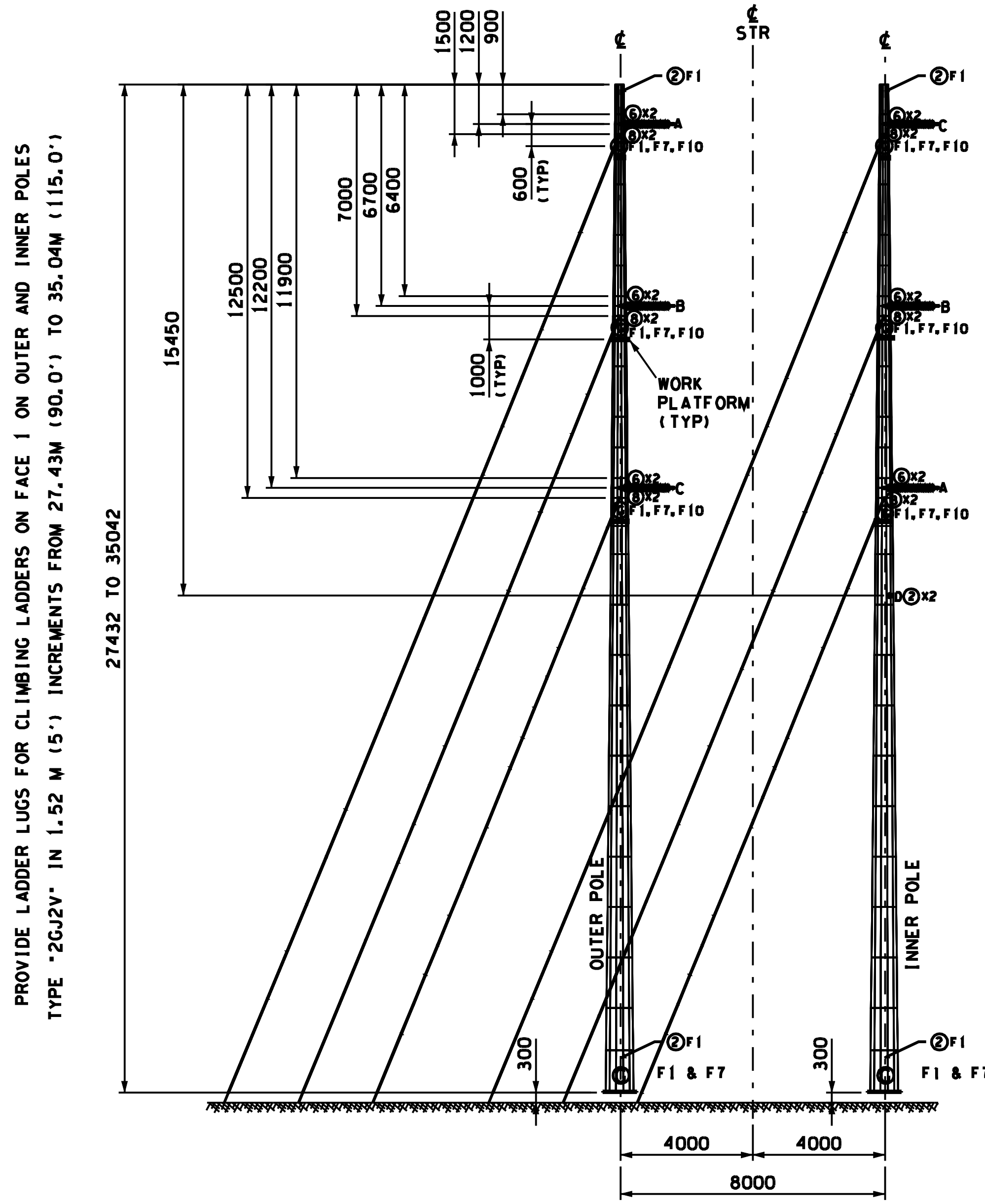
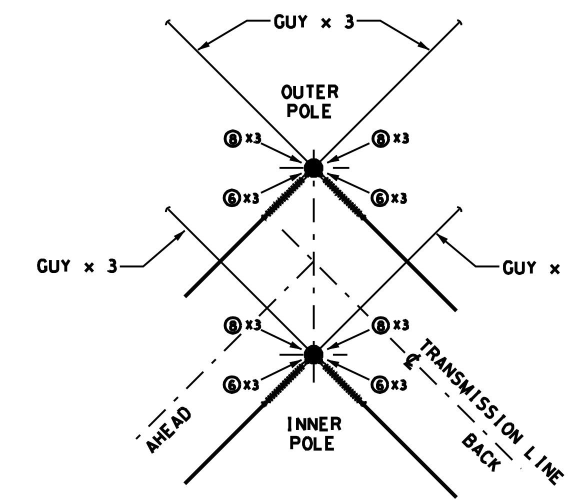
FORTISBC

FORTISBC
TYPE 2J2V DOUBLE CIRCUIT
MEDIUM ANGLE DEAD-END
SPECIFICATION DRAWING
SHEET 1 OF 2

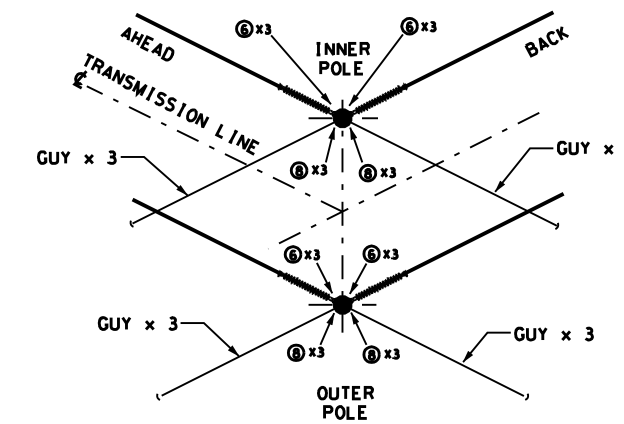
DRAWING NUMBER	REV
75L-T08-B32-1	



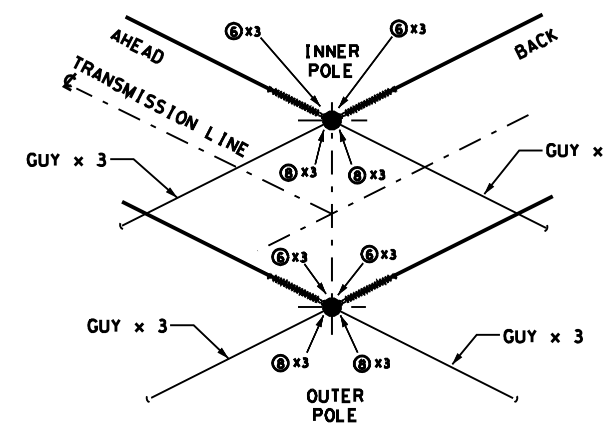
TRANSVERSE ELEVATION



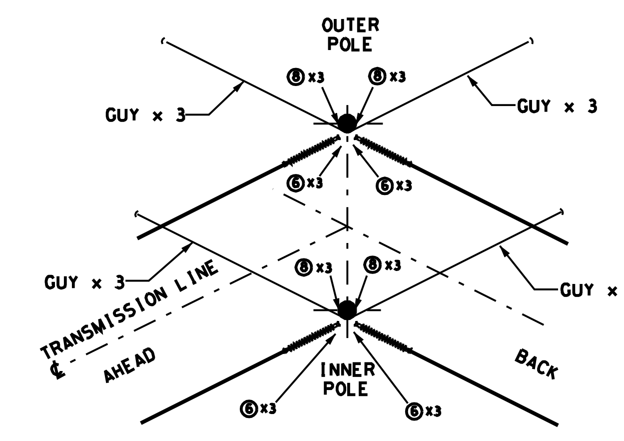
PLAN STR. 5/5
(TRUE LA = 90° LEFT)



PLAN STR. 54/1
(TRUE LA = 53° LEFT)



PLAN STR. 51/1
(TRUE LA = 54° RIGHT)



PLAN STR. 59/5
(TRUE LA = 51° LEFT)

SYMBOL LEGEND:

•	PHASE CONDUCTOR (A, B, C)
•	GROUNDWIRE (S)
•	ADSS FIBRE (D)
Ⓖ	GROUND LUG
①	ATTACHMENT DETAIL NUMBER. SEE DWG. 2L129-T08-B7
F3	POLE FACE FOR ATTACHMENT (F3 = FACE 3)
———	GUY

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. FOR GENERAL STRUCTURE SPECIFICATIONS, SEE DWG. 2L129-T08-B6.
2. FOR POLE ATTACHMENT DETAILS. SEE DWG. 2L129-T08-B7.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.
4. PHASE CONDUCTOR AND FIBRE:
   STANDARD: SINGLE 1590 KCMIL 45/7 ACSR LAPWING, OD = 38.20 MM, RTS = 194,832 N, BARE MASS = 26.0087 N/M.
   ADSS FIBRE: AT-3BE27DT-048-TPBE-Z(ADSS), BARE MASS = 2.15 N/M.
5. FOR GUY ASSEMBLY HARDWARE DETAILS, SEE DWG: 2L129-T08-B6, NOTE 13.

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FORTISBC

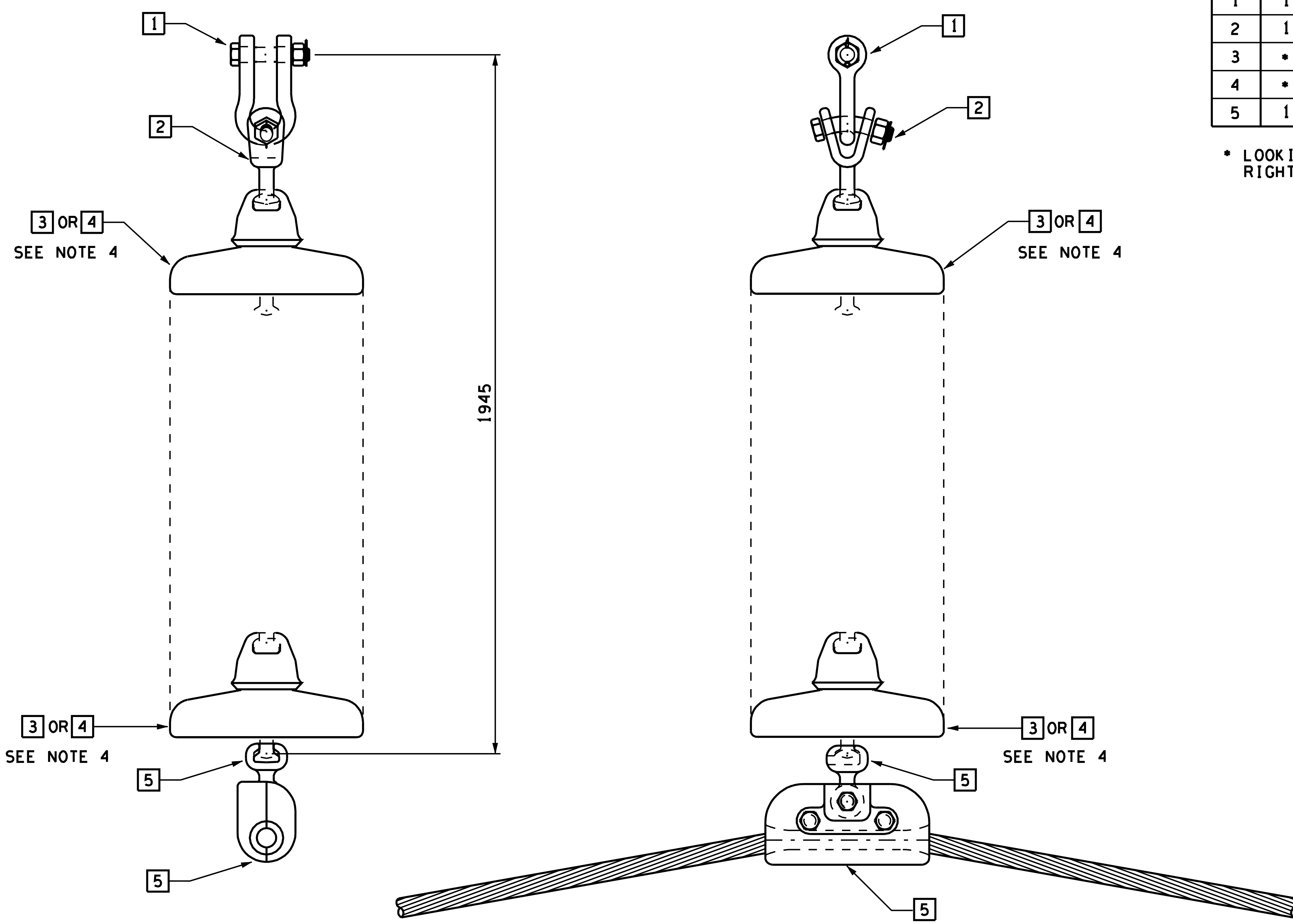
FORTISBC
TYPE 2GK2V DOUBLE CIRCUIT
GUYED HEAVY ANGLE DEAD-END
SPECIFICATION DRAWING
SHEET 1 OF 2

DRAWING NUMBER	REV
75L-T08-B33-1	

APPENDIX G: INSULATOR AND HARDWARE TYPES

BILL OF MATERIAL FOR ONE ASSEMBLY				
ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	1	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN
2	1	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, ¾"Ø BOLT, 120 kN
3	*	EA	410-0995	INSULATOR, SUSPENSION, TOUGHENED GLASS, 146 x 254, 140 kN
4	*	EA	410-1013	INSULATOR, SUSPENSION, TOUGHENED GLASS, 146 x 254, 70 kN
5	1	EA	96004267	CLAMP, SUSPENSION, CORONA FREE, c/w SOCKET EYE, FOR LAPWING CONDUCTOR

* LOOKING TO VIT, LEFT CIRCUIT (SIDE A) TO HAVE 12 INSULATORS (ITEM 3 OR 4), RIGHT CIRCUIT (SIDE B) TO HAVE 15 INSULATORS (ITEM 3 OR 4).



PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES, ±2 mm, UNLESS OTHERWISE NOTED.
2. APPROXIMATE ASSEMBLY MASS = 55 kg.
3. THE COTTER PIN IN ITEM 5 SHALL BE LOCATED ON THE SIDE OF THE SUSPENSION CLAMP NEAREST THE POLE.
4. USE ITEM 4, 70 kN INSULATOR 410-1013, ONLY FOR JUMPERS AND SUSPENSION ASSEMBLY ON 2A2HF STRUCTURES.

REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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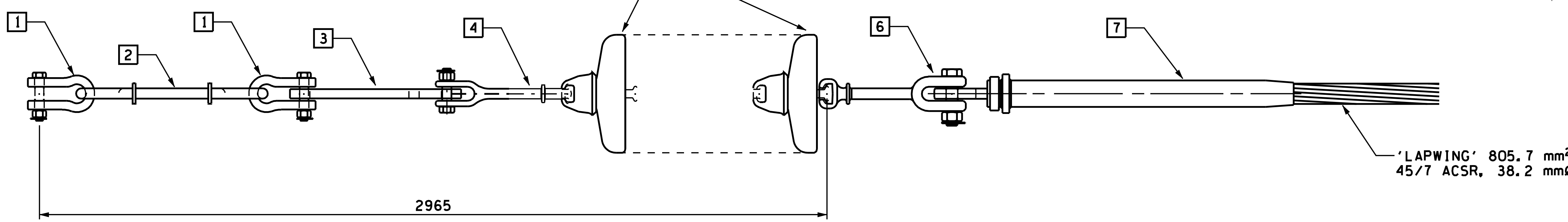
FORTISBC
SINGLE 70 kN OR 120 kN INSULATOR STRING
SUSPENSION HARDWARE ASSEMBLY
FOR 'LAPWING', 45/7, ACSR CONDUCTOR

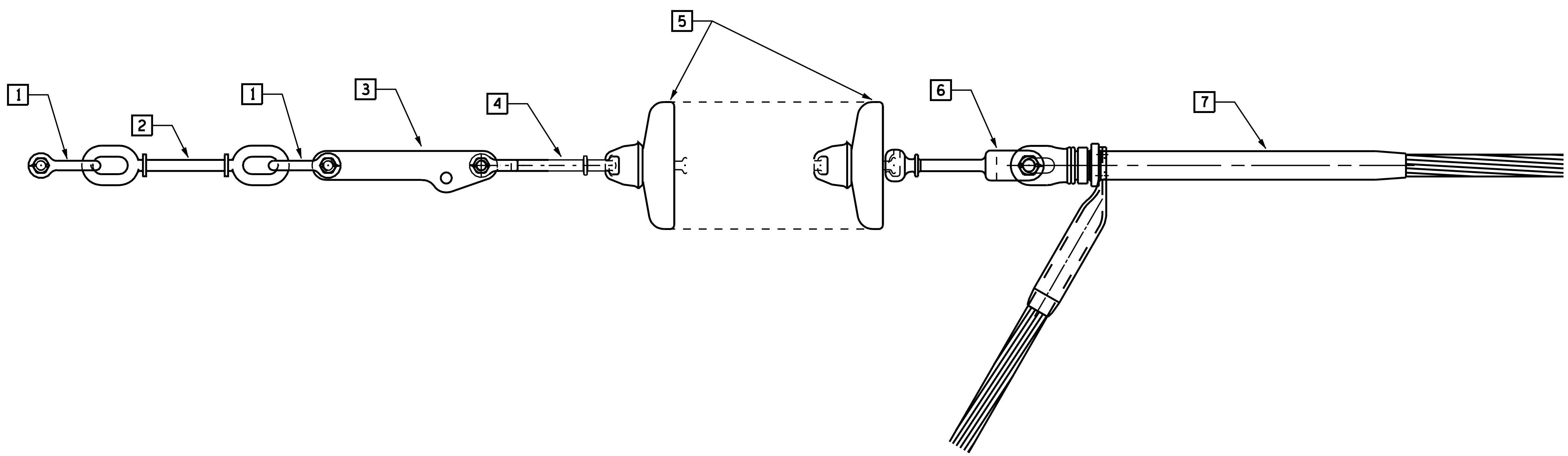
DRAWING NUMBER: 75L-T08-B9
REV

BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	2	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN
2	1	EA	413-1761	OVAL EYE, DOUBLE, EXTENSION, H/L, 370 LG, 70 OPEN, 220 kN
3	1	EA	413-0525	PLATE, PULLING, 370 LG, 160 kN
4	1	EA	96004259	CLEVIS, BALL, H/L, 220 kN, 270 LONG, ¾"BOLT, 30 OPEN
5	*	EA	410-0999	INSULATOR, SUSPENSION, 156 x 292, 160 kN
6	1	EA	413-1423	CLEVIS, SOCKET, H/L, 270 LG, 29 OPEN, 1"Ø BOLT, 220 kN
7	1	EA	96004261	DEAD END, COMPRESSION, C/W TERMINAL, FOR LAPWING, 45/7 ACSR

* LOOKING TO VIT, LEFT CIRCUIT (SIDE A) TO HAVE 12 INSULATORS (ITEM 5), RIGHT CIRCUIT (SIDE B) TO HAVE 15 INSULATORS (ITEM 5).





PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES, ±2 mm, UNLESS OTHERWISE NOTED.
2. APROXIMATE ASSEMBLY MASS = 90 kg.

REVISIONS								
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE		

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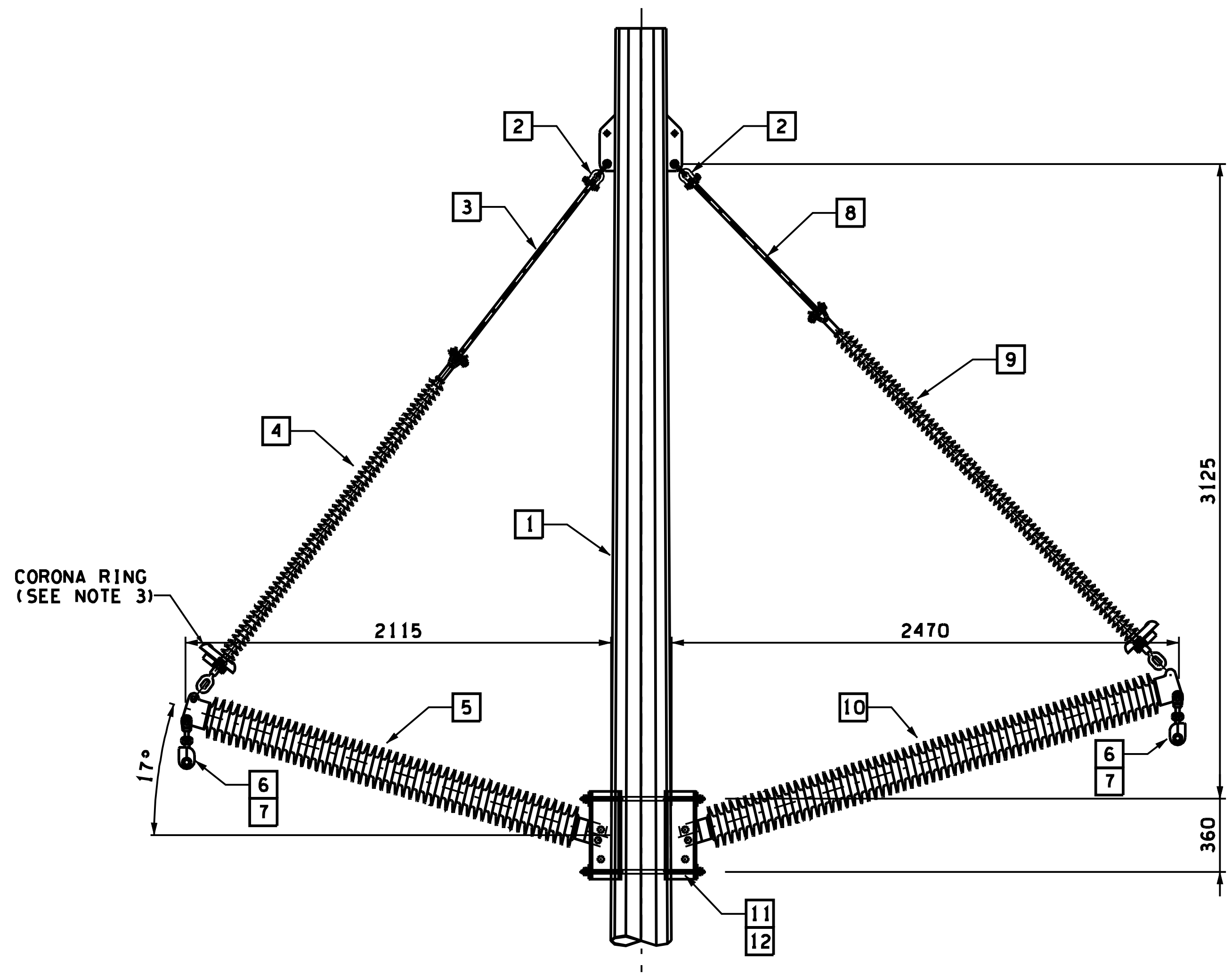
FORTISBC

SINGLE 160 kN INSULATOR STRING DEAD END HARDWARE ASSEMBLY FOR 'LAPWING' 45/7, ACSR CONDUCTOR

DRAWING NUMBER	REV
75L-T08-B10	

BILL OF MATERIAL FOR ONE STRUCTURE, UPPER AND LOWER PHASES				
ITEM	QTY	HU	BCH STOCK No./ MANUF CAT No.	DESCRIPTION
1	1	EA	-	POLE, STEEL, GALVANIZED.
2	4	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
3	2	EA	2L129-T08-A40 ITEM 2	PLATE, LINK, 60 × ⅝" × 1030 LG
4	2	EA	NGK 251-SS580-YE-08	INSULATOR, SUSPENSION, POLYMER, 110 kN, 2060 LG
5	2	EA	NGK L3-SN491-13	INSULATOR, LINE POST, POLYMER, 2115 LG
6	4	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, ¾"Ø BOLT, 120 kN
7	4	EA	96004267	CLAMP, SUSP, ASSY, CORONA FREE, HOT LINE, C/W SOCKET EYE, FOR LAPWING
8	2	EA	2L129-T08-A40 ITEM 1	PLATE, LINK, 60 × ⅝" × 820 LG
9	2	EA	NGK 251-SS700-YE-08	INSULATOR, SUSPENSION, POLYMER, 110 kN, 2420 LG
10	2	EA	NGK L3-SN591-13	INSULATOR, LINE POST, POLYMER, 2470 LG
11	4	EA	2L129-T08-A41	BOLT, DOUBLE ARMING
12	8	EA	102-4162	WASHER, HELICAL SPRING, FOR ⅞"Ø BOLT
13	4	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN



PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. INSTALL THE CORONA RING ON THE LINE END FITTING WITH THE OPENING FACING DOWN. THE MOUNTING ARM OF THE CORONA RING FITS ONTO THE SPACE BETWEEN THE LIP AND THE STEP ON THE END OF THE FITTING. THE SPHERE SURFACE OF THE CORONA RING FACES THE RUBBER WEATHERSHED.
   PLACE ½" - 13UNC CAP SCREWS, STOP RINGS, CLAMP, SPRINGWASHERS AND NUTS. TIGHTEN NUTS ON BOTH SIDES EVENLY WITH A WRENCH TO 20 N.M (15 FT-LBS) TORQUE, MAINTAINING THE REQUIRED RING POSITION AND DIRECTION.
3. THE ARRANGEMENT SHOWN IN 'ELEVATION A' IS FOR THE BASIC ASSEMBLY ATTACHED TO THE LOWER AND UPPER PHASE ATTACHMENTS OF THE LEFT AND RIGHT POLES.
4. DETAILS OF THE CONNECTION FOR THE OFF-SET MIDDLE PHASE - BRACE AND BASE ATTACHMENTS AS SHOWN IN ELEVATION 'B' ARE TO BE DEVELOPED BY THE STEEL POLE DESIGNER/ SUPPLIER.
5. FOR INSTALLATION ON TYPE '2A2P', '2A2PG' AND '2A2PGT' STRUCTURES.

REFERENCE DRAWINGS:

2L129-T08-B6 GENERAL SPECIFICATIONS
2L129-T08-B7 ATTACHMENT DETAILS
2L129-T08-A40 EXTENSION PLATES FOR BRACED POST AND HORIZONTAL INSULATOR ASSEMBLIES
2L129-T08-A41 DOUBLE ARMING BOLT TABLE

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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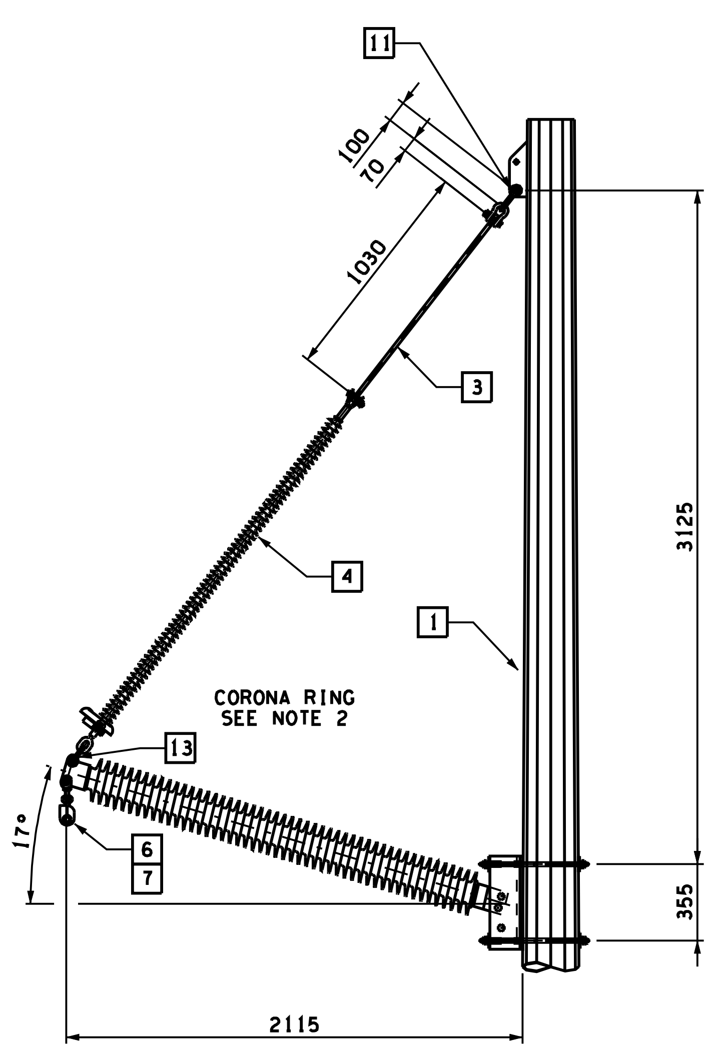
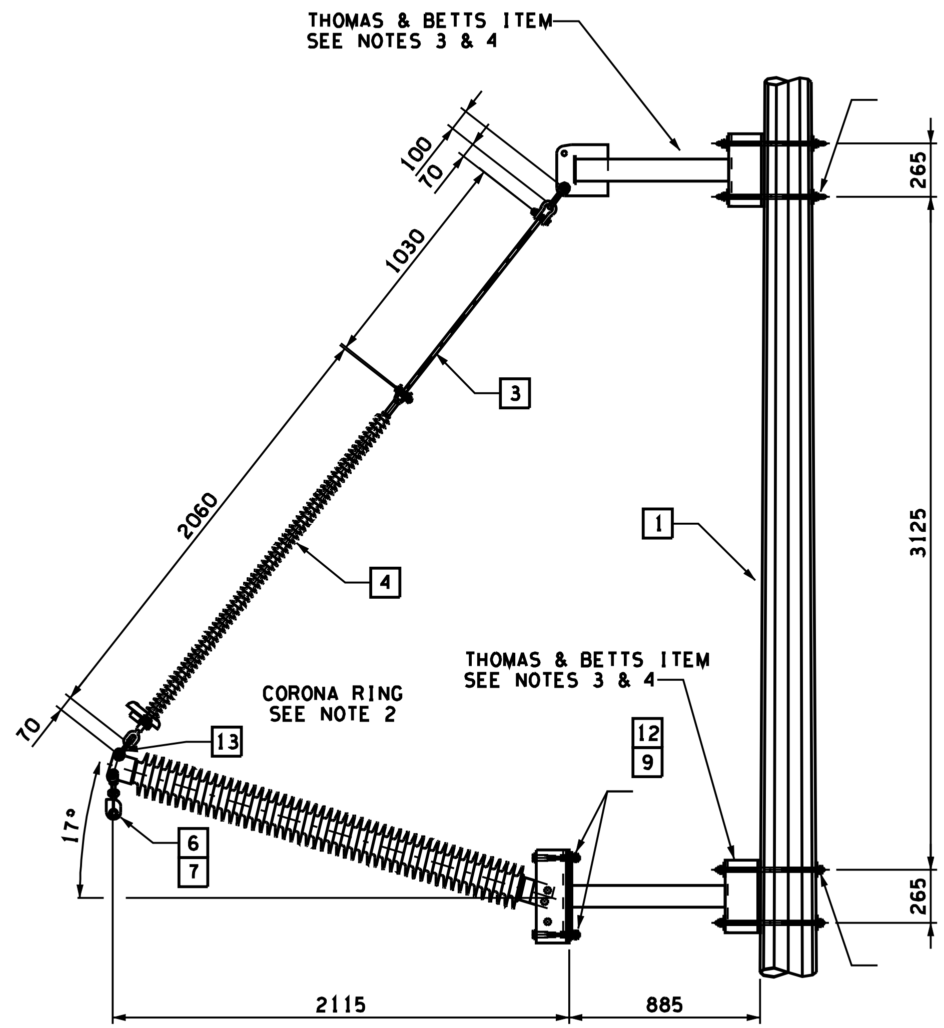
BRACED POST INSULATOR HARDWARE ASSEMBLY

DRAWING NUMBER	REV
75L-T08-B11	

BILL OF MATERIAL FOR ONE STRUCTURE				
ITEM	QTY	HU	BCH STOCK No. / MANUF CAT No.	DESCRIPTION
1	1	EA	-	POLE, STEEL, GALVANIZED.
2	3	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
3	3	EA	2L129-T08-A40 ITEM 2	PLATE, LINK, 60 x ⅝" x 1030 LG
4	3	EA	NGK 251-S5580-YE-08	INSULATOR, SUSPENSION, POLYMER, 110 kN, 2060 LG
5	3	EA	NGK L3-SN491-18	INSULATOR, LINE POST, POLYMER, 2115 LG
6	3	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, ¾"Ø BOLT, 120 kN
7	3	EA	96004267	CLAMP, SUSP, ASSY, CORONA FREE, HOT LINE, C/W SOCKET EYE, FOR LAPWING
8	8	EA	2L129-T08-A41	BOLT, DOUBLE ARMING
9	18	EA	102-4162	WASHER, HELICAL SPRING, FOR ⅞"Ø BOLT
10	8	EA	420-1526	WASHER, FLAT, 3" x 3", FOR 1"Ø BOLT
11	3	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN
12	2	EA	-	BOLT, MACHINE, ⅞"Ø x 8", GRADE 5, MIN. THREAD 6", c/w NUT
13	3	EA	ANDERSON 45-25-L-BNK	SHACKLE, ANCHOR



ELEVATION 'A' - UPPER/ LOWER PHASE ASSEMBLIES



ELEVATION 'B' - MID PHASE ASSEMBLIES

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. INSTALL THE CORONA RING ON THE LINE END FITTING WITH THE OPENING FACING DOWN. THE MOUNTING ARM OF THE CORONA RING FITS ONTO THE SPACE BETWEEN THE LIP AND THE STEP ON THE END OF THE FITTING. THE SPHERE SURFACE OF THE CORONA RING FACES THE RUBBER WEATHERSHED.
   PLACE ½" - 13UNC CAP SCREWS, STOP RINGS, CLAMP, SPRINGWASHERS AND NUTS. TIGHTEN NUTS ON BOTH SIDES EVENLY WITH A WRENCH TO 20 N.M (15 FT-LBS) TORQUE, MAINTAINING THE REQUIRED RING POSITION AND DIRECTION.
3. MID PHASE BRACE AND BASE EXTENSIONS SUPPLIED BY THOMAS & BETTS WITH POLE.
4. FOR INSTALLATION ON TYPE '2GD2FV' STRUCTURES.

REFERENCE DRAWINGS:

2L129-T08-B6 GENERAL SPECIFICATIONS
2L129-T08-B7 ATTACHMENT DETAILS
2L129-T08-A40 EXTENSION PLATES FOR BRACED POST AND HORIZONTAL INSULATOR ASSEMBLIES
2L129-T08-A41 DOUBLE ARMING BOLT TABLE

REVISIONS						
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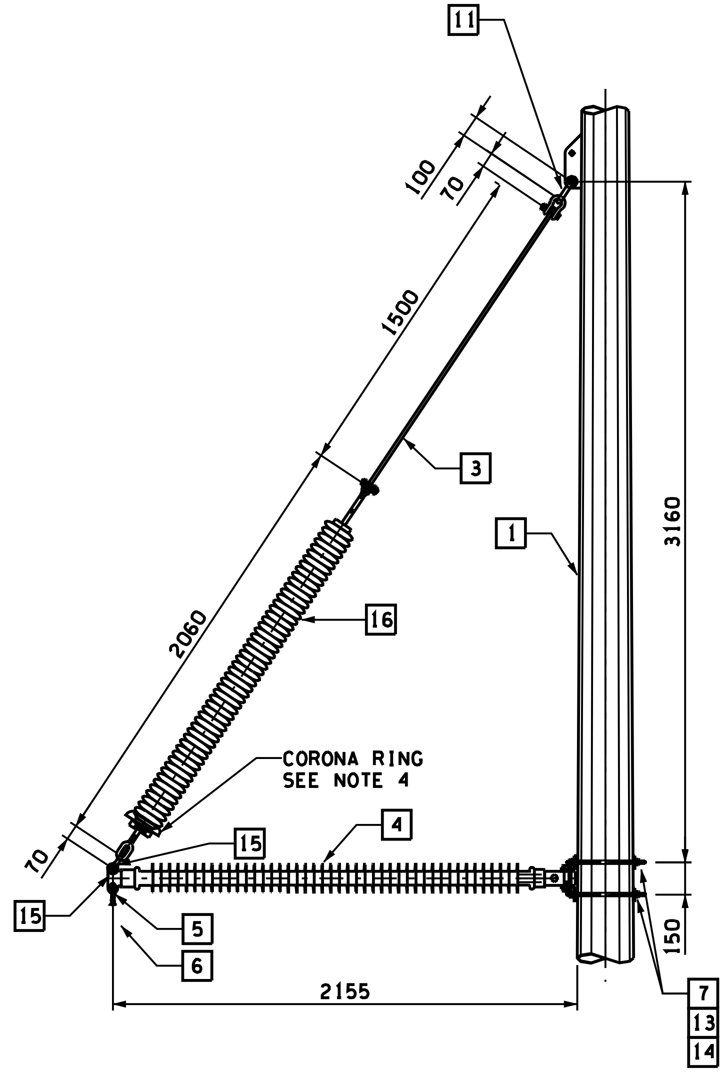
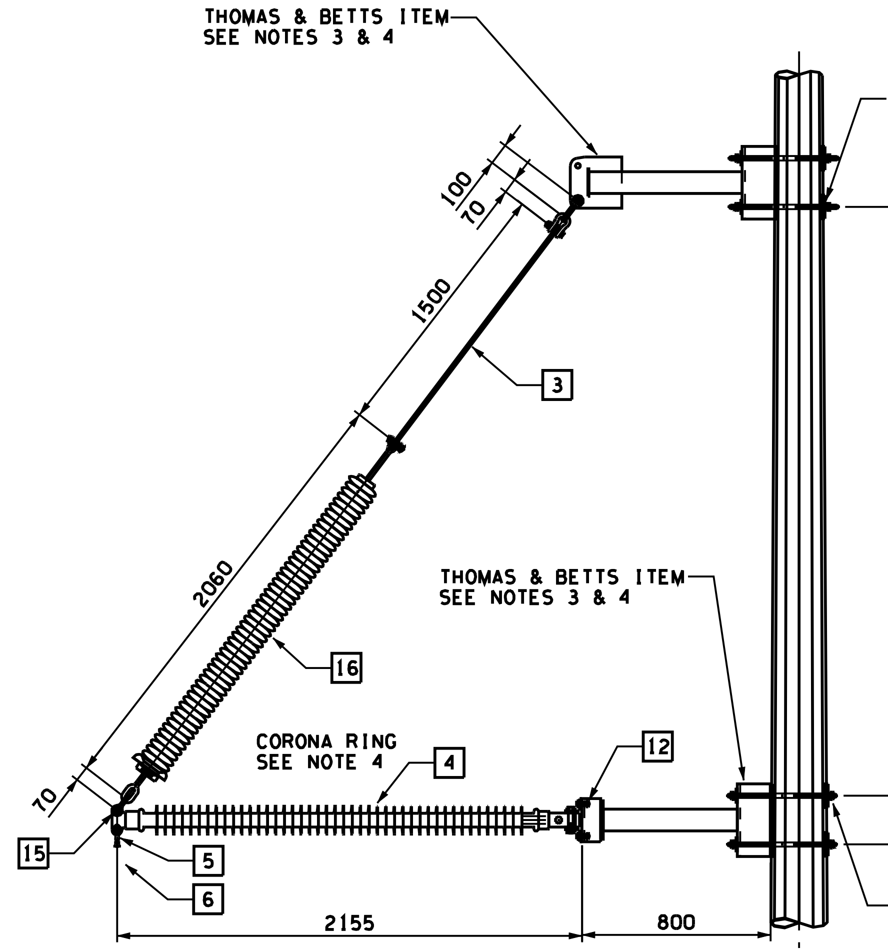
BRACED POST INSULATOR HARDWARE ASSEMBLY FOR TYPE 2GD2FV STRUCTURE

DRAWING NUMBER	REV
75L-T08-B12	

BILL OF MATERIAL FOR ONE STRUCTURE				
ITEM	QTY	HU	BCH STOCK No./ MANUF CAT No.	DESCRIPTION
1	1	EA	-	POLE, STEEL, GALVANIZED.
2	3	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, 3/4"Ø BOLT, 120 kN
3	3	EA	2L129-T08-A40 ITEM 4	PLATE, LINK, 60 x 5/8" x 1500 LG
4	3	EA	NGK L2-SM491-15*1	INSULATOR, LINEPOST, POLYMER
5	3	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, 3/4"Ø BOLT, 120 kN
6	3	EA	96004267	CLAMP, SUSP, ASSY, CORONA FREE, HOT LINE, C/W SOCKET EYE, FOR LAPWING
7	4	EA	2L129-T08-A41	BOLT, DOUBLE ARMING, 5/8"Ø
8	4	EA	2L129-T08-A41	BOLT, DOUBLE ARMING, 7/8"Ø
9	8	EA	102-4162	WASHER, HELICAL SPRING, FOR 7/8"Ø BOLT
10	8	EA	420-1526	WASHER, FLAT, 3" x 3", FOR 1"Ø BOLT
11	3	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, 3/4"Ø BOLT, 160 kN
12	2	EA	-	BOLT, MACHINE, 5/8"Ø x 2", GRADE 5, MIN. THREAD 1 1/2", c/w NUT
13	6	EA	102-4158	WASHER, HELICAL SPRING, FOR 5/8"Ø BOLT
14	4	EA	420-1524	WASHER, FLAT, 3" x 3", FOR 5/8"Ø BOLT
15	3	EA	ANDERSON 45-25-L-BNK	SHACKLE, ANCHOR
16	3	EA	NGK 251-SS580-YE-08	INSULATOR, SUSPENSION, POLYMER, 110 kN, 1060 LG, c/w CORONA RING LS2155



ELEVATION 'A' - UPPER/ LOWER PHASE ASSEMBLIES



ELEVATION 'B' - MIDDLE PHASE ASSEMBLY

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. INSTALL THE CORONA RING ON THE LINE END FITTING WITH THE OPENING FACING DOWN. THE MOUNTING ARM OF THE CORONA RING FITS ONTO THE SPACE BETWEEN THE LIP AND THE STEP ON THE END OF THE FITTING. THE SPHERE SURFACE OF THE CORONA RING FACES THE RUBBER WEATHERSHED.
   PLACE 1/2" - 13UNC CAP SCREWS, STOP RINGS, CLAMP, SPRINGWASHERS AND NUTS. TIGHTEN NUTS ON BOTH SIDES EVENLY WITH A WRENCH TO 20 N.M (15 FT-LBS) TORQUE, MAINTAINING THE REQUIRED RING POSITION AND DIRECTION.
3. MID PHASE BRACE AND BASE EXTENSIONS SUPPLIED BY THOMAS & BETTS WITH POLE.
4. FOR INSTALLATION ON TYPE '2GD2V, 2D2V & 2D2VG' STRUCTURES.

LOOKING TO VIT
LEFT CIRCUIT STANDARD INSULATORS

REFERENCE DRAWINGS:

2L129-T08-B6 GENERAL SPECIFICATIONS
2L129-T08-B7 ATTACHMENT DETAILS
2L129-T08-A40 EXTENSION PLATES FOR BRACED POST AND HORIZONTAL INSULATOR ASSEMBLIES
2L129-T08-A41 DOUBLE ARMING BOLT TABLE

REVISIONS						
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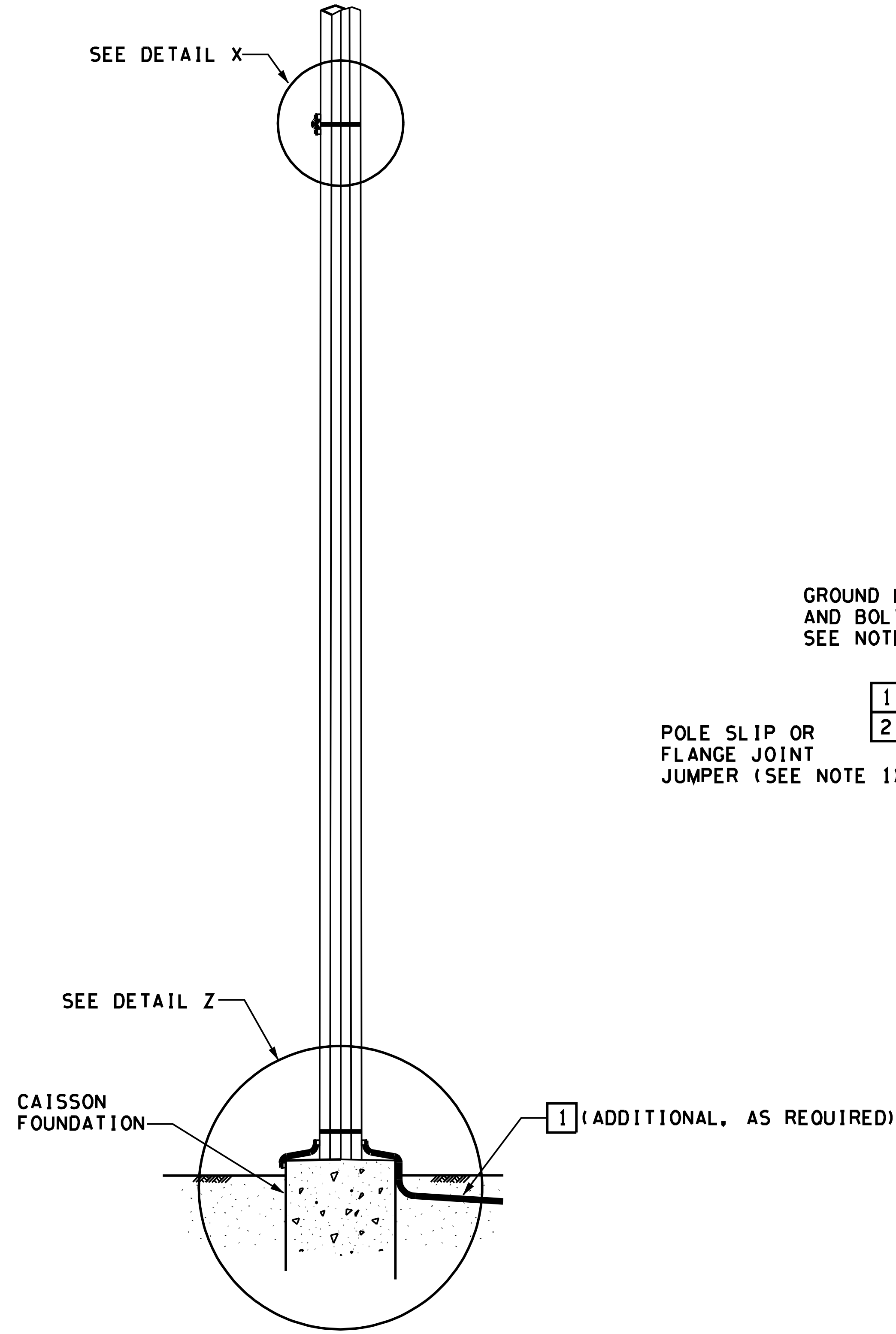
HORIZONTAL VEE INSULATOR HARDWARE ASSEMBLY FOR TYPE 2GD2V, 2D2V AND 2D2VG STRUCTURES

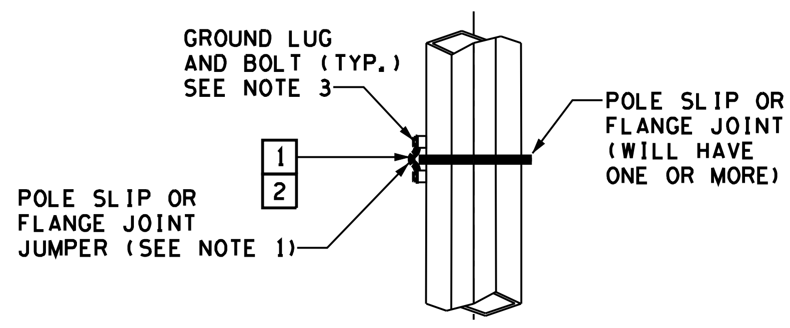
DRAWING NUMBER	REV
75L-T08-B13	

BILL OF MATERIAL FOR ONE ASSEMBLY

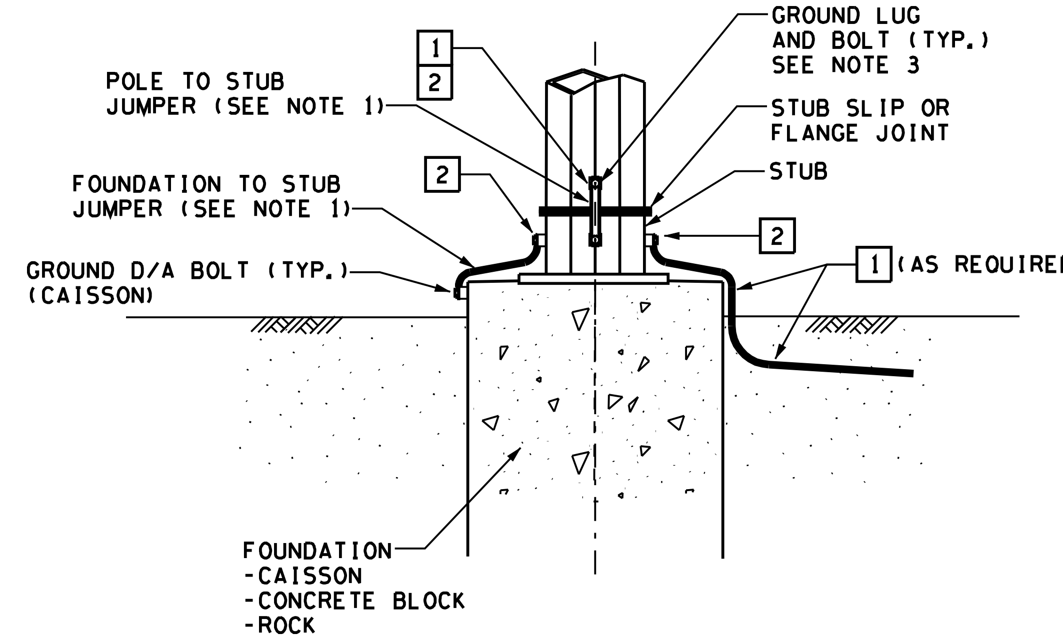
ITEM	BCH STOCK No.	DESCRIPTION
1	382-4236	COUNTERPOISE WIRE, GALVANIZED, STEEL, SIZE 10, GRADE 1300
2	413-2690	TERMINAL LUG



STEEL POLE WITH GROUNDING INSTALLED



DETAIL X



DETAIL Z

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ON ALL STEEL POLES, INSTALL ONE JUMPER ACROSS EACH POLE SLIP OR FLANGE JOINT. IF THE FOUNDATION HAS A EXTERNAL CMP OR CAISSON INSTALL A JUMPER FROM THE EMBEDDED BASE SECTION TO THE FOUNDATION. JUMPERS ARE MADE FROM COUNTERPOISE WIRE (ITEM 1) CUT TO LENGTH AND TWO TERMINAL LUGS (ITEM 2).
2. USE ALCAN DIE JDA7 OR DA7 TO INSTALL ITEM 2.
3. GROUND LUG AND BOLT ARE SUPPLIED WITH STEEL POLES.

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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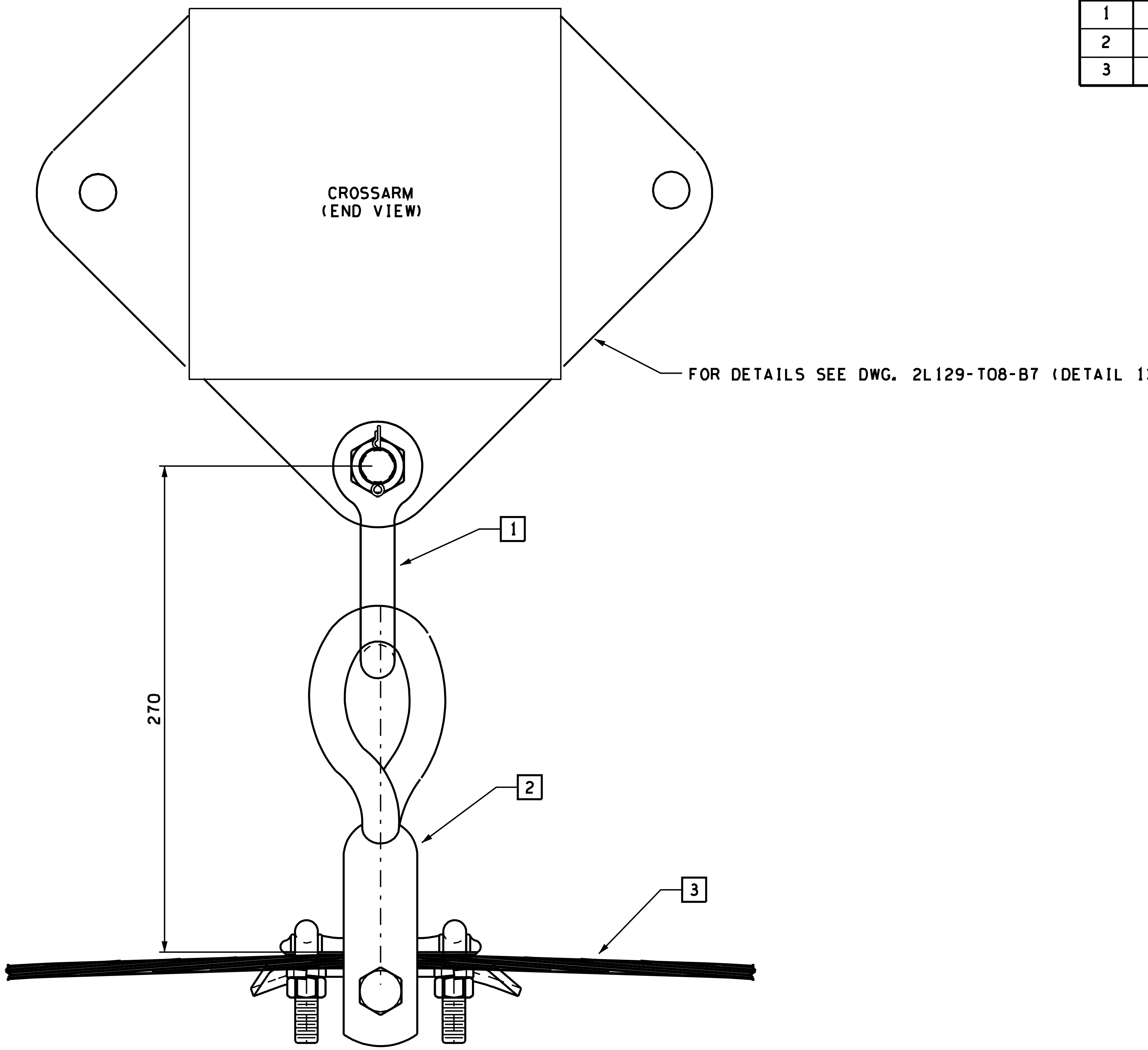
STANDARD POLE SECTION
JUMPER AND STRUCTURE
GROUNDING DETAILS
STEEL POLE STRUCTURES

DRAWING NUMBER	REV
75L-T08-B14	

BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	1	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
2	1	EA	SLACAN T2061-2	CLAMP, SUSPENSION, G/W
3	1	m	382-4244	WIRE, GROUND, SIZE 9, GRADE 1300



NON-INSULATED GROUNDWIRE SUSPENSION ASSEMBLY
TYPE 2A2PG & 2A2DG STEEL POLE STRUCTURE

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES ± 2 mm TOLERANCE UNLESS OTHERWISE NOTED.
2. MAXIMUM GROUNDWIRE TENSION: 21.0 kN
3. APPROXIMATE GROUNDWIRE HARDWARE ASSEMBLY MASS = 2 Kg.
4. FOR GENERAL SPECIFICATION DATA SEE BCH SPEC. 413-0000.

REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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DESIGNED BY		
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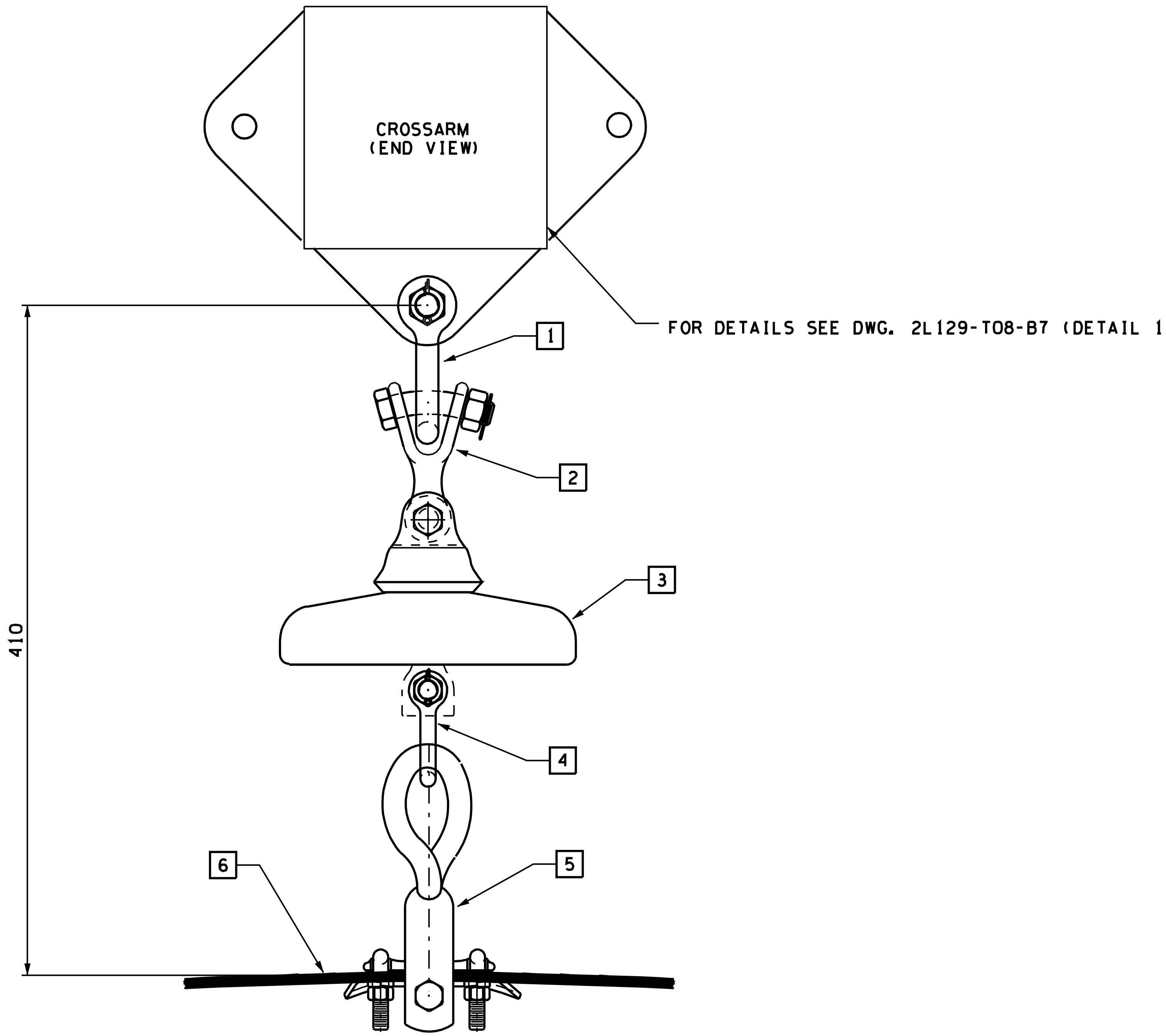
NON-INSULATED GROUNDWIRE SUSPENSION HARDWARE ASSEMBLY FOR STEEL POLE

DRAWING NUMBER	REV
75L-T08-B22	

BILL OF MATERIAL FOR ONE ASSEMBLY				
ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	1	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
2	1	EA	413-1182	CLEVIS, EYE, Y-TYPE, 90°, 100 LG, ¾"Ø BOLT, 120 kN
3	1	EA	410-1016	INSULATOR, GROUNDWIRE, CLEVIS EYE, 145 LG, 140 kN
4	1	EA	420-1506	SHACKLE, ANCHOR, 13 Ø, 23 OPEN, 70 LG, ⅝"Ø BOLT, 80 kN
5	1	EA	SLACAN 72062-2	CLAMP, SUSPENSION, G/W
6	1	m	382-4244	WIRE, GROUND, SIZE 9, GRADE 1300



INSULATED GROUNDWIRE SUSPENSION ASSEMBLY
TYPE 2A2PG & 2A2DG STEEL POLE STRUCTURE

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES ± 2 mm TOLERANCE UNLESS OTHERWISE NOTED.
2. MAXIMUM GROUNDWIRE TENSION: 21.0 kN
3. APPROXIMATE GROUNDWIRE HARDWARE ASSEMBLY MASS = 2 Kg.
4. FOR GENERAL SPECIFICATION DATA SEE BCH SPEC. 413-0000.

REVISIONS							
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE	

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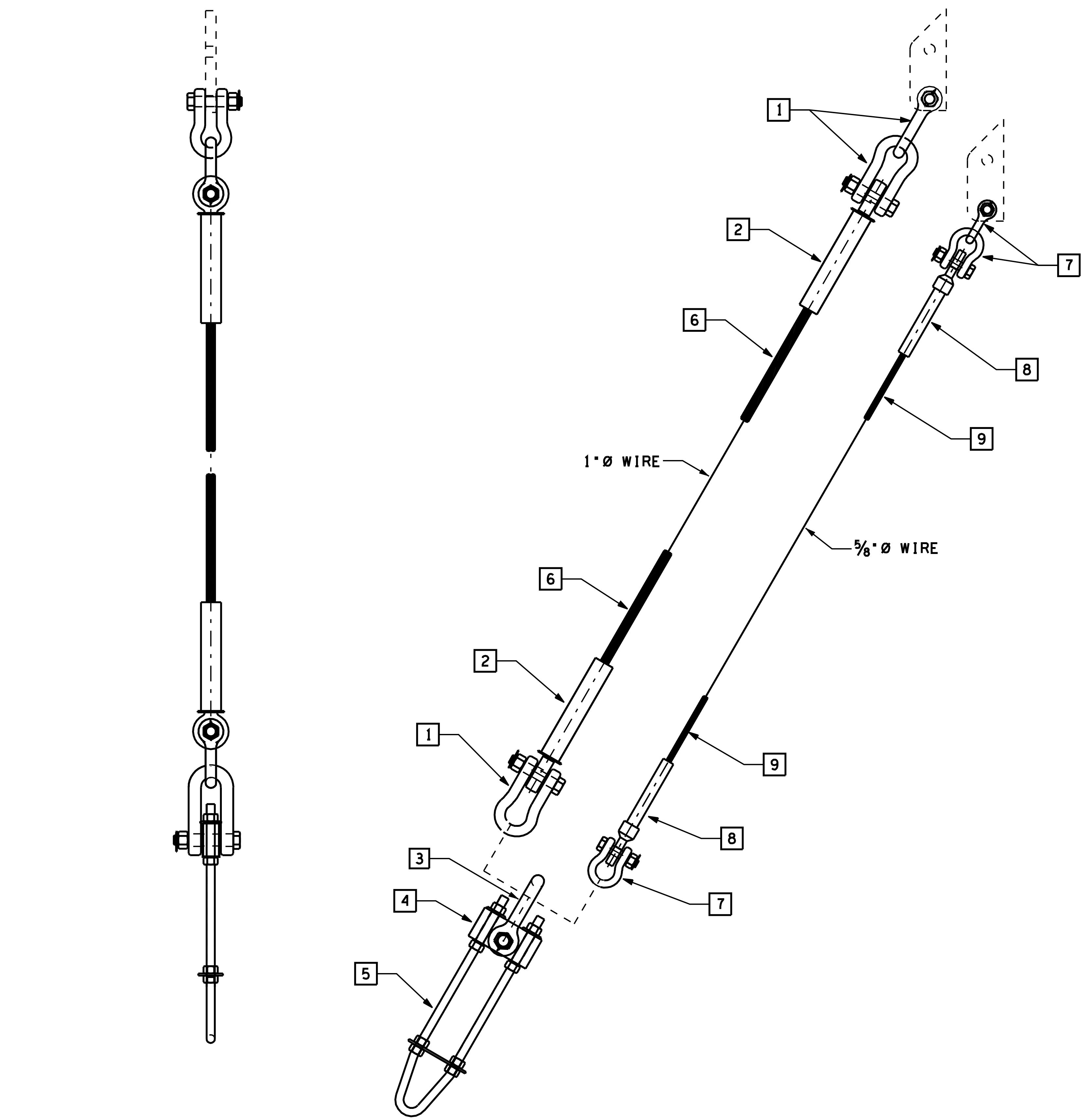
INSULATED GROUNDWIRE
SUSPENSION HARDWARE
ASSEMBLY
FOR STEEL POLE

DRAWING NUMBER	REV
75L-T08-B23	



BILL OF MATERIAL FOR 1" ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	3	EA	420-1444	SHACKLE, ANCHOR, 32 Ø, 48 OPEN, 172 LG, 1¼"Ø BOLT, 445 kN
2	2	EA	96004386	DEAD END, COMPRESSION, FOR SIZE 26, GRADE 1500, 480 kN GUY WIRE
3	1	EA	420-1445	SHACKLE, CHAIN, 38 Ø, 60 OPEN, 190 LG, 1½"Ø BOLT, 670 kN
4	1	EA	96004389	PLATE, GUY, FOR COMPRESSION GUY D/E's, GALV STEEL
5	1	EA	96004388	ADJUSTABLE U-BOLT, 1"Ø, C/W 8 NUTS, SPACER PLATE, 2 WASHERS
6	AS REQ'D	EA	96004385	WIRE, GUY, SIZE 26, GRADE 1500, 19 STR, 480 kN

BILL OF MATERIAL FOR 5/8" ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
3	1	EA	420-1445	SHACKLE, CHAIN, 38 Ø, 60 OPEN, 190 LG, 1½"Ø BOLT, 670 kN
4	1	EA	96004389	PLATE, GUY, FOR COMPRESSION GUY D/E's, GALV STEEL
5	1	EA	96004388	ADJUSTABLE U-BOLT, 1"Ø, C/W 8 NUTS, SPACER PLATE, 2 WASHERS
7	3	EA	420-1518	SHACKLE, ANCHOR, 22Ø, 37 OPEN, 95 LG, 1"Ø BOLT, 240 kN
8	2	EA	96004387	DEAD END, COMPRESSION, FOR SIZE 16, GRADE 1500, 175 kN GUY WIRE
9	AS REQ'D	EA	408-3003	WIRE, GUY, SIZE 16, GRADE 1500, 19 STR, 223 kN

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES ± 2 mm TOLERANCE UNLESS OTHERWISE NOTED.
2. FOR GENERAL SPECIFICATION DATA SEE BCH SPECIFICATION 413-0000.
3. MAXIMUM UNFACTORED ASSEMBLY DESIGN LOADS ARE AS FOLLOWS:

   5/8"Ø GUY = 190 kN
   1"Ø GUY = 445 kN

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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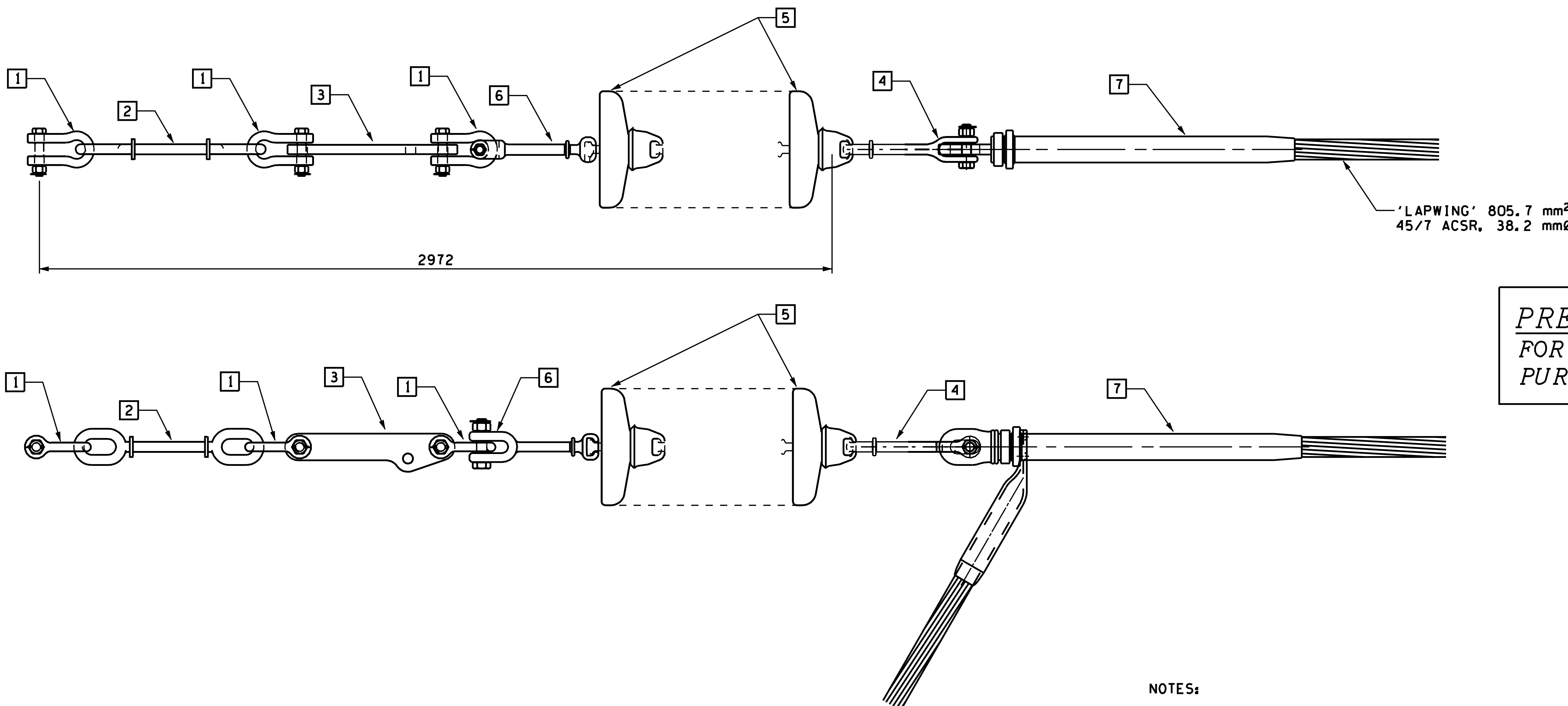
GUY ASSEMBLY FOR 5/8"Ø AND 1"Ø GUY WIRE WITH COMPRESSION DEAD ENDS

DRAWING NUMBER	REV
75L-T08-B24	

BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	3	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN
2	1	EA	413-1761	OVAL EYE, DOUBLE, EXTENSION, H/L, 370 LG, 70 OPEN, 220 kN
3	1	EA	413-0525	PLATE, PULLING, 370 LG, 160 kN
4	1	EA	96004259	CLEVIS, BALL, H/L, 220 kN, 270 LONG, ¾"BOLT, 30 OPEN
5	*	EA	410-0999	INSULATOR, SUSPENSION, 156 x 292, 160 kN
6	1	EA	413-1423	CLEVIS, SOCKET, H/L, 270 LG, 29 OPEN, 1"Ø BOLT, 220 kN
7	1	EA	96004261	DEAD END, COMPRESSION, C/W TERMINAL, FOR LAPWING, 45/7 ACSR



PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES, ±2 mm, UNLESS OTHERWISE NOTED.
2. APROXIMATE ASSEMBLY MASS = 90 kg.

REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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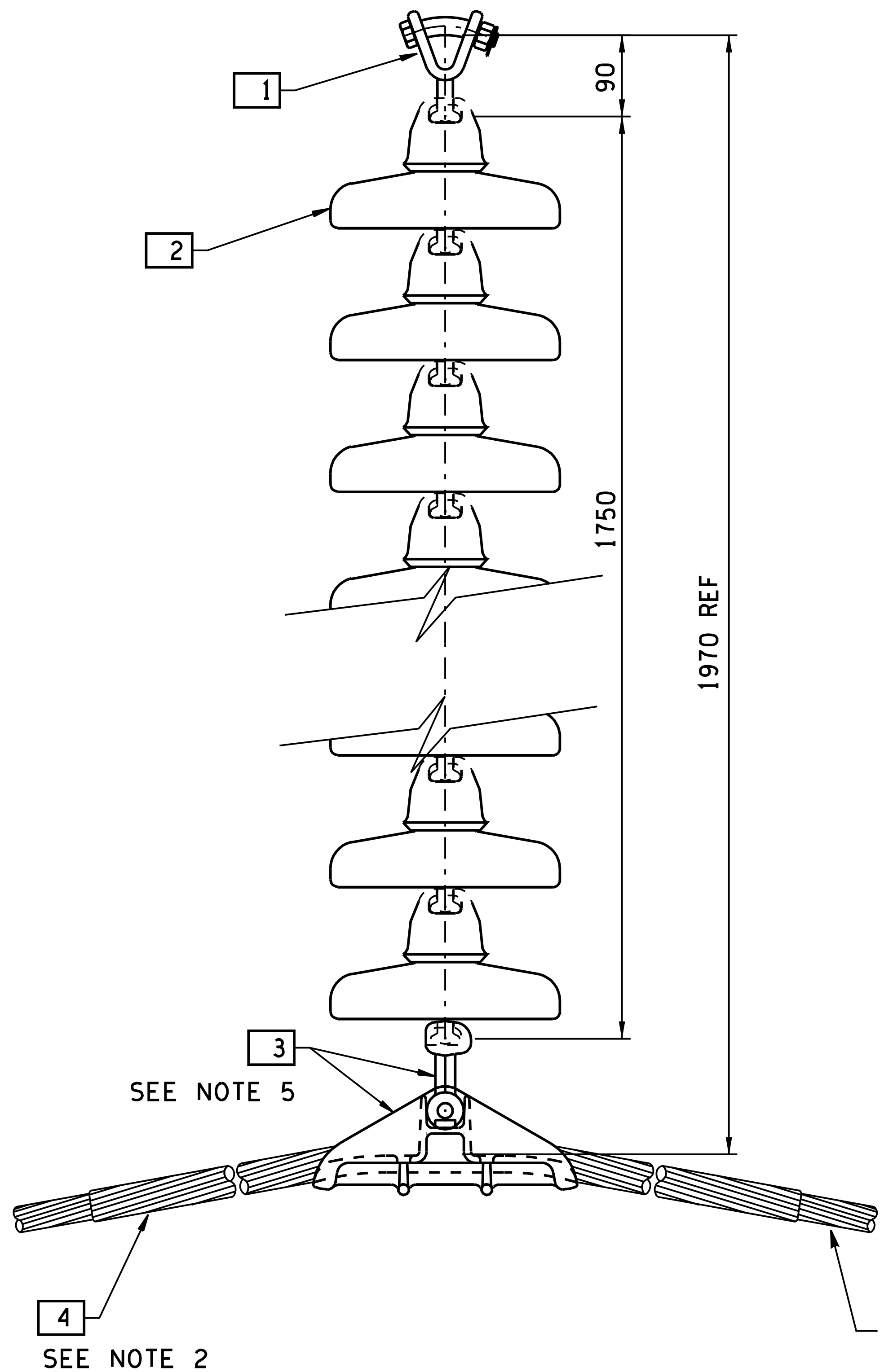
SINGLE 160 kN
REVERSED INSULATOR STRING
DEAD END HARDWARE ASSEMBLY FOR
'LAPWING' 45/7, ACSR CONDUCTOR

DRAWING NUMBER	REV
75L-T08-B17	



BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	1	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, ¾"Ø BOLT, 120 kN
2	12	EA	410-	INSULATOR, SUSPENSION, 146 x 254, 70 kN, (SEE NOTE 4)
3	1	EA	413-	CLAMP, SUSPENSION ASSEMBLY, CORONA-FREE, c/w SOCKET EYE (SEE DWG No. G-T08-B460)
4	1 SET	EA	388-	ROD, ARMOUR, PREFORMED, (SEE DWG No. G-T08-B460) SEE NOTE 2

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. WHEN THIS INSULATOR ASSEMBLY IS USED TO SUPPORT A JUMPER CUT ARMOUR ROD IN HALF. FILE CUT ENDS SMOOTH.
3. THE COTTER PIN IN THE BOLT JOINING THE SUSPENSION CLAMP AND SOCKET EYE SHALL BE LOCATED ON THE SIDE OF THE SUSPENSION CLAMP FACING THE NEAREST POLE.
4. USE 410-1009 (GREY PORCELAIN), 410-1012 (BROWN PORCELAIN) OR 410-1013 (GLASS). DO NOT MIX PORCELAIN AND GLASS ON SAME ASSEMBLY.
5. SUSPENSION CLAMP U-BOLT TO BE TIGHTENED TO THE FOLLOWING TORQUES UNLESS OTHERWISE STATED BY THE MANUFACTURER:
   ½"Ø = 50 N.m
   ⅝"Ø = 100 N.m
6. APPROXIMATE ASSEMBLY MASS = 55 kg

REFERENCE DRAWING:
G-T08-B460 CONDUCTOR HARDWARE TABLE

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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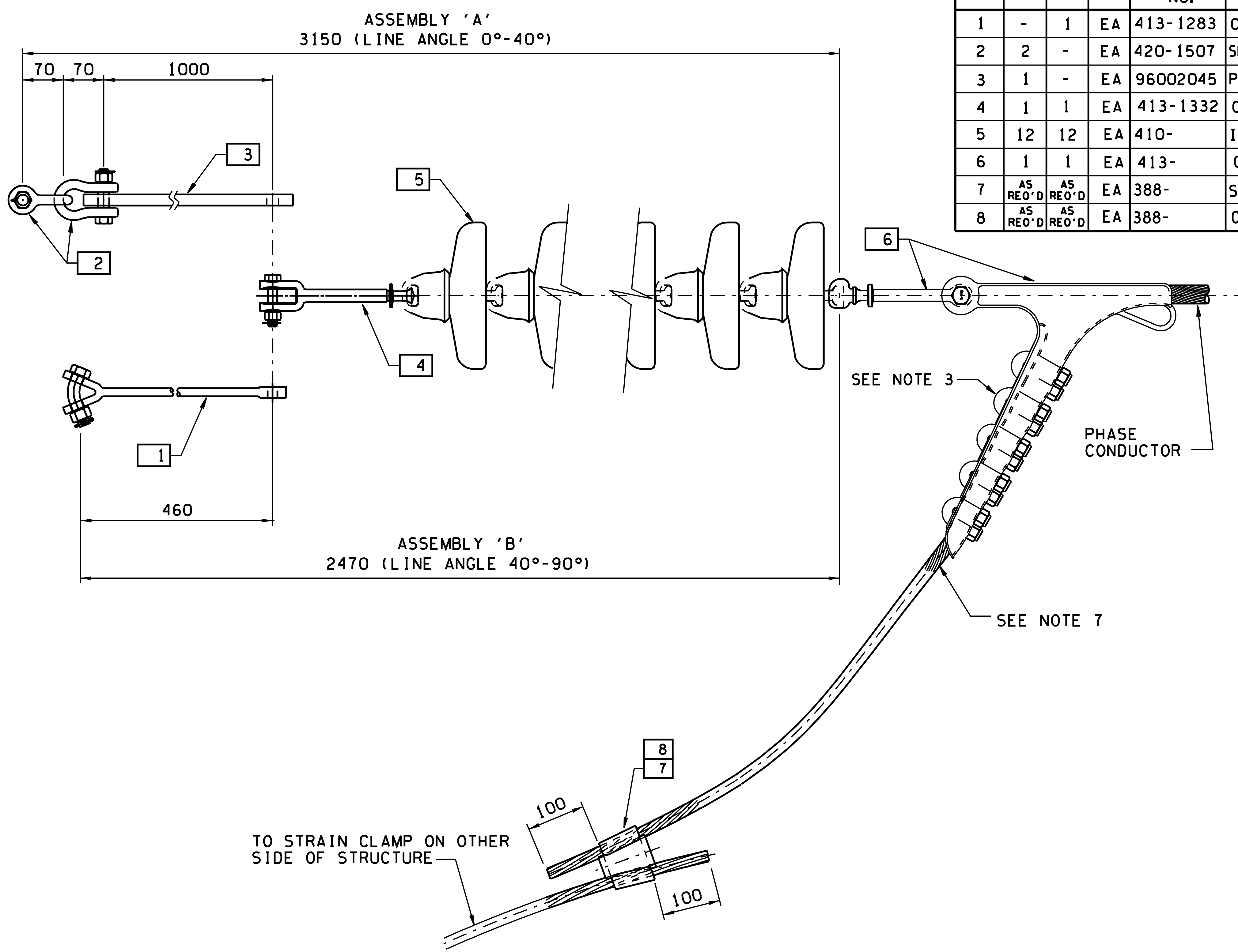
FORTISBC
SINGLE 70 kN INSULATOR STRING SUSPENSION HARDWARE ASSEMBLY FOR WOOD POLE STRUCTURES

DRAWING NUMBER	REV
40L-T08-B30	

BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY A	QTY B	HU	BCH STOCK No.	DESCRIPTION
1	-	1	EA	413-1283	CLEVIS, EYE, Y-TYPE, 460 LG, ¾"Ø BOLT, 120 kN
2	2	-	EA	420-1507	SHACKLE, ANCHOR, 18 Ø, 27 OPEN, 70 LG, ¾"Ø BOLT, 120 kN
3	1	-	EA	96002045	PLATE, EXTENSION, 2" X ¾" X 1070mm LG, 120 kN
4	1	1	EA	413-1332	CLEVIS, BALL, H/L, 260 LG, 24 OPEN, ⅝"Ø BOLT, 120 kN
5	12	12	EA	410-	INSULATOR, SUSPENSION, 146 x 254, 120 kN (SEE NOTE 5)
6	1	1	EA	413-	CLAMP, STRAIN, ASSY, c/w H/L SOCKET EYE, (SEE DWG No. G-T08-B460)
7	AS REQ'D	AS REQ'D	EA	388-	SPLICE, AMPACT (SEE DWG No. G-T08-B460)
8	AS REQ'D	AS REQ'D	EA	388-	CARTRIDGE, AMPACT (SEE DWG No. G-T08-B460)



PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED..
2. ASSEMBLY 'A' TO BE USED ON STRUCTURES WITH 0°-30° LINE ANGLE, ASSEMBLY 'B' TO BE USED ON STRUCTURES WITH 30°-90° LINE ANGLE.
3. STRAIN CLAMP U-BOLTS TO BE TIGHTENED TO THE FOLLOWING TORQUES UNLESS OTHERWISE STATED BY THE MANUFACTURER:
   ½"Ø = 50 N.m
   ⅝"Ø = 100 N.m
4. MAXIMUM CONDUCTOR TENSION SHALL BE THE LESSER OF 50% OF THE CONDUCTOR RATED TENSILE STRENGTH OR 33.4 kN.
5. USE 410-1015 (GREY PORCELAIN) OR 410-0995 (GLASS). DO NOT MIX PORCELAIN AND GLASS ON SAME ASSEMBLY.
6. APPROXIMATE ASSEMBLY MASS = 60 kg.
7. INSTALL THE STRAIN CLAMP ASSEMBLY WITH THE TAIL, IN A HORIZONTAL PLANE, POINTING TOWARDS THE JUMPER SUSPENSION CLAMP.

REFERENCE DRAWING:

G-T08-B460 CONDUCTOR HARDWARE TABLE

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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APPROVED BY	

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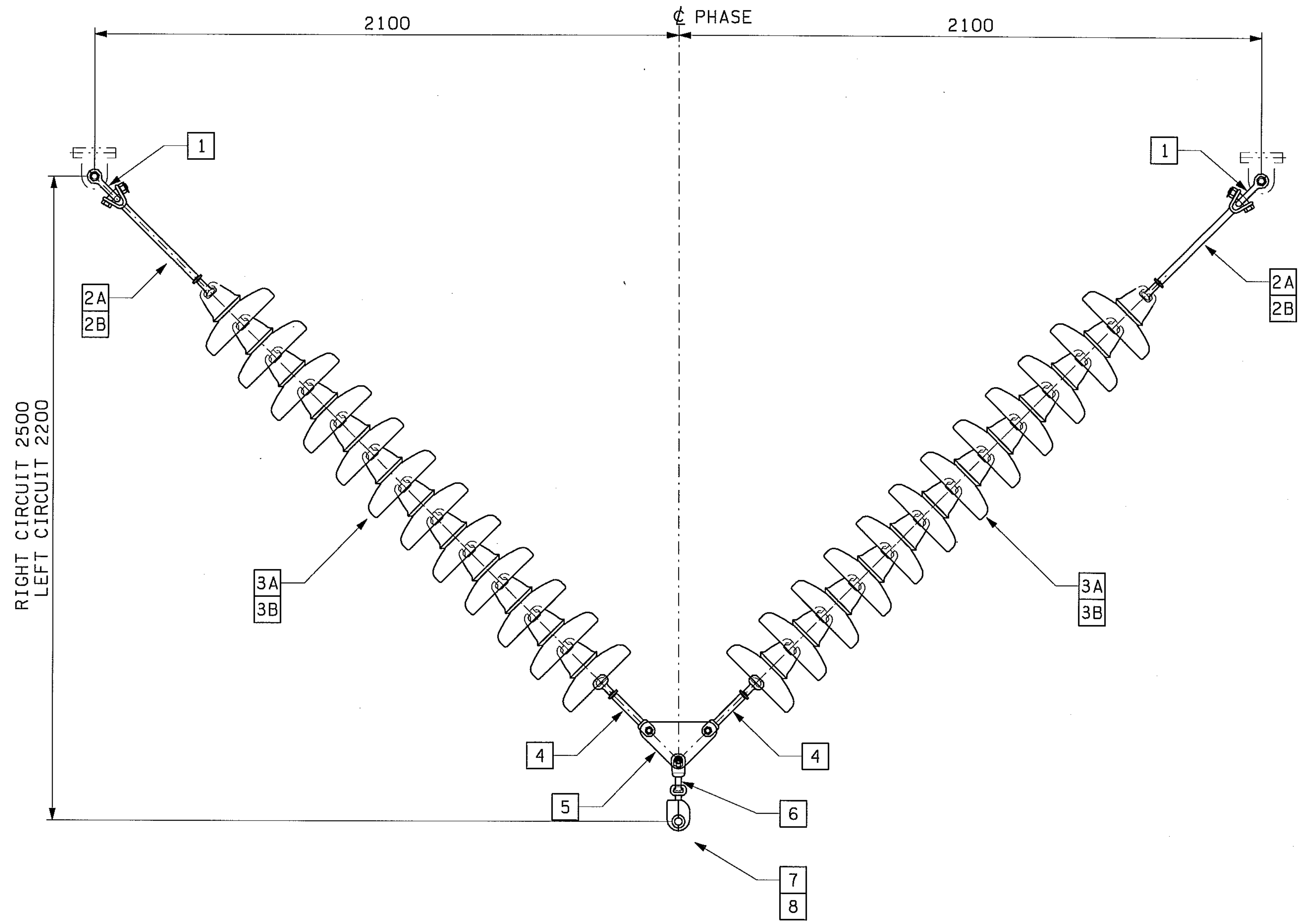
SINGLE 120 kN INSULATOR STRING DEAD END HARDWARE ASSEMBLY

DRAWING NUMBER	REV
40L-T08-B31	



BILL OF MATERIAL FOR ONE ASSEMBLY

ITEM	QTY	HU	BCH STOCK No.	DESCRIPTION
1	2	EA	420-1510	SHACKLE, ANCHOR, 19Ø, 27 OPEN, 102 LG, ¾"Ø BOLT, 160 kN
2A	2	EA	413-0256	CLEVIS, BALL, 'Y' TYPE, H/L, 685 LG, ¾"Ø BOLT, 120 kN
2B	2	EA	413-0257	CLEVIS, BALL, Y-TYPE, H/L, 460 LG, ¾"Ø BOLT, 120 kN
3A	24	EA	410-0995	INSULATOR, SUSPENSION, TOUGHENED GLASS, 146 x 254, 120 kN
3B	30	EA	410-0995	INSULATOR, SUSPENSION, TOUGHENED GLASS, 146 x 254, 120 kN
4	2	EA	413-1421	CLEVIS, SOCKET, H/L, 215 LG, 24 OPEN, ⅝"Ø BOLT, 120 kN
5	1	EA	2L129-T08-A80	PLATE, YOKE, 160 x ⅝" x 260 LONG
6	1	EA	413-1401	CLEVIS, BALL, Y-TYPE, 90 LG, ¾"Ø BOLT, 120 kN
7	1	EA	96004267	CLAMP, SUSP, ASSY, CORONA FREE, HOT LINE, c/w SOCKET EYE, FOR LAPWING

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. THE COTTER PIN IN THE BOLT JOINING THE SUSPENSION CLAMP AND THE SOCKET EYE SHALL BE LOCATED ON THE SIDE OF THE SUSPENSION CLAMP FACING THE STRUCTURE.
3. APPROXIMATE ASSEMBLY MASS = 150 kg.
4. ITEMS 2A AND 3A ARE FOR LEFT CIRCUIT
   ITEMS 2B AND 3B ARE FOR RIGHT CIRCUIT

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

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CHECKED BY		
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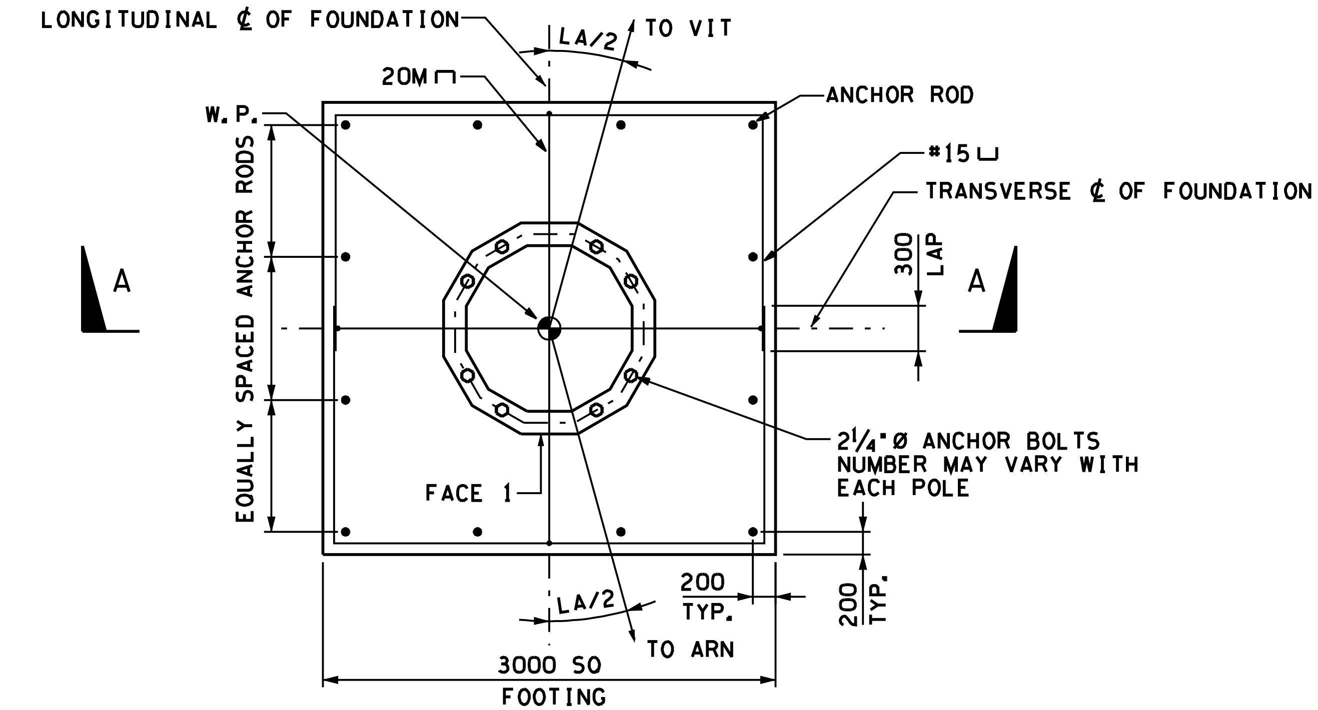
120 kN INSULATOR V-STRING SUSPENSION ASSEMBLY FOR TYPE '2A2HF' DOUBLE CIRCUIT H-FRAME

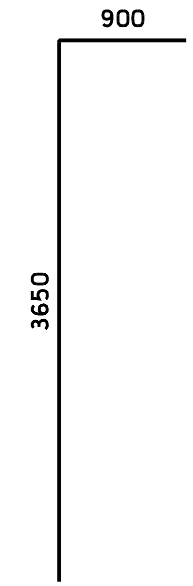
DRAWING NUMBER	REV
75[illegible]	0

APPENDIX H: FOUNDATION TYPES

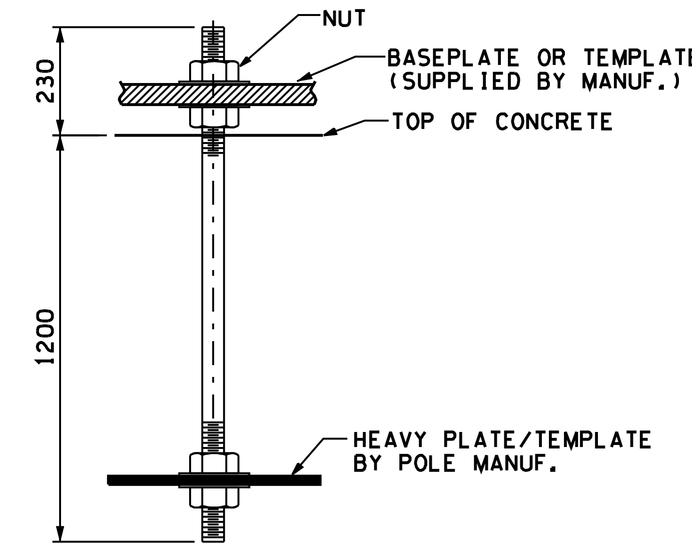
[1] Based on Design Basis Template – Original 4 May 2007



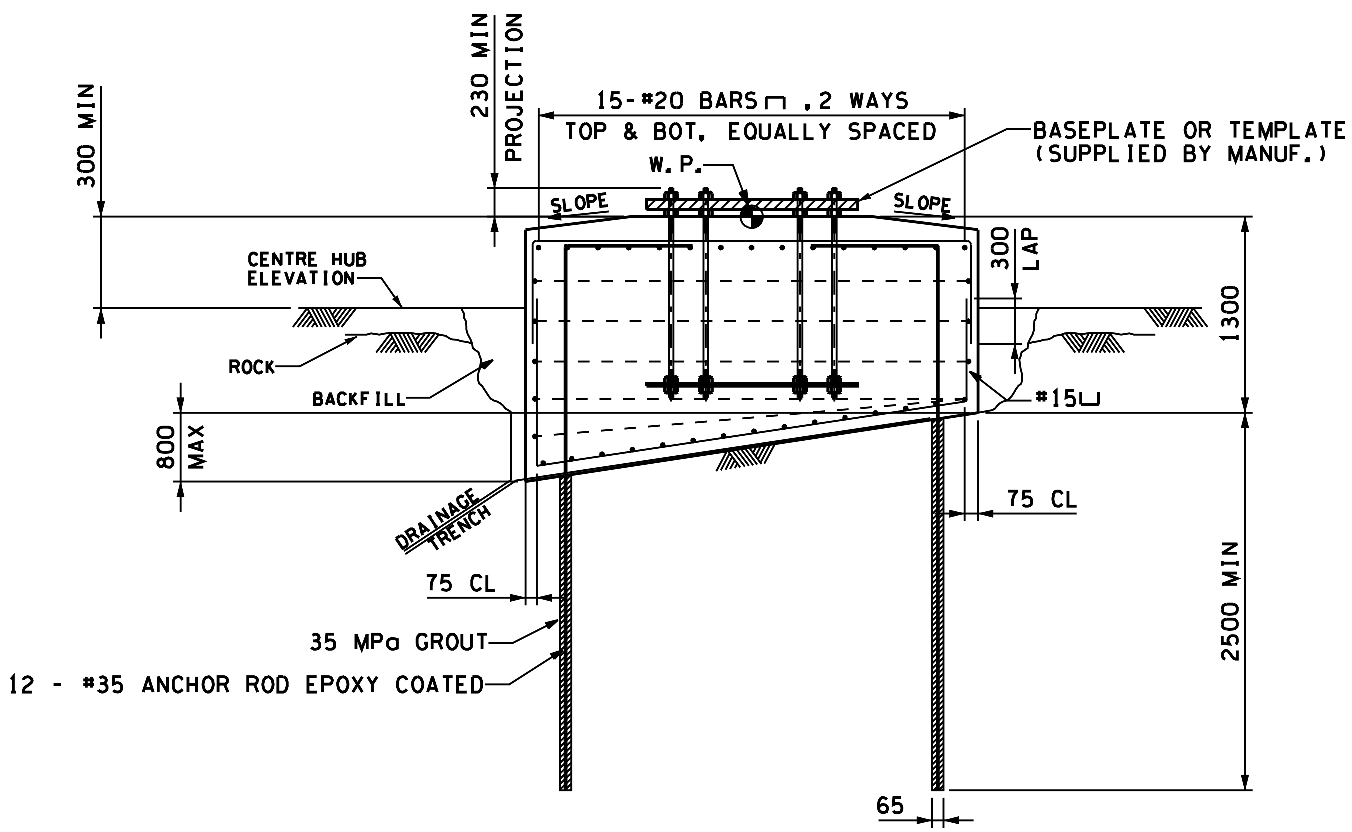
PLAN



ANCHOR ROD



ANCHOR BOLT



ELEVATION

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE MINIMUM 75 mm.
4. HIGH STRENGTH NON-SHRINK GROUT SHALL HAVE A COMPRESSIVE STRENGTH OF 35 MPa @ 28 DAYS.
5. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
6. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
7. BENCH FOUNDATION SHALL BE PREPARED SUCH THAT THE SLOPE OF ROCK DOES NOT EXCEED MAXIMUM SLOPE SHOWN IN ANY ONE DIRECTION.
8. EPOXY COATED ANCHOR RODS TO BE SUPPLIED BY THE CONTRACTOR AND TO BE MADE FROM DEFORMED REINFORCING BARS.
9. ALL REINFORCING BARS SHALL BE DEFORMED TYPE, GRADE 400 STEEL CONFORMING TO CSA STD. G30.18-M92 (R2002). BARS SHALL BE BENT ON A RADIUS OF FOUR BAR DIAMETERS. DIMENSIONS ARE OUTSIDE OF BARS.
10. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
11. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A MINIMUM YIELD STRENGTH OF 520 MPa.
12. WASHERS SHALL CONFORM TO ANSI B18.22-1 TYPE A LATEST EDITION.
13. ANCHOR BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS

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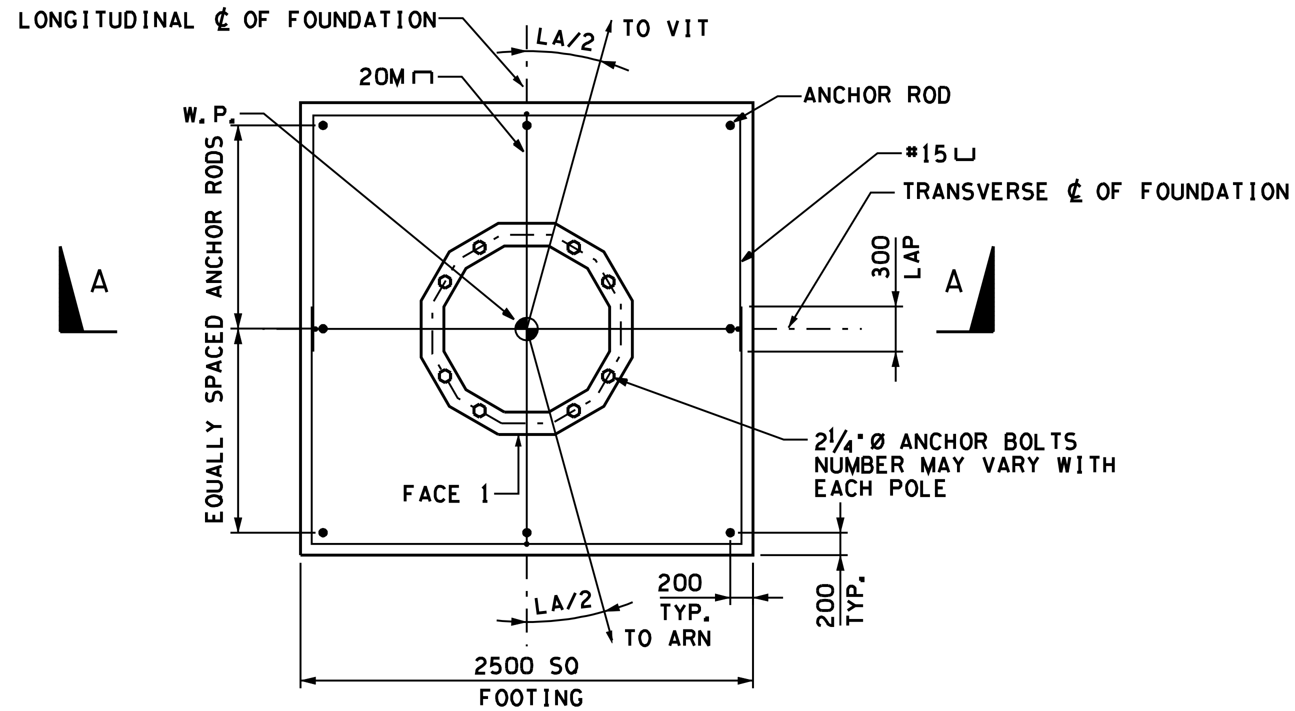
ROCK FOUNDATION FOR STEEL POLES TYPE HR INSTALLATIONS

DRAWING NUMBER	REV
75L-T08-B15	



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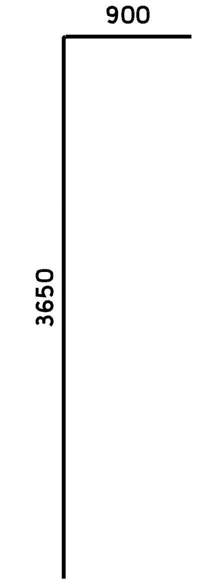
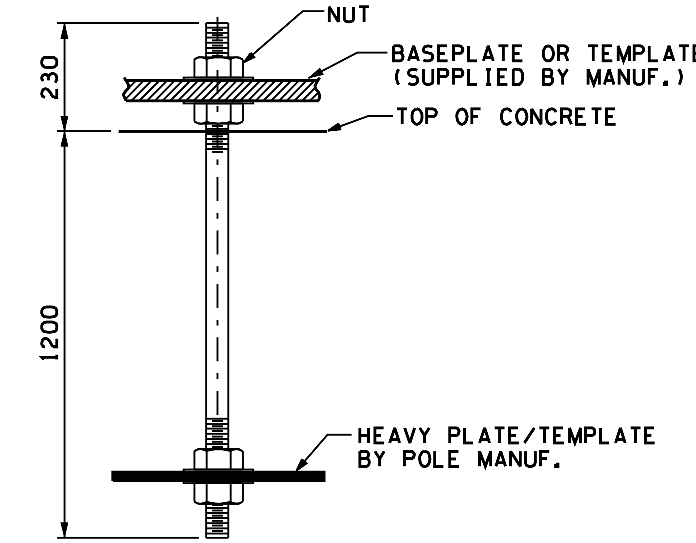
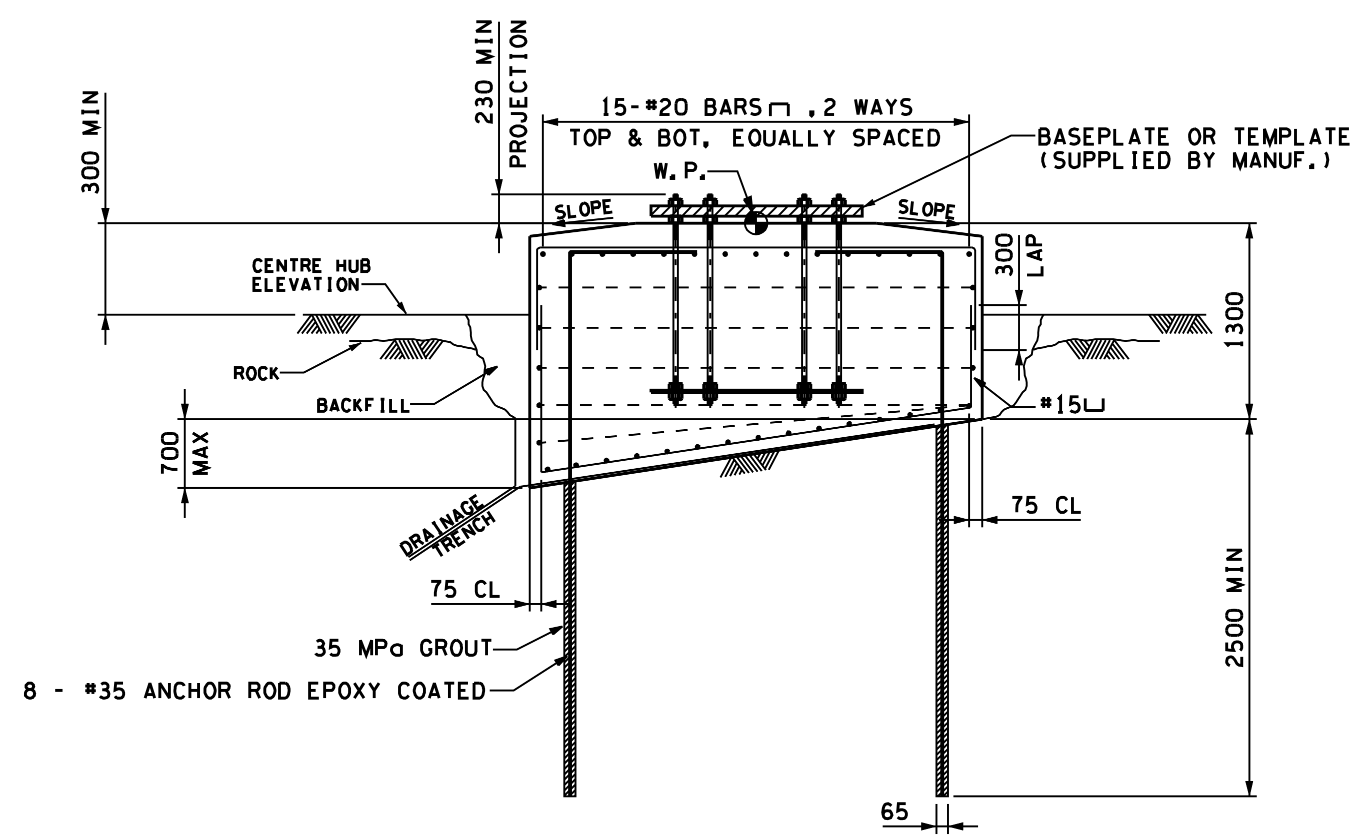


ANCHOR ROD



ANCHOR BOLT



ELEVATION

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE MINIMUM 75 mm.
4. HIGH STRENGTH NON-SHRINK GROUT SHALL HAVE A COMPRESSIVE STRENGTH OF 35 MPa @ 28 DAYS.
5. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
6. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
7. BENCH FOUNDATION SHALL BE PREPARED SUCH THAT THE SLOPE OF ROCK DOES NOT EXCEED MAXIMUM SLOPE SHOWN IN ANY ONE DIRECTION.
8. EPOXY COATED ANCHOR RODS TO BE SUPPLIED BY THE CONTRACTOR AND TO BE MADE FROM DEFORMED REINFORCING BARS.
9. ALL REINFORCING BARS SHALL BE DEFORMED TYPE, GRADE 400 STEEL CONFORMING TO CSA STD. G30.18-M92 (R2002). BARS SHALL BE BENT ON A RADIUS OF FOUR BAR DIAMETERS. DIMENSIONS ARE OUTSIDE OF BARS.
10. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
11. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A MINIMUM YIELD STRENGTH OF 520 Mpa.
12. WASHERS SHALL CONFORM TO ANSI B18.22-1 TYPE A LATEST EDITION.
13. ANCHOR BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS								
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ROCK FOUNDATION FOR STEEL POLES
TYPE MR INSTALLATIONS

DRAWING NUMBER	REV
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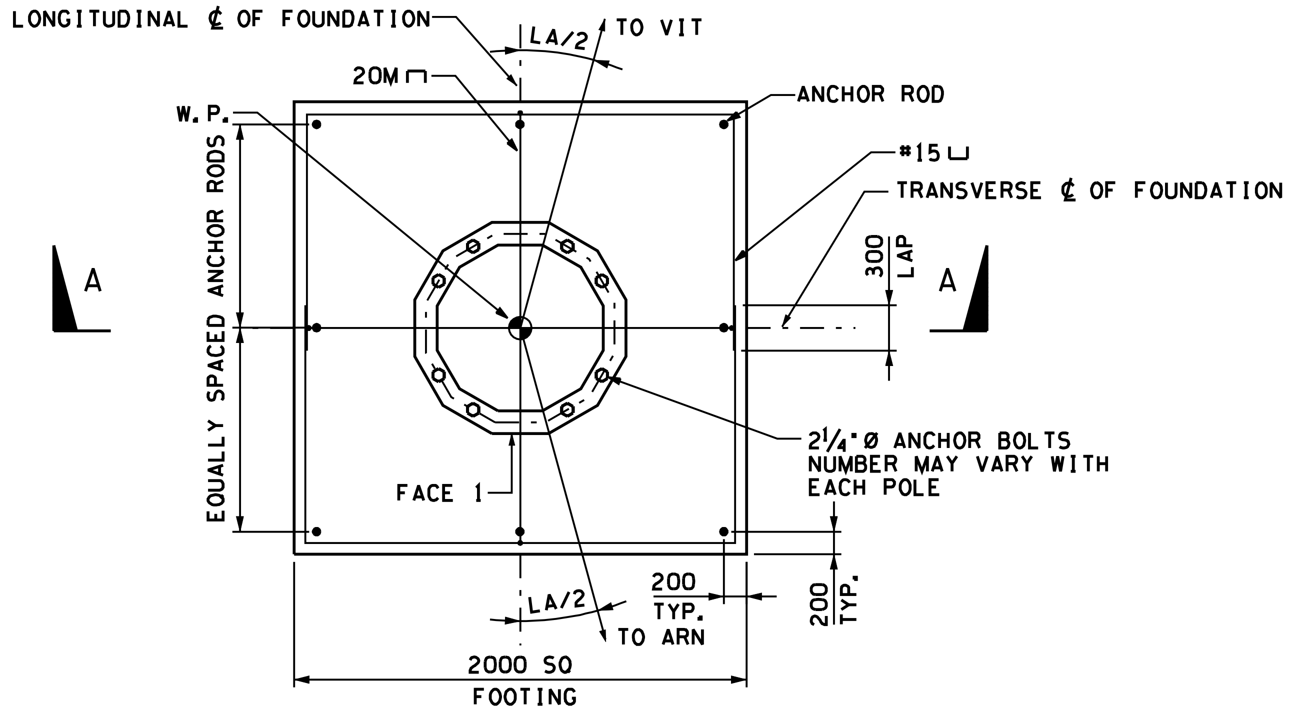

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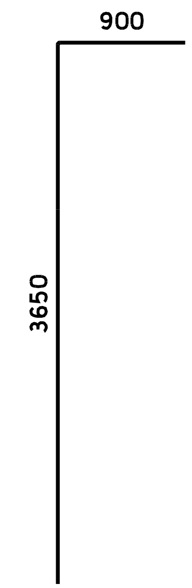
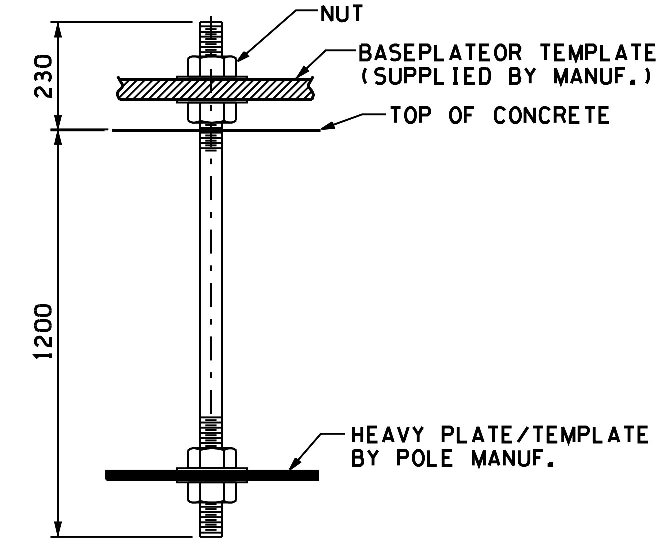
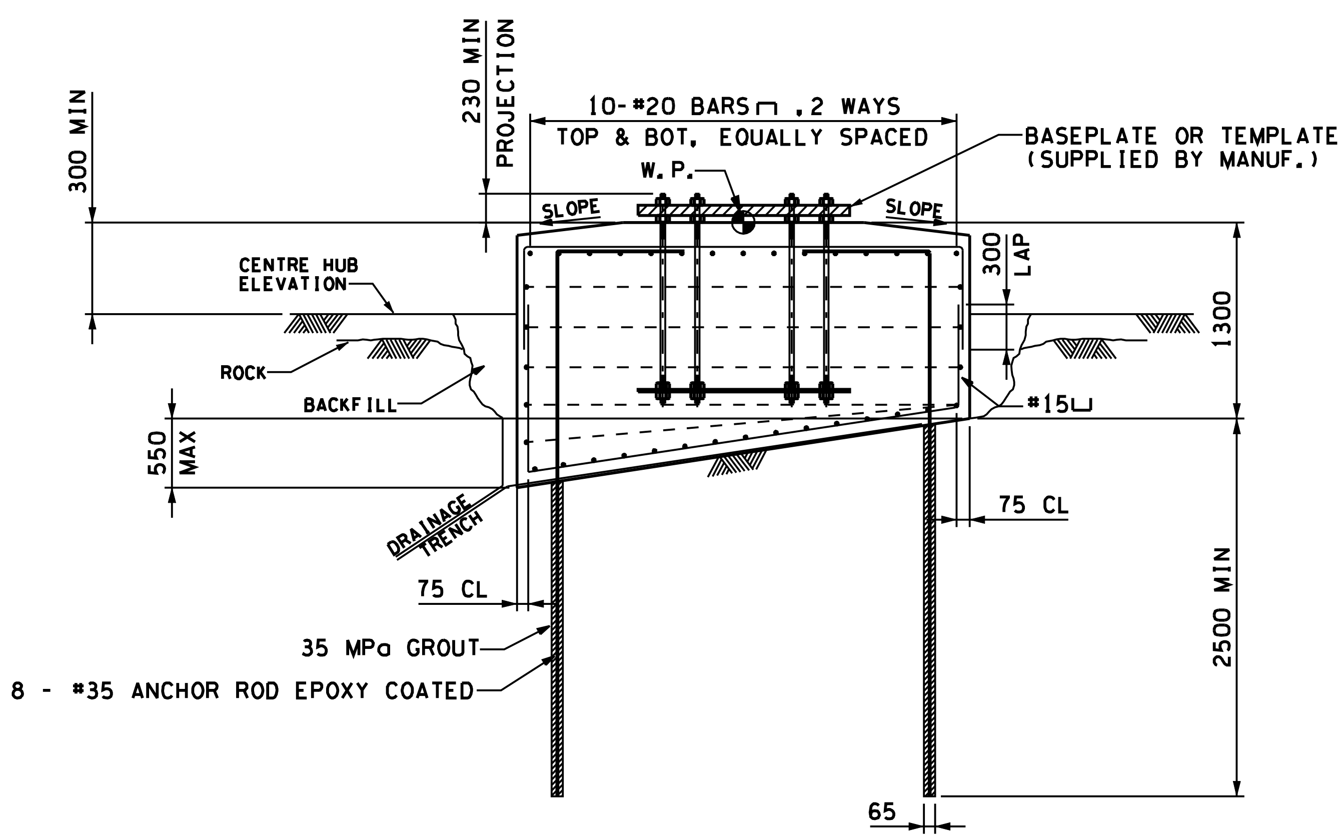


ANCHOR ROD



ANCHOR BOLT



ELEVATION

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE MINIMUM 75 mm.
4. HIGH STRENGTH NON-SHRINK GROUT SHALL HAVE A COMPRESSIVE STRENGTH OF 35 MPa @ 28 DAYS.
5. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
6. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
7. BENCH FOUNDATION SHALL BE PREPARED SUCH THAT THE SLOPE OF ROCK DOES NOT EXCEED MAXIMUM SLOPE SHOWN IN ANY ONE DIRECTION.
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10. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
11. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A MINIMUM YIELD STRENGTH OF 520 Mpa.
12. WASHERS SHALL CONFORM TO ANSI B18.22-1 TYPE A LATEST EDITION.
13. ANCHOR BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS						
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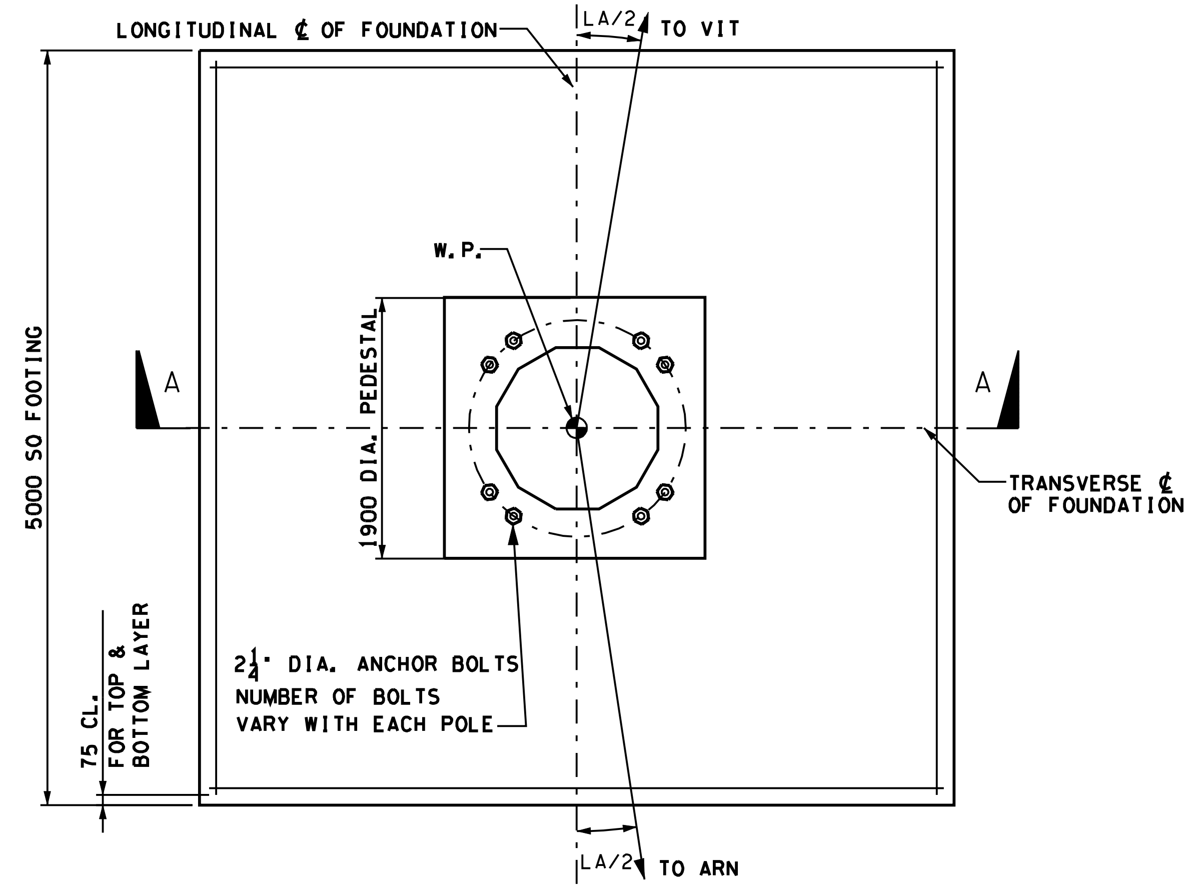
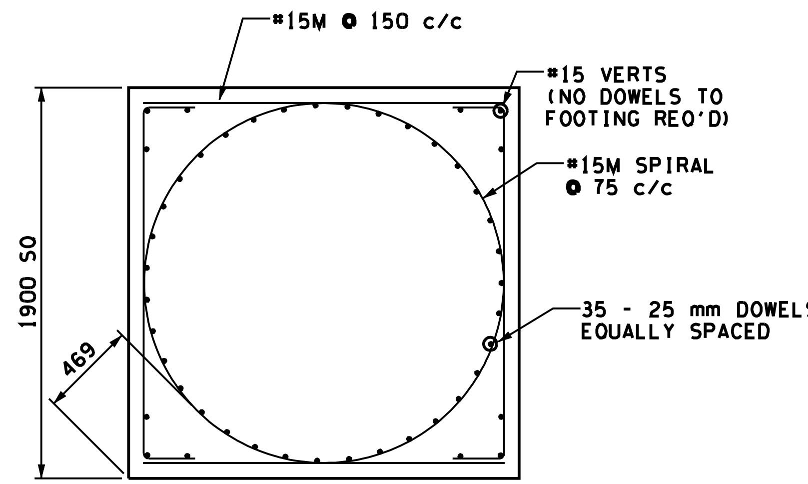
ROCK FOUNDATION FOR STEEL POLES TYPE LR INSTALLATION

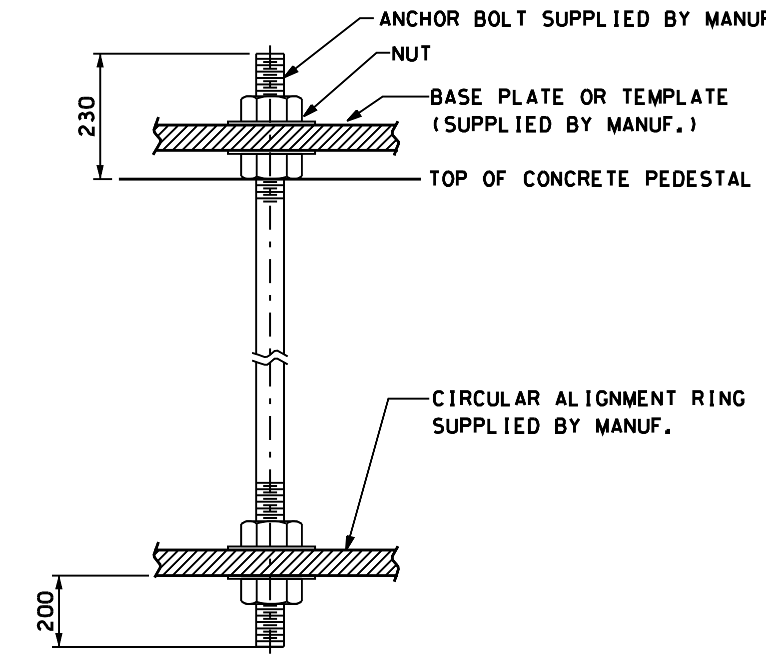
DRAWING NUMBER	REV
75L-T08-B18	

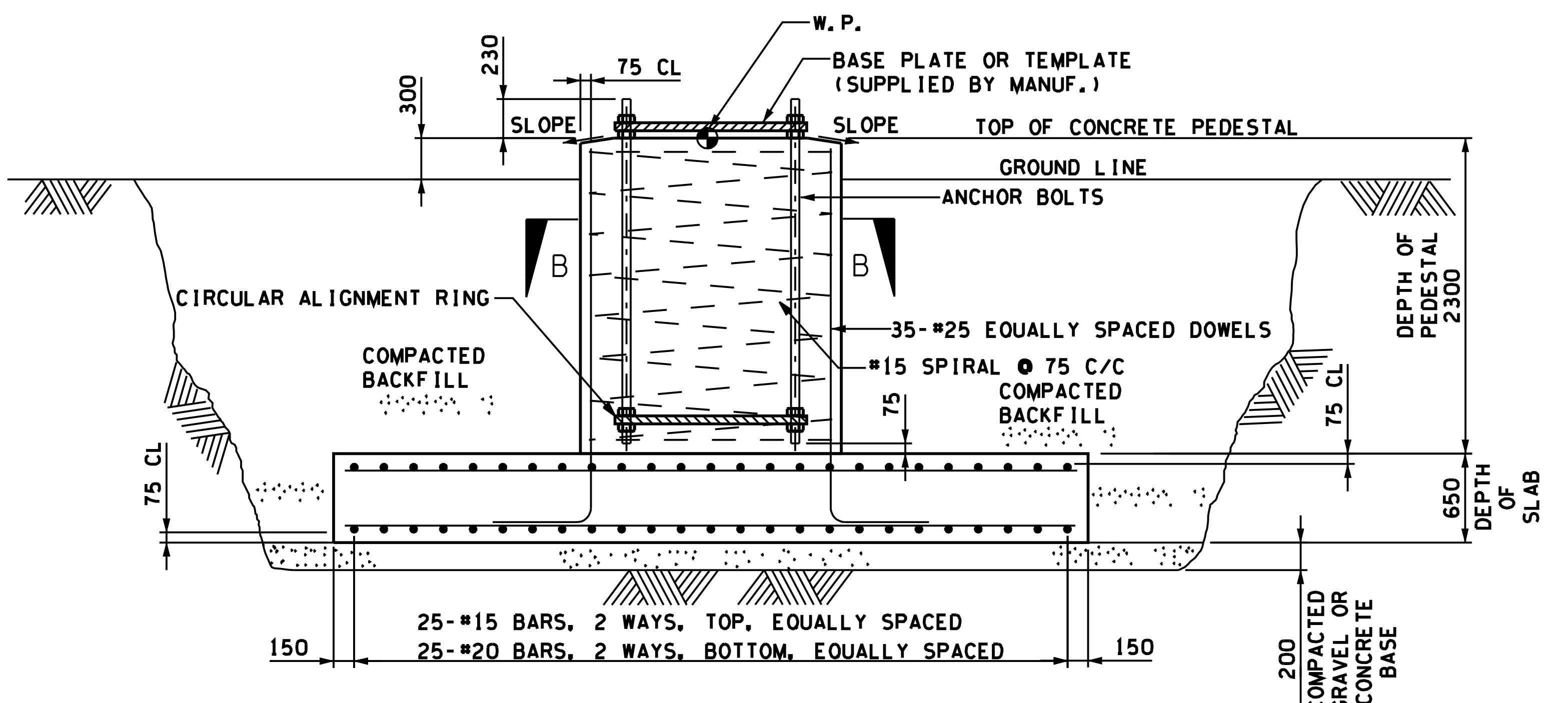


PLAN
1 : 50

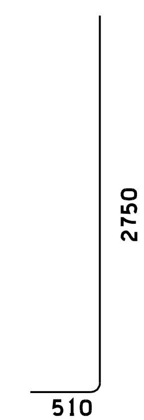


SECTION B-B
N.T.S.





SECTION A-A
1 : 50



DOWELS

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE A MINIMUM OF 75 mm.
4. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
5. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
6. ALL REINFORCING BARS SHALL BE DEFORMED TYPE, GRADE 400 STEEL CONFORMING TO CSA STD. G30.18-M92 (R2002). BARS SHALL BE BENT ON A RADIUS OF FOUR BAR DIMENSIONS. DIMENSIONS ARE TO OUTSIDE OF BARS.
7. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
8. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A YIELD STRENGTH OF 520 MPa.
9. WASHERS SHALL CONFORM TO ANSI B18.22-1 TYPE A LATEST EDITION.
10. BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS							
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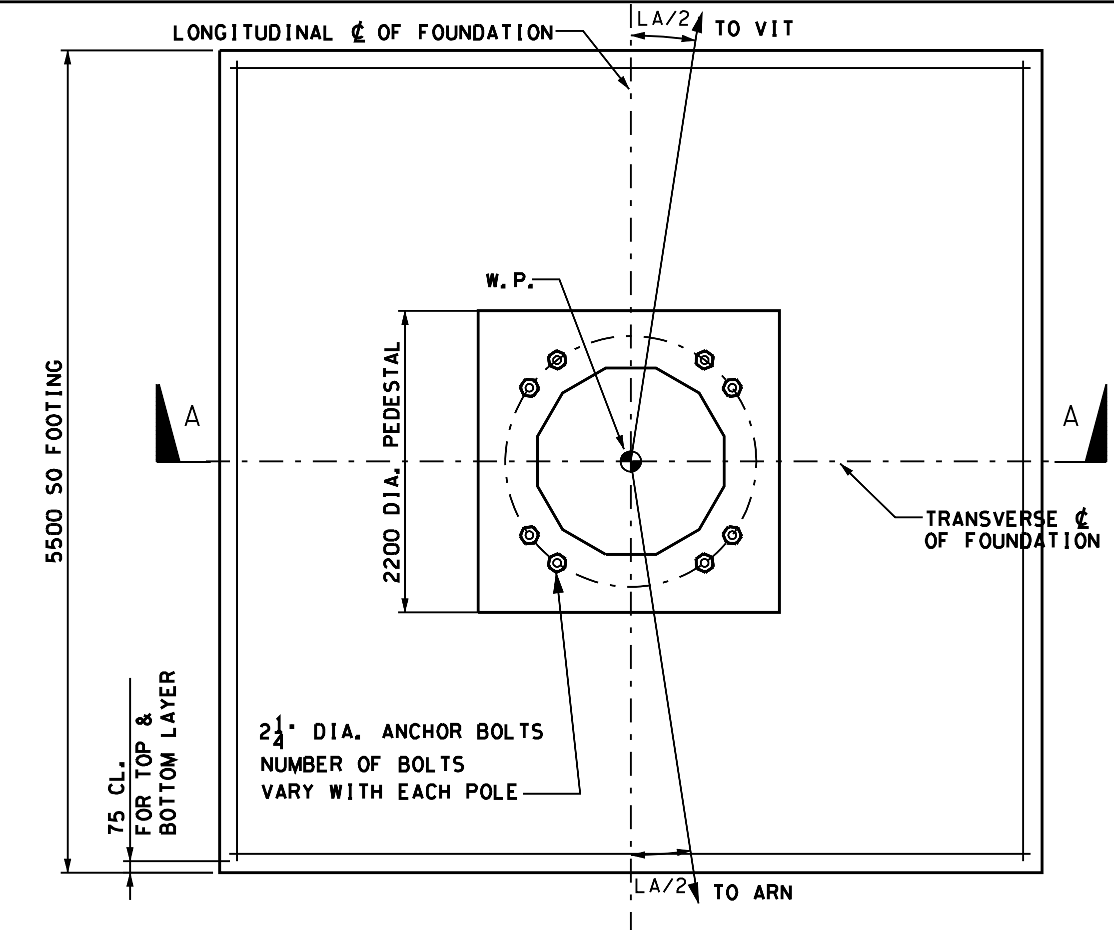
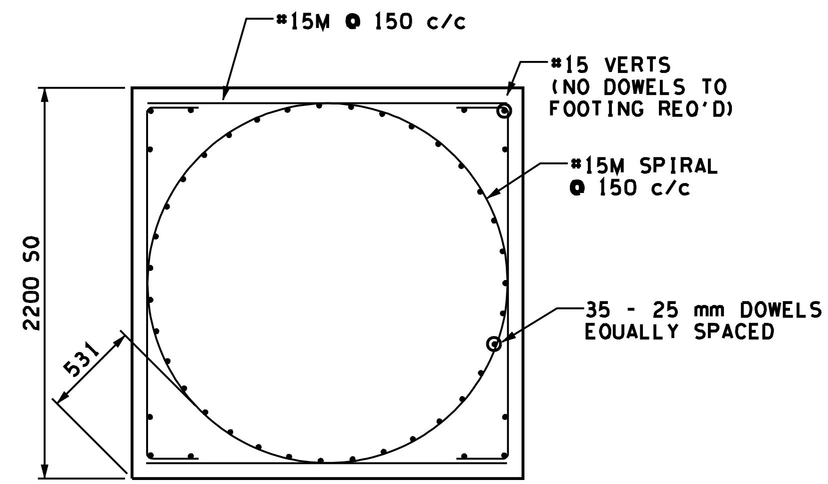
SHALLOW SQUARE FOUNDATION IN EARTH FOR STEEL POLE TYPE LC INSTALLATION

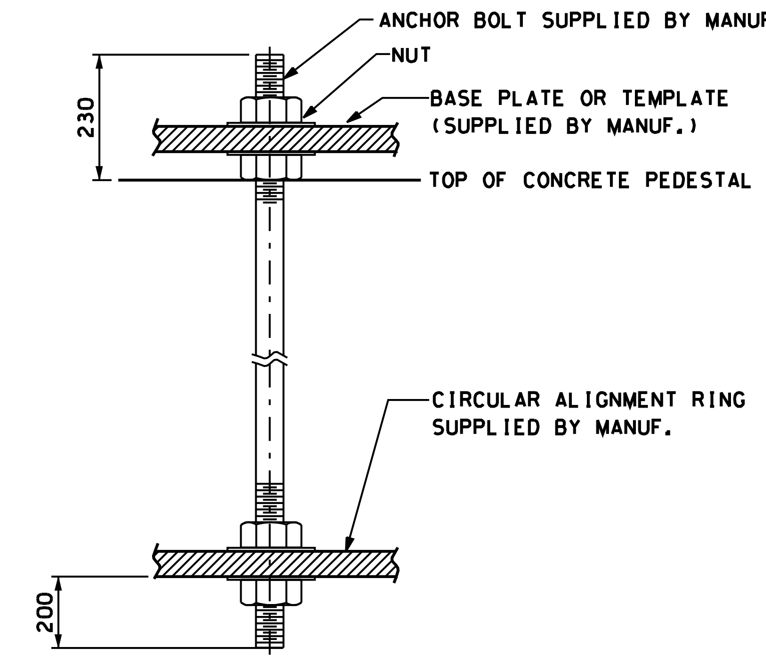
DRAWING NUMBER	REV
75L-T08-B19	



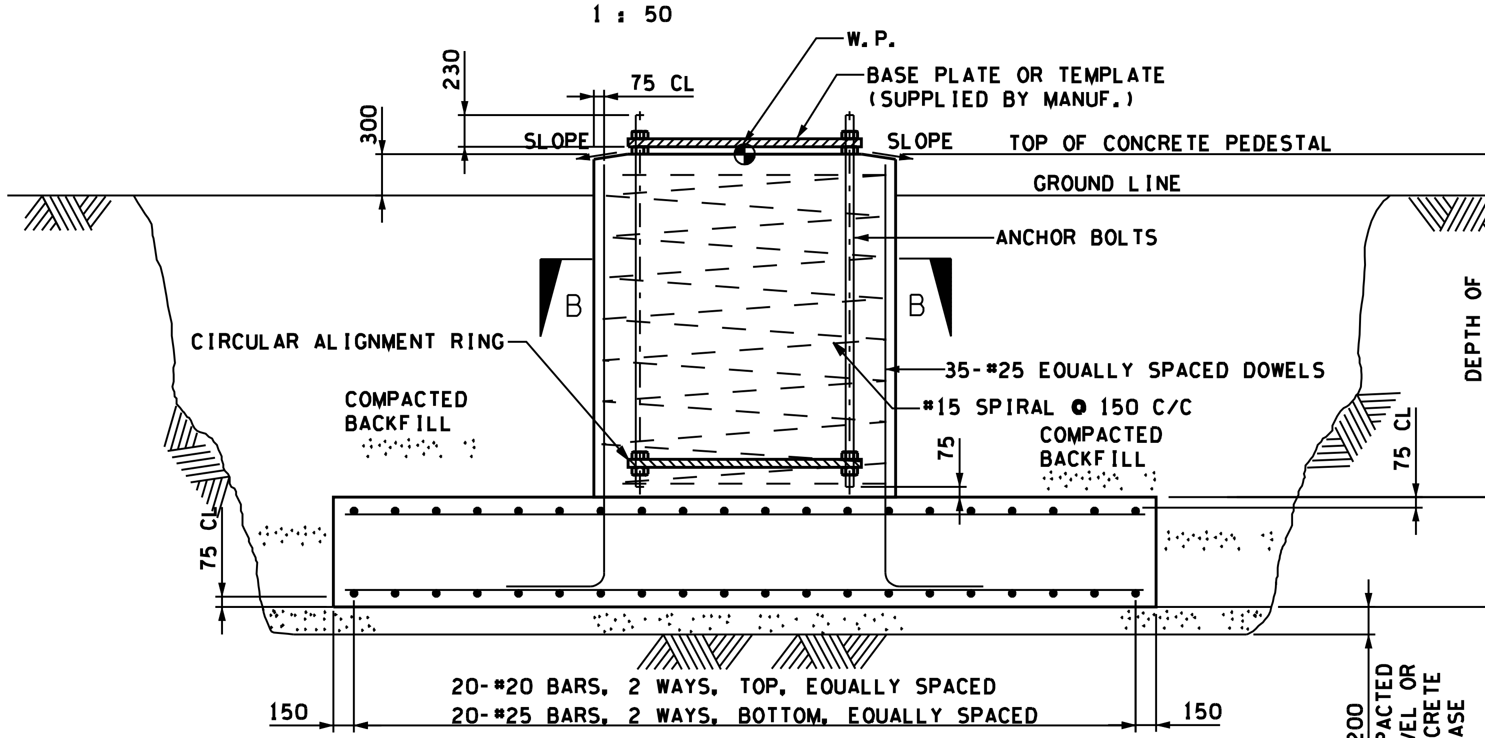
PLAN
1 : 50



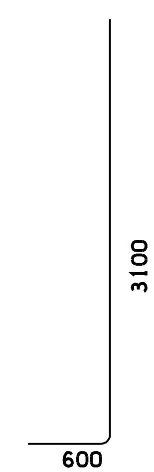
SECTION B-B
N.T.S.



ANCHOR BOLT
N.T.S.



SECTION A-A
1 : 50



DOWELS

PRELIMINARY
FOR DISCUSSION
PURPOSES ONLY

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE A MINIMUM OF 75 mm.
4. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
5. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
6. ALL REINFORCING BARS SHALL BE DEFORMED TYPE, GRADE 400 STEEL CONFORMING TO CSA STD. G30.18-M92 (R2002). BARS SHALL BE BENT ON A RADIUS OF FOUR BAR DIMENSIONS. DIMENSIONS ARE TO OUTSIDE OF BARS.
7. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
8. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A YIELD STRENGTH OF 520 MPa.
9. WASHERS SHALL CONFORM TO ANSI B18.22-1 TYPE A LATEST EDITION.
10. BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS							
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE	

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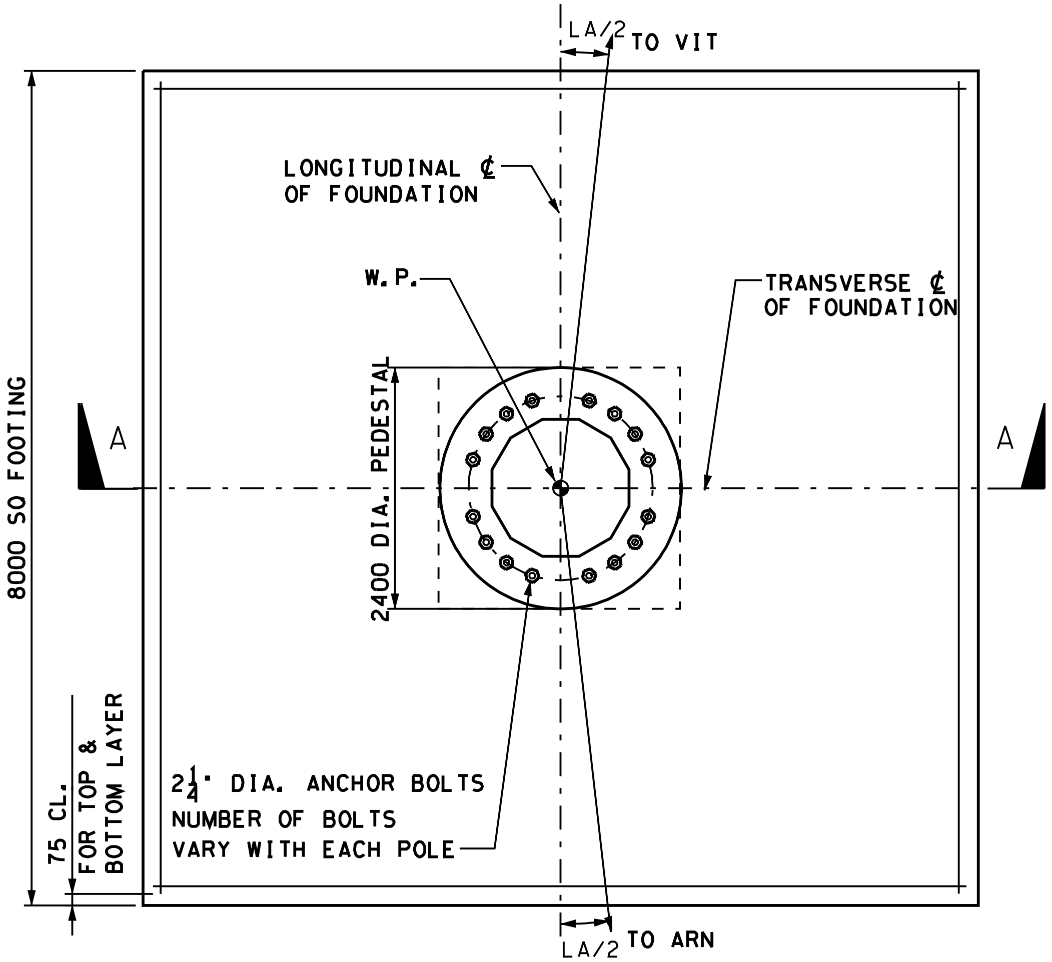
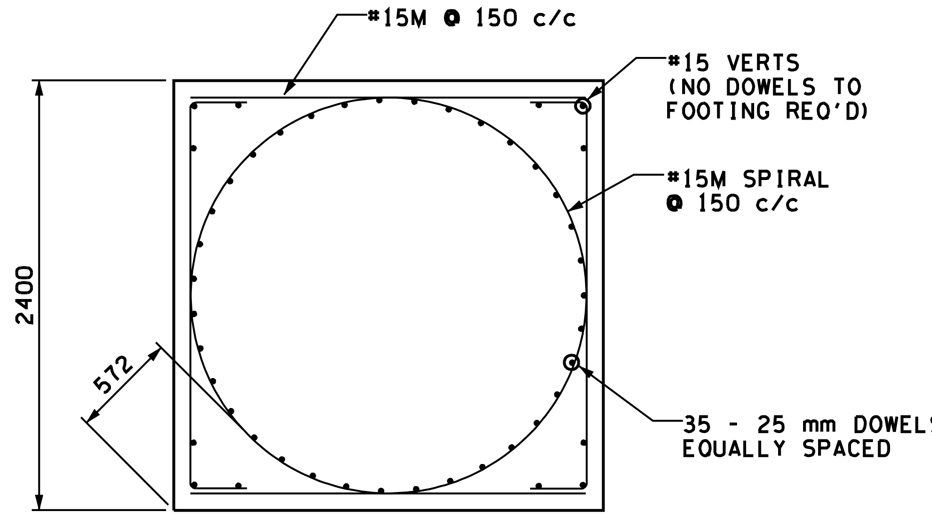
FORTISBC
SHALLOW SQUARE FOUNDATION IN EARTH FOR STEEL POLE TYPE MC INSTALLATION

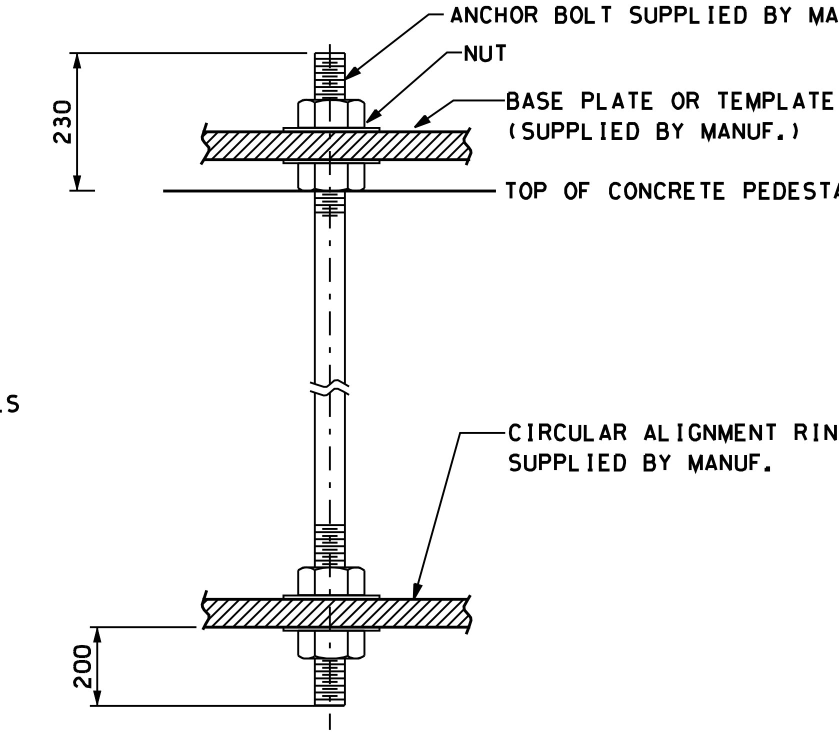
DRAWING NUMBER	REV
75L-T08-B20	



PLAN

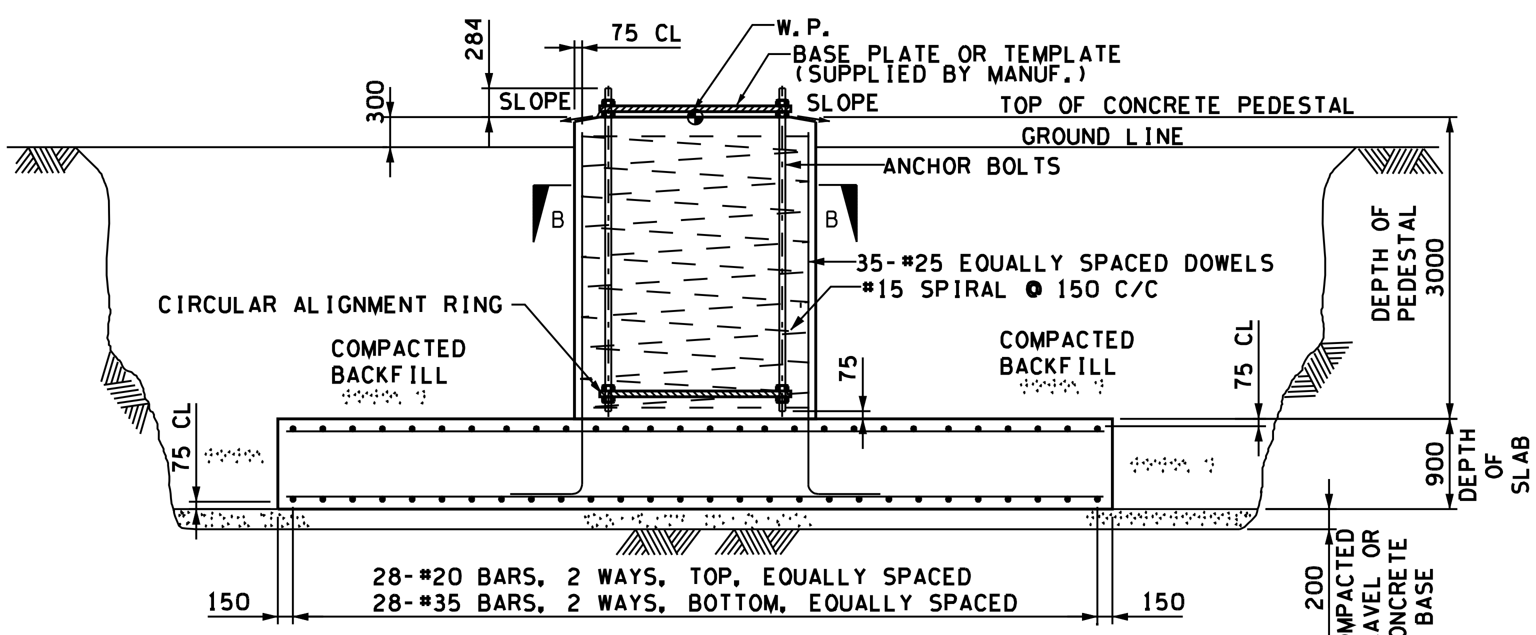


SECTION B-B
N.T.S.

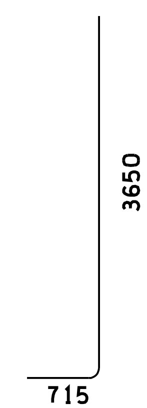


ANCHOR BOLT
N.T.S.

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY



SECTION A-A



DOWELS

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. CONCRETE SHALL BE STRUCTURAL GRADE WITH A MINIMUM COMPRESSIVE STRENGTH OF 25 MPa.
3. CONCRETE CLEAR COVER TO REINFORCEMENT SHALL BE A MINIMUM OF 75 mm.
4. THE TOP OF THE FOOTING IS TO BE SLOPED TO PROVIDE DRAINAGE TOWARDS ALL EDGES.
5. ALL EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE A 20 mm CHAMFER.
6. ALL REINFORCING BARS SHALL BE DEFORMED TYPE, GRADE 400 STEEL CONFORMING TO CSA STD. G30.18-M92 (R2002). BARS SHALL BE BENT ON A RADIUS OF FOUR BAR DIMENSIONS. DIMENSIONS ARE TO OUTSIDE OF BARS.
7. ANCHOR BOLTS, NUTS, WASHERS AND BASEPLATE/TEMPLATE SHALL BE SUPPLIED BY STEEL POLE SUPPLIER.
8. BOLTS SHALL BE FABRICATED FROM MATERIAL WITH A YIELD STRENGTH OF 520 MPa.
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10. BOLTS INCLUDING NUTS AND WASHERS SHALL BE GALVANIZED TO CSA G164-M AFTER FABRICATION.

REVISIONS							
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE	

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APPROVED BY	

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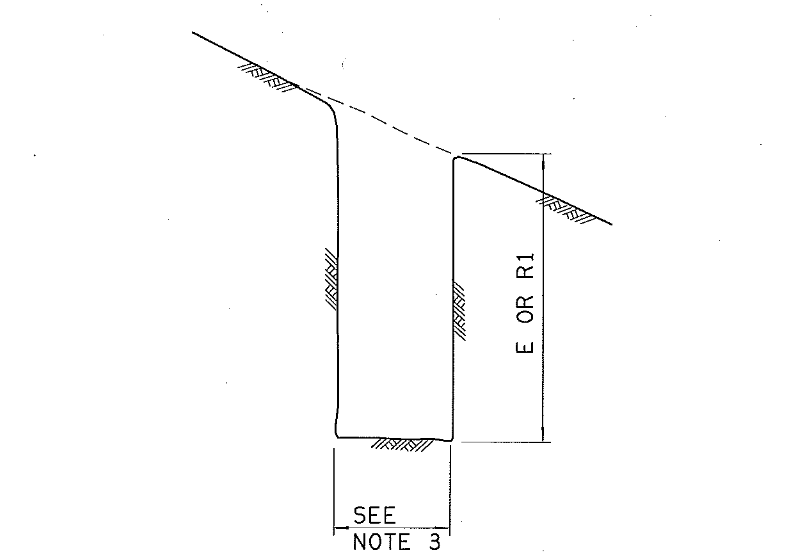
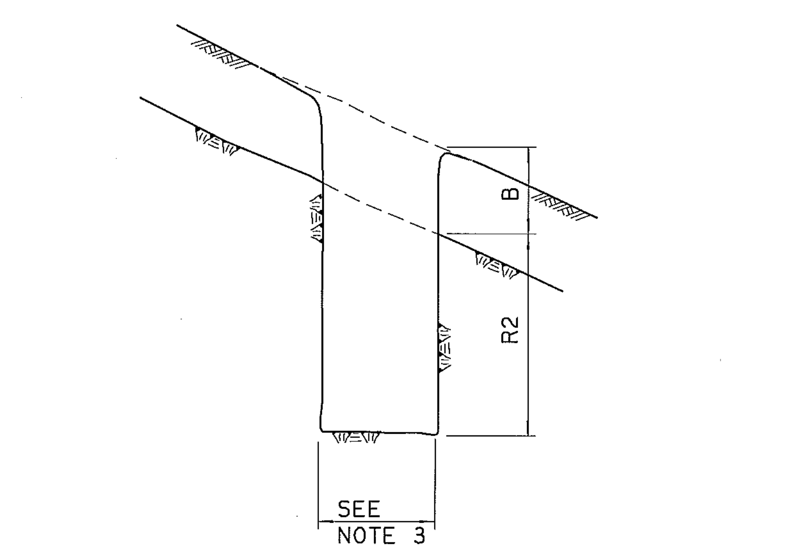
SHALLOW SQUARE FOUNDATION IN EARTH FOR STEEL POLE TYPE HC INSTALLATION

DRAWING NUMBER	REV
75L-T08-B21	

POLE HEIGHT																					
FEET	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
METRES	6.1	7.6	9.1	10.7	12.2	13.7	15.2	16.8	18.3	19.8	21.3	22.9	24.4	25.9	27.4	29.0	30.5	32.0	33.5	35.1	36.6
POLE HOLE IN EARTH ONLY																					
SETTING DEPTH (E)	1.4	1.5	1.7	1.8	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.9	3.0	3.2	3.4	3.5	3.7	3.7	3.7	3.7	3.7
POLE HOLE IN ROCK ONLY																					
SETTING DEPTH (R1)	1.2	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.2	2.3	2.3	2.4	2.4	2.5	2.6
POLE HOLE IN ROCK WITH OVERBURDEN																					
OVERBURDEN (B)	ROCK (R2)																				
0.3	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.2	2.3	2.3	2.4	2.5
0.6	0.9	0.9	1.0	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.7	1.8	1.8	1.9	2.0	2.1	2.1	2.1	2.1	2.2	2.3
0.9	0.6	0.6	0.6	0.6	0.8	0.8	0.9	1.1	1.2	1.3	1.4	1.5	1.7	1.8	1.8	2.0	2.1	2.0	2.0	2.1	2.2
1.2	0.2	0.3	0.5	0.4	0.6	0.6	0.8	0.8	1.1	1.2	1.2	1.4	1.5	1.5	1.7	1.7	1.8	1.9	1.9	2.0	2.0
1.5	0.0	0.0	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.2	1.4	1.4	1.5	1.6	1.7	1.7	1.9	1.9
1.8			0.0	0.0	0.0	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6	1.6
2.1						0.0	0.0	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.4
2.4								0.0	0.0	0.2	0.3	0.4	0.5	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.2
2.7										0.0	0.0	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	0.9
3.0												0.0	0.0	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.6
3.3														0.0	0.0	0.2	0.3	0.3	0.3	0.4	0.4
3.6																	0.2	0.2	0.2	0.2	0.2



POLE SET IN EARTH (E) OR ROCK (R1)



POLE SET IN ROCK (R2) WITH OVERBURDEN (B)

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. FOR ROCK HOLE WITH OVERBURDEN ADD DEPTH OF OVERBURDEN (B) TO ROCK (R2) FOR TOTAL SETTING DEPTH.
3. IN ROCK THE MINIMUM DIAMETER OF THE HOLE IS POLE BUTT DIAMETER + 200 mm AND THE MAXIMUM IS POLE BUTT DIAMETER X 2. IF THE HOLE DIAMETER IS MORE THAN THE MAXIMUM USE THE EARTH SETTING DEPTH.
4. DEPTH OF HOLE IN SLOPING GROUND SHALL BE MEASURED FROM LOWER SIDE OF HOLE.

PRELIMINARY
FOR DISCUSSION PURPOSES ONLY

REVISIONS						
REV	DATE	BY	CHECKED	DESCRIPTION	REV. APPR	DATE

DRAWN BY
DESIGNED BY
CHECKED BY
APPROVED BY

FORTISBC

FORTIS BC

STANDARD POLE SETTING DEPTH FOR WOOD/STEEL POLE STRUCTURES

DRAWING NUMBER	REV
75[illegible]	0

APPENDIX I: BC HYDRO TRANSMISSION ENGINEERING STANDARDS, PROCEDURES AND GUIDELINES, MANUAL 41K, SECTION 1, TABLE J

[1] Based on Design Basis Template – Original 4 May 2007

5.1 - TABLE J

MINIMUM OPERATING CLEARANCES FOR UPRATING OF AC TRANSMISSION LINES (m)

Crossing Over*1 *10	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
	Nominal Line to Line Voltage					
GROUND*6 Accessible to:						
Vehicles & Equipment*11	5.2	5.5	6.1	6.5	6.8	9.6*8
Pedestrians Only*2 *9	5.0	5.4	6.0	6.4	6.7	7.7
ROADS						
Minor Roads & Highways	6.9	7.3	7.9	8.3	9.4*8	14.2*8
Logging & Mining Roads*3	L+2.5	L+2.9	L+3.5	L+3.9	L+4.2	L+5.2
RAILWAYS*7	8.4	8.7	9.3	9.7	10.0	11.0
PIPELINES	8.6	9.0	9.6	10.0	10.3	11.3
WIRES*4 (STRUCTURES)*5						
0 - 25 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
69 kV	1.4(1.4)	2.0(2.0)	2.6(2.6)	3.1(3.1)	3.5(3.5)	4.2(4.2)
138 kV		1.5(2.3)	2.1(2.9)	2.7(3.4)	3.0(3.8)	4.2(4.5)
230 kV			2.4(2.8)	3.0(3.3)	3.4(3.7)	4.5(4.4)
287 kV				3.1(3.3)	3.6(3.7)	4.7(4.4)
345 kV					3.7(3.3)	4.9(4.0)
500 kV						5.4(3.7)

---

*1 The crossing conductors are considered to be in their maximum final sag position. Additional clearance must be provided for survey and construction tolerances.

*2 This is generally ground where the slope is greater than 30° to the horizontal.

TABLE J - (cont'd)

*3 Some judgement must be exercised when determining the value of L (load height). The travelling load height must be obtained from the companies involved. If it is not possible to determine the height, use a value of 7.6 m for L. Regardless of the value used for L, the clearance over main haul roads cannot be less than the value required for minor roads crossed by lines of that voltage class.

*4 Upper conductors at final sag shall be above the straight line between the support points of the lower wire. Where the sag of the lower wire exceeds 6 m, the clearance may be reduced by one half the difference between this sag and 6 m.

*5 These clearances apply if the upper conductor in the swung position, as determined in Note 6, is within 3 m horizontally of a structure.

*6 To determine clearances to sidehills, horizontal deviation shall be calculated using the non-sheltered span curve from Table 1 of CAN/CSA-C22.3 No. 1-M87 and applying the design clearance requirements for ground normally accessible to pedestrians only (Table 2).

*7 These clearances also apply where the conductors are along roads or railway tracks, if the conductors in the swung position as calculated in Note 6 are closer than the horizontal distances shown below, to the vertical projection of edge of travelled way or closest rail. Reference CAN/CSA-C22.3 No. 1-M87 Clauses 4.4 (Table 6), 4.7.3.2 and 4.7.3.3 (Table 9).

	Voltage					
Location	69 kV	138 kV	230 kV	287 kV	345 kV	500 kV
Roads	1.8	2.2	2.8	3.2	3.5	4.5*
Main Rail	4.0	4.3	4.9	5.3	5.6	6.6
Sidings	3.4	3.7	4.3	4.7	5.0	6.0

* Or 12 m from the rest position, whichever is the greater.

*8 Values apply only to the structure configurations shown in Fig.1.

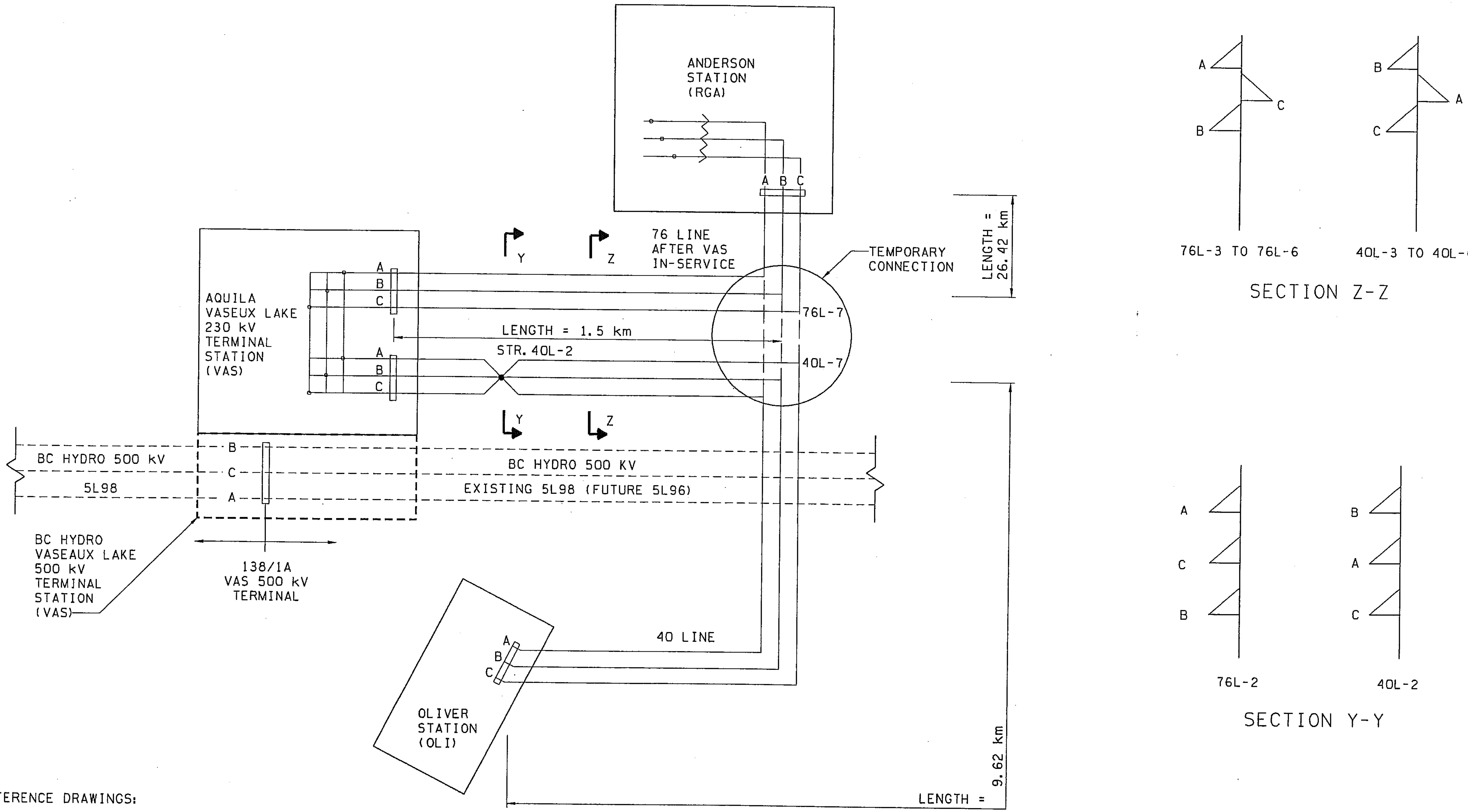
*9 Where snow depths are known to be greater than 1 m, the clearance shall be increased accordingly.

*10 For elevations over 1000 m, increase the electrical component of the clearances (see Table A) by 1 percent for each additional 100 m.

*11 When it is determined that higher objects will be present, the clearances shall be increased by the amount that the object height exceeds 4.15 m. In the case of high pressure irrigation systems, the object height to be used is 6 m. For 345 kV and 500 kV, a study of electrostatic induction effects may be required.

APPENDIX J: PHASING DIAGRAM

[1] Based on Design Basis Template – Original 4 May 2007



REFERENCE DRAWINGS:

4-000-2801 R1	AQUILA LOOP PASSING BC HYDRO VERNON STATION TO BC HYDRO KOOTNEY CANAL STATION
5L98-T06-A1	CIRCUIT 5L98 AND FUTURE 5L96 PHASING DIAGRAM

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION

DESIGNED BY	GSB
DRAWN BY	BE
CHECKED BY	RDC for VAS
APPROVED BY	[signature] Oct 4/04

FORTISBC

BChydro

BC HYDRO DWG NO. 304D-T06-B1 R

VASEUX LAKE TERMINAL STATION
40L AND 76L T/L LOOPS
PHASING DIAGRAM

DRAWING NUMBER 040-04604 REV 0

FORTISBC

OKANAGAN TRANSMISSION REINFORCEMENT PROJECT (OTR)

Station Preliminary Design Scope

Prepared for FortisBC by:

BC hydro
Engineering

October 2007

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BEN_3-385-SK1S2	Bentley Terminal Specification Sheet
BEN_3-385-0003	Bentley Terminal General Arrangement
DGB_3-371-SK2S1	DG Bell Terminal One - Line
DGB_3-371-SK2S2	DG Bell Terminal Specification Sheet
DGB_3-371-0003	DG Bell Terminal General Arrangement
FAL_3-314-SK2S1	FA Lee Terminal One - Line
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FAL_3-372-1029	FA Lee Terminal General Arrangement
OLI_3-386-SK1	Oliver Terminal One-Line Existing
OLI_3-386-SK2	Oliver Terminal One – Line Removals
OLI_3-386-SK3S1	Oliver Terminal One – Line Proposed
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OLI_3-386-NEW	Oliver Terminal Cross Section
OLI_3-386-1015	Oliver Terminal Cross Section
OLI_3-386-1017	Oliver Terminal General Arrangement
RGA_3-380-SK1	RG Anderson Terminal One – Line Existing
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RGA_3-380-SK1S2	RG Anderson Terminal Specification Sheet
RGA_3-380-1004	RG Anderson Terminal 230kV General Arrangements
RGA_3-380-1005	RG Anderson Terminal 63kV General Arrangements
RGA_3-380-1007A	RG Anderson Terminal 230kV Cross Section 1
RGA_3-380-1007	RG Anderson Terminal 230kV Cross Section 2
RGA_3-380-1008	RG Anderson Terminal 230kV Cross Section 3
RGA_3-380-1010	RG Anderson Terminal 230kV Cross Section 4
RGA_3-380-1013	RG Anderson Terminal 230kV Cross Section 5
VAS_3-388-SK5S1	Vaseux Lake Terminal One – Line 500 kV
VAS_3-388-SK6S1	Vaseux Lake Terminal One – Line 500/230/161 kV
VAS_3-388-SK6S2	Vaseux Lake Terminal One – Line Specification Sheet
VAS_3-338-1002	Vaseux Lake Terminal 230kV Switchyard Plan
VAS-304D-E05-D5004	Vaseux Lake Terminal 500kV Switchyard Plan

BELL PN AC One Line Diagram
BEN Control Block Diagram
BEN PN AC One Line Diagram
LEE PN AC One Line Diagram
OLI PN AC One Line Diagram
RGA PN AC One Line Diagram
VAS 230kV PN AC One Line Diagram

PROJECT SCOPE NOTES

Title: Okanagan Transmission Reinforcement – FortisBC Facilities

Station Planning

Overview: The backbone transmission system from RG Anderson Terminal at Penticton to Vaseux to the existing Oliver Station is to be rebuilt. Refer to the overview diagram of the FortisBC South Okanagan system. The essential change is to convert the existing 161 kV system from RG Anderson to Vaseux to Bentley to 230 kV, converting the stations and rebuilding the transmission lines. This work includes a new transformer station called Bentley Terminal adjacent to the existing Oliver station that gets converted to a 63 kV switching station.

Insulation coordination for the various new 230 kV line terminals requires at least one span of shielded conductor combined with tower grounding to achieve a maximum of 10 ohms. In addition, each line terminal shall be equipped with CVTs and surge arresters for lightning surge control.

R.G. Anderson Terminal (RGA)

The existing station HV is built to 230 kV standards and part of it is operated at 230 kV for a line north from Kelowna. The remainder is operated at 161 kV and requires conversion to 230 kV operation. This conversion involves adding three 230 kV circuit breakers to complete the ring and replacement of one transformer. T2 will be replaced by a new transformer; the old T2 will be relocated to RGA.

In accordance with the note above about line terminal insulation coordination, it is planned to add surge arresters on each of the 230 kV line terminals. If that is a design problem, consideration will have to be given to a longer line shield wire.

Failure of CB3 is a common mode event that will take out both lines from Vaseux (75L & 76L). The north line from Lee/Bell will support the station at this stage so it is not considered necessary to configure the station to avoid ever losing both lines adjacent to CB3 but in order to permit the lines to go back into service, motor operators are to be provided for CB3 isolating disconnects to allow the isolation of CB3. Remote control and indication is required for these switches.

Adding a circuit breaker to split the 63 kV bus is also an optional portion of the project to be costed. Physical space is a problem and it may be necessary to utilize a drawout style of breaker. This physical consideration requires Design study in the next stage.

The existing arrangement is recorded in the attached One Line 3-380-SK1. Changes are indicated in the attached One Line 3-380-SK3 sheet 1 and in Specification Sheet 3-380-SK3 Sheet 2.

Vaseux Terminal (VAS)

The LV portion of Vaseux presently is operated at 161 kV. This project requires its complete conversion to 230 kV. The existing 500-161 kV transformers are reconnectable and shall be reconnected to 500-230 kV. All connected lines are to be rebuilt to 230 kV standards.

A new 230 kV line from RGA (75L) shall be terminated at Vaseux, requiring the addition of CB5.

It is the desire of FortisBC to split the switching for T1 and T2 into separate zones as they are presently a single zone. This requires the addition of CB3. It will also require the addition of a 500 kV CB and reconfiguration of the 500 kV bus connections. This latter work is within BC Hydro ownership and BCTC's management responsibility. FortisBC will have to work out an agreement for this work so this entire portion of the project is optional pending a FortisBC agreement with BCTC. Failure of CB3 is a common mode event that will take out both transformers. The other supply lines will support the system at this stage so it is not considered necessary to configure the station to avoid ever losing both transformers as it is expected to be a very low probability event but in order to permit the transformers to go back into service, motor operators are to be provided for CB3 isolating disconnects to allow the isolation of CB3. Remote control and indication is required for these switches.

For station details refer to the attached One Lines 3-388-SK5, 3-380-SK6 sheet 1 and Specification Sheet 3-380-SK6 Sheet 2.

Bentley Terminal (BEN)

This project requires the construction of a new station at Oliver BC, adjacent to the existing Oliver Terminal, to connect 230 kV from Vaseux to 63 kV for the local load, a 161 kV tie line to the FortisBC system at Trail and a 138 kV line to Keremeos and Princeton.

It is the intention to use one of the transformers from RGA at Bentley. The present plans are based on using RGA T2 in BEN T1.

The introductory note about line shielding applies to the 230 kV line and may be an issue as initial field observations suggest grounding may be a problem at this site.

In order to protect the gas insulated circuit breakers from lightning surges, it is recommended that each 63 kV line terminal be equipped with a CVT and surge arresters. FortisBC normally uses potential transformers at 63 kV so there may need to be further discussion of this aspect.

For station details see One Line 3-385-SK1 Sheet 1 and Specification Sheet 3-385-SK1 Sheet 2.

Oliver Terminal (OLI)

Oliver Terminal presently connects 161 kV to 63 and 138 kV plus a small 13 kV distribution station. In this project the major transformation is to be removed, converting the station to a 63 kV switching station plus a new 63 -13 kV distribution station. Transformation will move to the adjacent new Bentley Terminal.

Oliver presently has two separate 63 kV buses. An optional part of this project is to connect them together via a new circuit breaker. It has been assumed for purposes of putting together this information that the combined buses will require new bus protection zones and four core current transformers to accommodate the new protection. Further discussion of this aspect with FortisBC is required to confirm his aspect but for the moment it is included and CT replacement is indicated.

The new 63-13 kV distribution station will be in accordance with FortisBC standards for distribution stations.

For station details see One Lines 3-386-SK1 indicating the existing arrangement, 3-386-SK2 indicating removals in this stage and 3-386-SK3 Sheet 1 indicating additions and Specification Sheet 3-386-SK3 Sheet 2.

F.A. Lee Terminal (FAL)

The requirement is to add a switched 30 Mvar shunt capacitor. Fuseless capacitor technology is preferred. With back-back capacitors and radial circuits terminating in transformers, control of inrush transients is recommended. The indicated configuration for the bank is the BC Hydro approach with inrush damping at the neutral end of the phases. Voltage differential protection in accordance with BC Hydro practice is assumed. Detailed requirements in accordance with BC Hydro Specification are assumed.

The new capacitor shall be combined with the existing bank in a single-point-grounding configuration utilizing a 15 kV cable to interconnect the grounds.

For station details see One Line 3-314-SK2 sheets 1 and Specification Sheet 3-314-SK2 sheet 2 attached.

D.G. Bell Terminal (DGB)

The requirement is to add a switched 30 Mvar shunt capacitor. Fuseless capacitor technology is preferred. With back-back capacitors and radial circuits terminating in transformers, control of inrush transients is recommended. The indicated configuration for the bank is the BC Hydro approach with inrush damping at the neutral end of the phases. Voltage differential protection in accordance with BC Hydro practice is assumed. Detailed requirements in accordance with BC Hydro Specification are assumed.

For station details see One Line 3-371-SK2 sheets 1 and Specification Sheet 3-371-SK2 sheet 2 attached.

Protection Planning

Revision: 0

Teleprotection Requirements

1. Provide mirrored-bit communication channels for new 230kV lines PY and SY PN between VAS and RGA (75L) and between VAS and Bentley (40L).
2. Provide mirrored-bit communication channels for new 161kV lines PY and SY PN between BEN and KET (48L).
3. Provide mirrored-bit communication channels for new 60kV lines PY and SY PN between BEN and NKM (66L). (DTT received from NKM)
4. No tele-protection requirements needed between BEN and KER (43L).
5. Provide communication channels for 68L and 69L PY and SY current differential relays between BEN and OLI (1km apart).

Work At VAS (FortisBC 230 kV station)

1. **This scope does not include 500kV protection at VAS which is one the BC Hydro/BCTC portion of the station.**
2. **Revise all station equipment settings for reconfiguration at 230kV yard.**
3. **Existing Transformer T1 PN**

   Remove PY and SY PN connections to T1 230kV side CTs, 500kV and 230kV side neutral CTs.
   Connect PY and SY PN to CB1 and CB3 CTs.
   Remove PY and SY protection tripping and BFI to CB4.
   Add PY and SY PN tripping and BFI to CB3.
   Remove CB4 status connections to PY and SY PN.
   Add CB3 status connections to PY and SY PN.
   Remove PY and SY lockout relays 86T1 and 86T1S (79T-H and 79T-L initiation) connections to 79T-L.
   Add PY and SY lockout relays 86T1 and 86T1S (79T1L initiation) connections to the new 79T1L.

4. **Existing Transformer T2 PN**
   Remove PY and SY PN connections to T2 230kV side CTs, 500kV and 230kV side neutral CTs.
   Connect PY and SY PN to CB3 and CB4 CTs.
   Remove PY and SY PN tripping and BFI to 5CB14 and 5CB22.
   Add PY and SY PN tripping and BFI to 5CB12 and 5CB13.
   Remove 5CB14 and 5CB22 status connections to PY and SY PN.
   Add 5CB12 and 5CB13 status connections to PY and SY PN.
   Remove PY and SY protection tripping and BFI to CB1.
   Add PY and SY PN tripping and BFI to CB3.
   Remove CB1 status connections to PY and SY PN.
   Add CB3 status connections to PY and SY PN.
   Remove PY and SY lockout relays 86T2 and 86T2S (79T-H and 79T-L initiation) connections to 79T-H and 79T-L.
   Add PY and SY lockout relays 86T2 and 86T2S (79T2H and 79T2L initiation) connections to the new 79T2H and 79T2L.

5. **Existing Transformer Auto-reclose 79T-H (Reused as 79T1H)**
   Rename the existing 79T-H as 79T1H.
   Remove T2-1, T2-2 and T1-2 status connections to 79T1H.
   Remove CB4 BF 86BF4 output to 79T1H.
   Remove SEL-279H line VT (V2 & V6) connections to 5CVT Ph.A and C.
   Connect SEL-279H line VT (V2) input to 5CVT13 Ph.B.

6. **Existing Transformer Auto-reclose 79T-L (Reused as 79T2H)**
   Rename the existing 79T-L as 79T2H and relocate this module from panel #5 (T1 PY PN PNL) to panel #7 (T2 PY PN PNL).
   Remove all existing AC & DC connections.
   Connect 79T2H VT inputs as shown on attached VAS 230kV PN AC one line diagram.
   Add PY and SY lockout relays 86T2 and 86T2S (79T2H and 79T2L initiation) connections to 79T2H.
   Add T2-1, 5CB12-1, 5CB12-2, 5CB12, 5CB13-1, 5CB13-2 and 5CB13 status connections to 79T2H.
   Add 5CB12 and 5CB13 BF outputs connections to 79T2H.
   Add close outputs from 79T2H to 5CB12 and 5CB13.

7. **New Transformer Auto-reclose 79T1L**
   Add one SEL-421-2 relay as T1 low voltage side auto-recloser 79T1L.
   79T1L will also provide closing synch check and BF PN for CB3.
   79T1L will be located on panel #5.

   CT and VT connections of 79T1L are shown in the attached VAS 230kV protection AC one line diagram.

8. **New Transformer Auto-reclose 79T2L**
   Add one SEL-421-2 relay as T2 low voltage side auto-recloser 79T2L.
   79T2L will be located on panel #7.

   CT and VT connections of 79T2L are shown in the attached VAS 230kV protection AC one line diagram.

9. **Existing 161kV Bus PN**
   Remove the existing 161kV Bus PY and SY PN relays 87B and 87BS.
   Remove the existing Bus PY and SY PN lockout relays 86B and 86BS.

10. **Existing 76L Line PN**
    Remove PY and SY (CB1 BF) PN tripping to Bus PN 87B & 87BS.
    Remove PY and SY (CB1 BF) PN BFI from Bus PN 87B & 87BS and T2 PN T2 & T2S.
    Add PY and SY (CB1 BF) PN tripping to T1 PN 87T1 and 87T1S.
    Remove CB1 BF lockout relay blocking to 79T-L.
    Add CB1 and CB3 BF lockout relays blocking to the new 79T1L.

11. **Existing 40L Line PN**
    Remove PY and SY PN connections to B2-CVT.
    Add PY and SY PN connections to the new 75-CVT.
    Remove PY and SY (CB4 BF) PN tripping to Bus PN 87B & 87BS.
    Remove PY and SY (CB4 BF) PN BFI from Bus PN 87B & 87BS, T1 PN 87T1 & 87T1S and T2 PN T2 & T2S.
    Add PY and SY (CB5 BF) PN BFI from and tripping to the new 75L PN 21L and 21LS.
    The new CB5 BF will be done by 40L PY and SY PN.
    The existing CB4 BF function inside PY and SY PN will be removed.
    Revise the existing CB4 BF lockout relay 86BF4 as the new CB5 lockout relay 86BF5.
    Remove the previous 86BF4 blocking to 79T-H & 79T-L and tripping and close blocking to CB1.
    Add 86BF5 tripping and close blocking to the new CB5.

12. **New 230kV Line 75L PN**
    Add one SEL-421-3 as the new Line 75L PY PN.
    Add one SEL-421-2 as the new Line 75L SY PN.
    Add one hot line tag relay 79TAG.
    Add one lockout relay 86BF4 for CB4 BF lockout.
    CB4 BF function will be done by 75L PY and SY PN.
    New 75L PN panel will be #0.

    CT and VT connections of the PY and SY PN are shown in the attached VAS 230kV protection AC one line diagram.

13. **New CB3 and CB5 BF PN**
    CB3 BF PN will be provided by the two new 79T1L relay (SEL-421-2).
    CB5 BF PN will be provided by 40L PY and SY PN.
    Add one FortisBC 2081 module for 86BF3 and 86BF4 on panel #3.

Work At BEN

1. **230kV 40L Line PN**
    Provide one SEL-421-3 relay as 40L PY PN and one SEL-421-2 relay as 40L SY PN. Both line protections will be permissive overreaching transfer trip, using mirrored bits. Primary and standby relays also provide automatic reclose, and BF PN and control for CB40 and control of T1-2.
    Provide one Electroswitch Hot Line Tag relay switch for 40L.

2. **161kV 48L Line PN**
    Provide one SEL-421-3 relay as 48L PY PN and one SEL-421-2 relay as 48L SY PN. Both line protections will be permissive overreaching transfer trip, using mirrored bits. Primary and standby relays also provide automatic reclose, and BF PN and control for CB2 and control of T2-2.
    Provide one Electroswitch Hot Line Tag relay switch for 48L.

3. **138kV 43L Line PN**
   Provide one SEL-421-3 relay as 43L PY PN and one SEL-421-2 relay as 43L SY PN. No tele-protection requirements. Primary and standby relays also provide automatic reclose, and BF PN and control for CB4 and control of T3-2.
   Provide one Electroswitch Hot Line Tag relay switch for 43L.

4. **Transformer T1 PN**
   Provide one SEL-387-6 relay as T1 PY PN and one SEL-387-6 relay as T1 SY PN.
   Provide two Electroswitch Lockout relays as T1 lockout 86T1 and 86T1S.

5. **Transformer T2 PN**
   Provide one SEL-387-6 relay as T2 PY PN and one SEL-387-6 relay as T2 SY PN.
   Provide two Electroswitch Lockout relays as T2 lockout 86T2 and 86T2S.

6. **Transformer T3 PN**
   Provide one SEL-387-6 relay as T3 PY PN and one SEL-387-6 relay as T3 SY PN.
   Provide two Electroswitch Lockout relays as T3 lockout 86T3 and 86T3S.

7. **Transformer T1 Auto-Recloser 79T1**
   Provide one SEL-421-2 relay as T1 auto-recloser 79T1. The reclosing is for Transformer LV Breakers.
   79T1 will provide CB13 BF PN, CB13 close synch check and standby local control.

8. **Transformer T2 Auto-Recloser 79T2**
   Provide one SEL-421-2 relay as T1 auto-recloser 79T2. The reclosing is for Transformer LV Breakers.
   79T2 will provide CB12 BF PN, CB13 close synch check and standby local control.

9. **Transformer T3 Auto-Recloser 79T3**
   Provide one SEL-421-2 relay as T3 auto-recloser 79T3. The reclosing is for Transformer LV Breakers.

10. **60kV 68L Line PN**
    Provide one SEL-311L relay as 68L PY PN and one SEL-311L relay as 68L SY PN.
    Links to the line remote end PN relays will be fibre
    Provide one SEL-421-2 relay as 68L auto-recloser and BF PN, and control device for CB11 and control of 68-1.
    Provide one Electroswitch Hot Line Tag relay switch for 68L.

11. **60kV 69L Line PN**
    Provide one SEL-311L relay as 69L PY PN and one SEL-311L relay as 69L SY PN.
    Links to the line remote end PN relays will be fibre.
    Provide one SEL-421-2 relay as 69L auto-recloser and BFPN, and control device for CB17 and control of 69-1.
    Provide one Electroswitch Hot Line Tag relay switch for 69L.

12. **60kV 66L Line PN**
    Provide one SEL-421-3 relay as 66L PY PN and one SEL-421-2 relay as 66L SY PN and BFPN, and control device for CB18, CB19 and control of 66-1.
    Both line protections will receive transfer trips from NKM, using mirrored bits.
    Provide one Electroswitch Hot Line Tag relay switch for 66L.

13. **Station Service Transformer T2 PN**
    Provide one SEL-351S-6 relay as SST2 PN.

14. **Station Service Transformer T3 PN**
    Provide one SEL-351S-6 relay as SST3 PN.

15. **230kV CB40 BF**
    CB40 BF PN will be provided by 40L 21L and 21LS relay.
    Provide one Electroswitch lockout relay as CB40 BF lockout 86BF40.

16. **161kV CB48 BF**
    CB2 BF PN will be provided by 48L 21L and 21LS relay.
    Provide one Electroswitch lockout relay as CB48 BF lockout 86BF2.

17. **138kV CB43 BF**
    CB4 BF PN will be provided by 43L 21L and 21LS relay.
    Provide one Electroswitch lockout relay as CB4 BF lockout 86BF4.

18. **60kV CB11, CB12, CB13, CB17, CB18 AND CB19 BF**
    CB11 BF PN will be provided by 68L auto-reclose relay SEL-421-2.
    CB12 BF PN will be provided by 79T2 relay SEL-421-2.
    CB13 BF PN will be provided by 79T1 relay SEL-421-2.
    CB17 BF PN will be provided by 69L auto-reclose relay SEL-421-1.
    CB18 and CB19 BF PN will be provided by 66L 21L and 21LS relay.
    Provide one Electroswitch lockout relay for each of the 6 60kV circuit breakers as BF lockout 86BF11, 86BF12, 86BF13, 86BF17, 86BF18 and 86BF19.

    All PN CT and VT connections are shown in the attached Bentley Substation protection AC one line diagram.

<u>Work At R.G.A</u>

1. **230kV 73L Line Protection**
   Remove the existing 73L line PY and SY protection relays SEL-221H and SEL-221F.
   Provide one new SEL-421-3 relay as 73L PY PN and one new SEL-421-2 relay as 73L SY PN.
   CB1 and CB5 BF PN will be provided by 73L PY and SY PN.

2. **Existing 230kV 76L Line Protection**
   Add current inputs from CB2 bushings to the existing 76L PY and SY PN relays SEL-421.
   Add single phase voltage inputs from the new CVT1 and CVT75 to the existing 76L PY and SY PN relays SEL-421.
   Add trip/close controls from the existing 76L PY and SY PN relays SEL-421 to the new CB2.
   CB2 and CB3 BF PN will be provided by 76L PY and SY PN.

3. **The new 230kV 75L Line Protection**
   Provide one new SEL-421-3 relay as 73L PY PN and one new SEL-421-2 relay as 75L SY PN.
   Provide one Electroswitch Hot Line Tag relay switch for 75L.
   CB4 BF PN will be provided by 75L PY and SY PN.

4. **The Existing T1 Protection**
   Re-connect T1 PY PN relay SEL-387 CT inputs to CB2 line side out bushing, CB1 outer CT, CBT1 Bus side outer CT and T1 TV side out CT.
   Re-connect T1 SY PN relay SEL-387 CT inputs to the new CB2 line side inner bushing, CB1 mid-outer CT, CBT1 Bus side inner CT and T1 TV side inner CT.
   Re-connect 51T1H relay SEL-351 CT inputs from CB1 mid-outer CT to T1 high side outer CT. 51T1H voltage input will be fed from single phase CVT1 (for metering uses only).

The existing T1 LV and tertiary SY PN 51T1L and 51T1S will stay as it is.
Remove the existing CB1 PN SEL-2BFR.

5. **The Existing T4 Protection**
   Rename the existing T2 PY and SY PN as T4 PY and SY PN.
   Re-connect T4 PY PN relay SEL-387 CT inputs to the new CB5 line side outer bushing, the new CB4 line side outer bushing, CBT4 Bus side CT and the new T4 TV side outer CT.
   Re-connect T4 SY PN relay SEL-387 CT inputs to the new CB5 line side inner bushing, the new CB4 line side inner bushing, CBT4 T4 side CT and the new T4 TV side mid-outer CT.
   Re-connect 51T4H relay SEL-351 CT inputs from CB3 mid-inner CT to T4 high side outer CT. 51T4H voltage input will be fed from single phase CVT4 (metering uses only).
   The existing T4 LV SY PN 51T4L will stay as it is.
   Provide one SEL-351 relay as T4 tertiary side SY PN 51T4S.

6. **63kV Bus ½ Protection**
   Provide one SEL-487B relay as Bus ½ PN 87B1/2.
   Provide one Electroswitch Lockout relay as Bus 1/2 lockout 86B1/2 .

7. **63kV Bus ¾ Protection**
   Remove the existing 87-LVB B-Pro 8700 relay.
   Provide one SEL-487B relay as Bus 3/4 PN 87B3/4
   Provide Electroswitch Lockout relay as Bus 3/4 lockout 86B3/4.

8. **230kV CB1, CB2, CB3, CB4 And CB5 BF**
   CB1 and CB5 BF PN will be provided by 73L PY and SY PN relays SEL-421.
   CB2 and CB3 BF PN will be provided by 76L PY and SY PN relays SEL-421.
   CB4 BF PN will be provided by 75L PY and SY PN relays SEL-421.
   Provide one Electroswitch lockout relay for each of the 3 new 230kV circuit breakers as BF lockout 86BF-CB2, 86BF-CB4 and 86BF-CB5.

9. **63kV CB Tie BF**
   CB Tie BF PN will be provided by the existing RAS relay SEL-421(also possible to provide in Bus PN).
   Provide one Electroswitch lockout relay as CB Tie BF lockout 86BF-Tie.

10. **RGA T3, CX1, CX2, 45L, 52L and 53L all existing PN stays the same. But settings may need revisions for new fault level.**

    All PN CT and VT connections are shown in the attached R.G.A Substation protection AC one line diagram.

<u>**Work At OLI**</u>

1. **Remove the all existing 40L, 11W, 43L, T1 and T2 protective relays and control devices based on the removal of the related lines and transformers.**

2. **Revise all station equipment settings for station re-configuration.**

3. **The New 60kV 68L Line Protection**
   Provide one SEL-311L as 68L PY PN 87L and one SEL-311L as 68L SY PN 87LS.
   Links to the line remote end PN relays will be fibre.
   Provide one Electroswitch Hot Line Tag relay switch for 68L.

3. **The New 60kV 69L Line Protection**
   Provide one SEL-311L as 69L PY PN 87L and one SEL-311L as 69L SY PN 87LS.

Links to the line remote end PN relays will be fibre.
Provide one Electroswitch Hot Line Tag relay switch for 69L.

4. **The New 60kV Bus Protection**
   Provide three SEL-487B relays as Bus A, Bus B and Bus overall PN 87BA (phase A differential), 87BB (phase B differential), 87BC (phase C differential).
   Provide 2 Electroswitch lockout switch-relays as 86BA and 86BB.

5. **The Transformer T3 Protection**
   Per FortisBC Distribution Protection Standard, provide one SEL-387-6 relay as T3 PY PN 87T3, one SEL-351S relay as T3 High side SY PN 51T3HS, and one SEL-351S as T3 low side SY PN 51T3LS.
   CB41 BF PN will be provided by 51T3HS SEL-351S relay, and CB T3-1 BF PN will be provided by 51T3LS SEL-351S relay.
   Provide one Electroswitch lockout relay as 86T3.

6. **The Existing 44L Line Protection**
   The existing 44L line PN relays will stay, however the CT connections of the existing relays will be re-wired as shown on the attached AC One Line Diagram.
   Setting may need revision for new fault levels.

7. **The Existing 42L Line Protection**
   The existing 42L line PN relays will stay, however the CT connections of the existing relays will be re-wired as shown on the attached AC One Line Diagram.
   Setting may need revision for new fault levels.

9. **The Existing Cap. #1 Protection**
   The existing Cap #1 PN relays will stay, however the CT connections of the existing relays will be re-wired as shown on the attached One Line Diagram.
   Setting may need revision for new fault levels.

10. **The Existing Cap. #2 protection**
    The existing Cap #2 PN relays will stay, however the CT connections of the existing relays will be re-wired as shown on the attached One Line Diagram.
    Setting may need revision for new fault levels.

11. **63kV CB BF Protection**
    CB TA BF PN will be provided by 68L PY and SY PN relays SEL-311L.
    Provide one Electroswitch lockout relay as CB68 lockout 86CB68.
    CB TB BF PN will be provided by 69L PY and SY PN relays SEL-311L.
    Provide one Electroswitch lockout relay as CB69 lockout 86CB69.
    CB Tie BF PN will be provided by the existing RAS relay SEL-421(also possible to provide in Bus PN).
    Provide one Electroswitch lockout relay as CB Tie lockout 86CBTie.
    CB41 BF PN will be provided by T3 high side SY PN relay SEL-351S.
    Provide one Electroswitch lockout relay as CBT3 lockout 86CBT3.

12. **13kV Feeders Protection**
    Provide one SEL-351S for each of the three 13kV feeders (3 SEL-351S relays total).
    Provide one Electroswitch hot line tag relay for each of the three 13kV feeders (3 relays total).

    All PN CT and VT connections are shown in the attached OLI Substation protection AC one line diagram.

Work At BELL

1. **The New 138kV Capacitor Bank CAP1 Protection**
   Provide one SEL-451 as CAP1 PY PN.
   Provide one SEL-351S as CAP1 SY PN.
   Provide 1 Electroswitch lockout switch-relay as 86CAP1.
   CB CAP1 BF PN will be provided by CAP1 PY PN relay SEL-451and SY PN relay SEL-351S.

2. **The Existing 138kV Bus Protection**
   The existing 138kV bus PY PN relay SEL-387 will be replace by a new SEL-487B relay.
   The existing 138kV bus SY PN relay SEL-421 will stay, however its settings may be revised.
   The existing lockout relays 86BUS1 and 86BUS2 will be extended to trip and lockout the new CB CAP1.

   All PN CT and VT connections are shown in the attached BELL Substation protection AC one line diagram.

Work At LEE

1. **The New 138kV Capacitor Bank CAP2 Protection**
   Provide one SEL-451 as CAP2 PY PN.
   Provide one SEL-351S as CAP2 SY PN.
   Provide one Electroswitch lockout switch-relay as 86CAP2.
   CB CAP2 BF PN will be provided by CAP2 PY PN relay SEL-451and SY PN relay SEL-351S.

2. **The New Existing 138kV Bus A Protection**
   The existing 138kV Bus-A PN relay SEL-387 will be replaced by a new SEL-487B relay.
   The existing lockout relays 86BUSA will be extended to trip and lockout the new CB CAP2.

   All PN CT and VT connections are shown in the attached LEE Substation protection AC one line diagram.

Control Planning

Revision: 0

Currents of all CBs and Transformers and voltages of all VTs and CVTs should be monitored by DFR.

Work At VAS

1. **DFR**
   Add DFR modules for CB3 and CB5 currents, and 75-CVT and B3-CVT voltages.

   CT and VT connections of the new DFR modules are shown in the attached VAS 230kV protection AC one line diagram.

2. **Metering**
   Remove T2 Meter PML 6200 connections to B2-CVT.
   Add T2 Meter PML 6200 connections to the new B3-CVT.
   Add one PML-7650 as the new Line 75L Power Quality Meter. The new 3053 module will be on panel #11.

3. **Local Control Of CB3, CB4, CB5, CB3-1, CB3-2 and 75-1**
   Revise HMI and RTU configuration to accommodate the PY local controls of those new 230kV breakers and MODs.
   Remove CB4 SY local control function on 40L PY and SY PN relays.
   Pushbuttons on 40L PY and SY PN relays will provide SY controls of CB6 and CB5.
   Pushbuttons on the new 75L PY and SY PN relays will provide SY controls of CB4, CB5 and 75-1
   Pushbuttons on 79T1L and 79T2L relays will provide SY controls of the new CB3, CB3-1 and CB3-2.

4. **Alarms**
   Provide '30 relays' for the new breakers CB3 and CB5 and MODs 75-1, CB3-1 and CB3-2.
   Modify the local annunciator to accommodate new alarms (FortisBC Alarm grouping roles applied).
   Wire all alarms to GE RTU. Currently there are enough spare points.

5. **Remote Status And Control Of The New CB3, CB5, CB3-1, CB3-2 and 75-1**
   Assign and wire the new control and status points for those new breakers and MODs. There are enough spare points currently.

6. **SEL Relays Remote Access**
   Provide connections for the 4 new SEL relays to the two existing SEL-2032 relays.

7. **GPS**
   Use one ForticBC GPS (using SEL-2407) module to replace the existing GPS clock module.

<u>**Work At BEN**</u>

1. **DFR**
   Provide two TESLA 3000 Disturbance Fault Recorders with total 72 analog and 128 digital channels.
   Provide current and voltage DFR modules for all analog inputs, which shown on the AC One Line Diagram.

2. **Transformer Tap-Changer Control**
   Provide one FortisBC 2074B module, which is equipped with Beckwith 2001C, INCON 1250B and other devices, for each of T1, T2 and T3 LTC as its auto LTC controller, local Tap Position indicator and remote Tap Position transducer.

3. **Metering**
   Provide one PML 7650 for each of the 40L, 43L, 48L and 66L 60kV transmission lines as its local and remote power quality meter. At BEN end 68L and 69L are not required for PML meters, since PML meters will be equipped at OLI end.

4. **Announciator**
   Provide one FortisBC 1037 Module as local alarm annunciator.

5. **Alarm Multiply and Grouping**
   Provide one 125VDC 30 relay for each of all alarms from the yard and control room for alarm multiply and grouping purpose.
   Each alarm will be sent to RTU individually and to the annunciator after grouping per FortisBC standard.

6. **GE D200 RTU**
   Provide one GE D200 RTU as local and remote control, statuses and alarm processor. The D200 RTU should be equipped with one D20K module, 4 D20 KI control modules (32 control points) and 4 D20S digital input modules (128 status points and 128 alarm points). Provide one current ForisBC 125/48VDC converter module.

7. **HMI**
   Provide one HMI computer to perform primary local control, status and detailed alarm display.

8. **Local CB and MOD Control**
   Primary CB and MOD control will be done by HMI via RTU.
   Standby CB and MOD control will be implemented by the pushbuttons on the SEL relays.

9. **SEL Relay Remote Access**
   Provide two SEL-2032 relay communication processors, which should be equipped with 2701 Ethernet card.

10. **GPS and Ethernet Hub**
    Provide one FortisBC 2078 Module as Station Ethernet Hub.
    Provide one FortisBC GPS (using SEL-2407) module and antenna for station time synchronizing.

11. **I/O Panels**
    Provide enough I/O panels for indoor and outdoor interface.

<u>**Work At R.G.A**</u>

1. **DFR**
   Re-use T1 and T2 high side current DFR modules as the new CB5 and CB2 currents.
   Provide new DFR modules for CB4 currents, CB Tie currents and CVT75.
   Remove the existing DFR module for T1 and T2 neutral CTs.
   Check with the existing DFR to confirm if there are enough spare points to accommodate the new DFR points.

2. **Transformer Tap-Changer Control**
   Re-use the existing T2 LTC controller as the new T4 LTC controller.

3. **Metering**
   The existing 73L/T1HM PML 7600 will be re-used as 73L meter.
   The existing 76L/T2HM PML 7600 will be re-used as 76L meter.
   Provide one PML 7650 as 75L metering device.
   Provide one PML 7650 as T1 LV metering. The existing PML 7700 will be removed.
   Provide one PML 7650 as T4 LV metering. The existing PML 7700 will be removed.
   T1 high side telemetry will be from the existing 51T1H relay SEL-351.
   T1 low side telemetry will be from the existing 51T1L relay SEL-351.
   T1 tertiary side telemetry will be from the existing 51T1S relay SEL-351.
   T4 high side telemetry will be from the existing 51T4H relay SEL-351.
   T4 low side telemetry will be from the existing 51T4L relay SEL-351.
   T4 tertiary side telemetry will be from the new 51T4S relay SEL-351.

4. **Alarms**
   Provide 30 relays for the new breakers CB2 and CB4 CB5, CB Tie and T4 alarms.
   Modify the local announciator to accommodate new alarms (FortisBC Alarm grouping roles applied). One more annountiator may be required if there is not enough spare points left.

Wire all alarms to GE RTU. RTU may be required to be extended if there is not enough alarm point left.

5. **Local And Remote Control Of The New CB2, CB4 And CB5**
   Revise HMI and RTU program to accommodate the remote and PY local control of those new CBs. RTU may be required to be extended if there is not enough status and control point left
   CB1 and CB5 SY local controls will be performed by the PB on 73L PY and SY PN SEL-421 relays.
   CB2 and CB3 SY local controls will be performed by the PB on 76L PY and SY PN SEL-421 relays.
   CB4 SY local controls will be performed by the PB on 75L PY and SY PN SEL-421 relays.
   Provide one Electroswitch control switch as the new CB Tie standby local control.
   CB Tie synch check will be provided by the existing RAS SEL-421 relay.

6. **New SEL Relays Remote Access**
   Provide connections of all the new SEL-relays to the existing SEL-2032. If there are not enough spare ports, one more SEL-2032 will be needed.

7. **GPS**

   Use one ForticBC GPS (using SEL-2407) module to replace the existing GPS clock module.

<u>Work At OLI</u>

1. **DFR**
   Provide one TESLA 3000 Disturbance Fault Recorders with 36 analog and 64 digital channels.

2. **Alarms**
   Revise the existing announciator and RTU alarm inputs to accommodate the new alarms and to remove all un-used alarms related with the removed equipment.

3. **Local and Remote Controls**
   Revise the MIMIC and RTU control points to accommodate the CB CN and to remove all un-used CN points related with the removed equipment.
   Add one Eletroswitch Control switch as the new Tie CB local control. (Tie CB synch check will be implemented inside the existing RAS relay SEL-421)

4. **Metering**
   Provide one PML-7650 as 69L meter.
   Provide one PML-7650 as 68L meter.
   Provide one PML 7650 as T3 meter.
   Provide three PML 7550 meters for the three 13kV feeders.

5. **SEL Relay Remote Access**
   Provide one SEL-2032 relay to accommodate the 14 new SEL relays remote connection.

<u>Work At BELL</u>

1. **Local And Remote Control Of the New Breaker CB-CAP1**
   Revise HMI and RTU program to accommodate the remote and PY local control of the new CB CAP1. RTU may be required to be extended if there is not enough status and control point left.

CB CAP1 SY local controls will be performed by the PB on CAP1 PY PN relay SEL-451 and SY PN relay SEL-351S.
Provide one ABB-E213 POW controller to optimize manual (local and supervisory) trip and close control on CB-CAP1 in order to eliminate the CAP1 inrush.

2. **DFR**
   Provide new DFR modules for the new CB-CAP1 currents and the new CVT1 voltages.
   Check with the existing DFR to confirm if there are enough spare points to accommodate the new DFR points.

3. **ALARMS**
   Provide 30 relays for the new breaker CB-CAP1 alarms.
   Modify the local announciator to accommodate new alarms (FortisBC Alarm grouping roles applied).

4. **SEL Relays Remote Access**
   Provide connections of all the new SEL-relays to the existing SEL-2032. If there are not enough spare ports, one more SEL-2032 will be needed.

Work At LEE

1. **Local And Remote Control Of the New Breaker CB-CAP2**
   Revise HMI and RTU program to accommodate the remote and PY local control of the new CB CAP2. RTU may be required to be extended if there is not enough status and control point left.
   CB CAP2 SY local controls will be performed by the PB on CAP2 PY PN relay SEL-451 and SY PN relay SEL-351S.
   Provide one ABB-E213 POW controller to optimize manual (local and supervisory) trip and close control on CB-CAP2 in order to eliminate the CAP2 inrush.

2. **DFR**
   Provide new DFR modules for the new CB-CAP2 currents and the new VT-CAP2 voltages.
   Check with the existing DFR to confirm if there are enough spare points to accommodate the new DFR points.

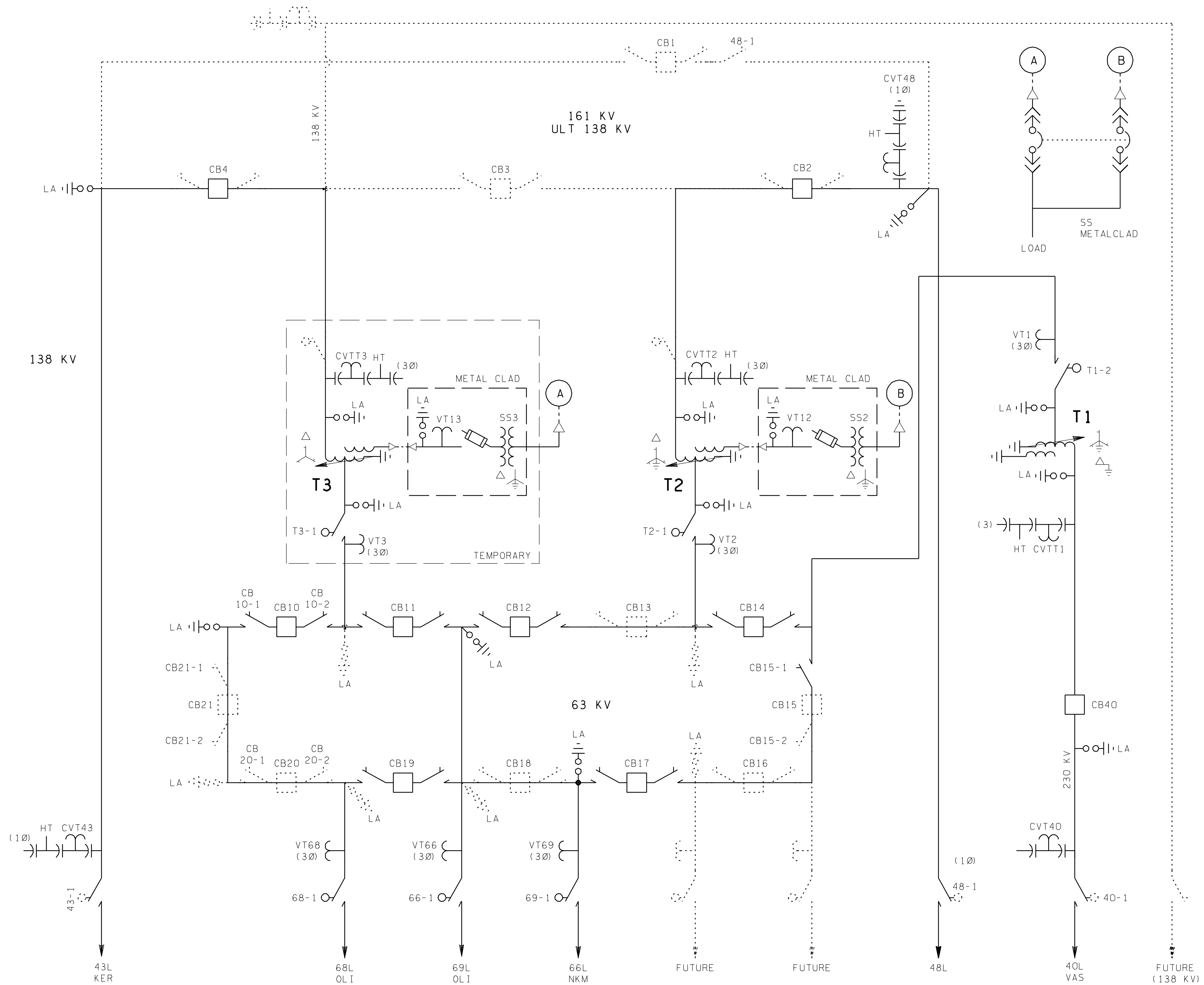
3. **ALARMS**
   Provide 30 relays for the new breaker CB-CAP2 alarms.
   Modify the local announciator to accommodate new alarms (FortisBC Alarm grouping roles applied).

4. **SEL Relays Remote Access**
   Provide connections of all the new SEL-relays to the existing SEL-2032. If there are not enough spare ports, one more SEL-2032 will be needed.

List of Attachments: Diagram/Drawing

BEN_3-385-SK1S1	Bentley Terminal One - Line
BEN_3-385-SK1S2	Bentley Terminal Specification Sheet
BEN_3-385-0003	Bentley Terminal General Arrangement
DGB_3-371-SK2S1	DG Bell Terminal One - Line
DGB_3-371-SK2S2	DG Bell Terminal Specification Sheet
DGB_3-371-0003	DG Bell Terminal General Arrangement
FAL_3-314-SK2S1	FA Lee Terminal One - Line
FAL_3-314-SK2S2	FA Lee Terminal Specification Sheet
FAL_3-372-1029	FA Lee Terminal General Arrangement
OLI_3-386-SK1	Oliver Terminal One-Line Existing
OLI_3-386-SK2	Oliver Terminal One – Line Removals
OLI_3-386-SK3S1	Oliver Terminal One – Line Proposed
OLI_3-386-SK1S2	Oliver Terminal Specification Sheet
OLI_3-386-NEW	Oliver Terminal Cross Section
OLI_3-386-1015	Oliver Terminal Cross Section
OLI_3-386-1017	Oliver Terminal General Arrangement
RGA_3-380-SK1	RG Anderson Terminal One – Line Existing
RGA_3-380-SK3S1	RG Anderson Terminal One – Line Proposed
RGA_3-380-SK1S2	RG Anderson Terminal Specification Sheet
RGA_3-380-1004	RG Anderson Terminal 230kV General Arrangements
RGA_3-380-1005	RG Anderson Terminal 63kV General Arrangements
RGA_3-380-1007A	RG Anderson Terminal 230kV Cross Section 1
RGA_3-380-1007	RG Anderson Terminal 230kV Cross Section 2
RGA_3-380-1008	RG Anderson Terminal 230kV Cross Section 3
RGA_3-380-1010	RG Anderson Terminal 230kV Cross Section 4
RGA_3-380-1013	RG Anderson Terminal 230kV Cross Section 5
VAS_3-388-SK5S1	Vaseux Lake Terminal One – Line 500 kV
VAS_3-388-SK6S1	Vaseux Lake Terminal One – Line 500/230/161 kV
VAS_3-388-SK6S2	Vaseux Lake Terminal One – Line Specification Sheet
VAS_3-338-1002	Vaseux Lake Terminal 230kV Switchyard Plan
VAS-304D-E05-D5004	Vaseux Lake Terminal 500kV Switchyard Plan

BELL PN AC One Line Diagram
BEN Control Block Diagram
BEN PN AC One Line Diagram
LEE PN AC One Line Diagram
OLI PN AC One Line Diagram
RGA PN AC One Line Diagram
VAS 230kV PN AC One Line Diagram



BChydro ENGINEERING

BC HYDRO DWG NO. 304J-P06-SK1 R 0

BENTLEY TERMINAL (BEN)

ONE-LINE DIAGRAM
200X STAGE

								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		
No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			

FORTISBC

DRAWING NUMBER	REV
3-385-SK1	0

BChydro STATION SPECIFICATION SHEET

Stations Planning

BEN2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
63 KV	72.5	350	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800

Comments
CB10, CB11, CB12, CB14, CB17, CB19: dual trip coils; Misubishi dead tank

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
CB4	145	650	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800

Comments
Mitsubishi dead tank: Dual trip coils

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
CB2 CB40	253	900	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800

Comments
Mitsibishi model 200-SFMT-40GE: Dual trip coils

Surge Arresters	rtd. KV	Type	Man	Comments
138 KV LINE	144	IEC 3		
138 KV TFR	120	IEC 3		
161 KV LINE	168	IEC 4		
161 KV TFR	144	IEC 3		
230 KV LINE	228	IEC 4		
230 KV TFR	192	IEC 3		
25 KV TERT	36	IEC 2		
63 KV LINE	72	IEC 2		
63 KV TFR	60	IEC 2		

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
138 KV	145 650	700/1200:1:1	1PWXY2PZ	3b	CVT Minimum 10 Nanofarads. Provision for harmonic measurement.
170 KV	170 750	800/1400:1:1	1PWXY2PZ	3b	CVT Minimum 10 Nanofarads. Provision for harmonic measurement.
230 KV	253 1,050	1200/2000:1:1	1PWXY2PZ	3b	CVT Minimum 10 Nanofarads. Provision for harmonic measurement.
25 KV	27.5 150	200:1	1PWXY2PZ	2	VT
63 KV	72.5 350	350/600:1:1	1PWXY2PZ	3b	VT

Miscellaneous Ratings

40-1	2000 A	900 kV BIL	
43-1	1200 A	650 kV BIL	
48-1	2000 A	900 kV BIL	
63 kV DS	2000 A	350 kV BIL	
SS2-FU			
SS2/SS3	DYn1	150 kV BIL	25.2+/-2x2.5% - 120/208
SS3-FU			

Transformers & Shunt Reactors

T1

Voltage	BIL	Wdg	TapChanger		%Z (ONAN)
225	900	An	LTC +/-16 x .75%	90/120/150//168	ZHL 9.08
63	350	An0		90/120/150//168	
8.75					

Current Transformers — CSA Type TPS — Ial= 5%

HV	Outer	6/3/2/100 - 5	2.5L400
	Inner	20/15/1200-5	2.5L800
LV	Outer	20/15/1200-5	2.5L800
	Inner	20/15/1200-5	2.5L800
	TV Ground	20/15/1200-5	2.5L400

ex RGA T2 S/N 289415 Man CGE

Notes On 161 kV: 73.5/97.9/122.7//137.5 MVA Z = 5.18% on 90 MVA and 161 kV.

T2

Voltage	BIL	Wdg	TapChanger		%Z (ONAN)
161	750	An	LTC +/- 16x0.625	90/120/150	ZHL 7.50
63	350	An0		90/120/150	ZHT 15.20
25	150	D1		30/30/30	ZLT 6.30

Current Transformers — CSA Type TPS — Ial= 5%

HV Outer & Mid-outer	12/8/3/200 - 5	2.5L400
HV Inner & Mid-inner	20/15/12/400 - 5	2.5L800
LV Outer & Mid-outer	20/15/12/400 - 5	2.5L800
LV Inner & Mid-inner	20/15/12/400 - 5	2.5L800
LV Neutral Inner & Outer	20/15/12/400 - 5	2.5L400
TV Outer & Middle	30/25/22/1000 - 5	2.5L800
TV Inner	12/8/3/200 - 5	2.5L400

Notes HV reconnectible 161/138 kV. 650 kV BIL on 138 kV. Impedances to tertiary approximate.

T3

Voltage	BIL	Wdg	TapChanger		%Z (ONAN)
138	650	An	LTC +/-16x0.625	60/80/100	ZHL 7.50
63	350	An0		60/80/100	ZHT 15.20
25	150	D1		20	ZLT 6.30

Current Transformers — CSA Type TPS — Ial= 5%

HV Outer & Mid-Outer	12/8/3/200 - 5	2.5L400
HV Inner & Mid-inner	20/15/12/400 - 5	2.5L800
LV Outer & Mid-Outer	20/15/12/400 - 5	2.5L800
LV Inner & Mid-inner	20/15/12/400 - 5	2.5L800
LV Neutral Inner & Outer	20/15/12/400 - 5	2.5L400
TV Outer & Middle	30/25/22/1000 - 5	2.5L800
Inner	12/8/3/200 - 5	2.5L400

Notes Impedances to tertiary approximate.

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

Station General Information

Transformer MVA Capacity

	Ultimate	this stage
230/63	168	168
138/63	150	100
161/63	-	150

Firm Tfr MVA Cap

Fault Levels
@ 1.05 p.u. voltage

3 ph MVA / SLG kA

Voltage	Ultimate	Present
230	4000/10	2800/7.3
161	-	900/3.5
138	1000/5	TBD
63	2000/20	1500/16
25	800/-	775/-

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
   -measured TBD
   c) stn gnd fault current - this stage 15 kA rms
   -ultimate 18 kA rms (63 kV)
   d) rise in station gnd potential
   - this stage kV TBD
   - ultimate kV < 5kV rms
2. Alarms: via supy. control
3. Station Control: supervisory

Notes :
PRELIMINARY INFORMATION. NOT FOR EQUIPMENT ORDERING
THIS IS NOT A BCTC PROJECT
Fault levels approximate. To be confirmed.

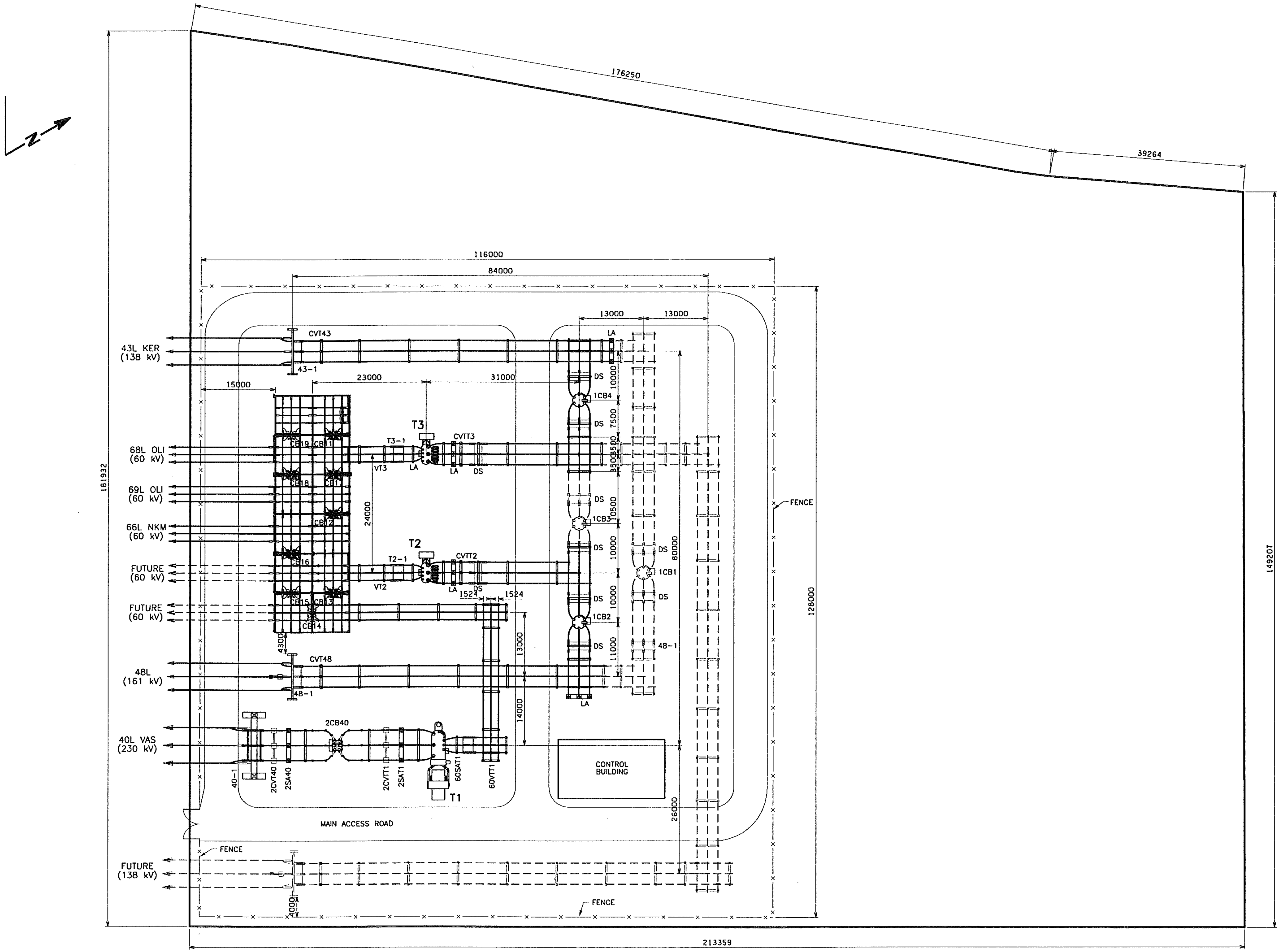
BChydro FORTISBC
ENGINEERING - Stations Planning

BENTLEY (BEN)OK

2008 Stage BC HYDRO DWG NO. 304J-P06-B1 R 0

Planning one-line
3-385-SK1
SHEET 2

Date :



SCALE 1:400 — 8 0 8 16 24 32 METRES

NOTE: ALL DIMENSIONS ARE IN MILLIMETRES

BChydro ENGINEERING

BC HYDRO DWG NO. 304J-E05-D3 R 0

SCALE: 1:400 SCALE FACTOR: 400

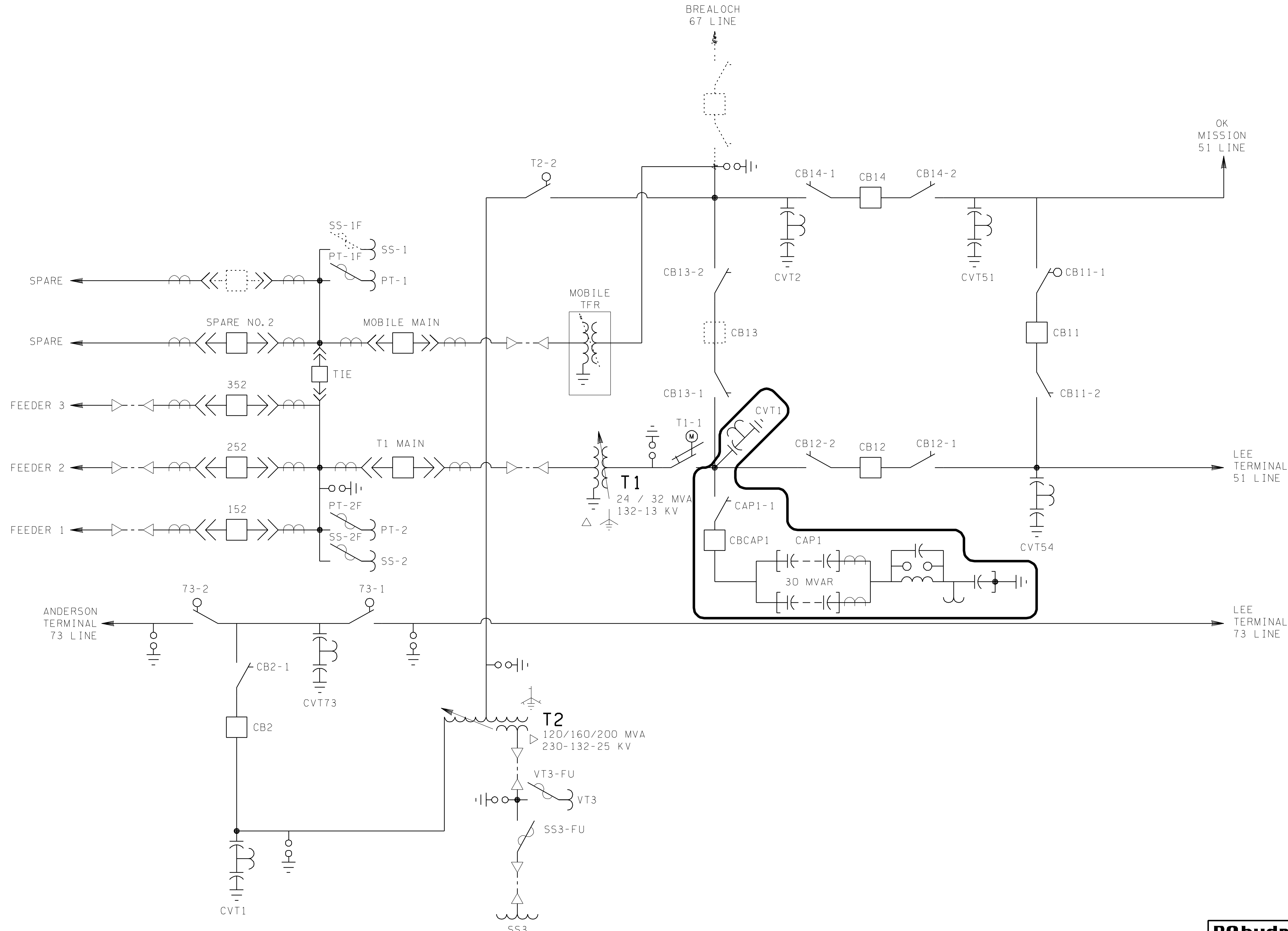
REVISIONS	REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE

DRAWN BY:
PLOT DATE:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

FORTISBC

DIVISION	OKANAGAN
DEPARTMENT	TRANSMISSION-DISTRIBUTION
LOCATION	BENTLEY SUBSTATION
TITLE	230/138/60 kV SWITCHYARD PLAN

DRAWING NUMBER	REVISION
3-385-0003	0



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	19JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

BChydro ENGINEERING

BC HYDRO DWG NO. 304M-P06-B2 R 0

D. G. BELL TERMINAL (DGB)

ONE-LINE DIAGRAM
2008 STAGE

DRAWING NUMBER	REV
3-371-SK2	0

BChydro STATION SPECIFICATION SHEET

Stations Planning

Transformers & Shunt Reactors

DGB2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	#CT	Ratio	Accuracy
	145	650	1200	40		3	12	12/8/3/200 - 5	2.5L400
CBCAP1									

Comments
IEC C2 very low restrike probability

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
CVT1	145 650	700/1200:1:1	1PWXY2PZ	3b	harmonic tap

Capacitors	max.kV	BIL	MVAR	Comments
CAP1	138	650	30.00	At 138 kV, fuseless, complete with TRV capacitors 0.125 uF, reactors at 200 kV BIL, SA rated at 60 kV, IEC 4. Neutral CTs and VTs to be defined

Miscellaneous Ratings

CAP1-1	1200 A	650 kV BIL

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

Station General Information

Transformer MVA Capacity

	Ultimate	this stage

Firm Tfr MVA Cap

Fault Levels
@ 1.05 p.u. voltage

Voltage	3 ph MVA / SLG kA Ultimate	Present

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
   -measured
   c) stn gnd fault current - this stage
   -ultimate
   d) rise in station gnd potential
   - this stage kV
   - ultimate kV
2. Alarms:
3. Station Control:

Notes :

BChydro FORTISBC

ENGINEERING - Stations Planning

D.G. BELL (DGB)OK

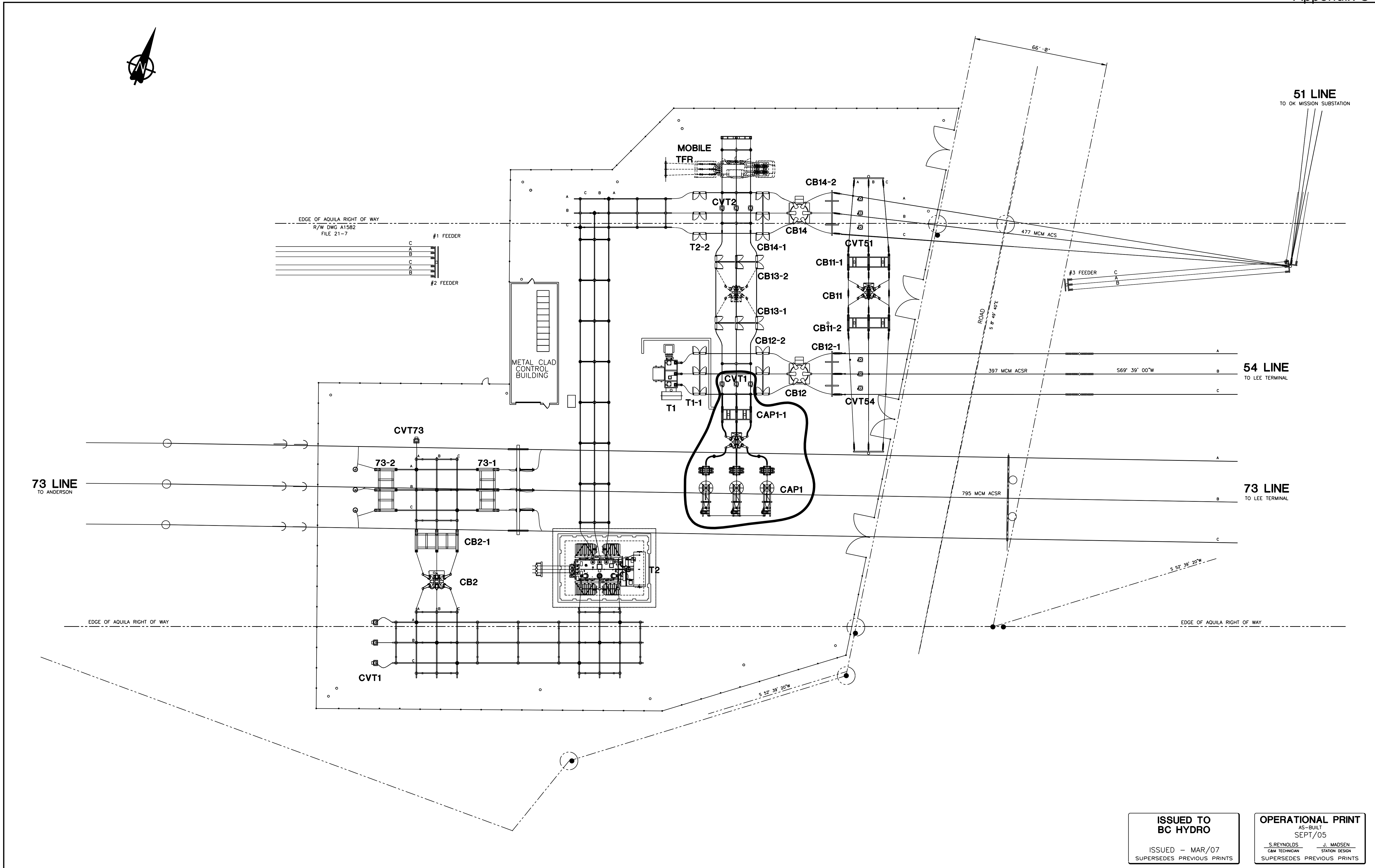
2008 Stage BC HYDRO DWG NO. 304M-P06-B2 R 0

Planning one-line

3-371-SK2

SHEET 2

Date :



REVISIONS

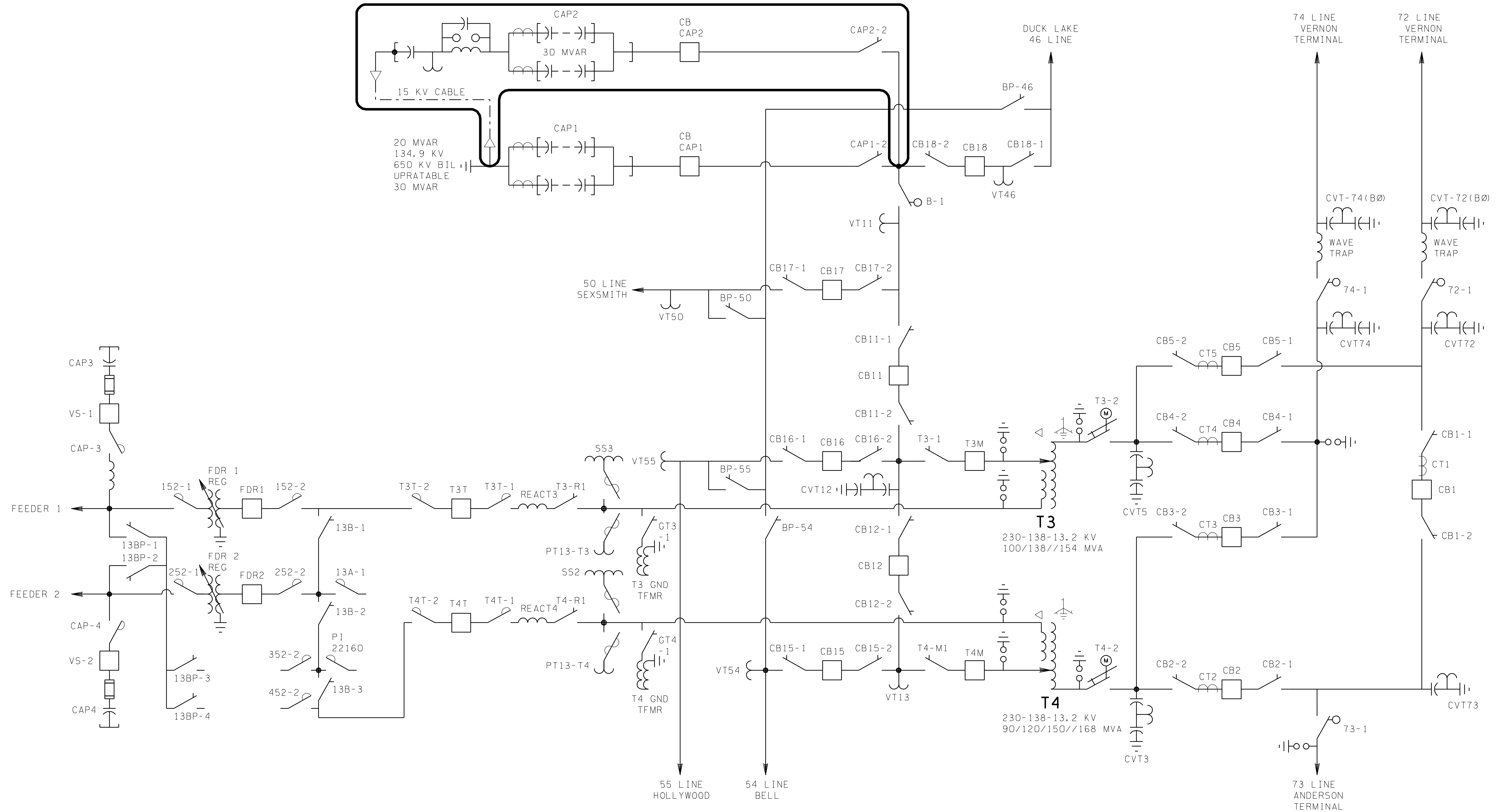
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
5	AUG/05	CV	JPM	AS BUILT		
4	JUN/04	PLZ	HJU	2004 KELOWNA CAPACITY INCREASE – ISSUED FOR APPROVAL		
3	DEC/00	PFE	KRH	FENCE REPLACEMENT		
2	SEPT/05	PFE		AS BUILT REVISIONS		

DRAWN BY: D. ST.DENIS MAR/95
PLOT DATE: 05-09-22
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: TRANSMISSION- DISTRIBUTION
LOCATION: D.G. BELL TERMINAL - KELOWNA
TITLE: SITE PLAN

SCALE: 1"=20'-0" SCALE FACTOR: 240
DRAWING NUMBER: 3-371-0003
REVISION: 6



BChydro ENGINEERING

BC HYDRO DWG NO. 309A-P06-B2 R 0

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION

DESIGNED BY BLA 19JUN07

DRAWN BY KLR

CHECKED BY

APPROVED BY

FORTISBC

F.A. LEE TERMINAL (FAL)

ONE-LINE DIAGRAM
2008 STAGE

DRAWING NUMBER	REV
3-314-SK2	0

BChydro STATION SPECIFICATION SHEET

Stations Planning

Transformers & Shunt Reactors

FAL2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
	145	650	1200	40		3	MIT	12	20/15/12/400 - 5	2.5L800
CAPCB2							Comments: IEC C2 very low restrike probability			

Capacitors	max.kV	BIL	MVAR	Comments
CAP2		550	30.00	At 138 kV, fuseless, complete with TRV capacitors 0.125 uF, reactors at 200 kV BIL, SA rated at 60 kV, IEC 4.Neutral CTs and VTs to be defined.

Miscellaneous Ratings		
CAP2-2	1200 A	650 kV BIL
neutral cable		110 kV BIL

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

Station General Information

Transformer MVA Capacity

	Ultimate	this stage

Firm Tfr MVA Cap

Fault Levels
@ 1.05 p.u. voltage

Voltage	3 ph MVA / SLG kA Ultimate	Present

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
      -measured
   c) stn gnd fault current - this stage
      -ultimate
   d) rise in station gnd potential
      - this stage kV
      - ultimate kV

2. Alarms:

3. Station Control:

Notes :

BChydro FORTISBC

ENGINEERING - Stations Planning

F.A. LEE (FAL)OK

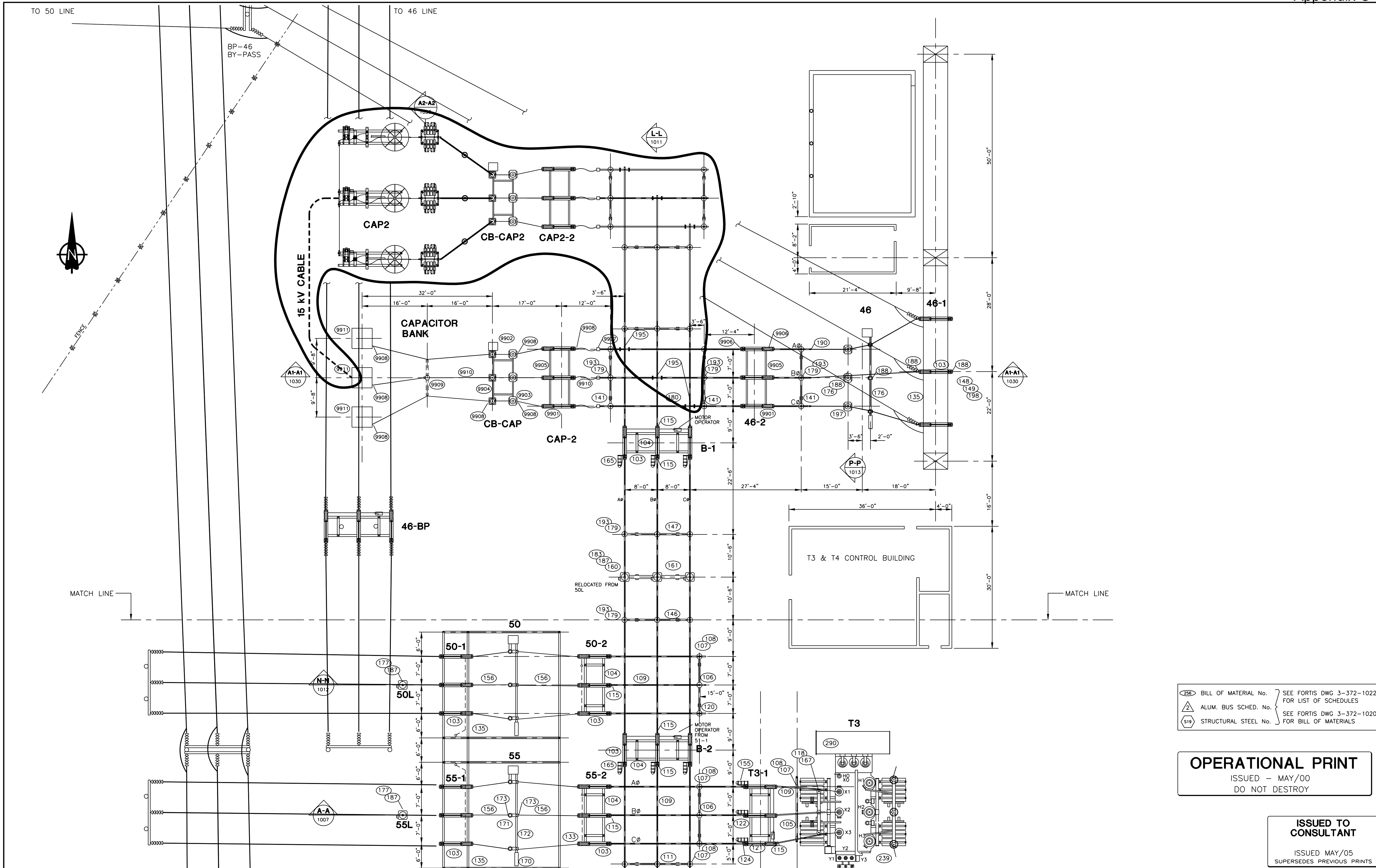
2008 Stage BC HYDRO DWG NO. 309A–P06–B2 R 0

Planning one-line

3-314-SK2

SHEET 2

Date :



(256) BILL OF MATERIAL No. / (2) ALUM. BUS SCHED. No.	SEE FORTIS DWG 3-372-1022 FOR LIST OF SCHEDULES
(S19) STRUCTURAL STEEL No.	SEE FORTIS DWG 3-372-1020 FOR BILL OF MATERIALS

OPERATIONAL PRINT
ISSUED – MAY/00
DO NOT DESTROY

ISSUED TO CONSULTANT
ISSUED MAY/05
SUPERSEDES PREVIOUS PRINTS

REVISIONS

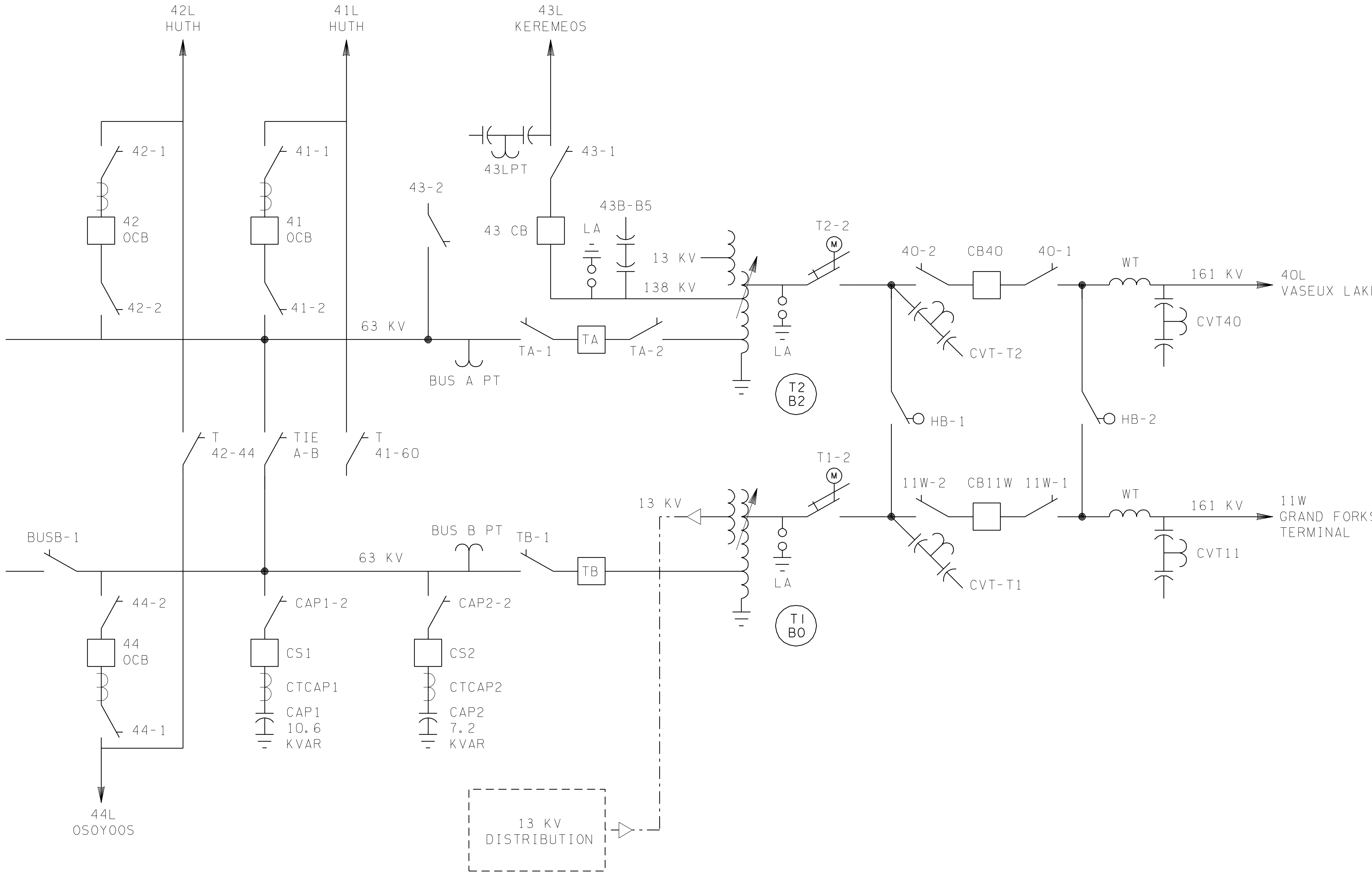
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4	MAY/00	HJU	KRH	ISSUED OPERATIONAL PRINT	K. HEDGES	MAY/00
3	SEPT/99	HJU	KRH	RELOCATED 46-2 SWITCH	K. HEDGES	JUN/99
2	JUN/99	HJU	KRH	CAPACITOR BANK ADDITION	K. HEDGES	JUN/99
5	JAN/01	PFE	KRH	RENAMED CAPACITOR SWITCH & 46/50L BYPASS	K. HEDGES	JAN/01

DRAWN BY: H.J. URSAKI NOV/95
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

FORTISBC

DIVISION	OKANAGAN
DEPARTMENT	PROTECTION-CONTROL
LOCATION	LEE TERMINAL - KELOWNA
TITLE	46 LINE RETERMINATION

SCALE: 1" = 10'-0" SCALE FACTOR: 120
DRAWING NUMBER: 3-372-1029
REVISION: 5



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

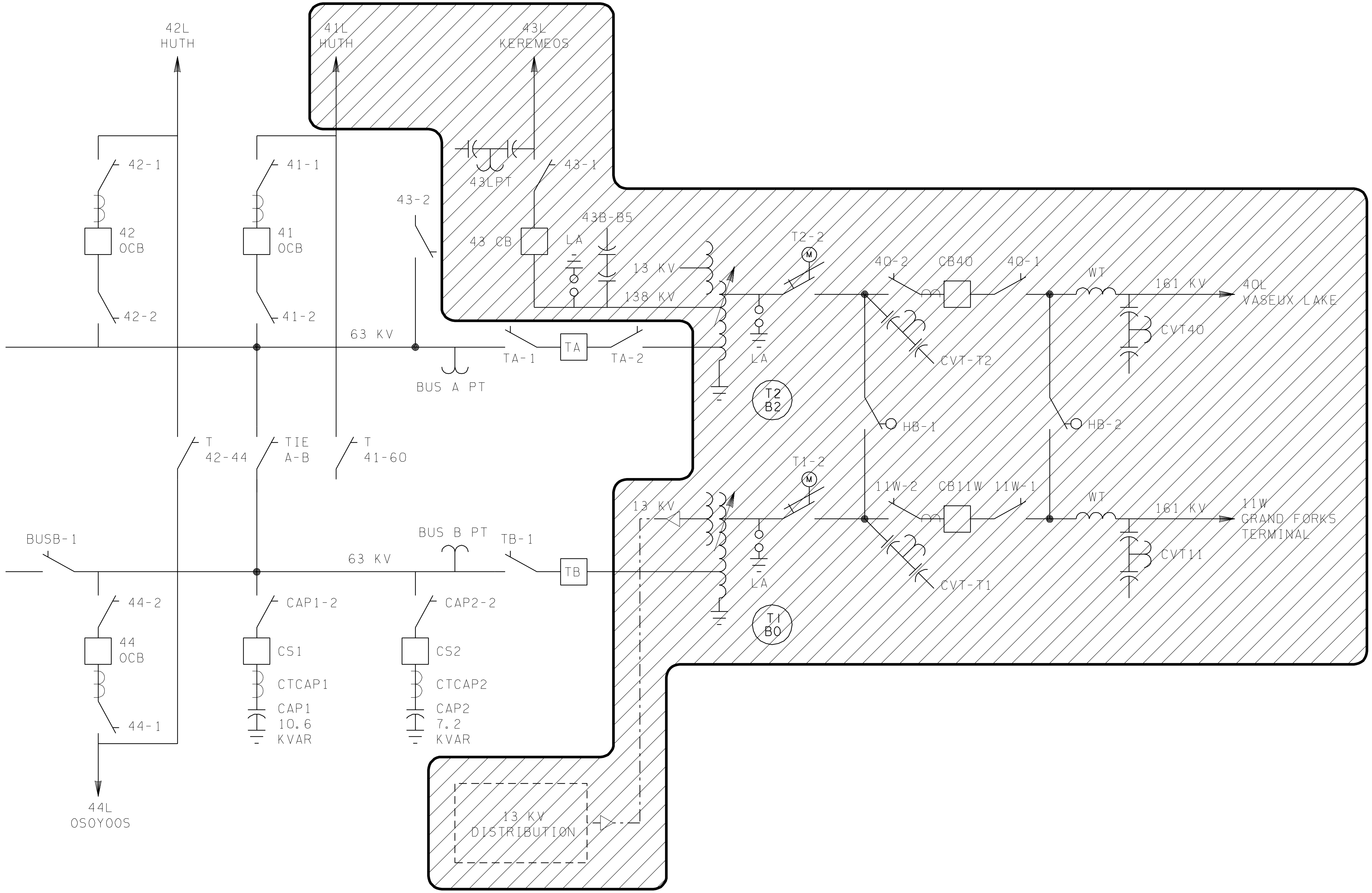
BChydro ENGINEERING

BC HYDRO DWG NO. 304H-P06-SK1 R 0

OLIVER TERMINAL (OLI)

ONE-LINE DIAGRAM
EXISTING STAGE

DRAWING NUMBER	REV
3-386-SK1	0



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

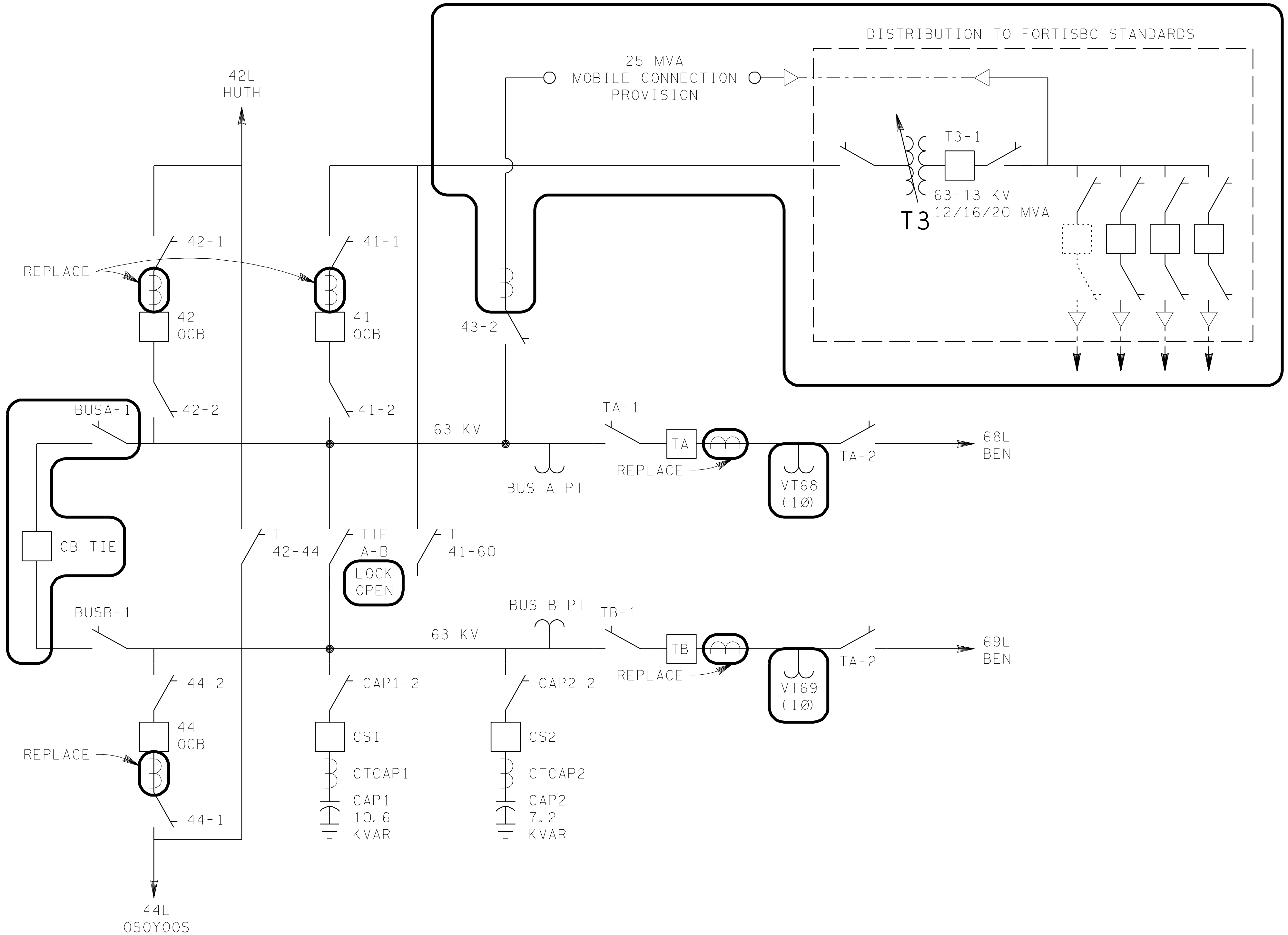
BChydro ENGINEERING

BC HYDRO DWG NO. 304H-P06-SK2 R 0

OLIVER TERMINAL (OLI)

ONE-LINE DIAGRAM
2008 STAGE REMOVALS

DRAWING NUMBER	REV
3-386-SK2	0



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

BChydro ENGINEERING

BC HYDRO DWG NO. 304H-P06-SK3 R 0

OLIVER TERMINAL (OLI)

ONE-LINE DIAGRAM
2008 STAGE

DRAWING NUMBER	REV
3-386-SK3	0

BChydro STATION SPECIFICATION SHEET

Stations Planning

OLI2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy	Comments
FDR CB 1,2	15	125				5					To FortisBC Standards
CB TIE	72.5	350	2000	12.5		3	MIT	12	20/15/12/400 - 5	2.5L800	Mitsubishi dead tank type: Dual trip coils

Current Trans	max.kV/BIL	Amps	Ratio	Accuracy	Comments
63 KV CTS	72.5 350	1,200	12/8/3/200 - 5-5-5-5	2.5L800	Six sets.

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
VT68	72.5 350	350/600:1:1	1PWXY2PZ	3b	single phase
VT69	72.5 350	350/600:1:1	1PWXY2PZ	3b	single phase

Miscellaneous Ratings

BusA-1	2000 A	350 kV BIL

Equipment Retirements and Disposition

Transformers	Voltages	Wdg	MVA	TapChanger		%Z(ONAN)	BCH	S/N
T1	161	A	45/85	LTC	+/-15%			
	63	An0	45/85					
	13	D1						

Notes : To T1 position, Grand Forks

Transformers	Voltages	Wdg	MVA	TapChanger		%Z(ONAN)	BCH	S/N
T2	161		61.5/8	LTC	+/-15%			
	132		2					
	13		61.5/8					
			2					

Notes : Scrap

CB11W 245 kV 2,500 Amps 17 kA ASA HPL
For possible re-use by FortesBC

CB40 245 kV 2,500 Amps 17 kA ASA HPL
For possible re-use by FortesBC

Current Trans	max.kV/BIL	Amps	Ratio	Accuracy	Comments
CB11W-CT	245	1,200	12000-5-5-5-5		For possible re-use by FortesBC
CB40-CT	245	1,200	1200-5-5-5-5		For possible re-use by FortesBC

VTs, CVTs	max.kV	BIL	Ratio	Accuracy	CSAgrp	Comments
CVT-T1	245		1200/2000:1:1			TRE Model : TEMP230 For possible re-use by FortesBC
CVT-T2	245		1200/2000:1:1			TRE Model : TEMP230 For possible re-use by FortesBC
CVT11W	161		800/1400:1			CGE Model : CV-2 single phase
CVT40	245		1200/2000:1:1			TRE Model : TEMP230 For possible re-use by FortesBC; single pahse

Transformers & Shunt Reactors

T3

Voltage	BIL	TapChanger		%Z (ONAN)
63	350	LTC +/-10%	12/16/20	
13	110		12/16/20	

Current Transformers CSA Type TPS Ial= 5%

Notes To FortisBC standards

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

Station General Information

Transformer MVA Capacity

Ultimate this stage

Firm Tfr MVA Cap

Fault Levels
@ 1.05 p.u. voltage

Voltage	3 ph MVA / SLG kA Ultimate	Present
63 kV	1500/16	1280/15
13 kV	250/12	240/11.5

1. Station Grounding
   - a) ground resistivity -ohm meters
   - b) stn gnd resistance -estimated
     - -measured TBD
   - c) stn gnd fault current - this stage 15 kA rms
     - -ultimate 16 kA rms
   - d) rise in station gnd potential
     - - this stage kV TBD
     - - ultimate kV <5 kV rms
2. Alarms: via supy. control
3. Station Control: automatic

Notes :
PRELIMINARY INFORMATION. NOT FOR EQUIPMENT ORDERING.
This is not a BCTC project.
Fault levels approximate. To be confirmed.

BChydro FORTISBC
ENGINEERING - Stations Planning

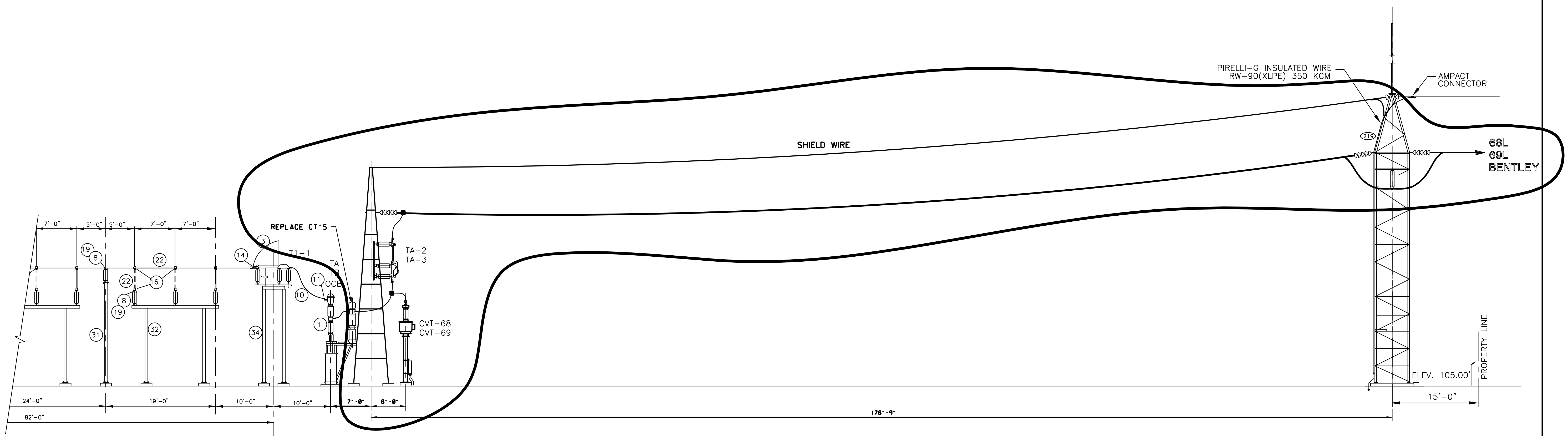
Oliver Terminal (OLI)OK

2008 Stage BC HYDRO DWG NO. 304H–P06–B1 R 0

Planning one-line

Date :

3-386-SK1
SHEET 2



SECTION A – A

OPERATIONAL PRINT
ASBUILT
ISSUED – JUN/06
R. BELANGER — C&M TECHNICIAN
D. ST.DENIS — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
6	JUN/06	ABZ	HJU	ONSITE ASBUILT		
5	SEP/05	LES		AS BUILT		
4	MAR/05	PLZ		SOK: OLIVER TERMINAL UPGRADE – ISSUED FOR CONSTRUCTION		
3	FEB/94	HJU	KRH	138 kV UPGRADE		

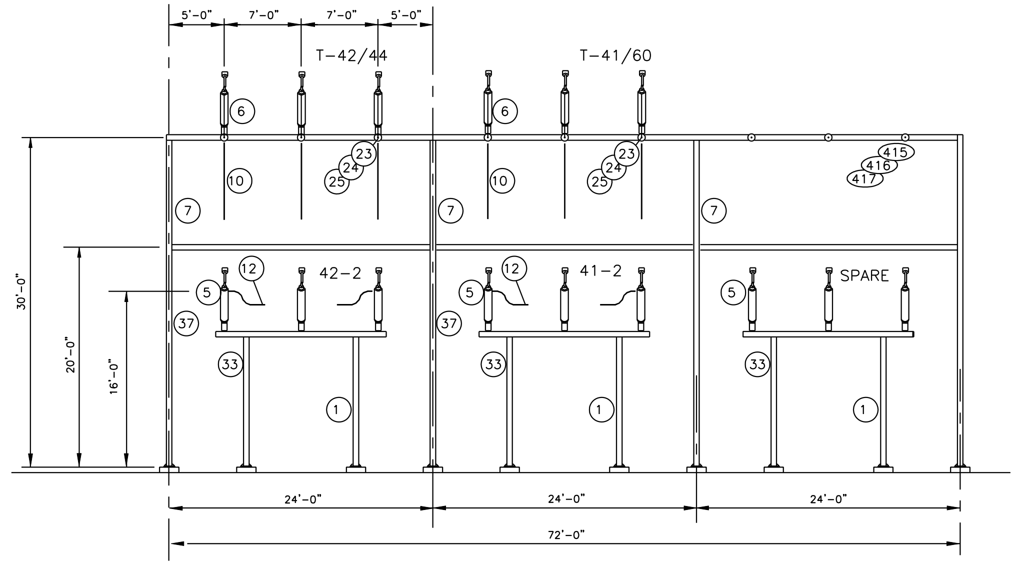
REVISIONS

DRAWN BY: H.URSAKI JAN/89
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

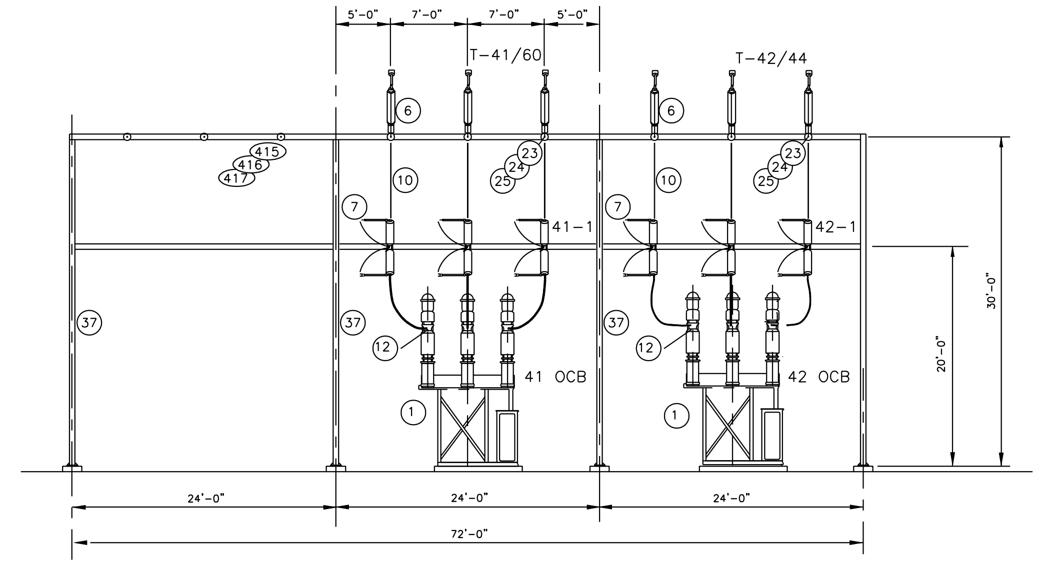
FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: TRANSMISSION - DISTRIBUTION
LOCATION: OLIVER TERMINAL
TITLE: 63kV SECTIONS 'G-G' TO 'K-K'

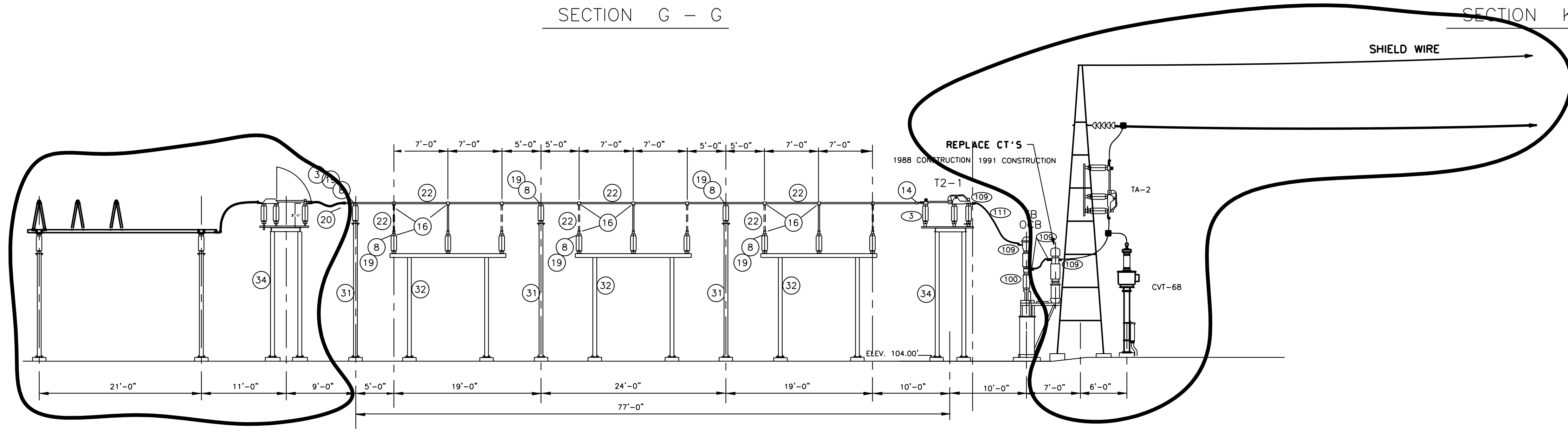
SCALE: 1/8" = 1'-0" SCALE FACTOR: 96
DRAWING NUMBER: 3-386-NEW
REVISION: 6



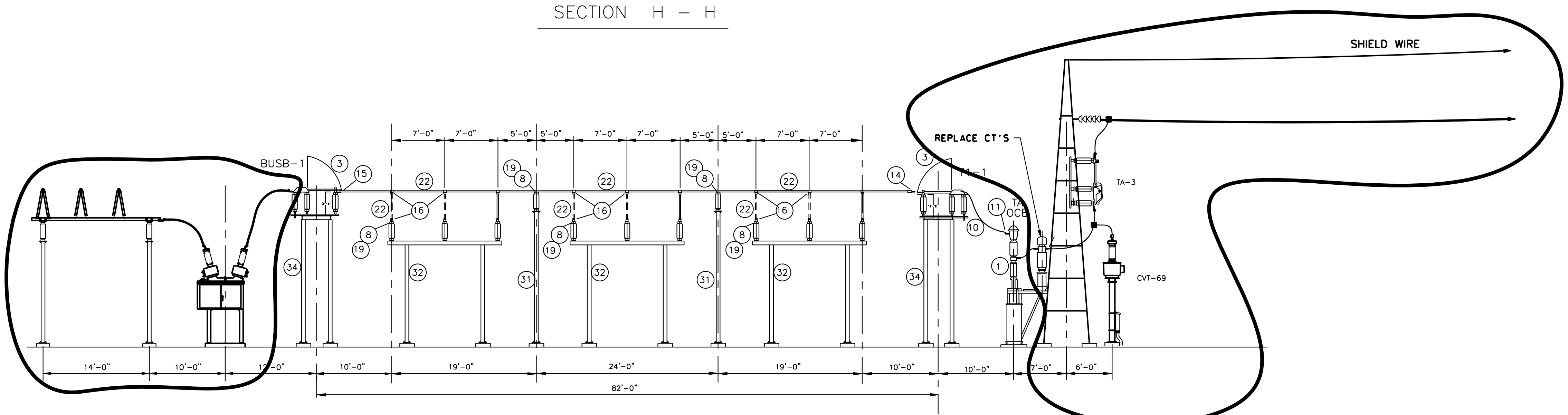
SECTION G – G



SECTION K – K



SECTION H – H



SECTION J – J

OPERATIONAL PRINT
ASBUILT
ISSUED – JUN/06
R. BELANGER — C&M TECHNICIAN
D. ST.DENIS — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
6	JUN/06	ABZ	HJU	ONSITE ASBUILT		
5	SEP/05	LES		AS BUILT		
4	MAR/05	PLZ		SOK: OLIVER TERMINAL UPGRADE – ISSUED FOR CONSTRUCTION		
3	FEB/94	HJU	KRH	138 kV UPGRADE		

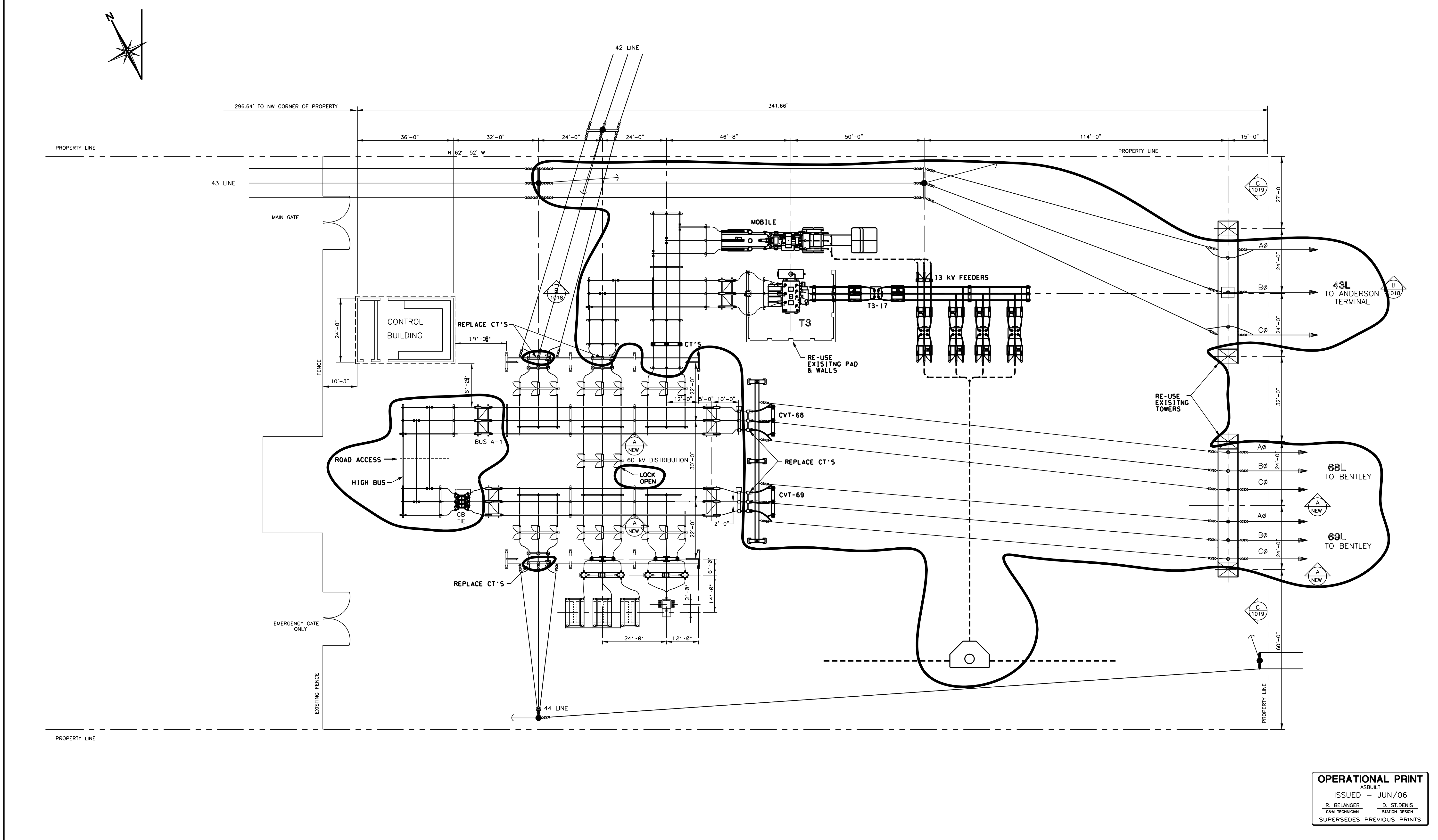
REVISIONS

DRAWN BY: H.URSAKI JAN/89
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: TRANSMISSION - DISTRIBUTION
LOCATION: OLIVER TERMINAL
TITLE: 63kV SECTIONS 'G-G' TO 'K-K'

SCALE: 1/8" = 1'-0" SCALE FACTOR: 96
DRAWING NUMBER: 3-386-1015
REVISION: 6



REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4	NOVE/93	DFS	KRH	43 LINE 138kV CONVERSION		
7	JUN/06	ABZ	HJU	ONSITE ASBUILT		
6	SEP/05	LES		AS BUILT		
5	MAR/05	PLZ		SOK: OLVER TERMINAL UPGRADE – ISSUED FOR CONSTRUCTION		

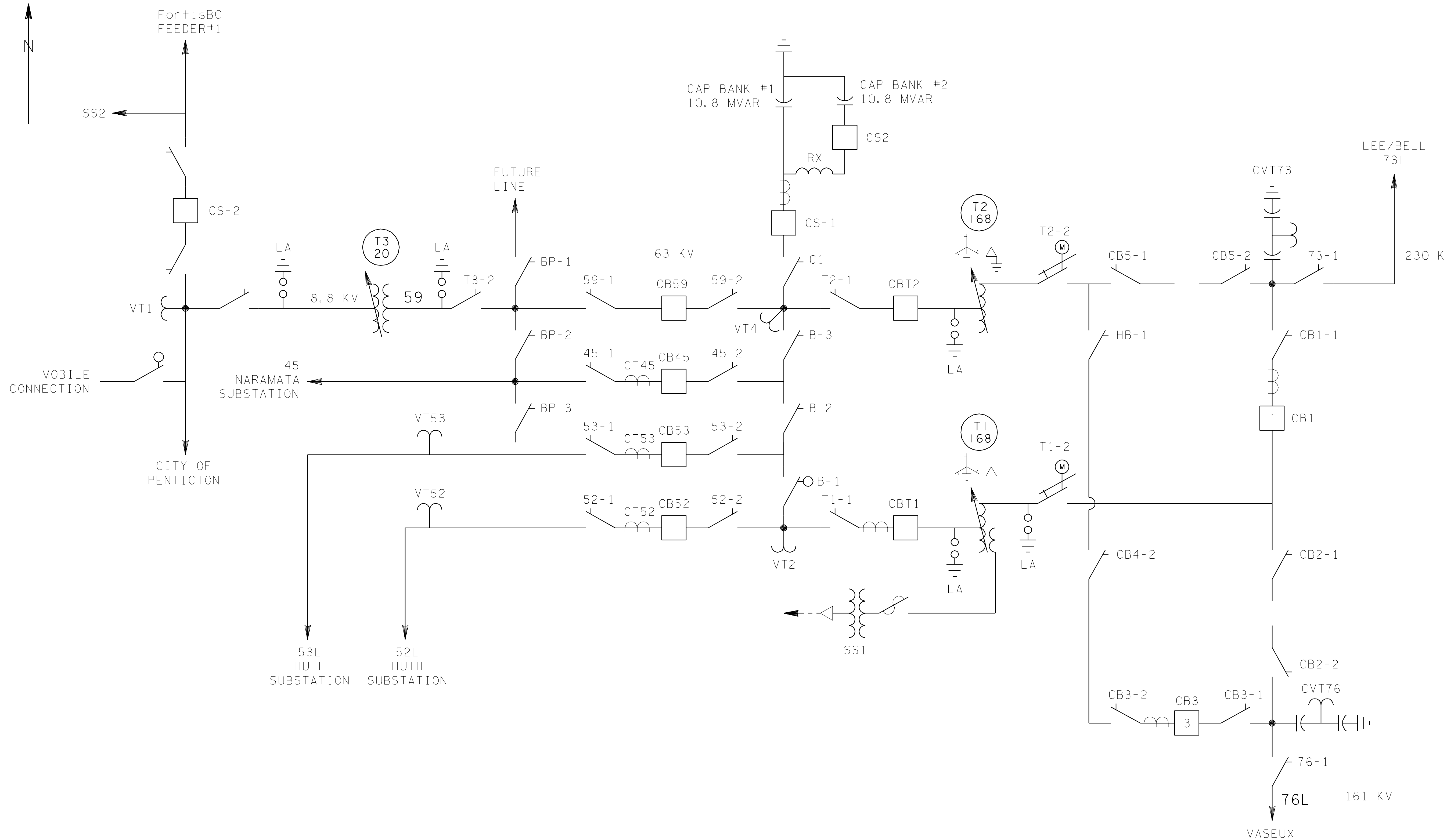
DRAWN BY: H. URSAKI JULY/90
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

FORTISBC

DIVISION	OKANAGAN
DEPARTMENT	TRANSMISSION – DISTRIBUTION
LOCATION	OLIVER TERMINAL
TITLE	TERMINAL GENERAL ARRANGEMENT

SCALE: 1/16" = 1'-0" SCALE FACTOR: 192

DRAWING NUMBER: 3-386-1017
REVISION: 7



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION

DESIGNED BY	BLA	18JUN07
DRAWN BY	KLR	
CHECKED BY		
APPROVED BY		

FORTISBC

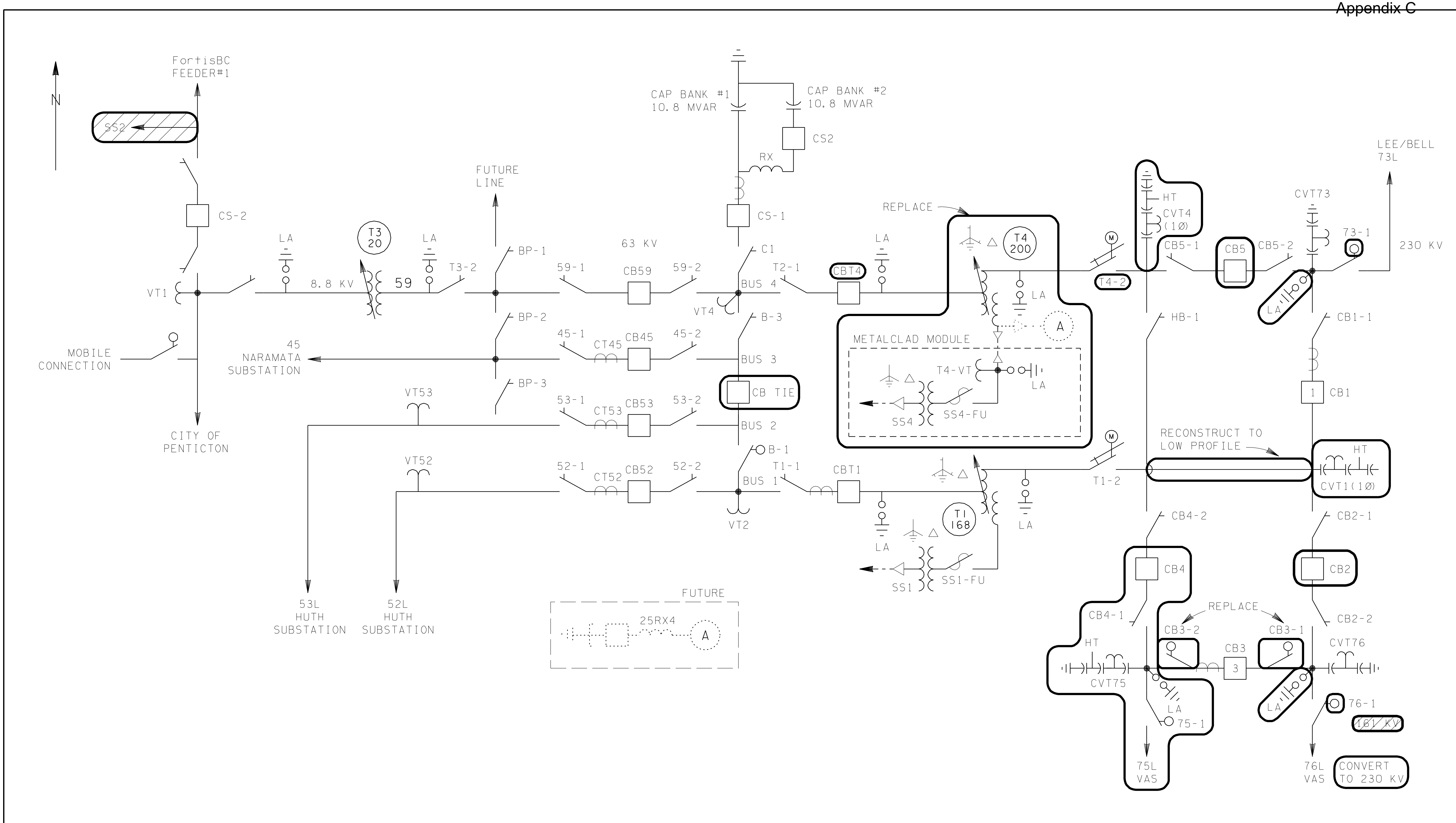
BChydro ENGINEERING

BC HYDRO DWG NO. 304K-P06-SK1 R 0

RG ANDERSON TERMINAL (RGA)

ONE-LINE DIAGRAM
EXISTING STAGE

DRAWING NUMBER	REV
3-380-SK1	0



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

BChydro ENGINEERING

BC HYDRO DWG NO. 304K-P06-SK3 R 0

RG ANDERSON TERMINAL (RGA)

ONE-LINE DIAGRAM
2008 STAGE

DRAWING NUMBER	REV
3-380-SK3	0

2007, June 19

BChydro STATION SPECIFICATION SHEET

Stations Planning

RGA2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	#CT	Ratio	Accuracy
	72.5	350	2000	40		3	12	20/15/12/400 - 5	2.5L800
CB TIE									

Comments
Mitsubishi dead tank

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
	253	900	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800
CB2										
CB4										
CB5										

Comments
Mitsubishi model 200-SFMT-40: Dual trip coils

Surge Arresters	rtd. KV	Type	Man	Comments
230KV LINE	228	IEC 4		
230KV TFR	192	IEC 3		
25KV TERT	36	IEC 2		
63KV TFR	60	IEC 2		

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
CVT1	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement. 1 phase
CVT4	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement. 1 phase
CVT75	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement.
T2-VT	27.5 150	200:1	1PWXY2PZ	2	

Miscellaneous Ratings

75-1	230 kV	2000 A	900 kV BIL	motor operated
CB3-1	230 kV	2000 A	900 kV BIL	motor operated
CB3-2	230 kV	2000 A	900 kV BIL	motor operated
CB4-1	230 kV	2000 A	900 kV BIL	
SS-T4	DYn1	kva TBD	150 kV BIL	25.2+/-2x2.5% - 120/208 V
SS4-FU				rating to be determined

Equipment Retirements and Disposition

Transformers	Voltages	Wdg	MVA	TapChanger		%Z(ONAN)	Man	BCH	S/N
T2	225 63 8.8		90/120/150/168 90/120/150/168 buried	LTC	+/-12%	ZHL: 5.44	CGE		289415

Notes : Reconnectible 225/161 kV. Transfer to Bentley Terminal T1 position

To Be Scrapped

CB3-1	scrap
CB3-2	scrap

Transformers & Shunt Reactors

T2

Voltage	BIL	TapChanger		%Z (ONAN)	
236	1050	LTC +/-10%	120/160/200	ZHL	7.50
69	350		120/160/200	ZHT	15.00
25.2	150		40/40/40	ZLT	6.10

Current Transformers — CSA Type TPS — Ial= 5%

HV	Outer	12/8/3/200 - 5	2.5L400
	Mid-Outer	12/8/3/200 - 5	2.5L400
	Mid-Inner	20/15/12/400 - 5	2.5L800
	Inner	20/15/12/400 - 5	2.5L800
LV	Outer	20/15/12/400 - 5	2.5L800
	Mid-Outer	20/15/12/400 - 5	2.5L800
	Mid-Inner	20/15/12/400 - 5	2.5L800
	Inner	20/15/12/400 - 5	2.5L800
LV	Neutral Outer	20/15/12/400 - 5	2.5L800
LV	Neutral Inner	20/15/12/400 - 5	2.5L800
TV	Outer and Middle	30/25/22/1000 - 5	2.5L800
TV	Inner	12/8/3/200 - 5	2.5L400

Notes Impedances to tertiary approximate. CTs and other details to be defined separately.

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

Station General Information

Transformer MVA Capacity

		Ultimate	this stage
	230/63	2 x 200	1x169 1x200
Firm Tfr MVA Cap	230/63	1 x 168	1 x 168

Fault Levels
@ 1.05 p.u. voltage

3 ph MVA / SLG kA

Voltage	Ultimate	Present
230	5000/15	TBD
63	2000/20	TBD
25	800/-	TBD
14	800/-	TBD

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
   -measured TBD
   c) stn gnd fault current - this stage 15.5 kA rms
   -ultimate 20 kA rms
   d) rise in station gnd potential
   - this stage kV TBD
   - ultimate kV <5 kV rms
2. Alarms: via supy. control
3. Station Control: supervisory

Notes :
PRELIMINARY INFORMATION. NOT FOR EQUIPMENT ORDERING.
This is not a BCTC project.

BChydro FORTISBC
ENGINEERING - Stations Planning

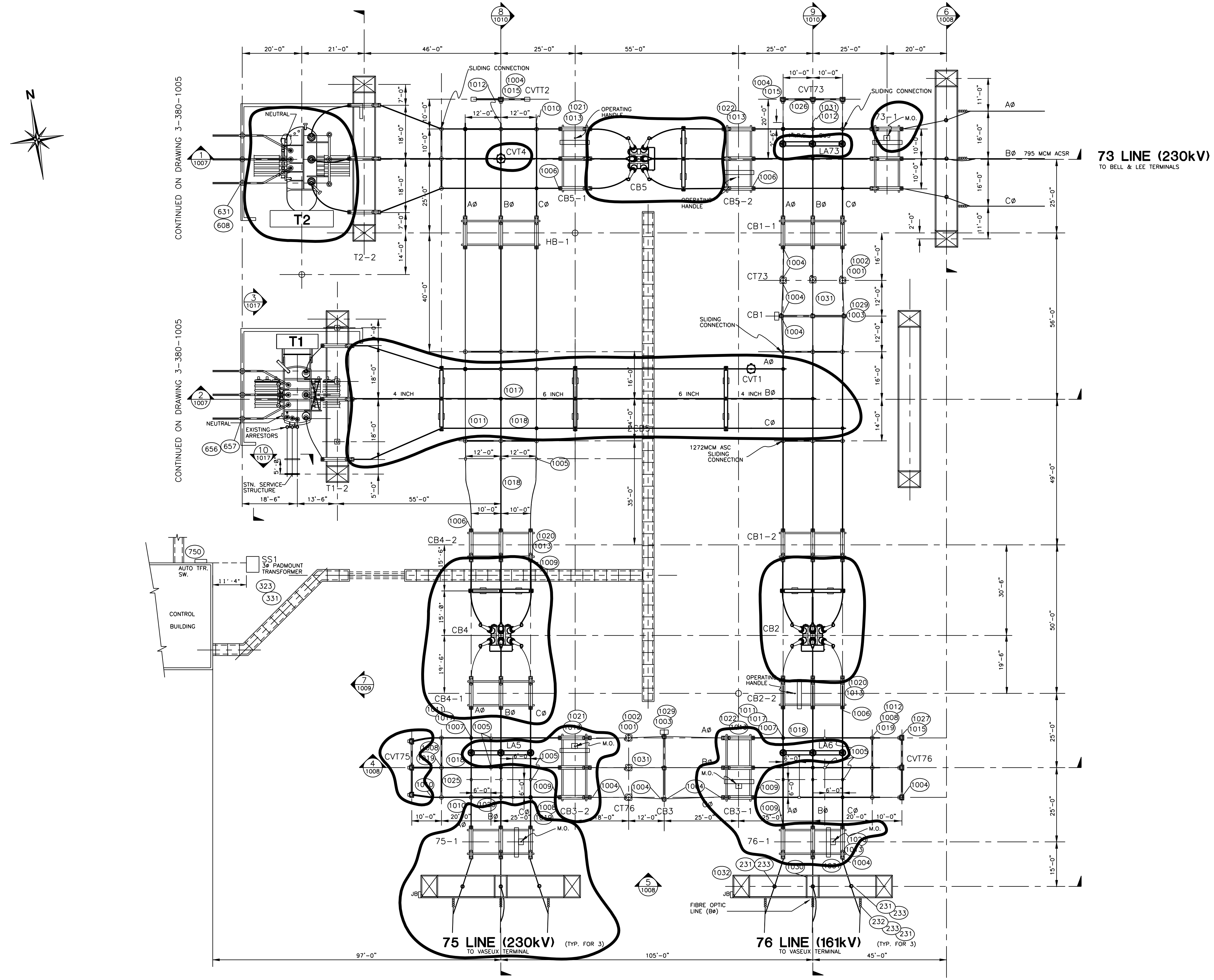
R G ANDERSON (RGA)OK

2008 Stage BC HYDRO DWG NO. 304K–P06–B1 R 0

Planning one-line

3-380-SK1
SHEET 2

Date :



OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4	JUN/06	LES	HJU	ONSITE AS-BUILT		
3	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 380-1012 REV.2(ASBUILT)	C. KLASHINSKY	NOV/04
2	APR/03	PFE	HJU	RENAMED 76 LINE TO 40 LINE		
1	APR/93	HJU	KRH	OLD DRAWING OBSOLETE, ADDED 93 CONSTRUCTION PLAN		

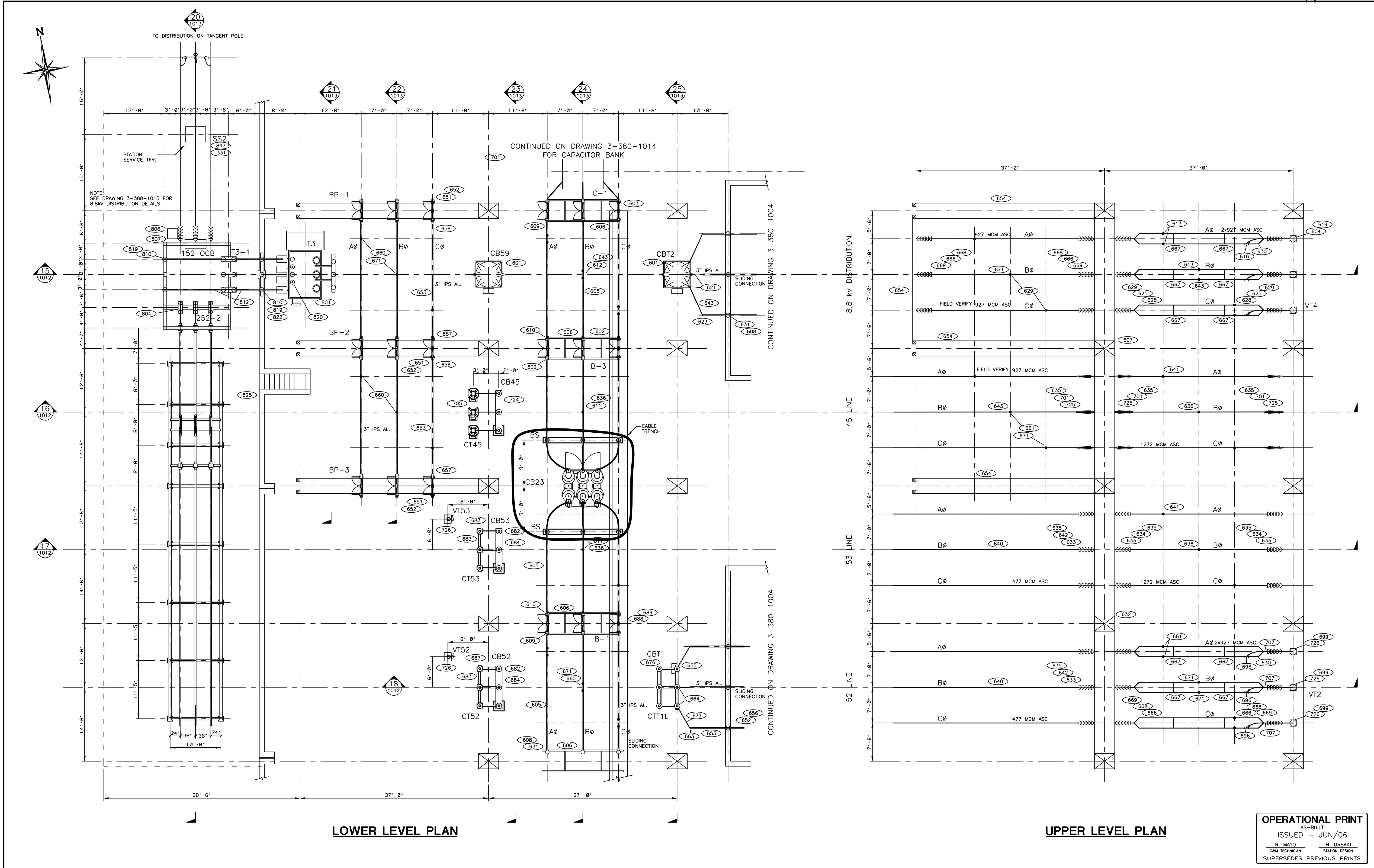
REVISIONS

DRAWN BY: H. URSAKI — APR/93
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: TRANSMISSION-DISTRIBUTION
LOCATION: ANDERSON TERMINAL - PENTICTON
TITLE: 230kV GENERAL ARRANGEMENT

SCALE: 1/16" – 1'-0" SCALE FACTOR: 192
DRAWING NUMBER: 3-380-1004
REVISION: 4



OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REVISIONS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
5	JUL/03	PFE	HJU	REDRAWN TO CAD		
4	JUL/00	PFE	KRH	ADDED PENTICTON STEEL		
7	JUN/06	LES	HJU	ONSITE AS BUILT		
6	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1006 REV.5 (ASBUILT)	C. KLASHINSKY	NOV/04

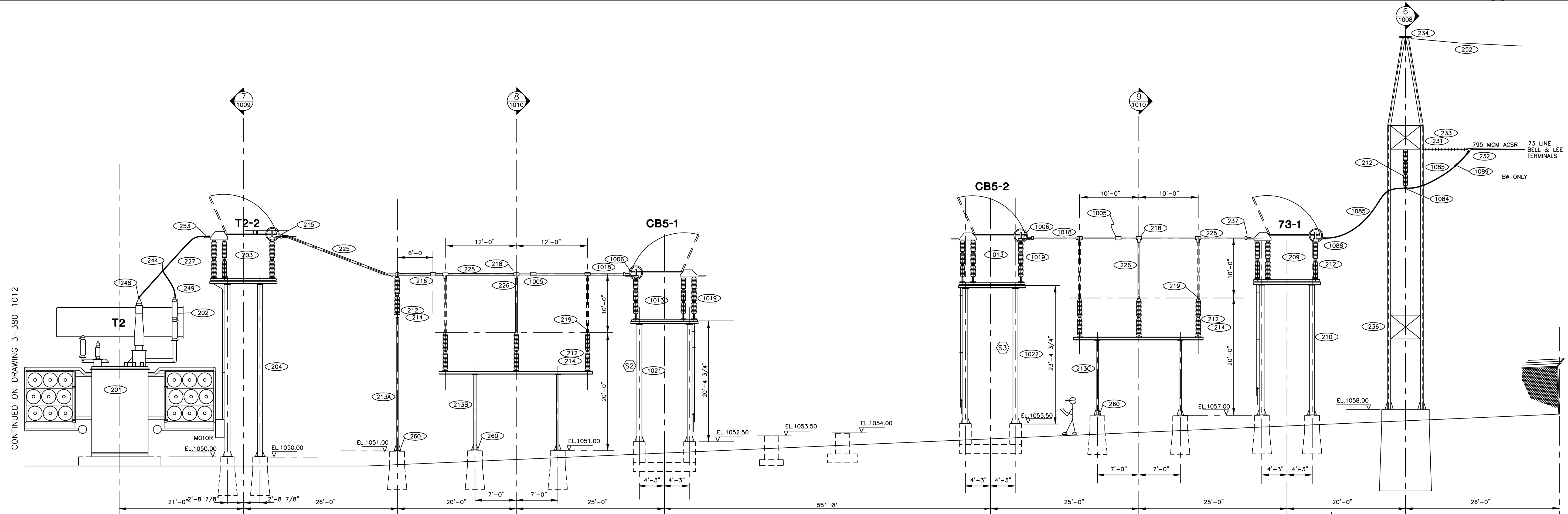
DRAWN BY: P.F. EDWARDS	JUL/03	
DESIGNED BY:		
CHECKED BY:		
APPROVALS: ELEC	CIVIL	MANAGEMENT

FORTISBC

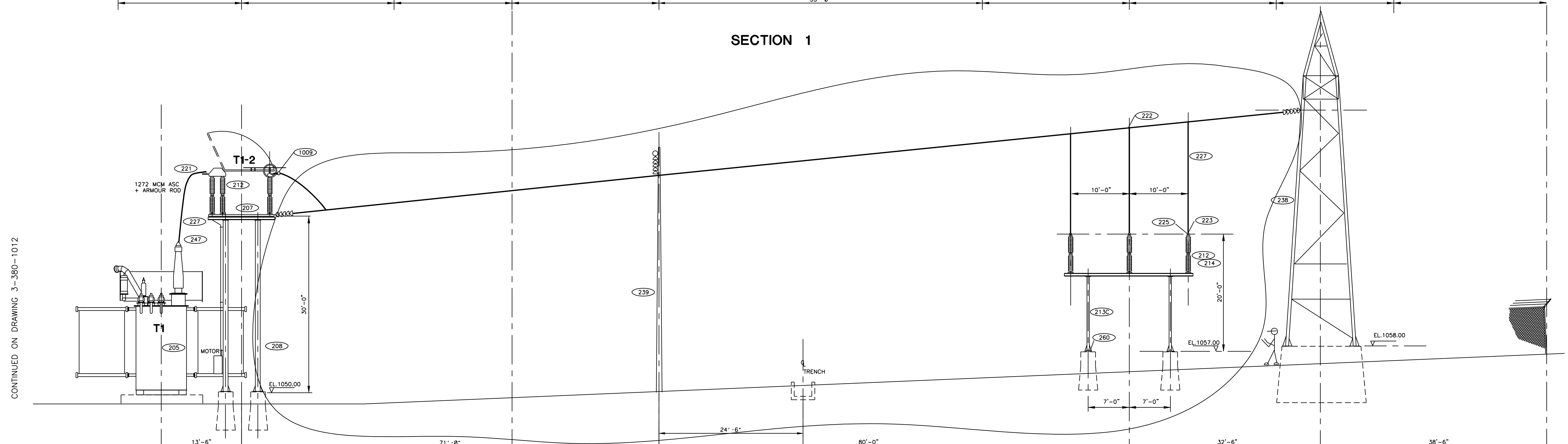
DIVISION	OKANAGAN
DEPARTMENT	PROTECTION-CONTROL
LOCATION	ANDERSON TERMINAL - PENTICTON
TITLE	63kV/8.8kV GENERAL ARRANGEMENTS

SCALE: 1/8" = 1'-0" SCALE FACTOR: 96

DRAWING NUMBER	REVISION
3-380-1005	7



SECTION 1



SECTION 2

OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4						
3						
2	JUN/06	LES	HJU	ONSITE AS BUILT		
1	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1013 REV.0 (ASBUILT)	C. KLASHINSKY	NOV/04

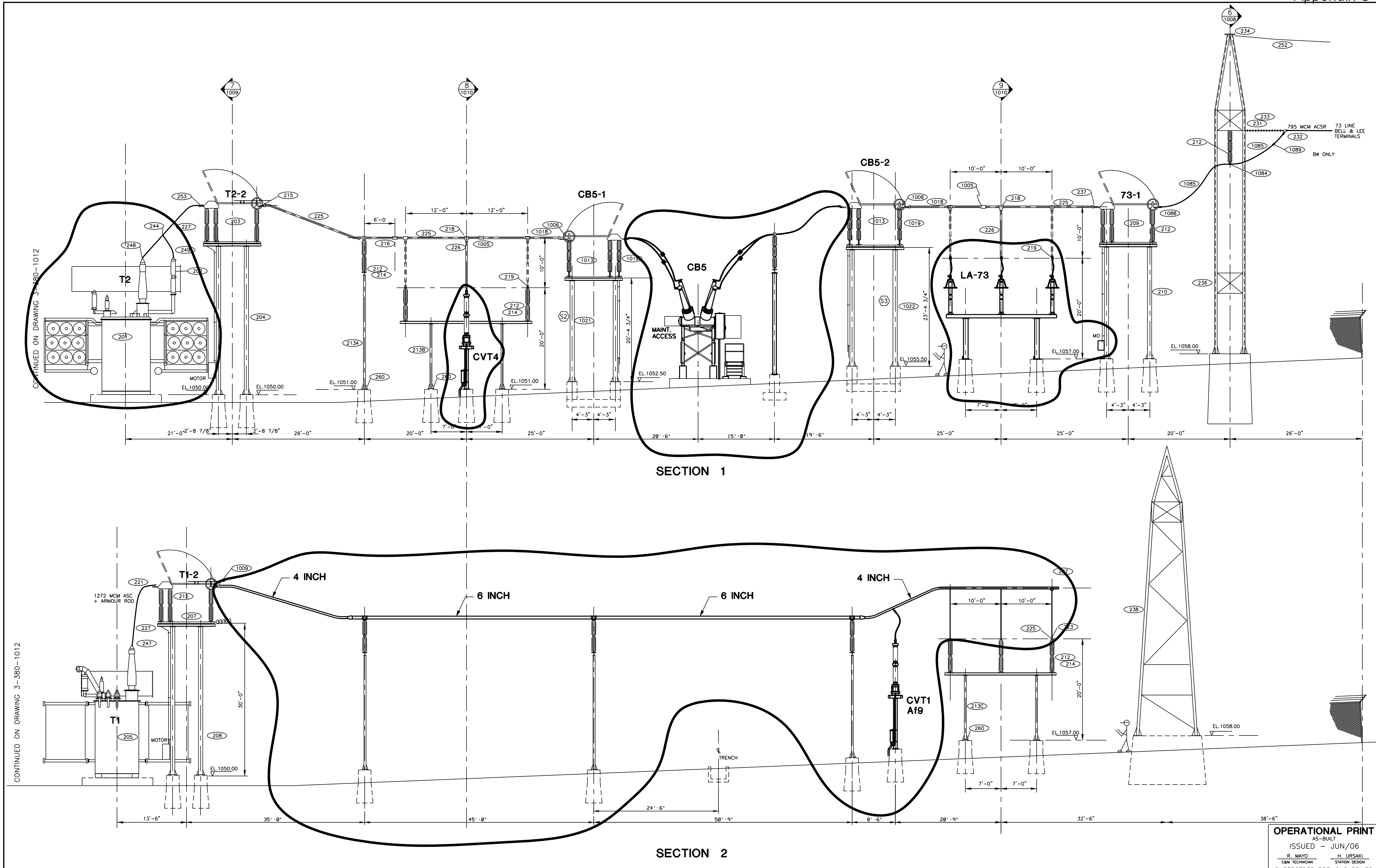
REVISIONS

DRAWN BY: H. URSAKI — JAN/93
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: PROTECTION-CONTROL
LOCATION: ANDERSON TERMINAL - PENTICTON
TITLE: 230kV SECTIONS SHEET 1 OF 4

SCALE: 1/8" = 1'0" — SCALE FACTOR: 96
DRAWING NUMBER: 3-380-1007
REVISION: 2



REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4						
3						
2	JUN/06	LES	HJU	ONSITE AS BUILT		
1	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1013 REV.0 (ASBUILT)	C. KLASHINSKY	NOV/04

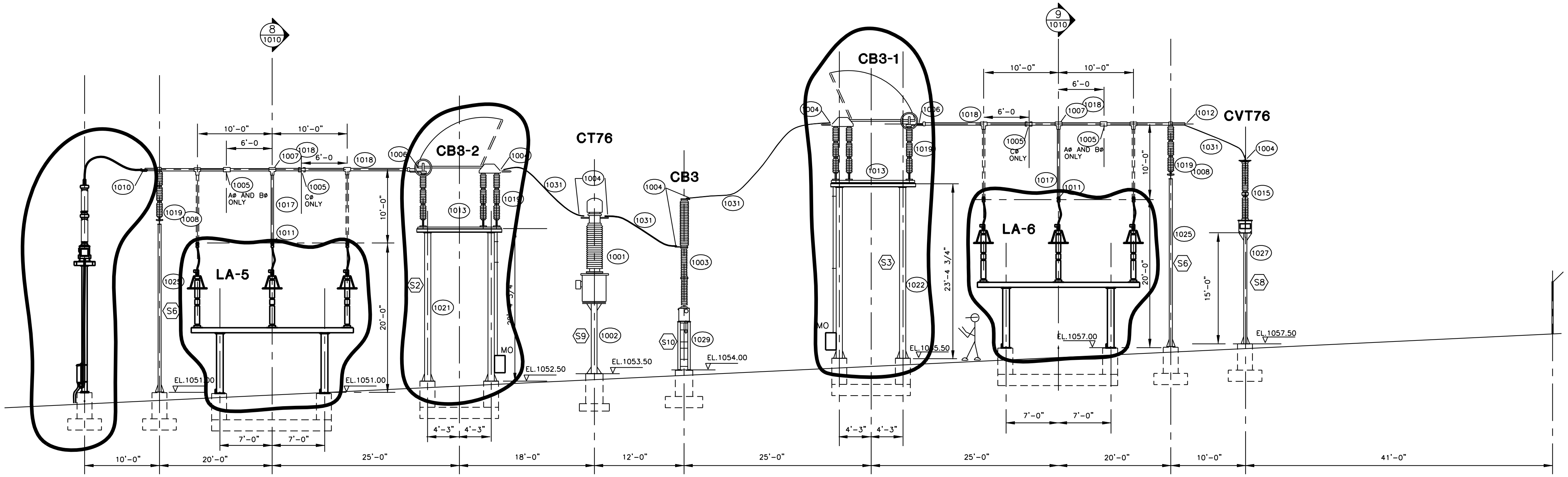
REVISIONS

DRAWN BY: H. URSAKI JAN/93
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC | CIVIL | MANAGEMENT

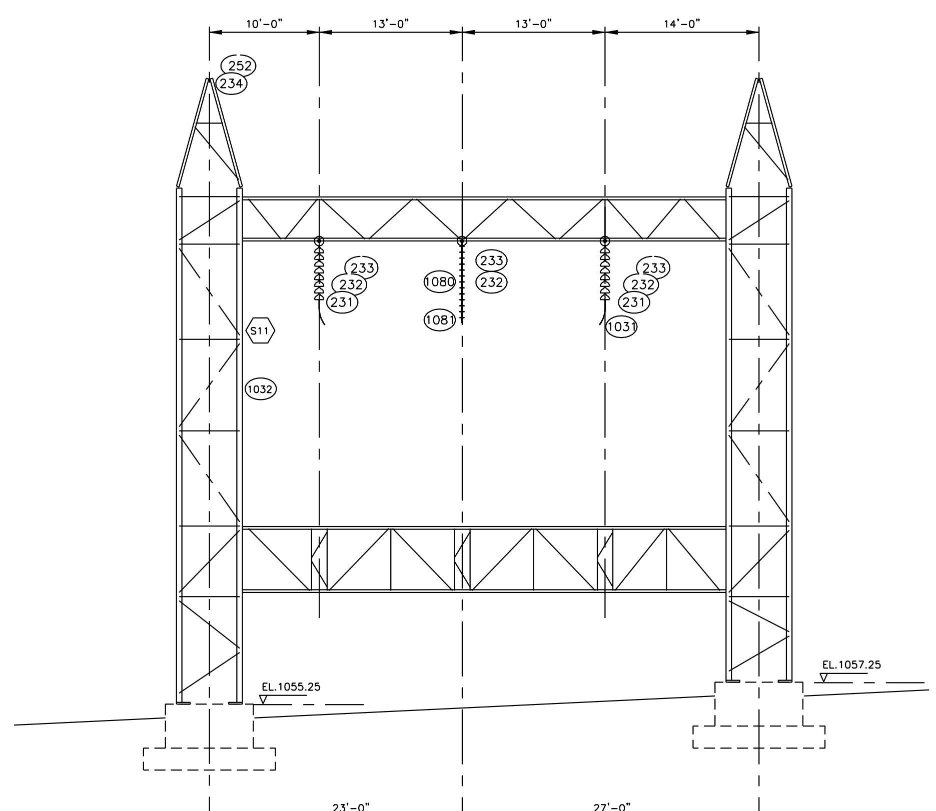
FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: PROTECTION-CONTROL
LOCATION: ANDERSON TERMINAL - PENTICTON
TITLE: 230kV SECTIONS SHEET 1 OF 4

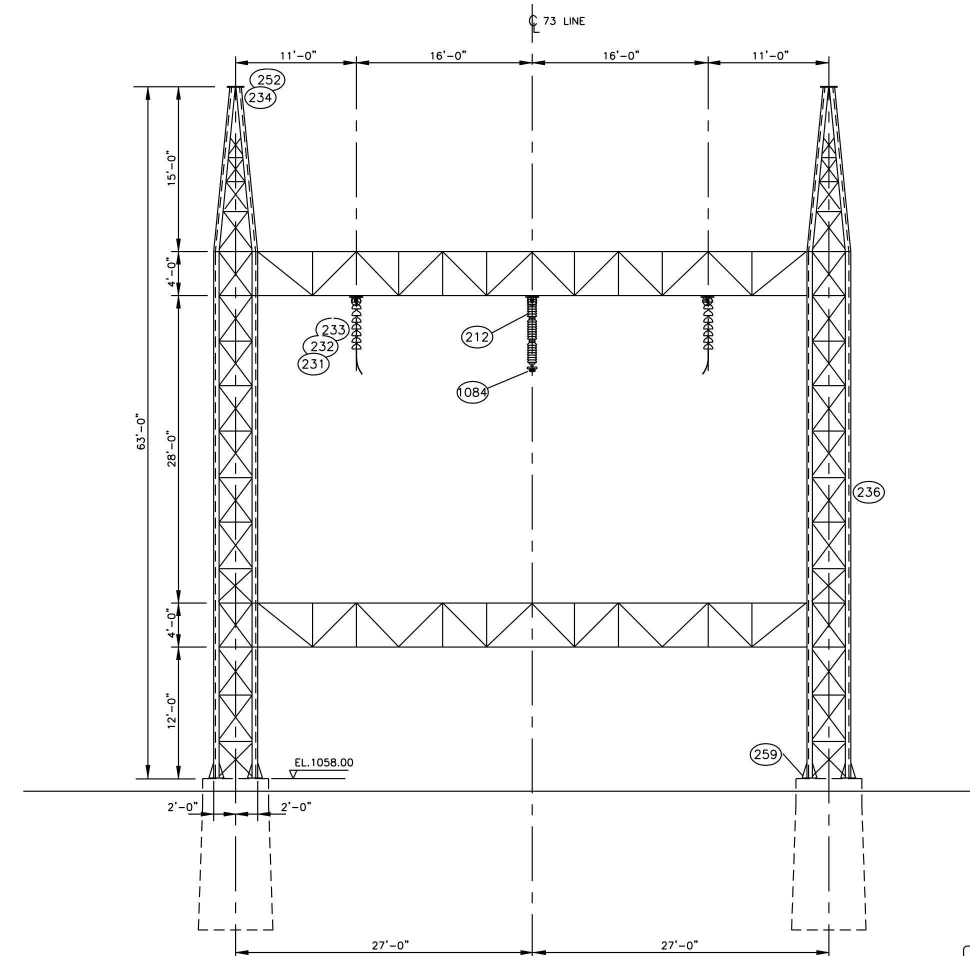
SCALE: 1/8" = 1'0" SCALE FACTOR: 96
DRAWING NUMBER: 3-380-1007
REVISION: 2



SECTION 4



SECTION 5
76 LINE TOWER (161kV)



SECTION 6
73 LINE TOWER (230kV)

OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4						
3						
2	JUN/06	LES	HJU	ONSITE AS BUILT		
1	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1015 R0 (ASBUILT)	C. KLASHINSKY	NOV/04

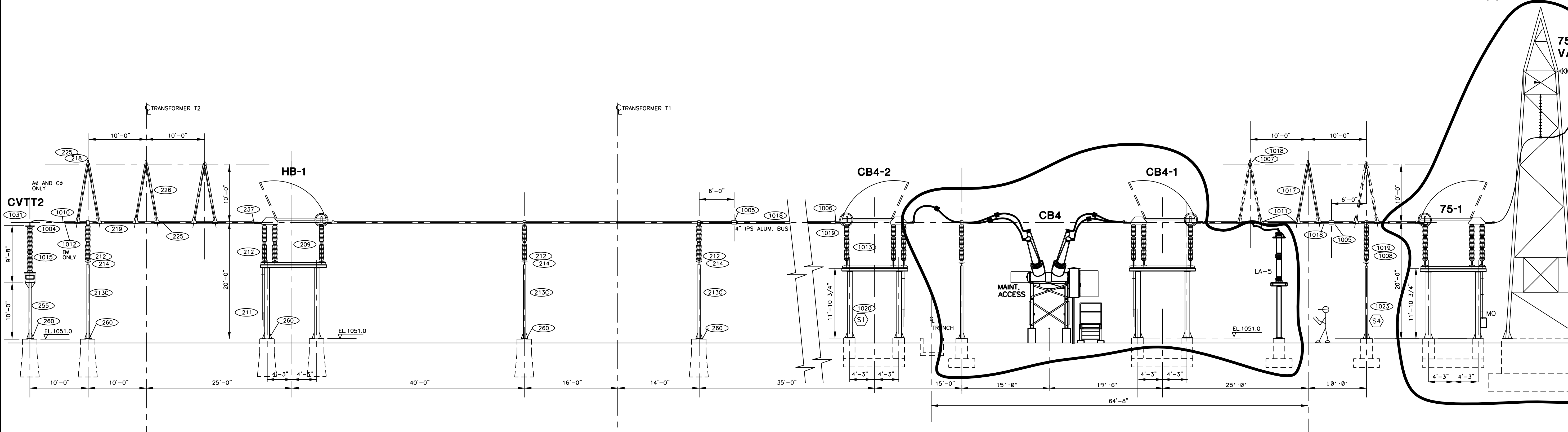
REVISIONS

DRAWN BY: H. URSAKI JAN/93
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

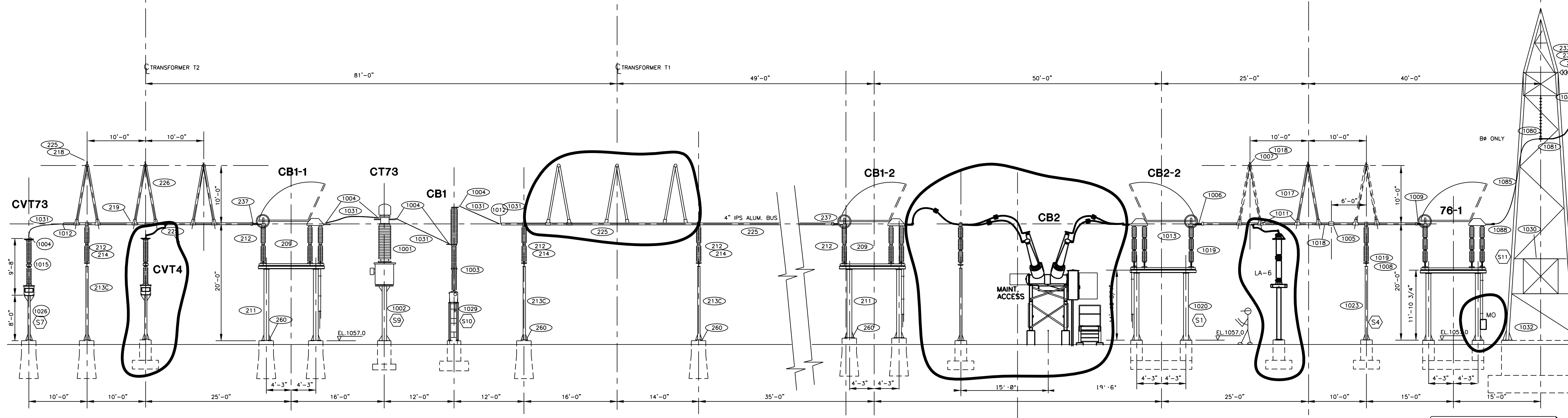
FORTISBC

DIVISION	OKANAGAN
DEPARTMENT	PROTECTION-CONTROL
LOCATION	ANDERSON TERMINAL - PENTICTON
TITLE	230KV SECTIONS - SHEET 2 OF 4

SCALE: 1/8" = 1'0" SCALE FACTOR: 96
DRAWING NUMBER: 3-380-1008
REVISION: 2



SECTION 8



SECTION 9

OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
4						
3						
2	JUN/06	LES	HJU	ONSITE AS BUILT		
1	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1014 R0 (ASBUILT)	C. KLASHINSKY	NOV/04

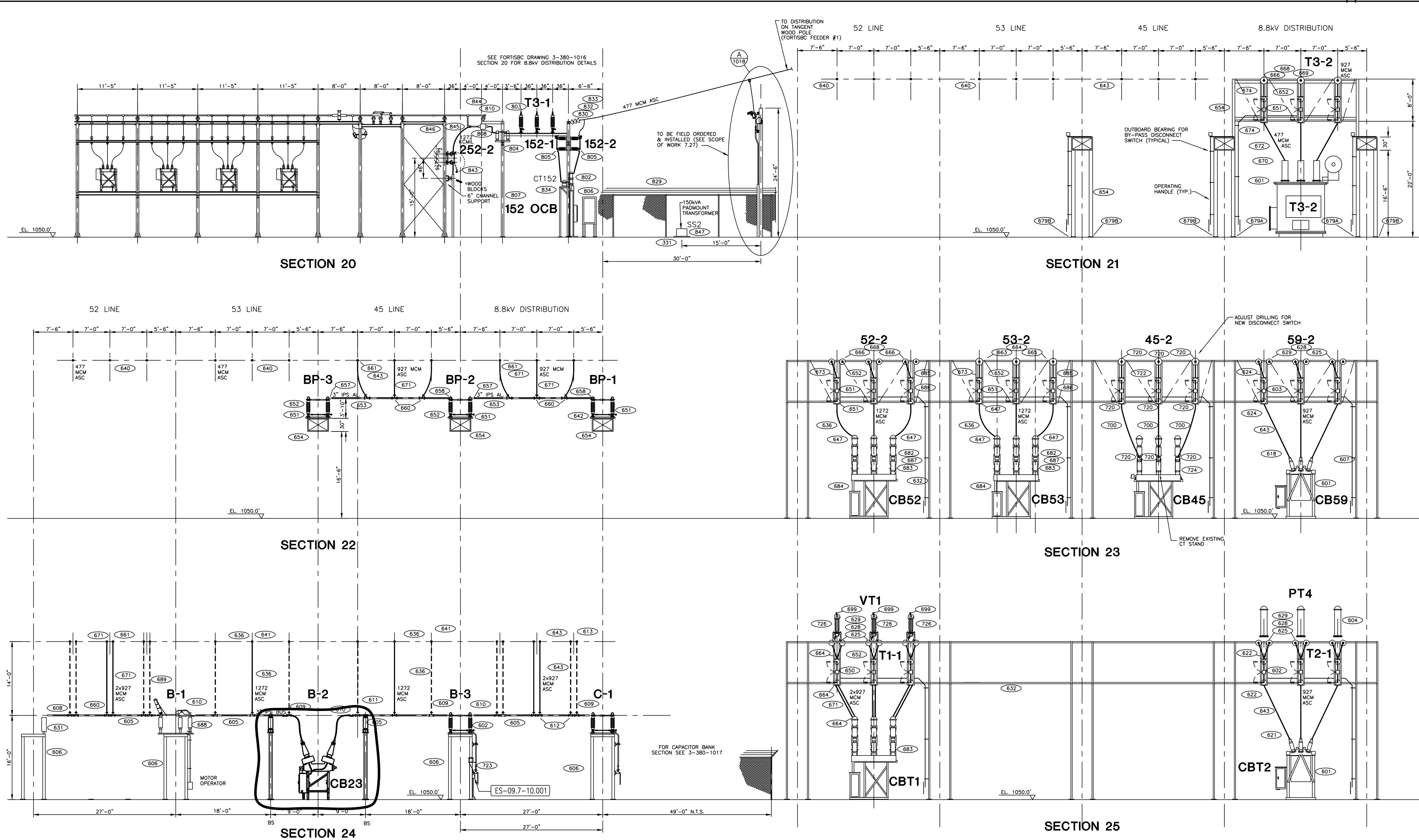
REVISIONS

DRAWN BY: H. URSAKI	JAN/93	
DESIGNED BY:		
CHECKED BY:		
APPROVALS		
ELEC	CIVIL	MANAGEMENT

DIVISION	OKANAGAN
DEPARTMENT	TRANSMISSION-DISTRIBUTION
LOCATION	ANDERSON TERMINAL - PENTICTON
TITLE	230kV SECTIONS SHEET 4 OF 4

SCALE: 1/8" = 1'-0" SCALE FACTOR: 96

DRAWING NUMBER	REVISION
3-380-1010	2



OPERATIONAL PRINT
AS-BUILT
ISSUED – JUN/06
R. MAYO — C&M TECHNICIAN
H. URSAKI — STATION DESIGN
SUPERSEDES PREVIOUS PRINTS

REVISIONS

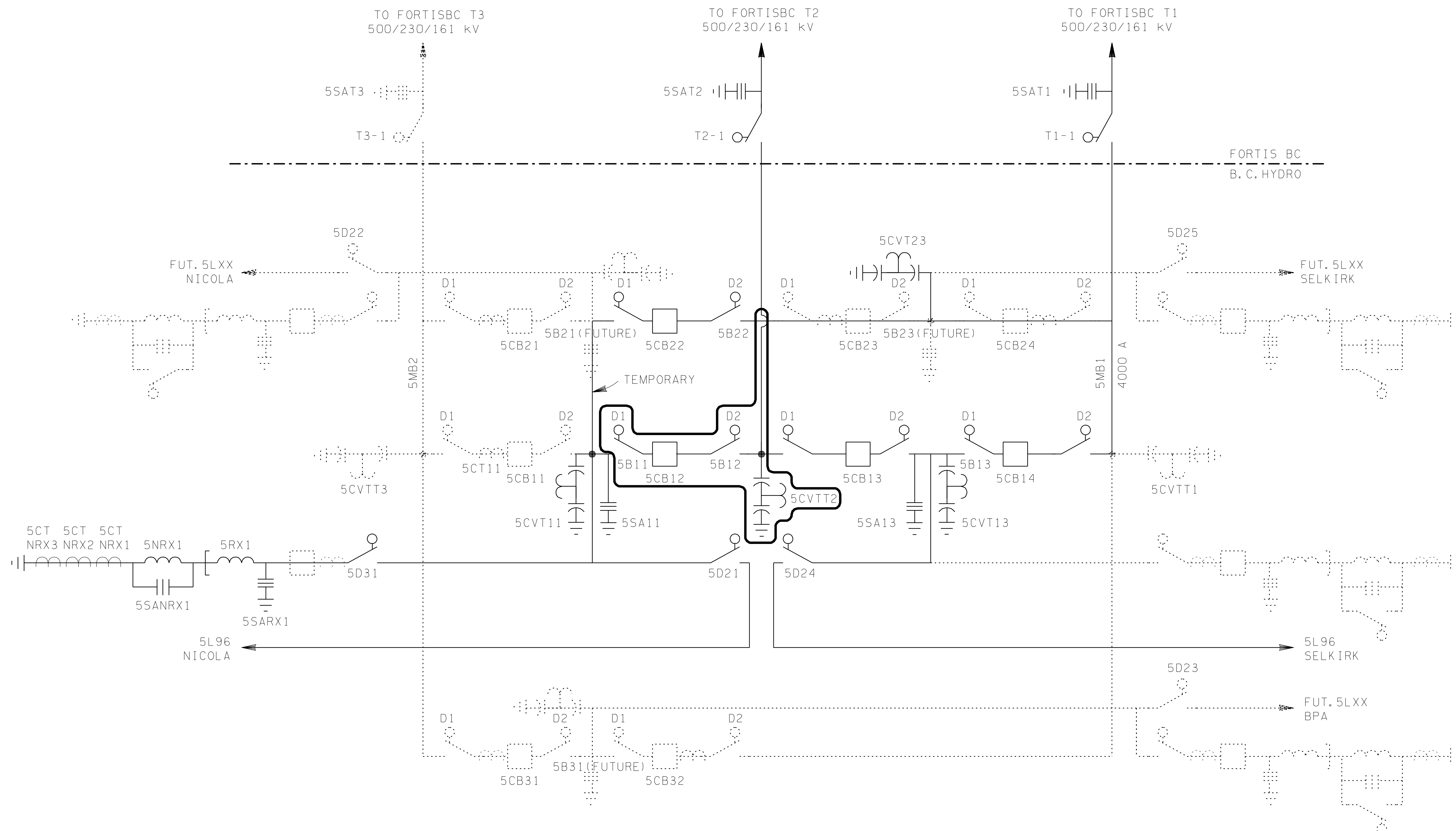
REV	DATE	BY	CHECKED	DESCRIPTION	REVISION APPROVAL	DATE
7	JUL/03	PFE	KRH	REDRAWN TO CAD		
6	JAN/01	PFE	KRH	ADDED CHANNEL SUPPORT ON PENTICTON STEEL		
9	JUN/06	LES	HJU	ONSITE AS BUILT		
8	OCT/04	EPA	HJU	ISSUED FOR CONSTRUCTION AS PER THE SOK PROJECT, DWG. TAKEN FROM 3-380-1010 REV. 7 (ASBUILT)	C. KLASHINSKY	NOV/04

DRAWN BY: P. EDWARDS JUL/03
DESIGNED BY:
CHECKED BY:
APPROVALS: ELEC / CIVIL / MANAGEMENT

FORTISBC

DIVISION: OKANAGAN
DEPARTMENT: TRANSMISSION-DISTRIBUTION
LOCATION: ANDERSON TERMINAL - PENTICTON
TITLE: 63kV SECTIONS - SHEET 2 OF 2

SCALE: 1/8" = 1'-0" SCALE FACTOR: 96
DRAWING NUMBER: 3-380-1013
REVISION: 9



BChydro ENGINEERING

BC HYDRO DWG NO. 304D-P06-SK5 R 0

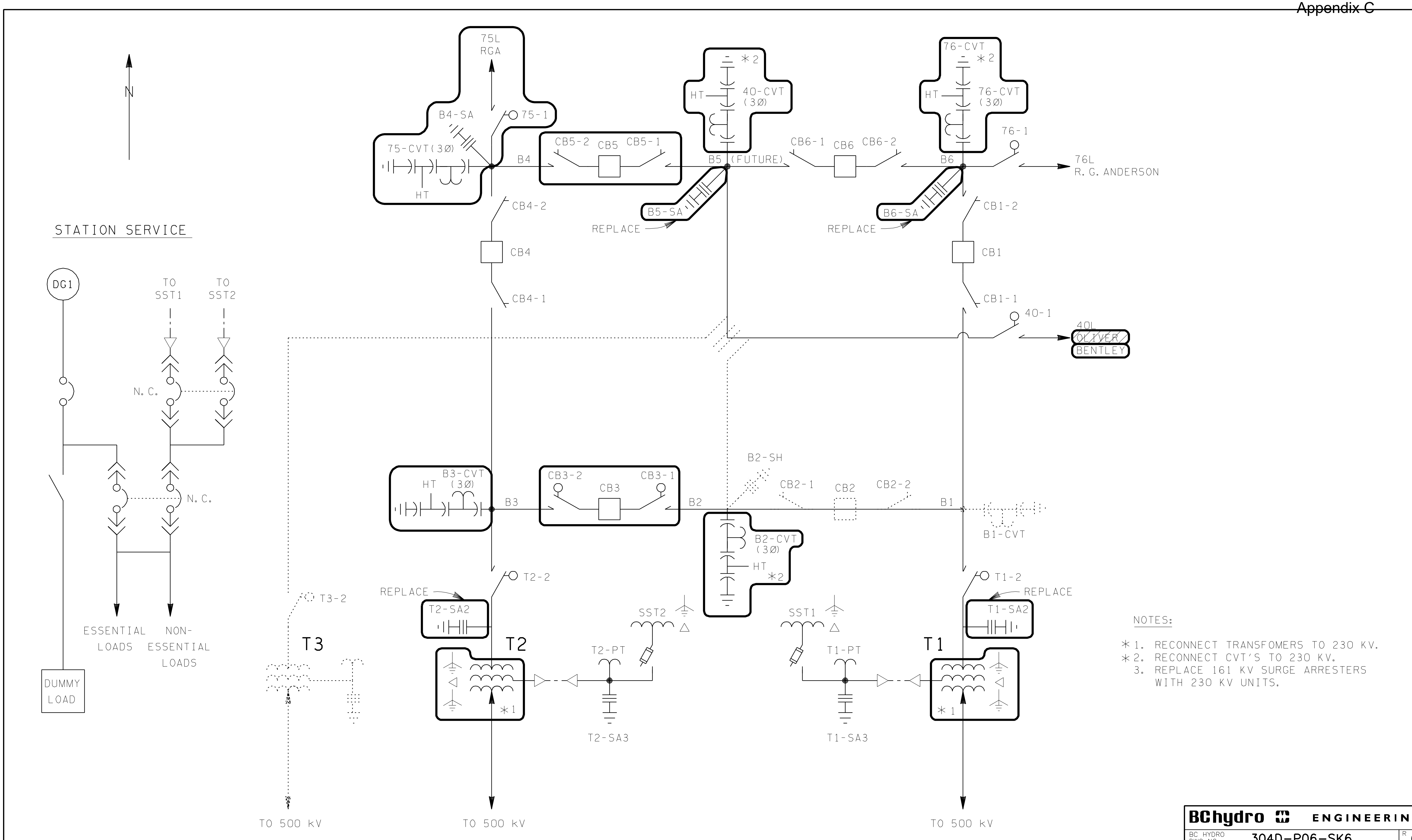
No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

VASEUX LAKE TERMINAL (VAS)

500 KV
ONE-LINE DIAGRAM
200X STAGE

DRAWING NUMBER	REV
3-388-SK5	0



No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION			
								DESIGNED BY	BLA	18JUN07
								DRAWN BY	KLR	
								CHECKED BY		
								APPROVED BY		

FORTISBC

BChydro ENGINEERING

BC HYDRO DWG NO. 304D-P06-SK6 R 0

VASEUX LAKE TERMINAL (VAS)

500/230/161 KV
ONE-LINE DIAGRAM
200X STAGE

DRAWING NUMBER	REV
3-388-SK6	0

BChydro STATION SPECIFICATION SHEET

Stations Planning

Transformers & Shunt Reactors

VAS2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
	253	900	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800
CB3										
CB5										

Comments
Mitsubishi model 200-SFMT-40: Dual trip coils

Surge Arresters	rtd. KV	Type	Man	Comments
B4-SA	228	IEC 4		
B5-SA	228	IEC 4		
B6-SA	228	IEC 4		
T1-SA2	192	IEC 3		
T2-SA2	192	IEC 3		

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
75-CVT	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement.
B3-CVT	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement.

Miscellaneous Ratings

75-1	230 kV	2000 A	900 kV BIL	motor operated
CB3-1	230 kV	2000 A	900 kV BIL	motor operated
CB3-2	230 kV	2000 A	900 kV BIL	motor operated
CB5-1	230 kV	2000 A	900 kV BIL	
CB5-2	230 kV	2000 A	900 kV BIL	

Station General Information

Transformer MVA Capacity

		Ultimate	this stage
	512.5/242/25	3x250	2x250
Firm Tfr MVA Cap	512.5-242	2x250	250

Fault Levels
@ 1.05 p.u. voltage

3 ph MVA / SLG kA

	Voltage	Ultimate	Present
Bus	500	34,000/25	8300/7.4
Bus	230	10,000/25	3500/10
Tert.bus	25	900/-	806/-

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
   -measured 0.7 ohm (2005)
   c) stn gnd fault current - this stage 8 kA rms
   -ultimate 16.5kA rms
   d) rise in station gnd potential
   - this stage kV 5.6 kV rms
   - ultimate kV < 5 kV rms
2. Alarms: via supy. control
3. Station Control: supervisory

Notes :
PRELIMINARY INFORMATION. NOT FOR EQUIPMENT ORDERING.
THIS IS NOT A BCTC PROJECT
This project requires the full conversion of the existing 161 kV station to 230 kV.

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

BChydro FORTISBC
ENGINEERING - Stations Planning

VASEUX LAKE (VAS)OK

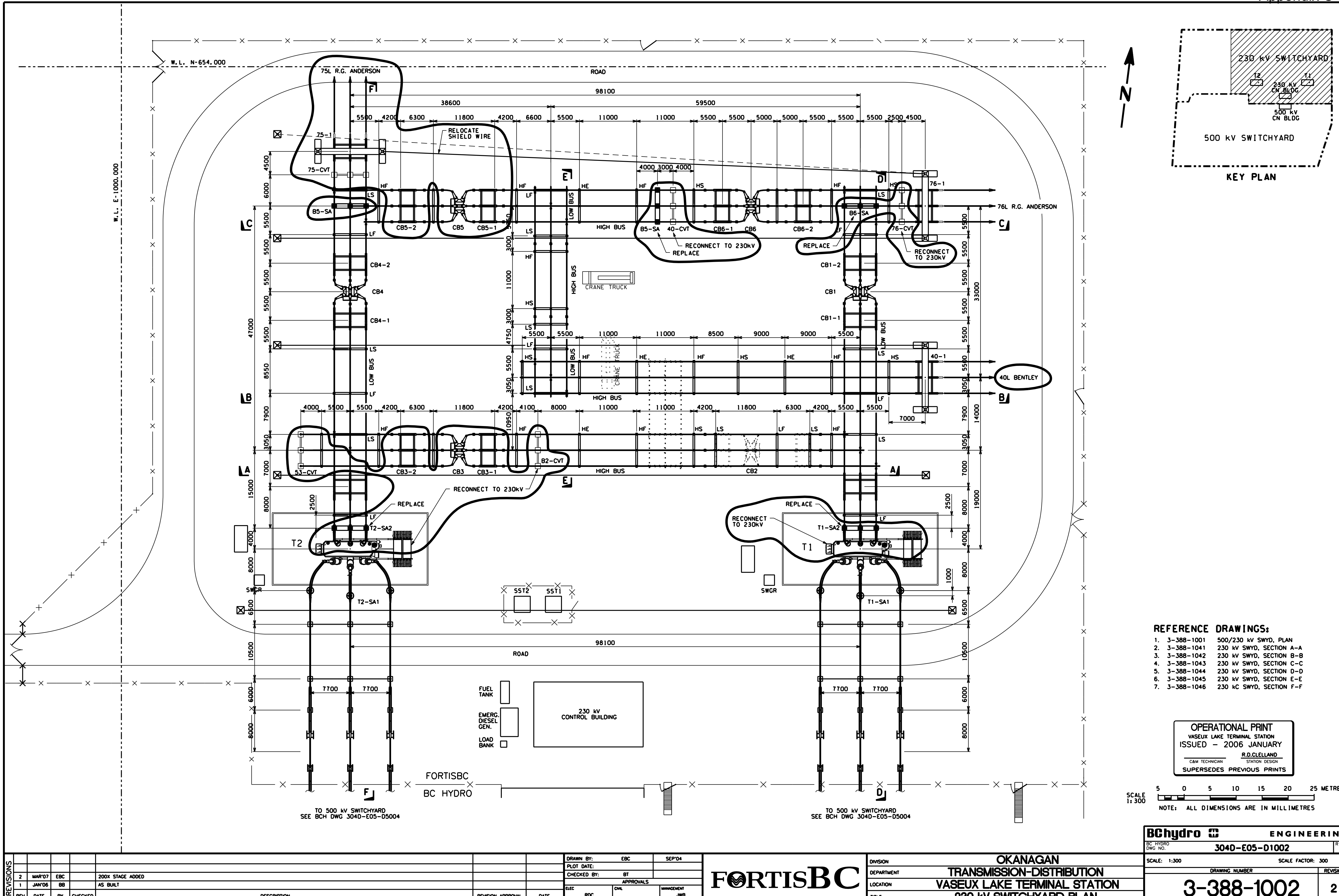
2008 Stage BC HYDRO DWG NO. 304D-P06-B6 R 0

Planning one-line

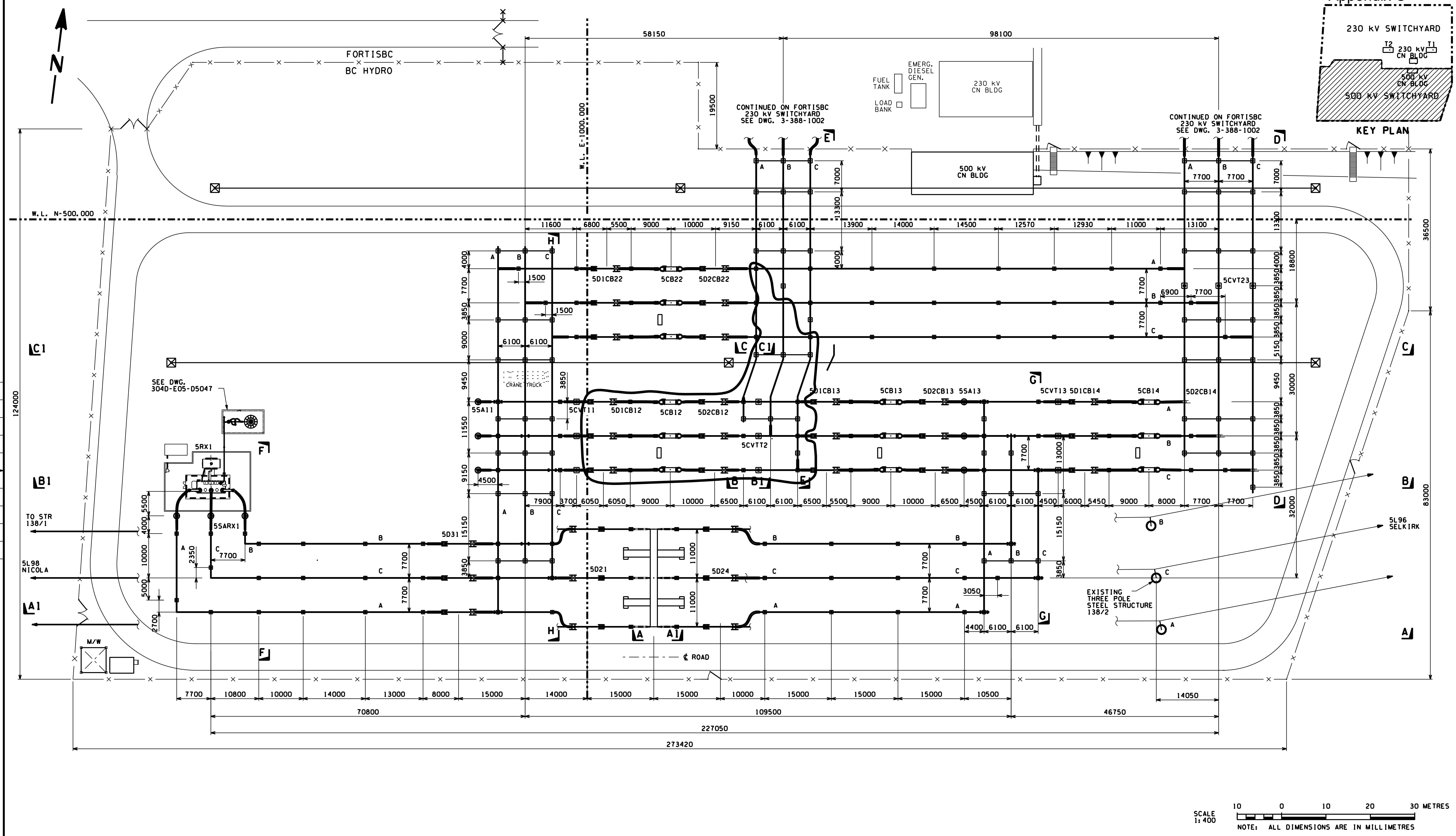
3-388-SK6

SHEET 2

Date :



KEY PLAN
230 kV SWITCHYARD
500 kV SWITCHYARD
230 kV CN BLDG
500 kV CN BLDG
T2
T1
N
W.L. N-654,000
W.L. E-1000,000
ROAD
75L R.G. ANDERSON
76L R.G. ANDERSON
40L BENTLEY
RELOCATE SHIELD WIRE
75-1
75-CVT
76-1
76-CVT
40-1
40-CVT
B5-SA
B6-SA
B2-CVT
53-CVT
CB1
CB1-1
CB1-2
CB2
CB3
CB3-1
CB3-2
CB4
CB4-1
CB4-2
CB5
CB5-1
CB5-2
CB6
CB6-1
CB6-2
HIGH BUS
LOW BUS
CRANE TRUCK
RECONNECT TO 230kV
REPLACE
T2-SA1
T2-SA2
T1-SA1
T1-SA2
SWGR
SST1
SST2
FUEL TANK
EMERG. DIESEL GEN.
LOAD BANK
230 kV CONTROL BUILDING
FORTISBC
BC HYDRO
TO 500 kV SWITCHYARD SEE BCH DWG 304D-E05-D5004
98100
38600
59500
REFERENCE DRAWINGS:
1. 3-388-1001 500/230 kV SWYD. PLAN
2. 3-388-1041 230 kV SWYD. SECTION A-A
3. 3-388-1042 230 kV SWYD. SECTION B-B
4. 3-388-1043 230 kV SWYD. SECTION C-C
5. 3-388-1044 230 kV SWYD. SECTION D-D
6. 3-388-1045 230 kV SWYD. SECTION E-E
7. 3-388-1046 230 kC SWYD. SECTION F-F
OPERATIONAL PRINT
VASEUX LAKE TERMINAL STATION
ISSUED - 2006 JANUARY
R.D.CLELLAND
C&M TECHNICIAN
STATION DESIGN
SUPERSEDES PREVIOUS PRINTS
SCALE 1:300
5 0 5 10 15 20 25 METRES
NOTE: ALL DIMENSIONS ARE IN MILLIMETRES
BChydro ENGINEERING
BC HYDRO DWG NO. 304D-E05-D1002 R 1
SCALE: 1:300 SCALE FACTOR: 300
DRAWING NUMBER 3-388-1002 REVISION 2
DIVISION OKANAGAN
DEPARTMENT TRANSMISSION-DISTRIBUTION
LOCATION VASEUX LAKE TERMINAL STATION
TITLE 230 kV SWITCHYARD PLAN
FORTISBC
DRAWN BY: EBC SEP'04
PLOT DATE:
CHECKED BY: BT
APPROVALS
ELEC RDC
CIVIL
MANAGEMENT JWB
REVISIONS
2 MAR'07 EBC 200X STAGE ADDED
1 JAN'06 BB AS BUILT
REV DATE BY CHECKED DESCRIPTION REVISION APPROVAL DATE



REF#	DRAWING NUMBER	TITLE
	304D-E05-D1002	230 kV SWITCHYARD PLAN
	304D-E05-D5003	500/230 kV SWITCHYARD PLAN

REFERENCE DRAWINGS

REF#	DRAWING NUMBER	TITLE
	304D-E05-D5047	REACTORS 5RX1 & 5NRX1 PLAN & SECTIONS
	304D-E05-D5046	500 kV SWYD SECTION G-G & H-H
	304D-E05-D5045	500 kV SWYD SECTIONS E-E & F-F
	304D-E05-D5044	500 kV SWYD SECTION D-D
	304D-E05-D5043	500 kV SWYD SECTIONS C-C & C1-C1
	304D-E05-D5042	500 kV SWYD SECTIONS B-B & B1-B1
	304D-E05-D5041	500 kV SWYD SECTIONS A-A & A1-A1

REFERENCE DRAWINGS

μ	NO	REMARKS	DATE	DESIGNED	INDEP CHK	DFTG	DFTG CHK	INSP	REV	ACPT
	1	AS BUILT	JAN 2006			BB				
M	0	03-4235, VAS05500: ISSUED FOR CONSTRUCTION REVISED DIMENSIONS BETWEEN FOOTINGS	OCT 2004	R.D.CLELLAND	RDC	EBC	BT			JWB

REVISIONS

DSGN	B. TAM
INDEP CHK	RDC
DFTG	EBC
DFTG CHK	BT
INSP	
REV	
ACPT	JWB

ORIGINAL ISSUE — PROFESSIONAL ENGINEER R. D. CLELLAND PROVINCE OF BRITISH COLUMBIA — SEALED BY

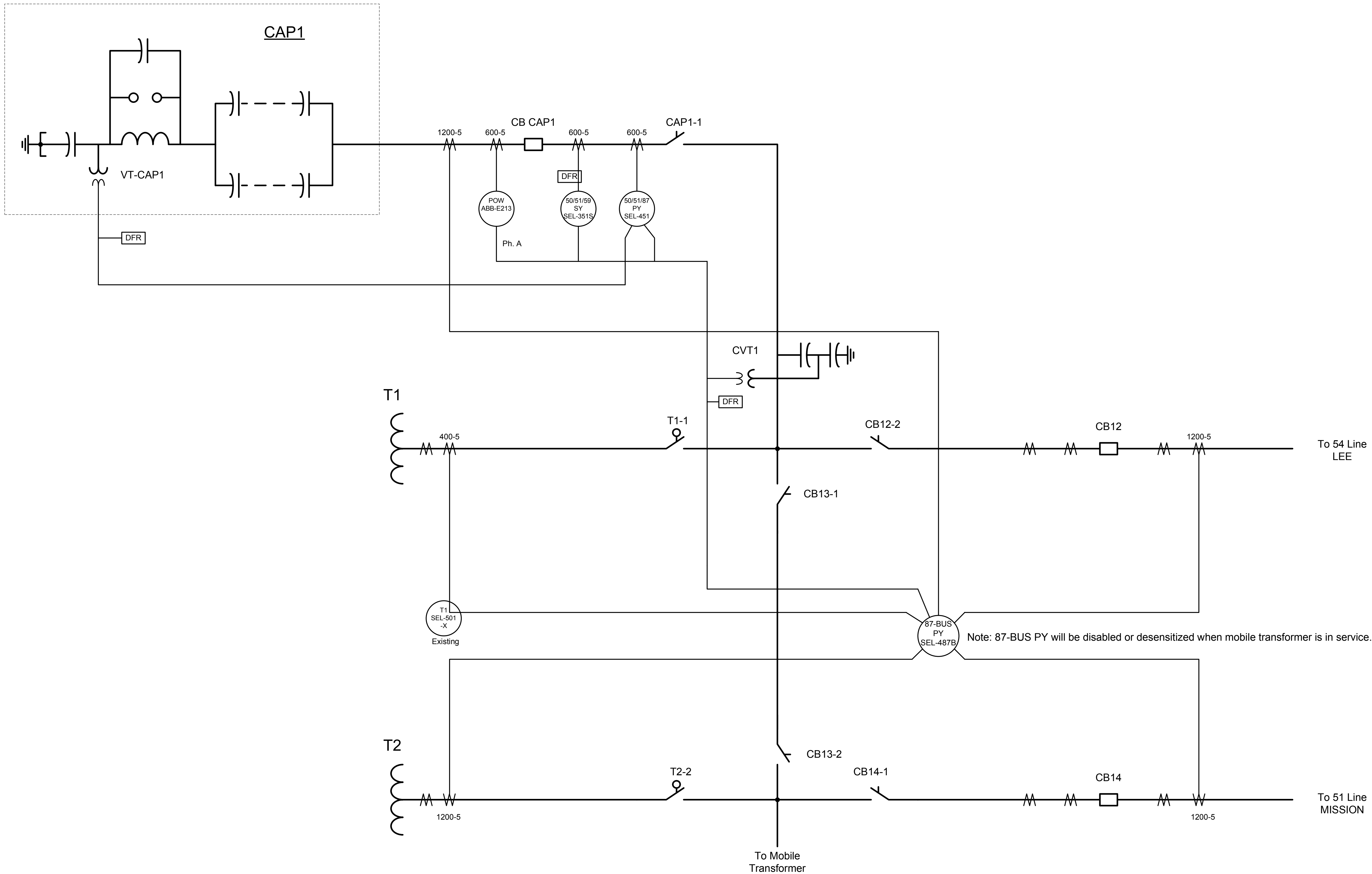
DATE OCT 2004

BChydro ENGINEERING

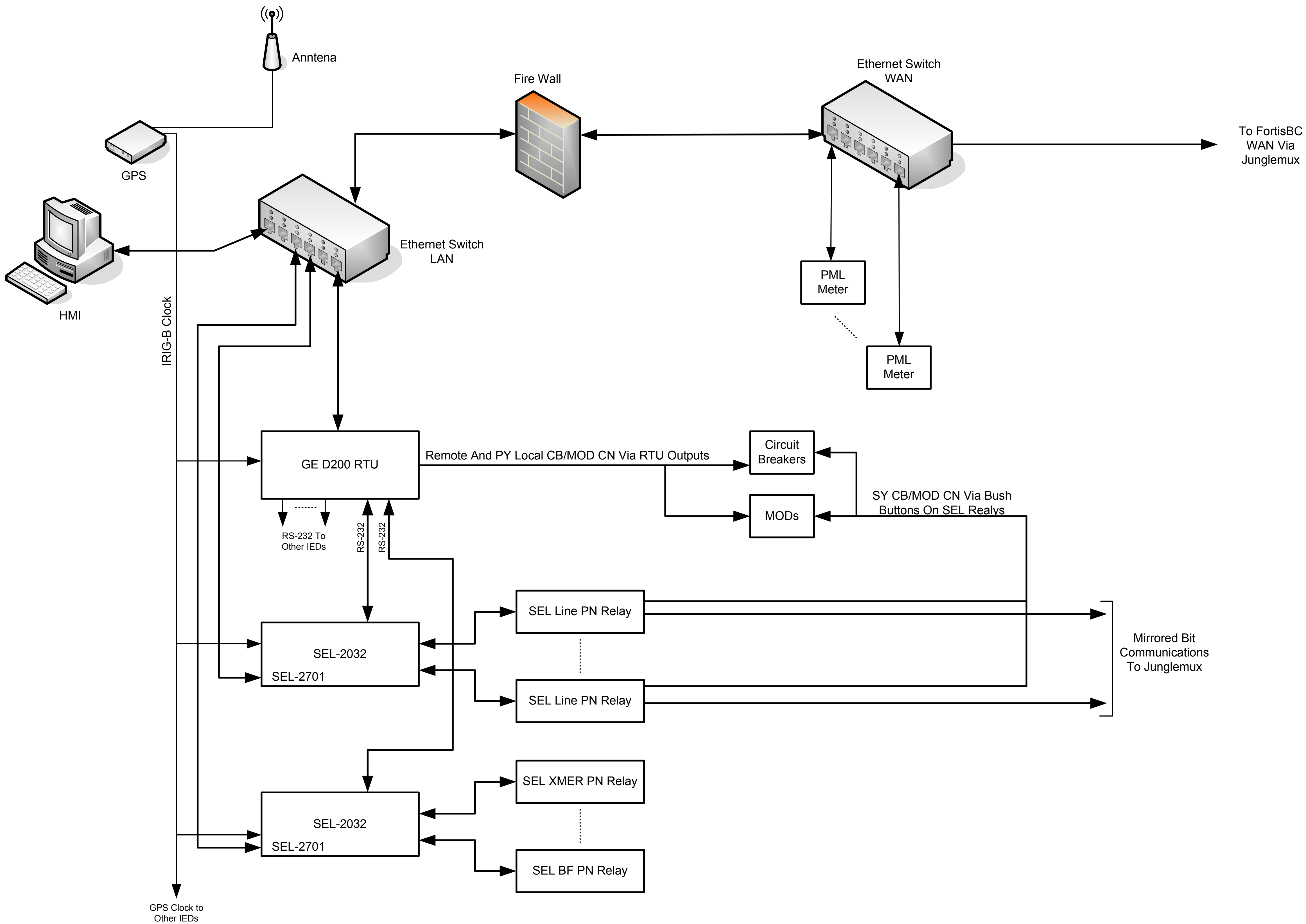
VASEUX LAKE TERMINAL STATION

500 kV SWITCHYARD PLAN

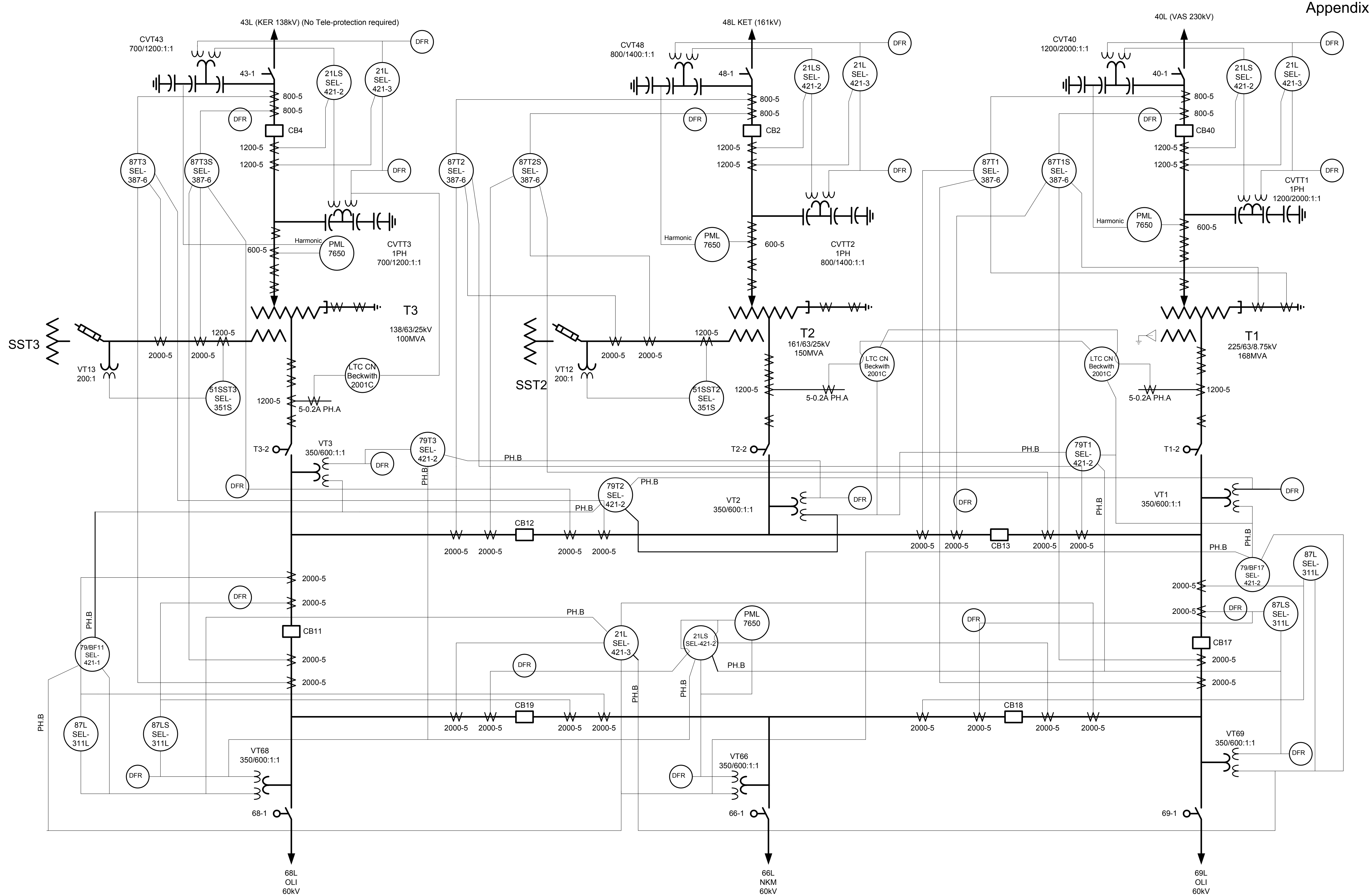
DISTR M — DWG NO CAD 304D-E05-D5004 — R 1



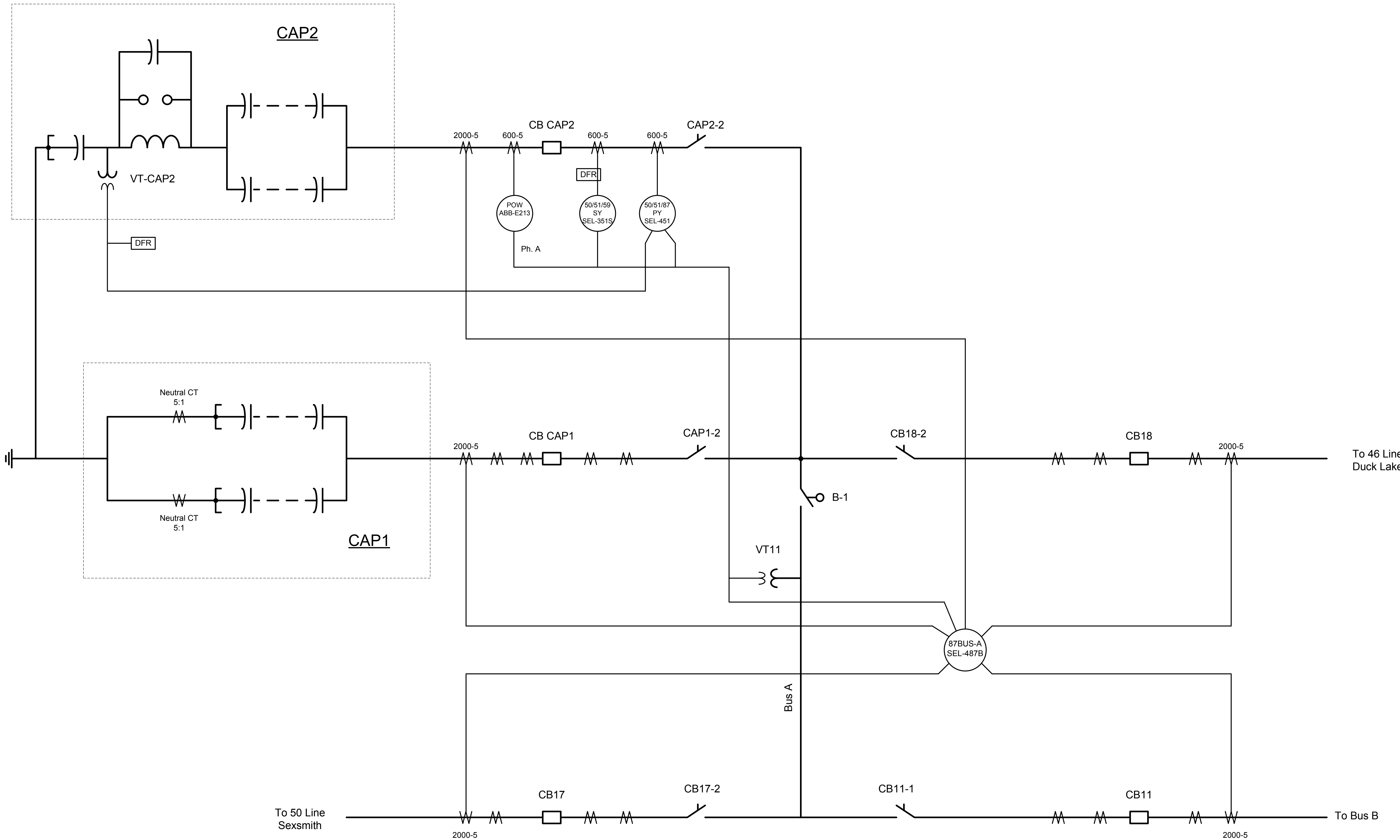
PROTECTION AC ONE LINE DIAGRAM – BELL
April. 17th, 2007 By Tony Jiao



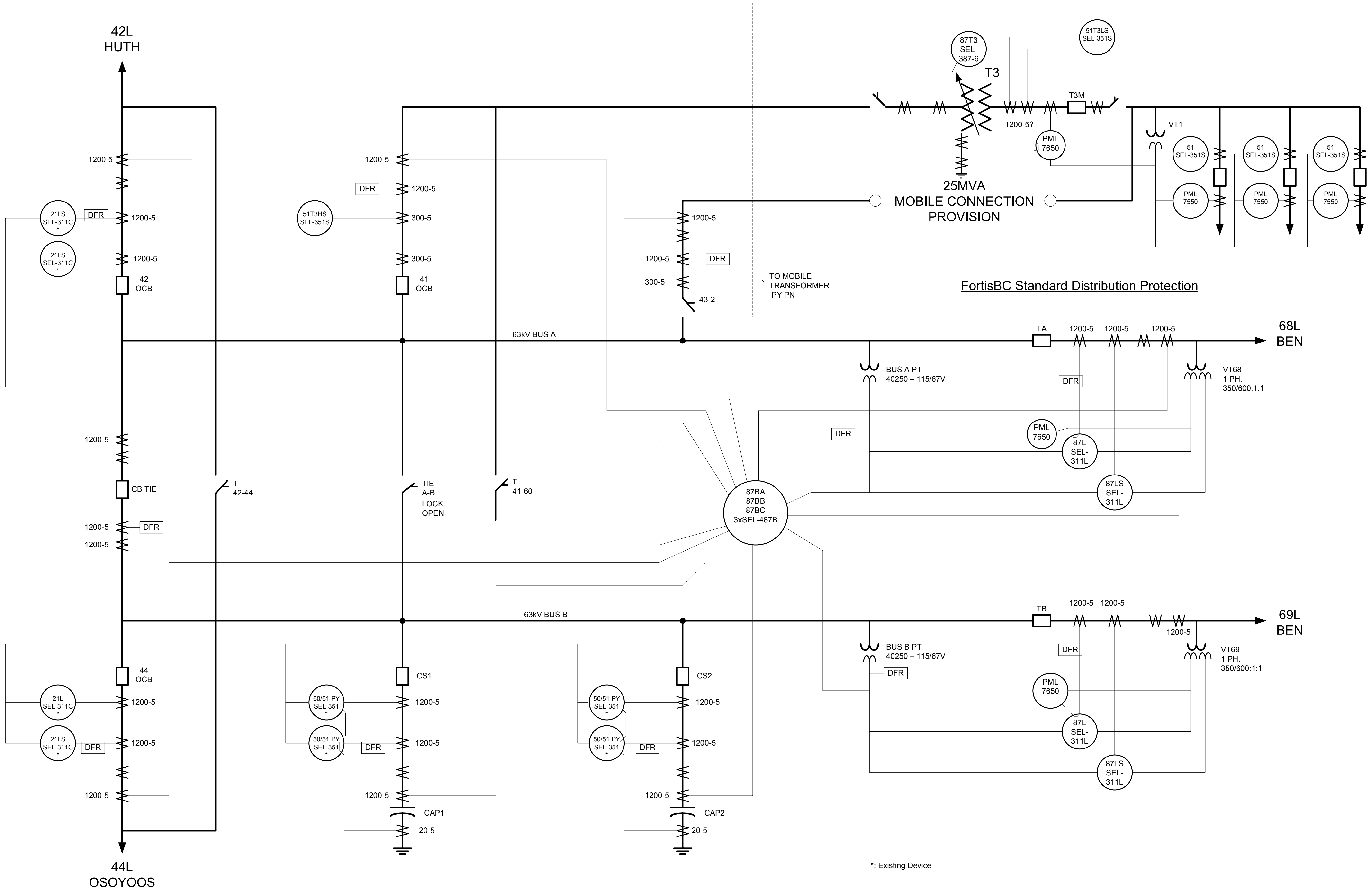
<u>Bentley Substation Control Block Diagram</u>
Dec. 19th, 2006, By Tony Jiao



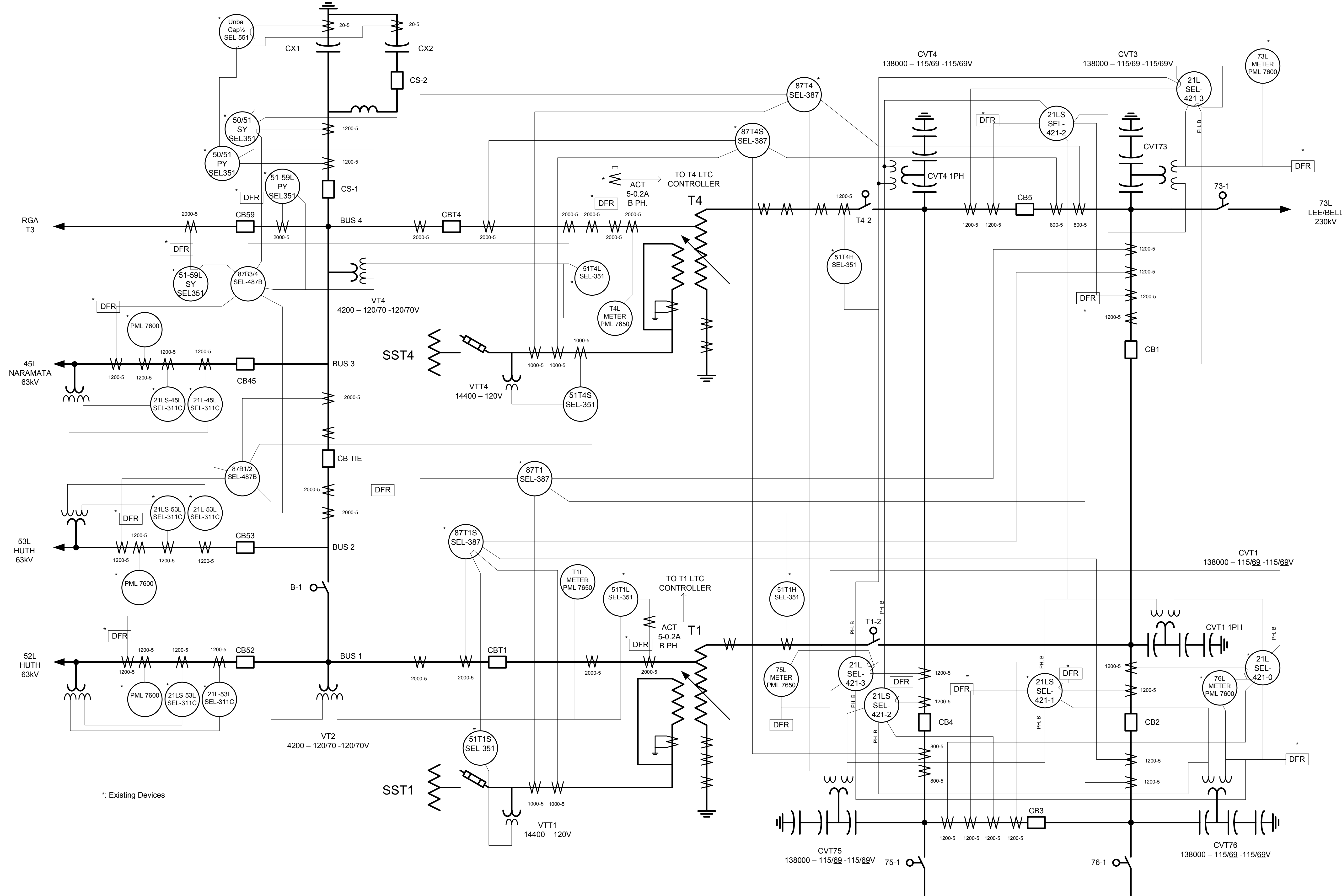
PROTECTION AC ONE LINE DIAGRAM – BENTLEY SUBSTATION
DEC. 12th, 2006 By Tony Jiao



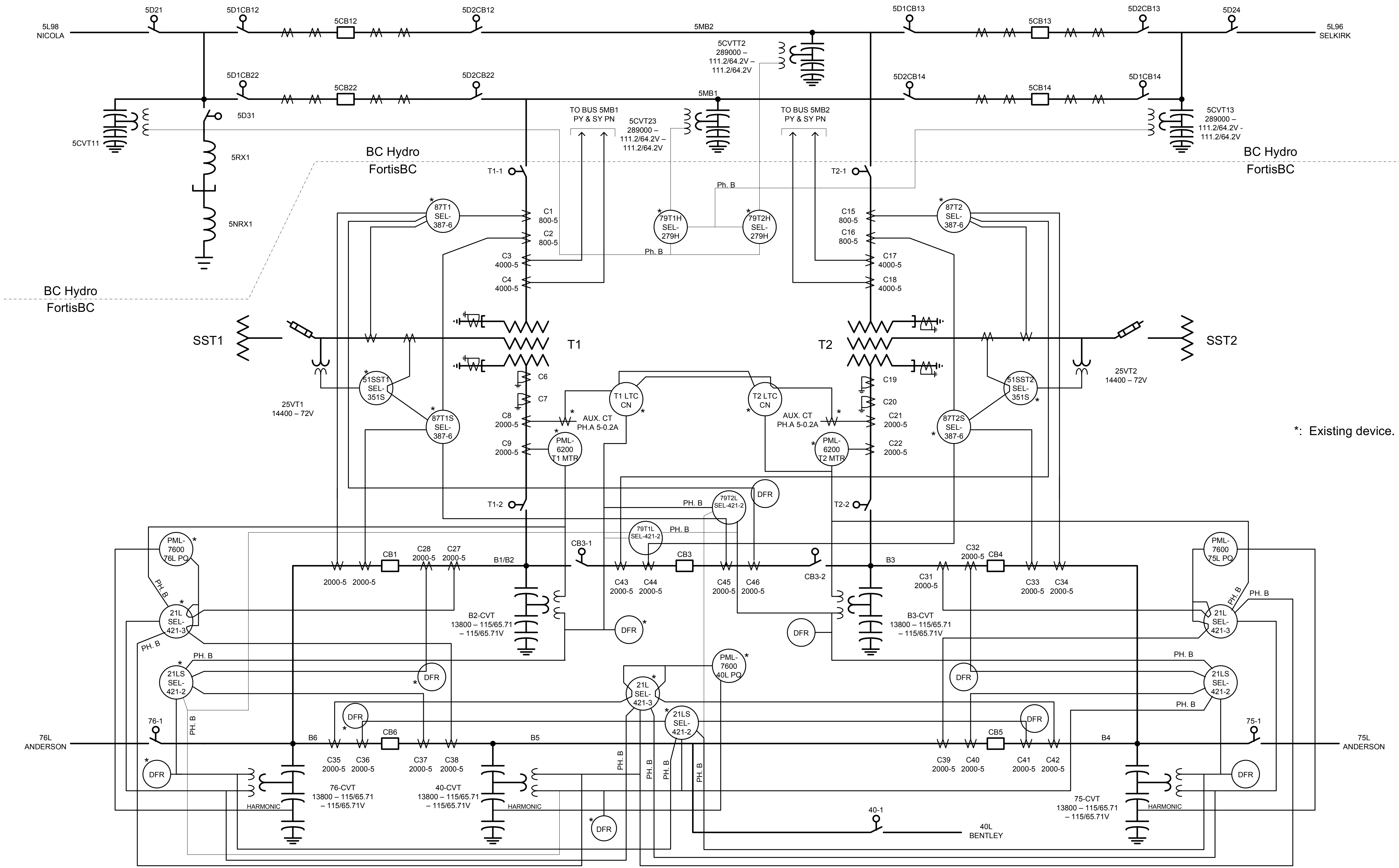
PROTECTION AC ONE LINE DIAGRAM – LEE
April. 17th, 2007 By Tony Jiao



PROTECTION AC ONE LINE DIAGRAM – OLIVER
Jan. 23rd, 2007 By Tony Jiao



PROTECTION AC ONE LINE DIAGRAM – R.G.A
Jan. 18th, 2007 By Tony Jiao



PROTECTION AC ONE LINE DIAGRAM – VAS 230kV
DEC. 12th, 2006 By Tony Jiao

BC Transmission CORPORATION
Building Connections

FORTISBC OKANAGAN TRANSMISSION REINFORCEMENT PROJECT (OTR) – VASEUX LAKE 500KV STATION

Station Preliminary Design Scope

Prepared for BCTC by:

BC hydro
Engineering

July 2007

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VAS_304D-P06-B5-Sh.1 Vaseux Lake 500 kV One - Line
VAS_304D-P06-B5-Sh.2 Vaseux Lake 500 kV Specification Sheet
VAS_304D-P06-B6-Sh.1 Vaseux Lake 500/230/161 kV One - Line
VAS_304D-P06-B6-Sh.2 Vaseux Lake 500/230/161 kV Specification Sheet
VAS 500kV AC One Line Diagram

PROJECT PRELIMINARY DESIGN SCOPE NOTES

Title: FortisBC Okanagan Transmission Reinforcement Project – BCTC Vaseux Lake 500 kV Station

Station Planning

FortisBC requires that separate tripping zones be established for T1 & T2 that presently share a common tripping zone. On the BC Hydro/BCTC side of VAS this requires the reconnection of T2 to its own bus position for which it is necessary to add 5CB12 and associated equipment. Reference the attached One Line 304D-P06-B5 sheet 1 R0 and the associated Station Specification sheet.

The following information is for reference only as the work is a FortisBC project and not for BCTC:

On the FortisBC side, 230 kV CB3 will be added to separate the tripping zones. CB3 will include motor operated disconnects to permit isolation of CB3 from the transformer zones in the event of a failure of the CB.

As part of this project T1 & T2 will be reconnected to 230 kV operation from the present 161 kV. Reference the attached One Line 304D-P06-B6 Sheet 1 R0 and the associated Station Specification Sheet for details. See the transmission section and the attached composite drawing for overall FortisBC project information.

Protection Planning

No Teleprotection Requirement

<u>Work at BCTC VAS:</u>

1. New 500kV bus 5B12 protection.
   Provide two SEL-587Z relays (with two bypass relays) as PY and SY protection.

2. The existing 500kV bus 5MB1/5B22 protection.
   Revise CT connection to net out T2 CTs.

3. The existing 5L98 protection.
   Connect PY and SY protection CT inputs to the new 5CB12 instead of 5CB13.
   Synch VT source will be changed from 5CVT13 to the new 5CVTT2.
   5CB13 BF function will be removed and the new 5CB12 BF function will be done by 5L98 PY and SY protection.
   5CB12 BF will trip into the new 5B12 PY and SY protection.
   5L98 will trip the new 5CB12 in stead of 5CB13.
   Remove 5CB22 BFI from T2 PY & SY PN.
   Add 5CB12 BFI from T2 PY & SY PN.
   Reconnect 5CB22 BF to block T1 HV auto-recloser.
   Add 5CB12 BF to block T2 HV auto-recloser.

4. The existing 5L96 protection.
   Synch VT source will be changed from 5CVT11 to the new 5CVTT2.
   5CB13 BF function will be done by 5L96 PY and SY protection.
   5CB13 BF will trip into the new 5B12 PY and SY protection.
   Remove 5CB14 BFI from T2 PY & SY PN.
   Add 5CB13 BFI from T2 PY & SY PN.

Reconnect 5CB14 BF to block T1 HV auto-recloser.
Add 5CB13 BF to block T2 HV auto-recloser.

5. Tripping and Closing From VAS 230kV PN.
   Add tripping of 5CB12 and 5CB13 from T2 PY and SY PN.
   Add closing of 5CB12 and 5CB13 from T2 HV auto-recloser.
   Remove tripping of 5CB14 and 5CB22 from T2 PY and SY PN.

Control Planning

Summary of Control-related Telecommunication Requirements
None.

Assumptions
All work in Fortis jurisdiction is excluded from this scope. This includes updates to the Fortis side of the Inter-Switchyard Data Links to send and receive new operational data between yard control systems, and updates to the Fortis side of the ICCP link.

Control Planning hours includes time for meetings and coordination with Fortis for data exchange.

VAS 500
SCADA access at the VAS 500kV switchyard is provided to SIC via RTU191 and to SCC via RTU190. All remote control work below will apply to both RTUs.

Provide local and remote control and indication of the new 5CB12. Consistent with station practice, provide local control, and local and remote indication, of isolating MODSes 5D1CB12 and 5D2CB12. Note a and b contacts will be wired for indication. The new control and indication points have been preallocated.

Update the Inter-Switchyard Data Links to send and receive new operational data (eg, 5CB12 status to Fortis switchyard, new 230kV equipment status from Fortis switchyard).

Provide alarms as required for the new CB and relays. There are adequate spare local and remote alarms at the Ethernet/dual-HMI station.

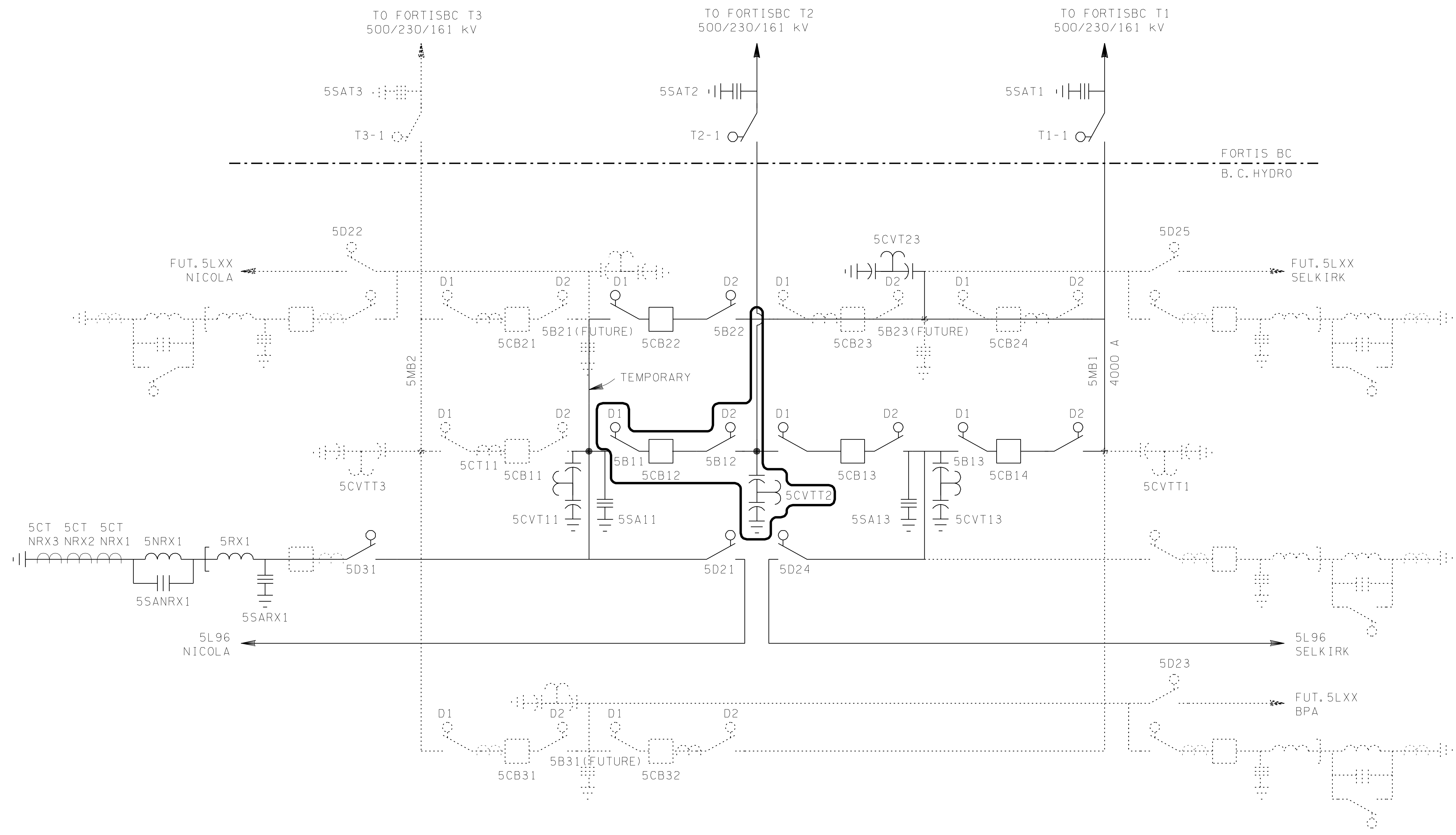
Remote Data Access
The existing SEL-2032 will be used for remote access to the 2 new relays.

Control Centre Work
Update database and displays at BCTC SIC and SCC as required for the new points listed above. Update the network model and advanced applications at SCC to reflect the new data. Also, note that the Fortis yard will be upgraded to 230kV operation under this project. Update the ICCP link to collect new data as required from the Fortis BC Control Centre.

Telecommunication Planning
Not required.

Attachments:

VAS_304D-P06-B5-Sh.1
VAS_304D-P06-B5-Sh.2
VAS_304D-P06-B6-Sh.1
VAS_304D-P06-B6-Sh.2
VAS 500kV AC One Line Diagram



REV NO	DATE	DWN	BCH INIT	BCH INSP	BCTC ACCPT	BCH APPD
2						
1						

DRAWN KLR
BCH Stn Planner INITIATED BLA
BCH P&C INSPECTED
BCTC Initiator ACCEPTED
BCH Engineering APPROVED
DATE 20 APR 07

BChydro
ENGINEERING
STATIONS APPLICATIONS

VASEUX LAKE TERMINAL (VAS)
500 kV
ONE-LINE DIAGRAM
200X STAGE

SHEET 1 | DWG NO 304D-P06-B5 | R 0

BChydro STATION SPECIFICATION SHEET

Station Applications

Transformers & Shunt Reactors

VAS2008A

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	#CT	Ratio	Accuracy
	550	1,550	4000	40		2	12	40/30/20/1500 - 5	TPY Ipsc=40kA Tp=.06s
5CB12									

Comments

IPO, BCH high TRV=1440 kV per BCH special requirements for series compensated lines. Mod. seismic. Out of phase switching capability per ANSI E2=1440 kV, t2=1724 micro sec. at 6 kA. Reclosing duty 0-0.3-CO-30s-CO.SIL 1175 kV Bias test >1440 kV Dead Tank

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
5CVTT2	550 1,550	2600/4500:1:1	1PWXY2PZ 0.6WXY1.2Z	3a	harmonic tap

Miscellaneous Ratings				
5D1/2CB12	550 kV	4000 A	1550 kV BIL	motor operated

PRELIMINARY

Station General Information

Transformer MVA Capacity

		Ultimate	this stage
	512.5/242/25	3x250	2x250
Firm Tfr MVA Cap	512.5-242	2x250	250

Fault Levels @ 1.05 p.u. voltage — 3 ph MVA / SLG kA

	Voltage	Ultimate	Present
Bus	500	34,000/25	8300/7.4
Bus	230	10,000/25	3500/10
Tert.bus	25	900/-	806/-

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
      -measured 0.7 ohm (2005)
   c) stn gnd fault current - this stage 8 kA rms
      -ultimate 16.5kA rms
   d) rise in station gnd potential
      - this stage kV 5.6 kV rms
      - ultimate kV < 5 kV rms
2. Alarms: via supy. control
3. Station Control: supervision

Notes :

1. FortisBC separating T1 & T2 into separate switching zones on the LV and reconnecting to 230 kV.
2. For estimating only. NOT FOR EQUIPMENT ORDERING

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

BChydro

ENGINEERING - Stations Applications

VASEUX LAKE (VAS) OK

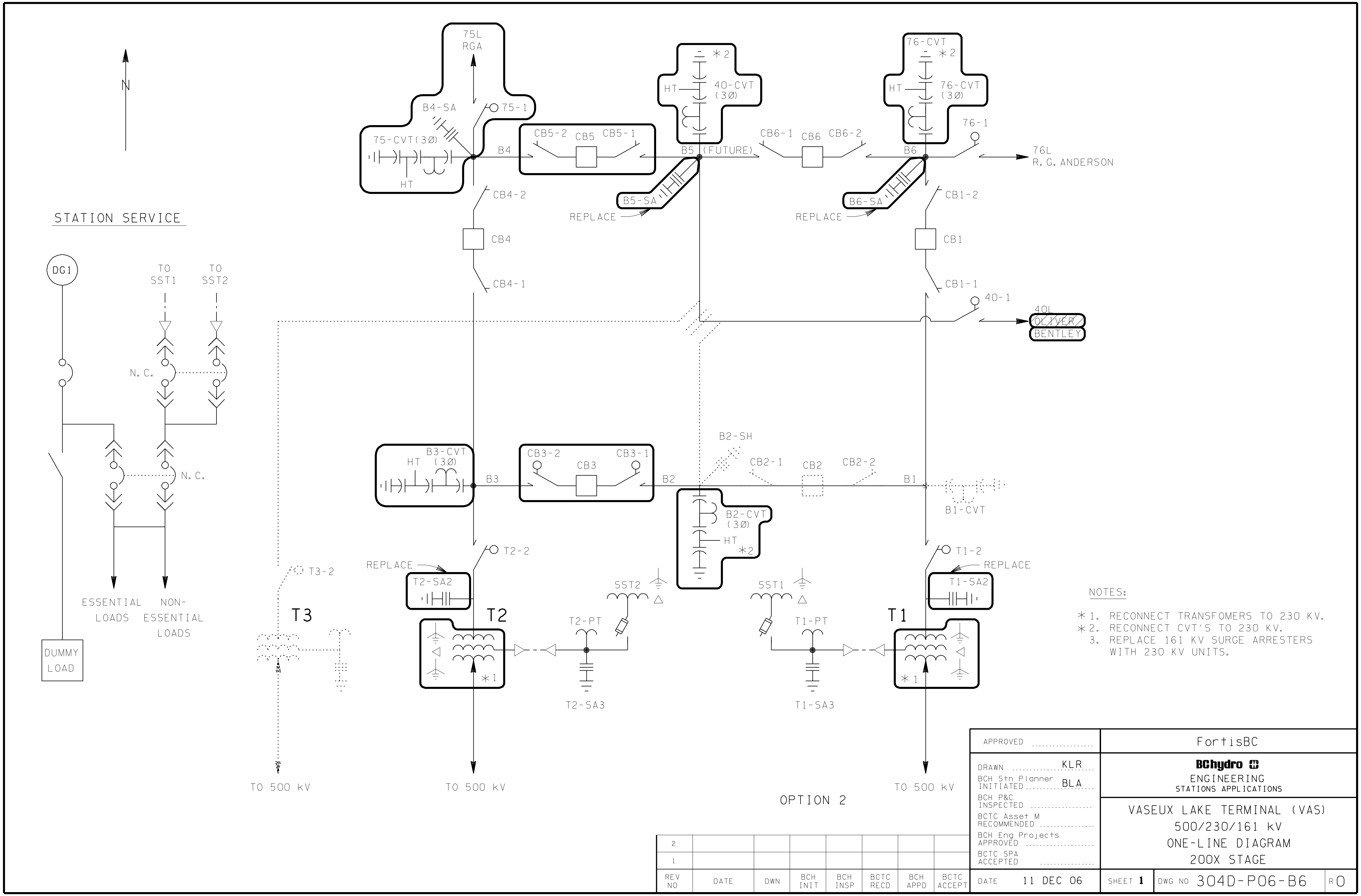
2008A Stage

Planning one-line

Date :

304D-P06-B5 R0

SHEET 2


N
STATION SERVICE
DG1
TO SST1
TO SST2
N.C.
N.C.
ESSENTIAL LOADS
NON-ESSENTIAL LOADS
DUMMY LOAD
75L RGA
B4-SA
75-1
75-CVT(3Ø)
HT
B4
CB5-2
CB5
CB5-1
*2
HT
40-CVT (3Ø)
B5 (FUTURE)
B5-SA
REPLACE
CB6-1
CB6
CB6-2
76-CVT
*2
HT
76-CVT (3Ø)
76-1
B6
76L R.G. ANDERSON
B6-SA
REPLACE
CB4-2
CB4
CB4-1
CB1-2
CB1
CB1-1
40-1
40L OLIVER BENTLEY
B3-CVT HT (3Ø)
B3
CB3-2
CB3
CB3-1
B2
B2-SH
CB2-1
CB2
CB2-2
B1
B1-CVT
B2-CVT (3Ø)
HT
*2
T2-2
T3-2
REPLACE
T2-SA2
T3
T2
*1
T2-PT
SST2
T2-SA3
SST1
T1-PT
T1-SA3
T1-2
REPLACE
T1-SA2
T1
*1
TO 500 kV
TO 500 kV
TO 500 kV
OPTION 2
NOTES:
*1. RECONNECT TRANSFOMERS TO 230 KV.
*2. RECONNECT CVT'S TO 230 KV.
3. REPLACE 161 KV SURGE ARRESTERS WITH 230 KV UNITS.
APPROVED
DRAWN KLR
BCH Stn Planner INITIATED BLA
BCH P&C INSPECTED
BCTC Asset M RECOMMENDED
BCH Eng Projects APPROVED
BCTC SPA ACCEPTED
FortisBC
BChydro
ENGINEERING
STATIONS APPLICATIONS
VASEUX LAKE TERMINAL (VAS)
500/230/161 kV
ONE-LINE DIAGRAM
200X STAGE
2
1
REV NO
DATE
DWN
BCH INIT
BCH INSP
BCTC RECD
BCH APPD
BCTC ACCEPT
DATE 11 DEC 06
SHEET 1
DWG NO 304D-P06-B6
R 0

BChydro STATION SPECIFICATION SHEET

Station Applications

Transformers & Shunt Reactors

VAS2008

Circuit Breakers	max.kV	BIL	Current	Int.KA	MVA	IntT~	Man	#CT	Ratio	Accuracy
	253	1,050	2000	40		3	MIT	12	20/15/12/400 - 5	2.5L800
CB3										
CB5										

Comments
Mitsubishi model 200-SFMT-40: Dual trip coils

Surge Arresters	rtd. KV	Type	Man	Comments
B4-SA	228	IEC 4		
B5-SA	228	IEC 4		
B6-SA	228	IEC 4		
T1-SA2	192	IEC 3		
T2-SA2	192	IEC 3		

VTs, CVTs	max.kV/BIL	Ratio	Accuracy	CSAgrp	Comments
75-CVT	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement.
B3-CVT	253 1,050	1200/2000:1:1	1PWXY2PZ	3a	Minimum 10 Nanofarads. Provision for harmonic measurement.

Miscellaneous Ratings

75-1	230 kV	2000 A	1050 kV BIL	motor operated
CB3-1	230 kV	2000 A	900 kV BIL	motor operated
CB3-2	230 kV	2000 A	900 kV BIL	motor operated
CB5-1	230 kV	2000 A	900 kV BIL	
CB5-2	230 kV	2000 A	900 kV BIL	

Station General Information

Transformer MVA Capacity

		Ultimate	this stage
	512.5/242/25	3x250	2x250
Firm Tfr MVA Cap	512.5-242	2x250	250

Fault Levels
@ 1.05 p.u. voltage

	Voltage	3 ph MVA / SLG kA Ultimate	Present
Bus	500	34,000/25	8300/7.4
Bus	230	10,000/25	3500/10
Tert.bus	25	900/-	806/-

1. Station Grounding
   a) ground resistivity -ohm meters
   b) stn gnd resistance -estimated
   -measured 0.7 ohm (2005)
   c) stn gnd fault current - this stage 8 kA rms
   -ultimate 16.5kA rms
   d) rise in station gnd potential
   - this stage kV 5.6 kV rms
   - ultimate kV < 5 kV rms
2. Alarms: via supy. control
3. Station Control: supervision

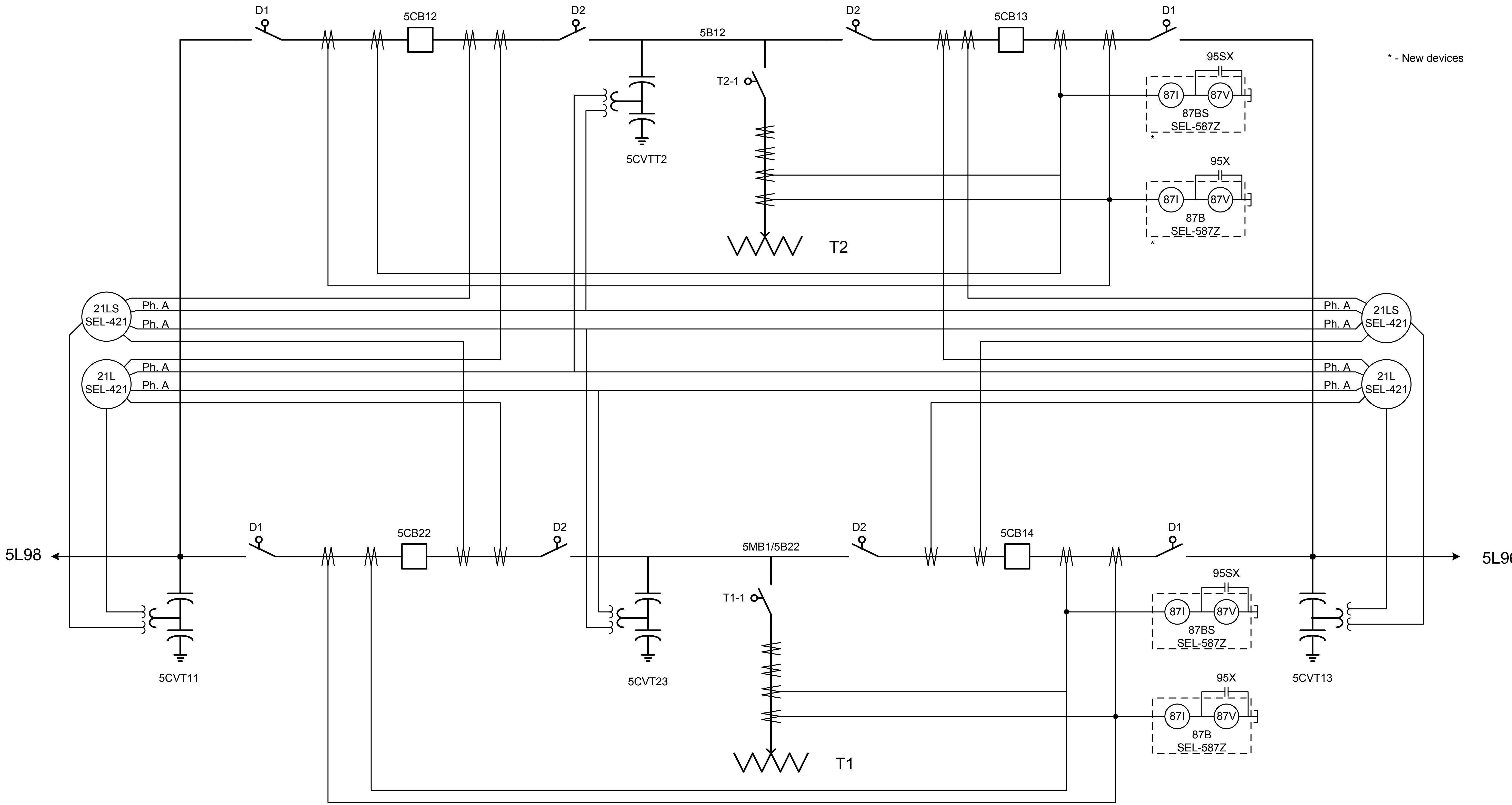
Notes :
PRELIMINARY INFORMATION. NOT FOR EQUIPMENT ORDERING.
THIS IS NOT A BCTC PROJECT
This project requires the full conversion of the existing 161 kV station to 230 kV.

Rev No.	Date	BCH Stn Planner Initiated	BCH P&C Inspected	BCTC Initiated and Approved	BCH Stn Applications Approved

BChydro
ENGINEERING - Stations Applications

VASEUX LAKE (VAS)OK
2008 Stage

Planning one-line
Date : **304D-P06-B6 R0**
SHEET 2



<u>VAS 500kV AC One Line Diagram</u>

FortisBC System Transformer Tertiary Risk Evaluation

Prepared for: **FortisBC**
Andy Ferraro

Trail, BC
250-368-0430

Submitted: December 19, 2006

Prepared by: ZE Power Engineering Inc.

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mike@ze.com
www.ze.com

FortisBC System Transformer Tertiary Risk Evaluation

Comparing Distribution Supply Reliability between Lee Substation and A New Black Mountain Substation.

J.A. Polvi P.Eng

J.A. Polvi P.Eng

ZE Power Engineering

Executive Summary

Fortis is planning to construct a new substation in the Black Mountain service area to serve a growing area load. The requirement for a new substation provides an opportunity to offload the distribution load presently served by the Lee Terminal system transformer tertiary windings. Serving distribution load from the tertiary winding can be detrimental to the long-term health of a transformer due to the relatively high number of through faults experienced by the transformer. The Lee transformers are large, expensive system transformers. Adding tertiary distribution load will increase the risk of a major transformer failure. Failure of a transformer such as T3 or T4 could lead to a lengthy outage increasing the risk of major distribution outages.

Fortis requested an evaluation of the supply reliability comparing the supply of significant distribution loads from the tertiary winding of the Lee Terminal system transformer with supplying the loads from a dedicated distribution step-down transformer at a new substation.

In addition, Fortis requested investigation into the risks associated with serving distribution load from the tertiary of a system transformer. The procedure followed was to research available technical reports, Institute of Electrical and Electronic Engineers (IEEE) papers etc to identify the increased risk of transformer failure when subjected to frequent through faults associated with serving distribution load from the tertiary of a system transformer. Technical documentation dating from the mid 70's identifying the increased risk to transformers was located.

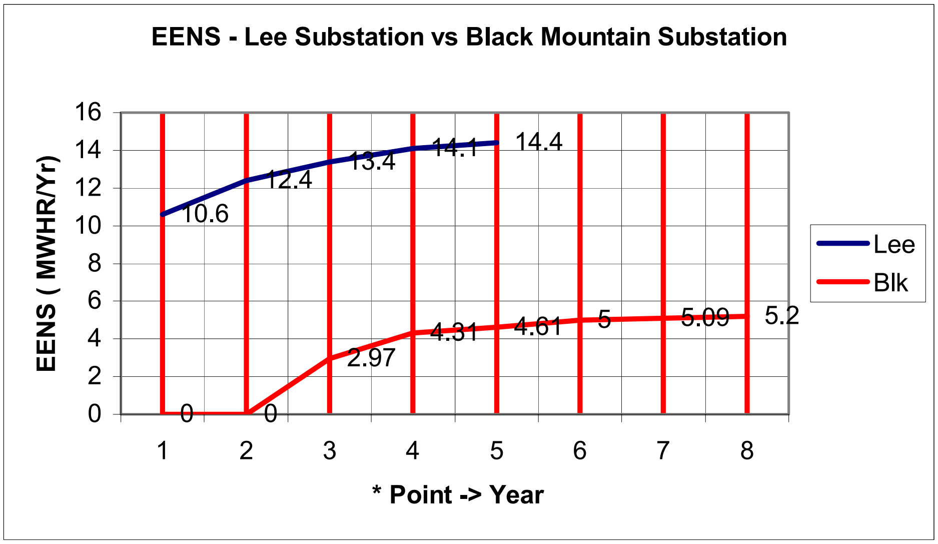
Two papers dating from the period that the transformers were manufactured discuss the risks and conclude that

> *Cellulosic insulation, which is major component of all liquid-filled transformers, undergoes two types of physical change in service. When it is mechanically loaded in compression it is not capable of retaining its original compressed dimension and its original loading pressure over a long period of time1. (pg 443)*
>
> *Another event which accelerates the relaxation of compressed insulation is a short-circuit1;-(pg 443)*
>
> *6. Short circuit currents below 50% of the maximum possible value have an inconsequential effect from the point of view of insulation wear. However, over large numbers of cycles, they still contribute to insulation compaction2.(pg 1283)*

Off-loading the transformer tertiary will eliminate the impact of distribution related outages as well as allow the decommissioning of equipment currently required to serve the distribution feeder load. Removing this equipment from service reduces the risk of failures that would subject the tertiary windings to the electrical and mechanical stress associated with through faults. The simulations confirm that through faults would continue to impact the transformer tertiary windings on average 1-3 times per year. With increased load growth, the customer impact related to the outages will grow.

Transferring the distribution load to a new dedicated distribution substation is expected to improve supply reliability and reduce the Expected Energy Not Served (EENS) for customers in the Black Mountain Service area.

Fortis is recommended to proceed with this project.



*** Point ->Year**

Point	Year
1	06/07
2	07/08
3	**08/09**
4	09/10
5	10/11
6	11/12
7	12/13
8	13/14

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Canada, V7C 4R9

Introduction

Lee Terminal is a major substation in the Fortis network in the Kelowna -service area. The substation has two high capacity system transformers that supply the local 132kV network. The tertiary winding on the transformers is utilized to supply two local feeders. The tertiary windings are not operated in parallel.

The area load forecast has increased requiring additional capacity in the service area. Fortis is planning to construct a new substation in the Black Mountain area to serve the growing load.

The proposed new substation will permit Fortis to offload the distribution load presently served by the system transformer tertiary windings. This will eliminate the probable detrimental impact of repeated faults on the present Lee terminal feeders. There is a risk of instigating failure of a major system transformer.

The analysis detailed in this report examines the reliability of service provided by the two alternatives, and identifies the increased risk of transformer failure due to repeated through faults on the distribution system.

Project Scope

Compare the supply reliability associated with serving significant distribution loads from the tertiary winding of the Lee Terminal system transformer versus supplying the loads from dedicated distribution step-down transformers at a new substation.

Research available technical reports, IEEE papers etc., to highlight the increased risk of transformer failure when subjected to frequent faults associated with serving distribution load from the tertiary of a system transformer. The intent is to identify technical documentation for the increased risk to a system transformer.

Procedure

Develop a reliability model to simulate system operation for the two options. The base case model will assume that the Black Mountain service area load will be supplied from the Lee and Hollywood substations with reinforcement added at Lee as required. Hollywood substation was not modeled. The recommended alternative will assume that the Black Mountain service area load will be served from a new substation. The Lee Transformer tertiary will be assumed to be off- loaded to the new substation. Future load growth will be provided by adding capacity to the Black Mountain substation or by adding a dedicated distribution transformer to Lee Terminal.

The reliability program, "Risk_A" was utilized to compute the reliability of the two alternatives. The simulation results will provide the comparative expected frequency, duration, demand not served and the expected energy not served for the two alternatives. The simulation results will also provide an estimate number of faults/year that the tertiary windings may be subjected to. A description of the software and its application is included.

Deliverables

A report detailing the results of the comparative reliability study listing the reliability indices for each of the two alternatives will be prepared. Included will be a summary of the highlights of technical material identified that is pertinent to the issue of serving distribution load from a system transformer tertiary.

Analyses and Simulation Results

Reliability Comparison between Supply from Lee Substation and a new Black Mountain Substation

A model of the Lee Terminal Substation and Black Mountain substation was developed for the Risk_A reliability program. Refer to Section 8, page 21 for load forecast data, forced outage data and model details.

Each model includes all elements that may, due to failure, lead to a disruption of distribution service. An outage on equipment which will not directly lead to a service disruption such as the feeder shunt capacitor banks were included to account for all elements which can initiate a through fault condition on the system transformers. At Lee Substation, this includes the feeder circuit breakers, feeder shunt capacitors plus associated circuit breaker, feeder voltage regulators, transformer 13 kV circuit breakers and the 13 kV grounding transformers. The forced outage rate for the F1 and F2 feeders is modeled based on statistics provided by Fortis. Each failure of any of the above elements will result in a through fault condition for the tertiary of either T3 or T4. The tertiary load is assumed to be supplied from the T4 tertiary with an automatic switchover to T3 on loss of T4 or elements associated with T4.

The Risk_A program simulates a year of operation for the portion of the network under study. The program determines if an outage has occurred based on the forced outage data included for elements in the model. Each iteration determines on an hourly basis whether an element failure has occurred. Each iteration steps through 8760 hours per year. If an outage occurs, the duration and MW impact are totaled for the simulation summary. The model was simulated through eight thousand iterations to obtain the results.

The Lee substation model simulates only distribution related outages. Outages related to events in the 132 kV network were not modeled. The through fault duty to the system transformers resulting from the 132 kV network and associated forced outages will be similar after the Lee distribution is transferred to Black Mountain and other nearby substations.

The analysis did not consider how the area supply reliability was impacted by the new substation. The current Lee terminal distribution load will be off-loaded to nearby substations as well as Black Mountain. The Black Mountain load model includes the Lee F2 feeder load as well as additional load as detailed in the Fortis Draft CPCN3. The simulations evaluate the overall impact of serving distribution load from Lee or transferring it elsewhere from the perspective of the Lee system transformers.

The results show that the proposed Black Mountain Substation will serve the distribution load more reliably as compared to the current supply from Lee substation. The primary reason for this is the reduction in the number of distribution elements in the new substation as compared to what is needed at Lee Substation.

The outage frequency and outage duration are roughly constant for each Lee and Black Mountain case. Fixed equipment forced outage rates were used for each simulation year resulting in roughly constant values for the outage frequency and duration. The MW magnitude of the load lost as well as the energy will vary with the size of the load lost and the outage duration.

Item 6 in the table below (page 11), summarizes the EENS impact of serving the Black Mountain area load after the Lee F2 feeder reaches capacity in 2010/11. The high EENS value calculated sums the impact of load in excess of the feeder capacity and is reflected as un-servable load.

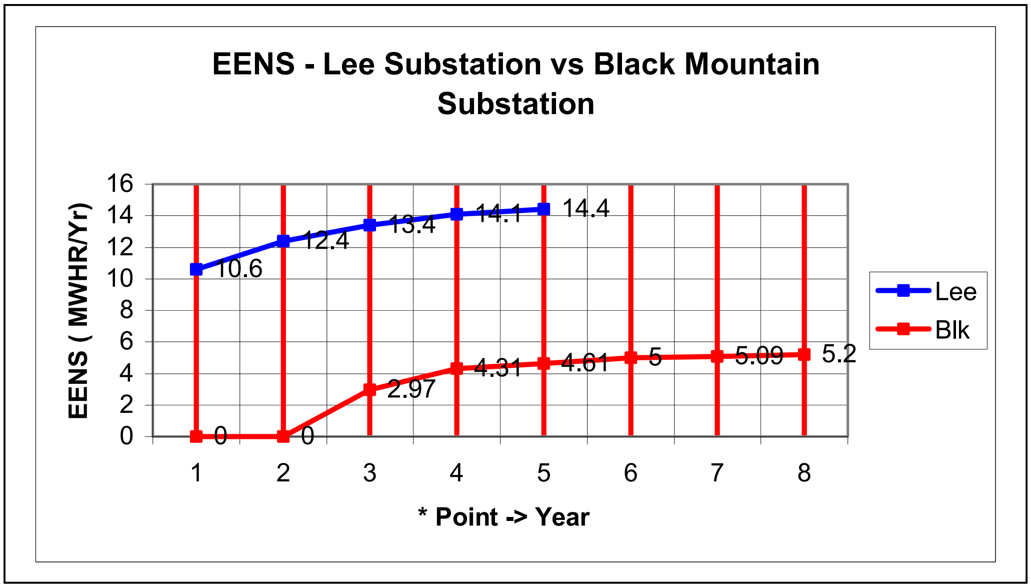
Lee Substation Simulation Results

	Lee Substation				
		NLC[1]	DLC[2]	DNS[3]	EENS[4]
1	06/07	1.2	131	4.16	10.6
2	07/08	1.2	131	4.77	12.4
3	**08/09**	**1.2**	**131**	**5.1**	**13.4**
4	09/10	1.2	131	5.09	14.1
5	10/11	1.2	131	5.39	14.4
6	10/11R	8.78	303	1.06	99.8
	1 - NLC - Number of Load curtailments/Year				
	2 - DLC - Median Duration of Load curtailments				
	3 - DNS - Expected Demand Not Served				
	4 - EENS - Expected energy Not Served				

Black Mountain Substation Simulation Results

1	Blk Mtn Substation				
2		NLC[1]	DLC[2]	DNS[3]	EENS[4]
3	06/07	0	0	0	0
4	07/08	0	0	0	0
5	**08/09**	**1.06**	**1.15**	**2.76**	**2.97**
6	09/10	1.06	1.15	3.95	4.31
7	10/11	1.06	1.15	4.23	4.61
8	11/12	1.06	1.15	4.56	5
9	12/13	1.06	1.15	4.68	5.09
10	13/14	1.05	1.15	4.77	5.2
	1 - NLC - Number of Load curtailments/Year				
	2 - DLC - Median Duration of Load curtailments				
	3 - DNS - Expected Demand Not Served				
	4 - EENS - Expected energy Not Served				

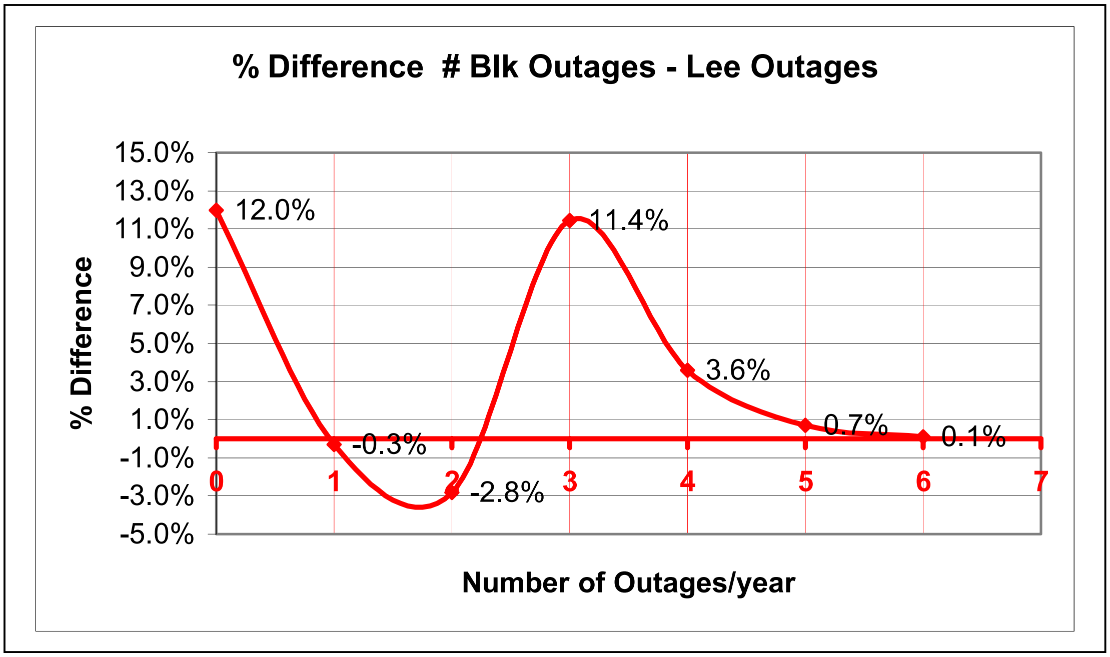
EENS Comparison between Lee and Black Mountain Substation Simulations



***Point-> Year**

Point	Year
1	06/07
2	07/08
3	**08/09**
4	09/10
5	10/11
6	11/12
7	12/13
8	13/14

Comparing the number of outages/year between the proposed Black Mountain Substation and the current supply from Lee.



e.g. BLK has zero outages per year 12% more frequently than LEE. BLK has two outages per year 2.8% more often than LEE.

Assumptions used for the Simulations

The following assumptions were used when completing the simulations:

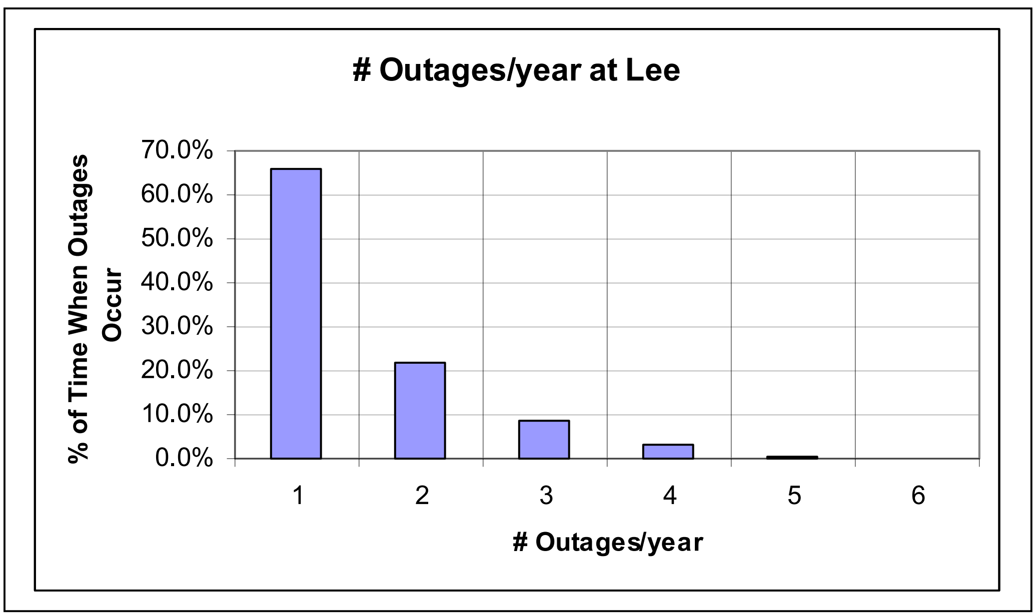
- The load forecast as provided by Fortis is valid for both Lee Substation and the proposed Black Mountain Substation.
- The forced outage statistics obtained from the 2003 CEA Forced Outage Performance of Transmission Equipment realistically reflects equipment installed at the Lee Substation and planned for Black Mountain Substation.
- Transformer End of Life probabilities as identified in “Guide on Economics of Transformer Management by Cigre WG 12-20 – Draft 23.7-02
- Forced outage data as provided by Fortis is reflective of system performance.
- The forced outage rate for the Lee F2 feeders as well as the future Black Mountain feeders are as assumed based on data for the Lee F1 feeder. Refer to Section 8, page xx.
- A winter peaking load shape is assumed.

Within the limits of the assumptions, the supply from Black Mountain should serve the load with fewer outages/years than a similar supply from Lee.

Investigation into the impact of distribution feeder related through faults on the Lee system transformers

The models developed for the simulations were designed to provide a comparative summary of the total number of outages in the simulation period for each model, i.e., the Lee Substation model and the Black Mountain model.

The number of outages calculated by the program is a reflection of the probable through fault duty on the T3 and T4 tertiary windings. Transferring the distribution load from Lee Substation to adjacent distribution substations as well as the planned Black Mountain Substation will reduce the fault duty on the Lee transformer tertiary windings by approximately, 1 -3 through faults per year on average.



Tertiary windings on a system transformer are a relatively low cost source for serving distribution load. The practice defers the need for a dedicated transformer with associated switching and control and is efficient in terms of the substation land area required for equipment and facilities. The concept has limitations, as additional equipment is required to provide a supply that meets conventional standards, i.e. CSA standards.

As tertiary windings are delta connected, an associated grounding transformer is required to allow ground fault currents to be detected when a feeder fault occurs. Voltage regulation may need to be added to ensure that the unregulated supply side voltage is within acceptable limits prior to delivery to customers. There may be a need for reactive power to support the supply voltage.

The three-phase short circuit level at the tertiary may exceed acceptable limits leading to a requirement for a series reactor to limit short circuit current.
The additional equipment will require circuit breakers to meet protection requirements and quickly isolate a faulted element.

All of the above equipment is required at the Lee Terminal substation to enable supply of distribution customers from the transformer tertiary. These additional elements each represent an additional risk of failure leading to a fault whereby the transformer tertiary is subjected to through fault current. Fortis advised that the available three phase short circuit was about 20kA. Therefore when one of the above elements failed, the tertiary would have been subjected to a through fault current of up to 20 kA. Until recently, a Lee distribution feeder fault would result in through current of up to 20 kA, which would be reduced as the fault location moves further from the substation.

Series reactors to reduce the short circuit level on the feeders were not installed until quite recently. The reactors will not affect the short circuit level between the reactors and the transformers.

Specific details on individual utility practices regarding supplying distribution loads from a system transformer tertiary are not available. Some utilities avoid utilizing the tertiary winding for supplying loads external to the substation to eliminate the additional risk associated with through fault currents.

There has been discussion relating to the risk to system transformers resulting from through faults. It has been of particular concern with distribution loads supplied from the tertiary windings increasing the frequency of occurrence for through faults.

A search for technical papers related to the topic carried out at the IEEE XPLORE web site identified two papers specifically related to this subject. The search, however was not exhaustive and was limited by available access to the IEEE database. Without doubt, other papers have been written on the subject.

Industry Standards

The papers were written in 1975 and 1976 and refer to IEEE and IEC standards in effect at that time. The Fortis transformers under consideration were commissioned into service in 1979 (T4) and 1985 (T3) respectively and would have been manufactured under the standards of the day which would very likely been the same ones referred to in the paper. At any rate, no information on when the specific standards may have been revised to reflect the concerns in the papers was located.

1. <u>Transformer Short circuit Strength and Standards – A State of the Art Paper</u>
   <u>By WJ McNutt, CJ McMillien, PQ Nelson and JE Dind.</u>

   Published in
   IEEE Transactions on Power Apparatus and Systems, Volume PAS, #2, Mar/Apr 1975

   Referring specifically to the paper for several key points:

Introduction – pg 432

"Industry failure statistics indicated that a predominant percentage of the major power transformer service outages were associated with the through-flow of current to system faults."

Review of Section 10 of ANSI C57.12.00

1. Short Circuit Life – pg 432

> *"The present wording requires a transformer to "be capable of withstanding without injury the mechanical and thermal stresses caused by short-circuits".*
>
> *In fact, transformer materials are inelastic and their condition can be altered by the cumulative effects of repeated mechanical and thermal stresses.*

6. Inherent Capability Limits – pg 433

> *Each material or component assembly has certain inherent strength limits beyond which deformation or some mode of failure will occur.*
>
> *However, it appears that due recognition was not given to the fact that such an Inherent capability limit existed when the arbitrary 25 times normal current capability limit was set.*

Short Circuit Life pg 433

> *"It is well-known that in the continuous operation of a transformer there is a gradual relaxation of the windings, leading to a sharp reduction of their dynamic strength. This is due to the contraction of the pressboard and the paper turns insulation. The main causes of the contraction are the ageing of the insulation and its effect on the specific mechanical characteristic.*
>
> *Cellulosic insulation, which is major component of all liquid-filled transformers, undergoes two types of physical change in service. When it is mechanically loaded in compression it is not capable of retaining its original compressed dimension and its original loading pressure over a long period of time.*

The combination of these two changes makes it unrealistic to anticipate retention of the original short-circuit capabilities of a transformer throughout its lifetime.

pg 434

Another event which accelerates the relaxation of compressed insulation is a short-circuit,

The consequence of the facts presented in this section is that transformers do not retain undiminished capability to withstand short-circuits throughout their service lifetime.

Times Normal Current Limits pp 436

The upper limit of 25 times normal current withstand capability in, the present standard seems to have been arrived at in an arbitrary fashion. No attempt was made to relate it to inherent capability of materials or designs, a subject discussed in a later section of this paper, Nor was there any indication of how the current was to be limited if the transformer impedance would permit magnitudes of greater than 25 times normal. This was a particular problem for autotransformers and multi-winding transformers having reduced capacity tertiary windings. Too frequently the fact was not recognized that specified transformer impedances would result in more than 25 times normal.

2. The combined effects of Thermal Aging and Short circuit Stresses on Transformer Life.
   by W.J.McNutt and M.R. Patel

   Published in
   IEEE Transactions on Power Apparatus and Systems Volume PAS-95, # 4 July/August 1976.

Introduction pg 1275

> *In the late 1960's when service problems stirred renewed interest in the short-circuit integrity of transformers, a second set of questions was asked regarding transformer life. "What is the short-circuit life of a transformer?" "What is the relative effect of one severe short-circuit versus multiple lesser faults?"*
>
> *Tear down of transformers which failed as a result of short-circuits have revealed conductor insulation which was mechanically worn to the point of rupture in regions of high compressive stress.*
>
> *Considering these observations it is relatively easy to establish a hypothesis for the progressive steps in the process of insulation degradation and ultimate breakdown for a service aged transformer. First, thermal aging over a period of years reduces the mechanical strength of the insulation. 'Second, repeated mechanical stresses resulting from short-circuit forces contribute to the mechanical weakening and eventual rupture of all or a portion of the weakened insulation. Finally, the reduced dielectric strength of the ruptured insulation allows a dielectric failure during a period of transient over-voltage.*

Relative Effects of Short Circuits pg 1282:

> *Once a qualitative life relationships such as equations have been established, there may be a temptation apply it directly to answer the question; "What is the short circuit life of a transformer?"*

For example, if equation (7) for disk windings is used, reducing the short circuit current by 10% reduces the mechanical stress by 19% and increases the wear life by a factor of 2. It can be seen that this isn't a significant reduction when the spread of life data is examined in Figure 7. However, if the short circuit current is reduced by 50% of maximum, the mechanical stress is reduced to the 25% level and the wear life is increased by a factor of 140.

Conclusions: pg 1283

6. Short circuit currents below 50% of the maximum possible value have an inconsequential effect from the point of view of insulation wear. However, over large numbers of cycles, they still contribute to insulation compaction.

Comment: The installation of the series reactor will have mitigated further damage on the basis of the magnitude of previous faults was. However ongoing of through faults due to supplying distribution loads from the T3/T4 tertiary windings could still lead to a failure of either transformer on the basis of the numbers of faults.

The CSA standard, C-88 of the day specifies that a winding is to be able to withstand 25 times ONAN current in order to withstand mechanical and thermal stresses associated with through faults. It is assumed, but not clear if this extends to the tertiary winding of a three winding transformer.
The impedance of the third winding is not independent of the two other windings.

The IEEE papers are included with this report as attachments.

Conclusion

The primary focus for the project was to investigate the risk associated with serving distribution load from the tertiary of large system transformers. The model developed for the simulations excluded all elements serving the 132 kV load that could lead to a transformer tripping or an outage. A loss of service to the 132 kV system would only occur if a double contingency T3-T4 outage occurred. The simulations did not see this occur. Only equipment and elements directly required to serve the distribution load were considered. Forced outage statistics for the system transformers were included to collect impacts related to numbers of transformer outages, however only distribution load would be impacted.

The simulations determined that the transformer tertiaries are subjected to average 1-3 more outages each year that will not occur if the distribution load is transferred to other substations.

A search of technical papers available at the IEEE XPLORER database located two papers relevant to the question. The search was limited to available access. Other similar papers may be in the database.

The papers describe risks to transformers resulting from through faults. Series reactors to limit tertiary through fault current were not installed until relatively recently hence close in faults in the past may have been a significant percentage of the maximum permitted for the transformer design.

The conclusion is that off-loading the transformer tertiary to reduce the frequency of through faults is recommended. A review of the manufacturers and the specification under which the transformers were purchased and manufactured might be appropriate to establish what the through fault rating for the tertiary windings is.

The reliability evaluation shows that within the limits of the assumptions made, supply reliability for customers to be served from the new Black Mountain Substation will be improved. The evaluation shows that the frequency of occurrence for distribution outages will be lower. The reduced EENS reflects the increased reliability that arises from a reduction in the number of elements, i.e. equipment, needed to supply the load. The existing Lee substation must have additional equipment such as voltage regulators, series reactors, and individual feeder shunt capacitors. Requiring additional equipment adds elements that can fail and lead to an outage.

Recommendations

The reliability evaluation computes the frequency of occurrence for though faults originating from feeders faults external to the Lee Substation. Associated distribution equipment located in the switchyard required to serve this load increases the frequency of occurrence and hence the risk of damage to Lee T3-T4 system transformers.

The transformers are now 21 and 27 years of age respectively4. Any damage to insulation or other compressible material supporting the windings that may have occurred in the past will only be exacerbated by continued aggravation resulting from through faults.

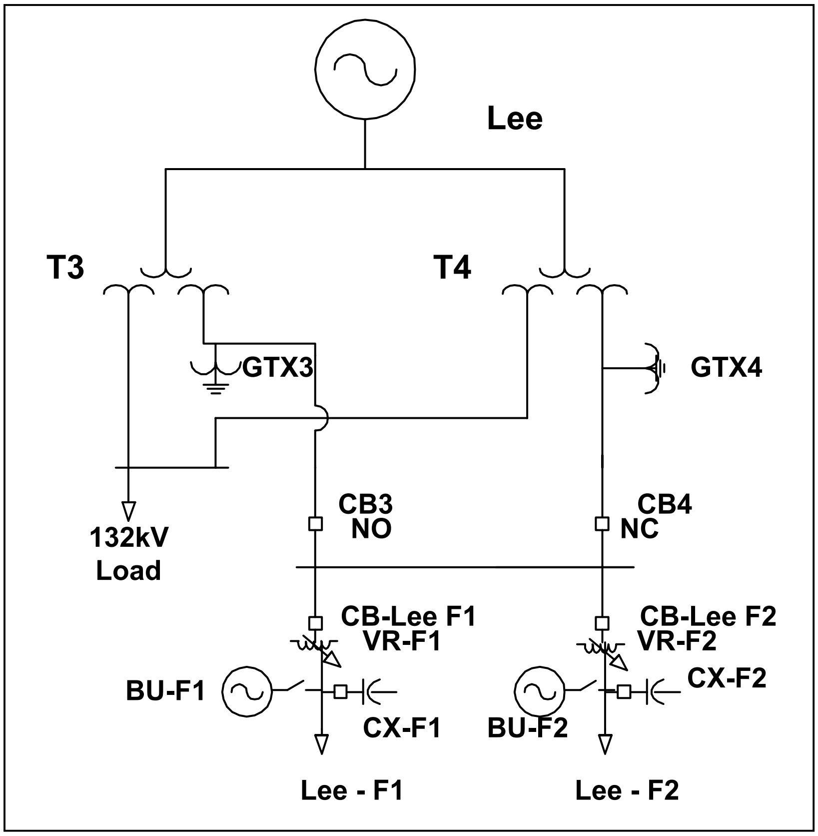
The installation of the series reactors to limit through fault current is a positive step forward; however they serve only to reduce the impact of ongoing through faults on the transformer tertiary windings.

The original specifications and standards under which the transformers were manufactured should specify the through fault rating for the tertiary windings. A review of the original specifications may be in order to verify that the degree to which tertiary through fault currents is within the winding design.

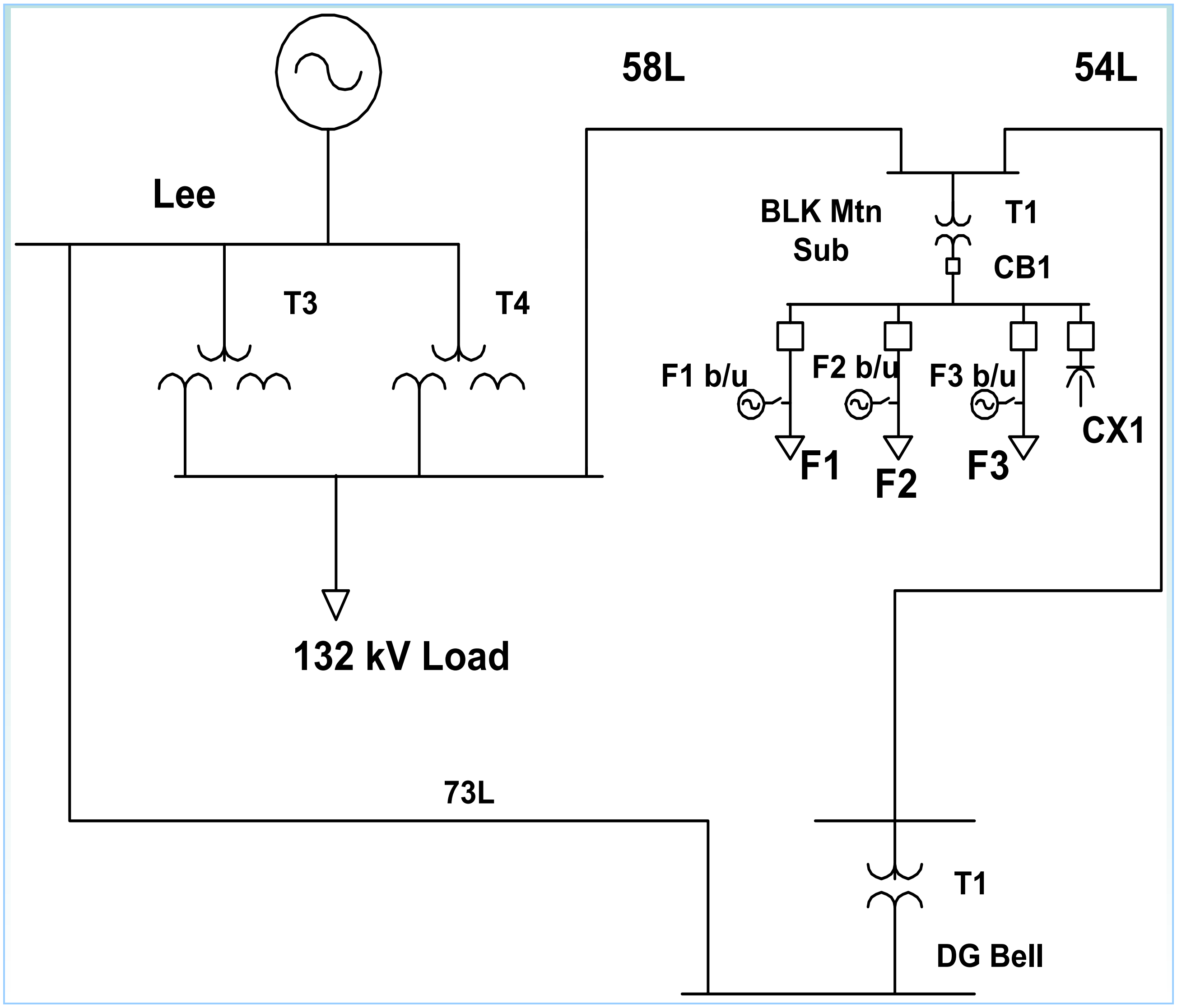
Fortis is recommended to proceed with the plans to off load distribution load from the T3-T4 system transformers to ensure that the risk of future internal damage due to the relatively frequent through faults will be minimized.

Forced Outage data and Simulation Models

Lee Substation Model



Black Mountain Substation Model



Forced Outage Data Applied

Lee Substation forced Outage Data			
	Frequency	duration	
73L	1.17	0.13	
51L	1.1	0.048	
54L	0.078	0.22	
F1	0.47	0.5	
F2[1]	0.25	0.5	**assumed**
1. Data supplied by Fortis showed that F2 had not expereinced			
a full outage during the 6 year period covered by the statistics			
A frequency , 50% of the F1 outage arte with the same duration			
for the simulations.			

54L is tapped for BLK Mtn		
54L is 15.7 kM long		
Lee-BLK - 5 km		
DG Bell-BLK - 10.8 kM		
	Calculated	
	Frequency	**Duration**
Lee-BLK	0.025	0.070
DGB-BLK	0.054	0.151

Lee Substation Load Forecast without Black Mountain

	From									
	FortisBC Distribution Load Forecast 2006.xls									
	2002/03	**2003**/04	**2004/0**	**2005**/06	**2006/07**	**2007/08**	**2008/0**	**2009/10**	**2010/11**	**2011/12**
Lee Tert	14574	15100	18912	17622	18712	20629	21575	22520	23466	24411
F1	13000	13190	12873	12390	13678	13678	13678	13678	13678	13678
F2	3110	6047	5874	7516	8997	8997	8997	8997	8997	8997
F2Lee Tot	21.3%	40.0%	31.1%	42.7%	48.1%	48.7%	51.5%	54.0%	56.3%	58.4%
					51.9%	51.3%	48.5%	46.0%	43.7%	41.6%

Lee Substation Load Forecast with Black Mountain

	Forecast Loads in the Model										
	Lee Model Loads					**BLK Loads**	**Yr 08/09 taken from Table 1 CPCN**				
Yr		**F1**	**F2**	**132**		**F1**	**F2**	**F3**		BLK I/S - 2008/09	
0	2006/07	10.7	8.3	261.2	2006/07	0	0	0			
1	2007/08	11.1	11493.1	282.3	2007/08	0	0	0		F1-F3 Load	
2	2008/09	10.9	13913.4	298.5	**2008/09**	**6600**	3050	2090	11740		8690
3	2009/10	10.8	15371.9	313.8	2009/10	8499	5738	2606	16843		11105
4	*2010/11*	*10.3*	*16871.1*	*330.9*	*2010/11*	8585	6349	2967	17901		11552
5	2011/12		19036.9		2011/12	9009	7376	2978	19363		11987
6	2012/13		19734.2		2012/13	9249	7570	2989	19808		12238
7	2013/14		20430.5		2103/14	9570	7677	3000	20247		12570
8	21014/15		20899.1			9840	7677	3011	20528		12851
9	2015/16		21392.3			10121	7677	3022	20820		13143
10	2016/17					10326	7677	3034	21037		
	F2 rating exceeded in 20010/11										

System Transformers T3 and T4			Comments
230/138/13.2	**Freq**	**Duration-Hrs**	**End of Life Probablility**
T3 (Tertiary)	0.0612	286	0.01
T4 (Tertiary)	0.0612	286	0.01
Black Mtn	**Freq**	**Duration-Hrs**	
138/13	0.0632	289	0.005
Assume Bulk oil CBs			
Circuit Breaker	**Assume below 109 kV values**		
15kV -	**Freq**	**Duration-Hrs**	
	0.0332	370	Assume 72 hours
Voltage Regulator -			
Assume windings and OLTC only - < 109 kV Values			
15kV -	Freq	Duration-Hrs	
	0.013	420	Assume 1-2 hrs
Shunt Capacitor bank			
Assume below 109 kV values			
15kV -	**Freq**	**Duration-Hrs**	
	0.0727	832	Assume 1-2 hrs
GTX - Assume winding/ insulation only for < 109 Kv Tx			
15kV -	**Freq**	**Duration-Hrs**	
	0.002	768	Assume 1-2 hrs
Reference:			
CEA - Forced Outaged Performance of Transmission Equipment			
2003 Report			

References

1. Transformer Short circuit Strength and Standards – A State of the Art Paper
   By WJ McNutt, CJ McMillien, PQ Nelson and JE Dind.
   Published in
   IEEE Transactions on Power Apparatus and Systems, Volume PAS, #2, Mar/Apr 1975

2. The combined effects of Thermal Aging and Short circuit Stresses on Transformer Life.
   by W.J.McNutt and M.R. Patel
   IEEE Transactions on Power Apparatus and Systems Volume PAS-95, # 4 July/August 1976.

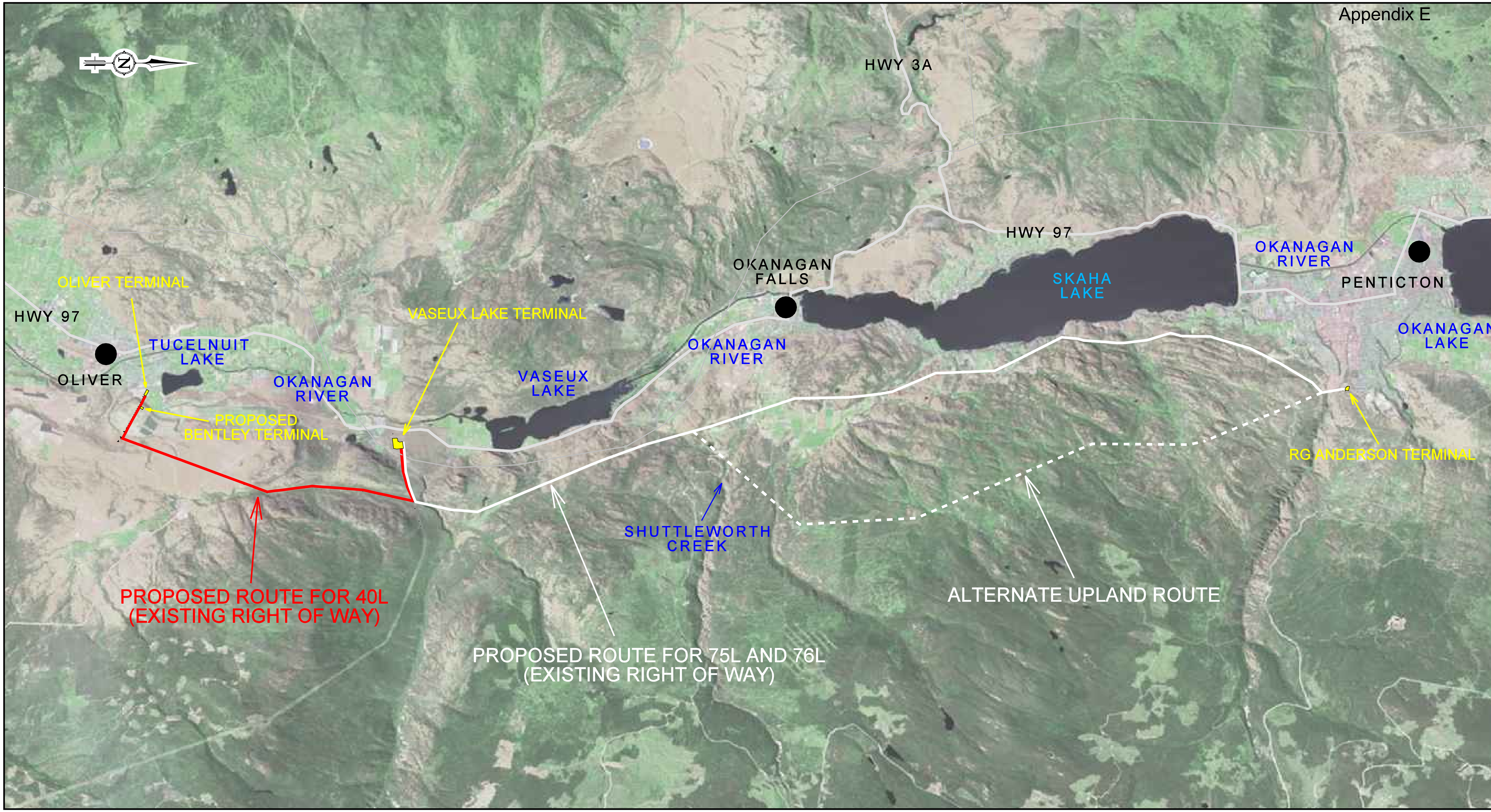
3. CPCN - Black Mountain rev 1.doc -

4. Fortis Drawing # 372-2009 (Relay) pdf, Fortis Drawing # 372-2007 (Relay) pdf

“2003 - CEA - Forced Outage Performance of Transmission Equipment” - Forced outage statistics for transformers, circuit breakers, shunt capacitors and voltage regulators.

“Guide on Economics of Transformer Management by Cigre WG 12-20 – Draft 23.7-02 - Transformer End of Life probabilities.

Index of Maps



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DIGITAL ORTHOPHOTO METRIC MAP

UTM ZONE 11, NAD83
BCGS REFERENCE: 82E

LANDSAT 2004 SATELLITE IMAGE
30 METER PIXEL RESOLUTION

4K 0 4K 8K

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION		
								DESIGNED BY	
								DRAWN BY	GJB
								CHECKED BY	
								APPROVED BY	

FORTISBC

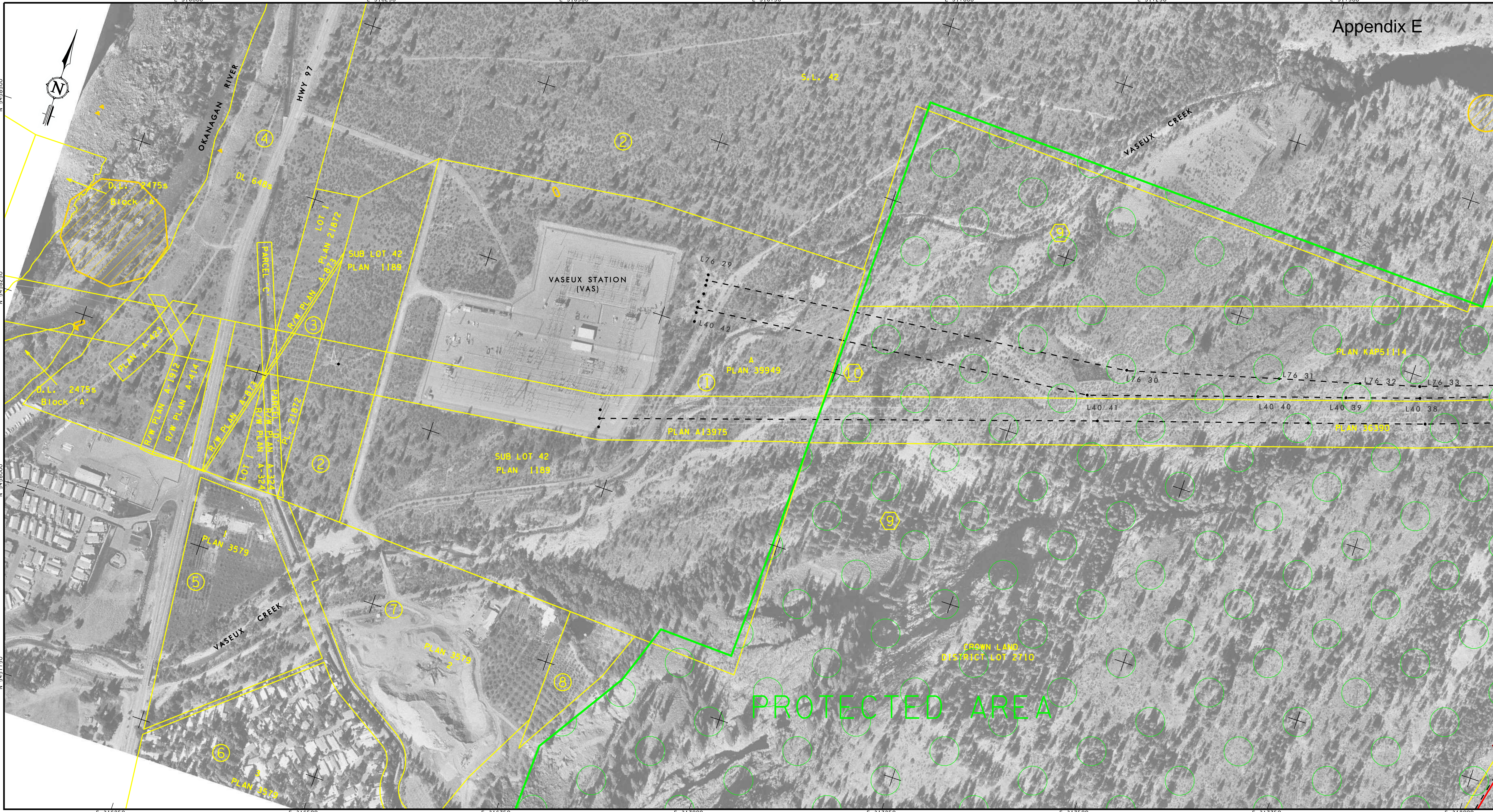
BChydro ENGINEERING

BC HYDRO DWG NO. 40L - T07 - B2 R C

FORTIS BC - OTR PROJECT
TRANSMISSION ROUTES
STATELLITE MAP
Rev C - 28 Sept.07 - Refinements to Alt. Upland Route
SHEET 01 OF 01

DRAWING NUMBER	REV
40L - T07 - B2	D

Appendix E



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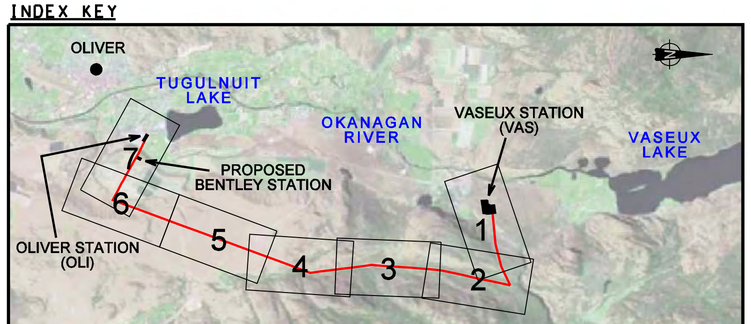

LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES

- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services, BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

PRELIMINARY

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION		
								DESIGNED BY	
								DRAWN BY	GJB
								CHECKED BY	
								APPROVED BY	

FORTISBC

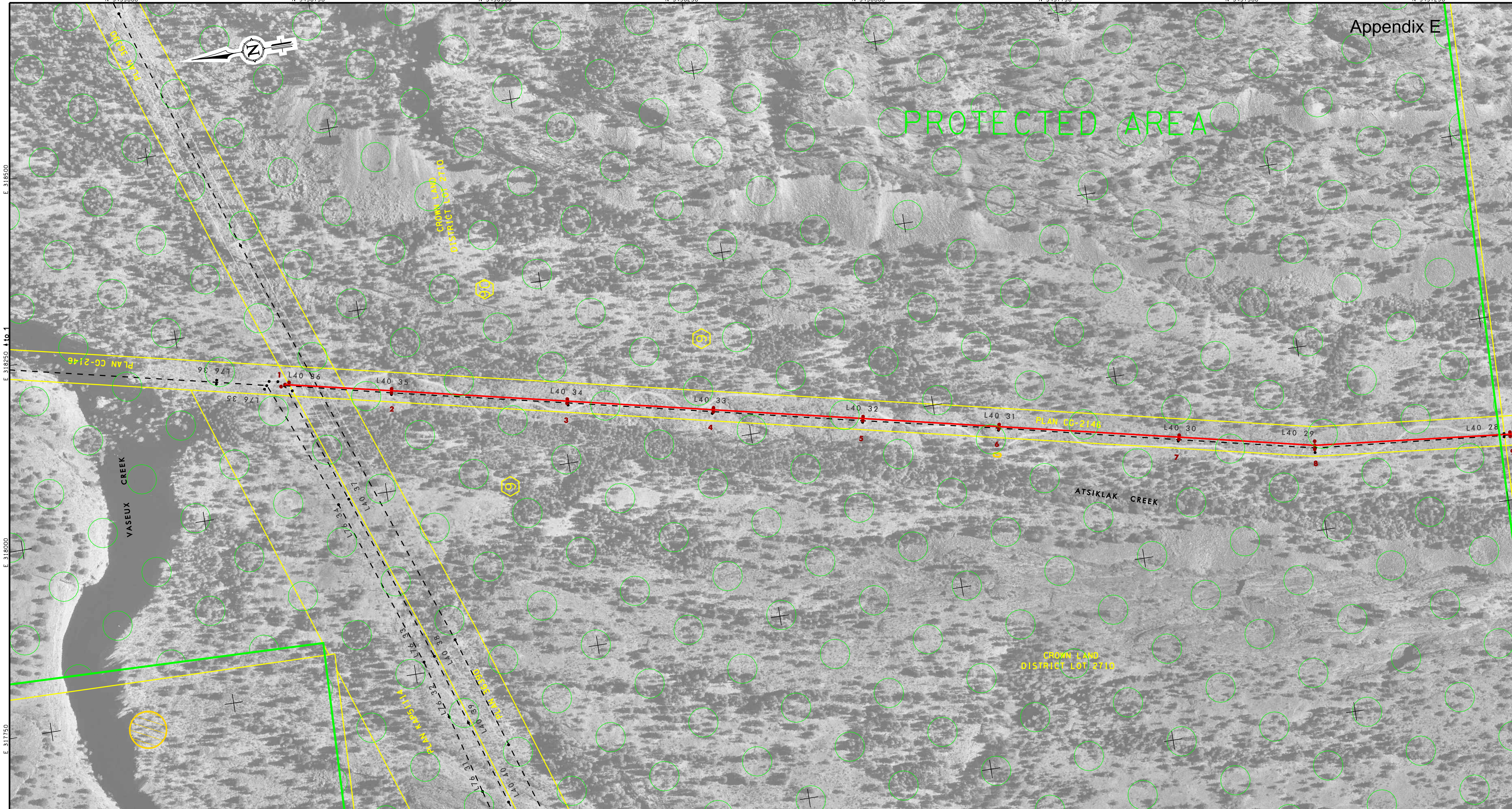
BC hydro ENGINEERING

BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP
SHEET 01 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E



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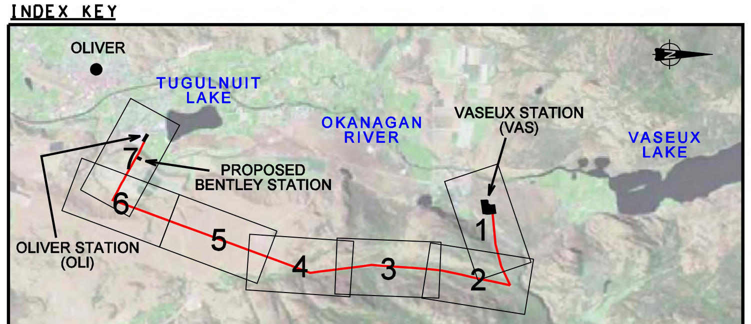


LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

PRELIMINARY

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION		
								DESIGNED BY	
								DRAWN BY	GJB
								CHECKED BY	
								APPROVED BY	

FORTISBC

BC hydro ENGINEERING

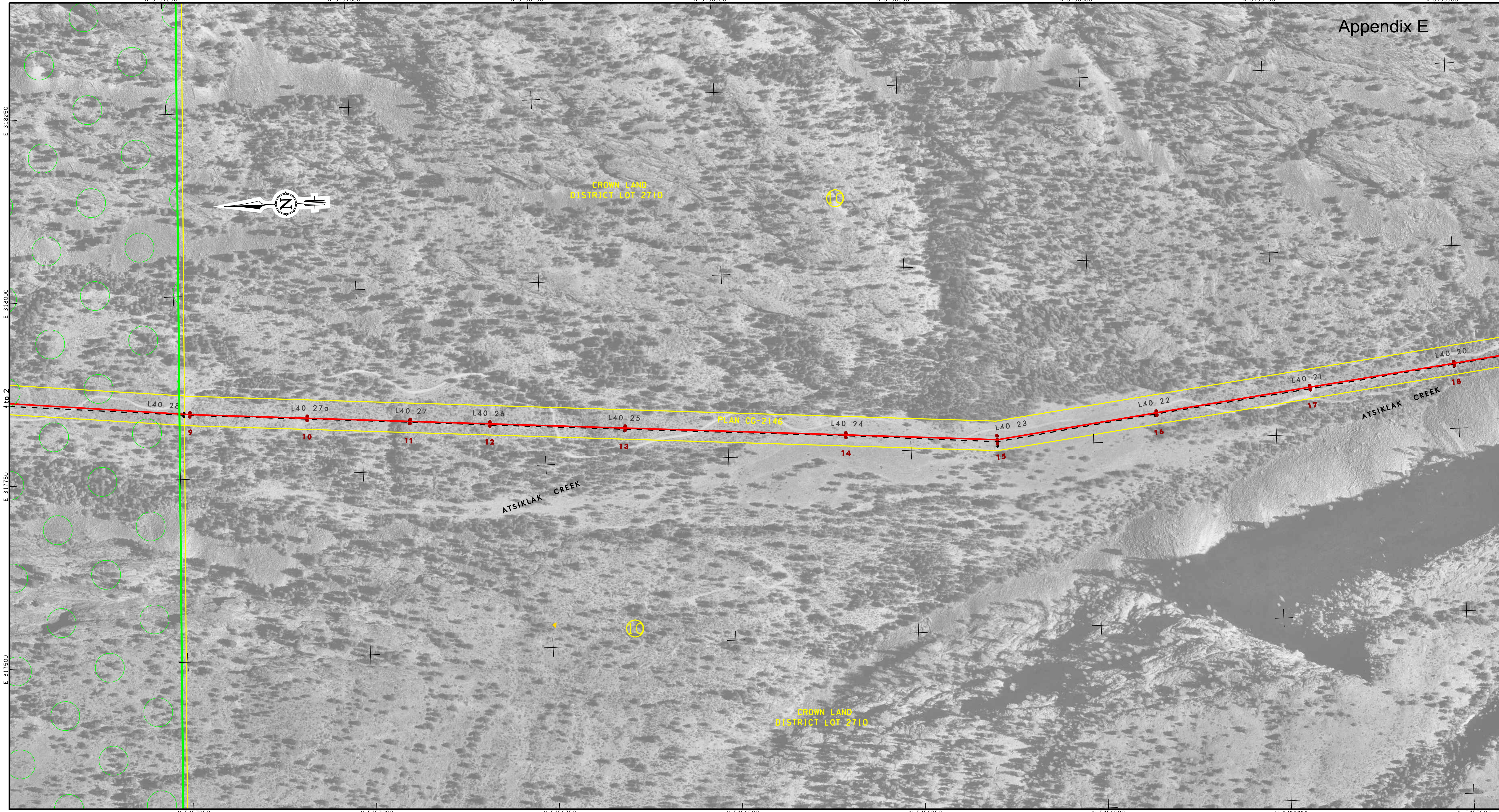
BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP

SHEET 02 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E



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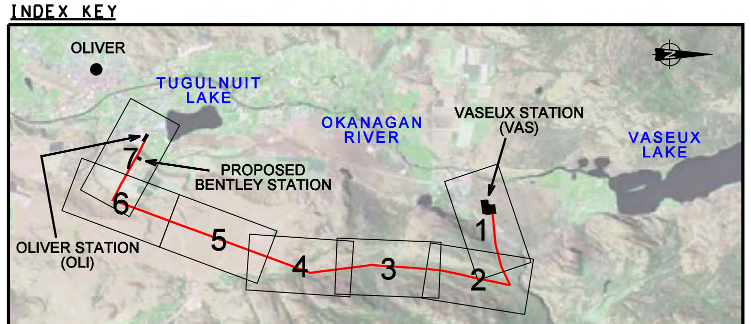

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

PRELIMINARY

No.	BY	DATE	DESCRIPTION	No.	BY	DATE	DESCRIPTION		
								DESIGNED BY	
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FORTISBC

BC hydro ENGINEERING

BC HYDRO DWG NO. 40L - T07 - D3 R G

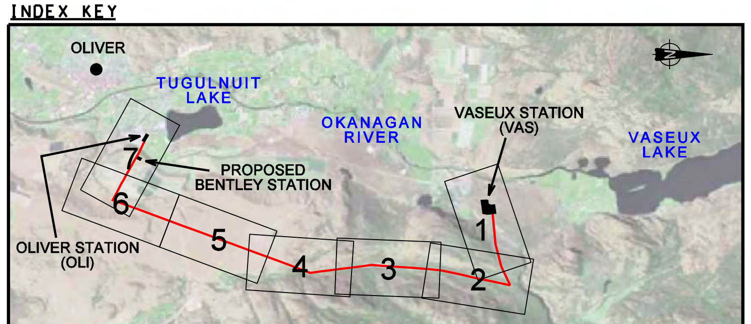
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP

SHEET 03 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E

INDEX KEY



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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ORTHOPHOTO GENERATED AND
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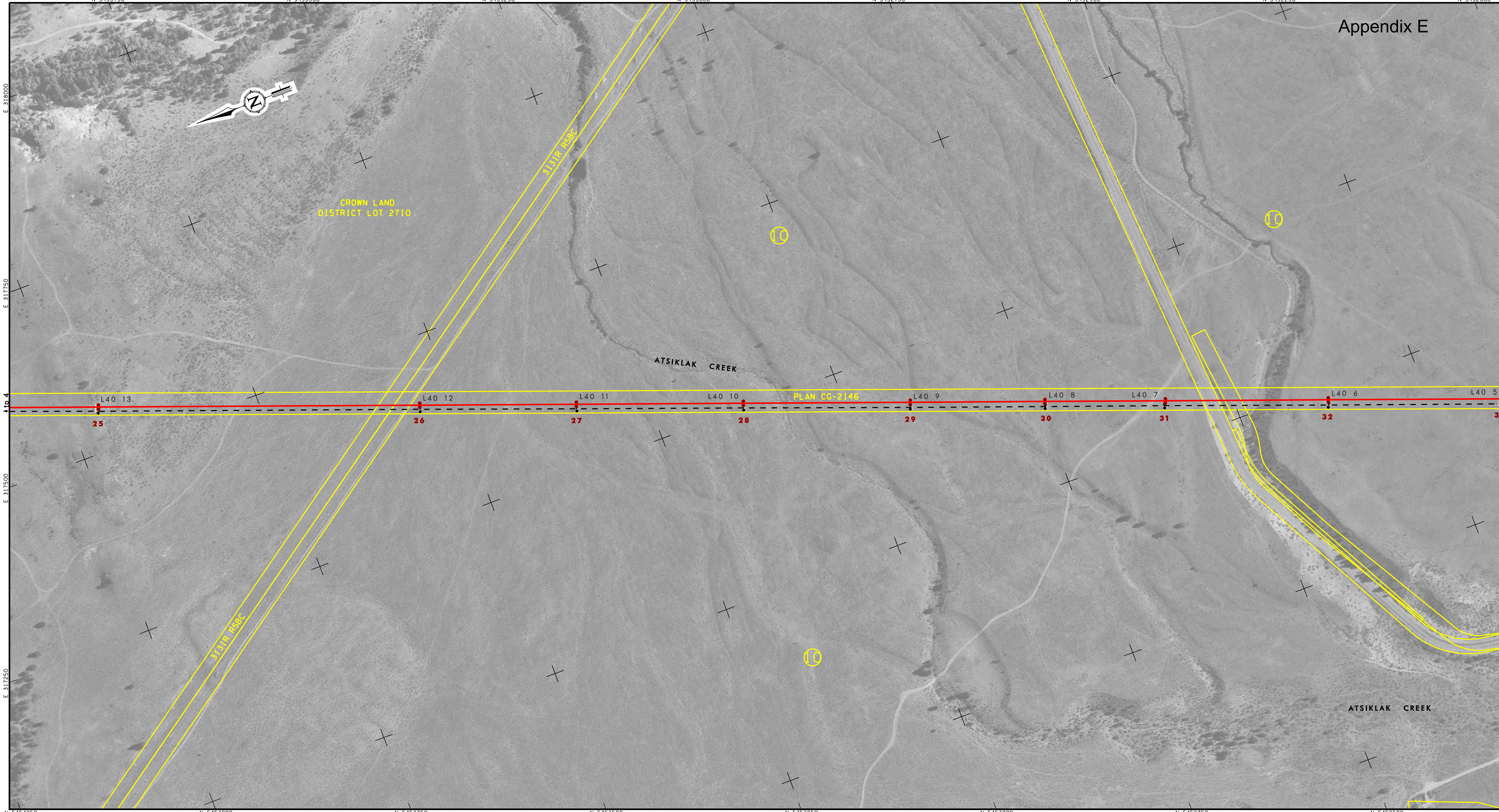
BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP

SHEET 04 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E



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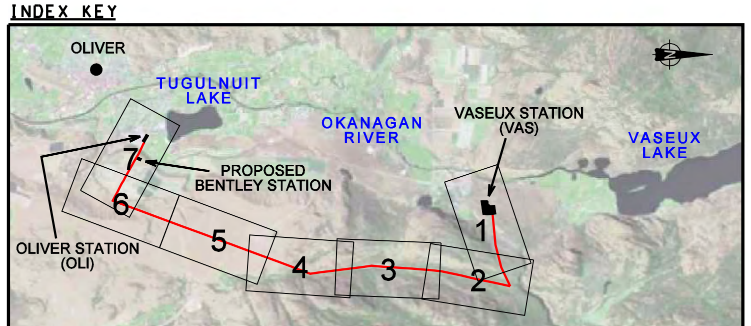

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

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BC hydro ENGINEERING

BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP

SHEET 05 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

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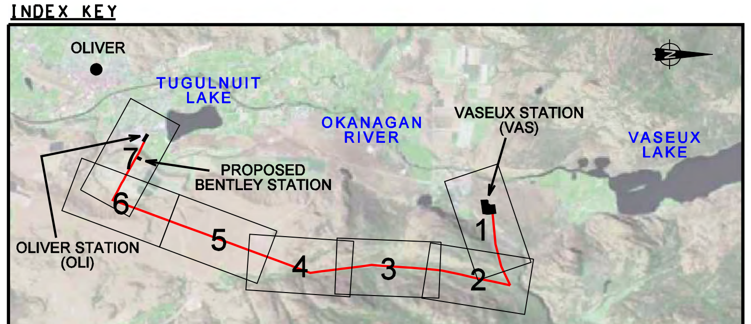

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

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CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

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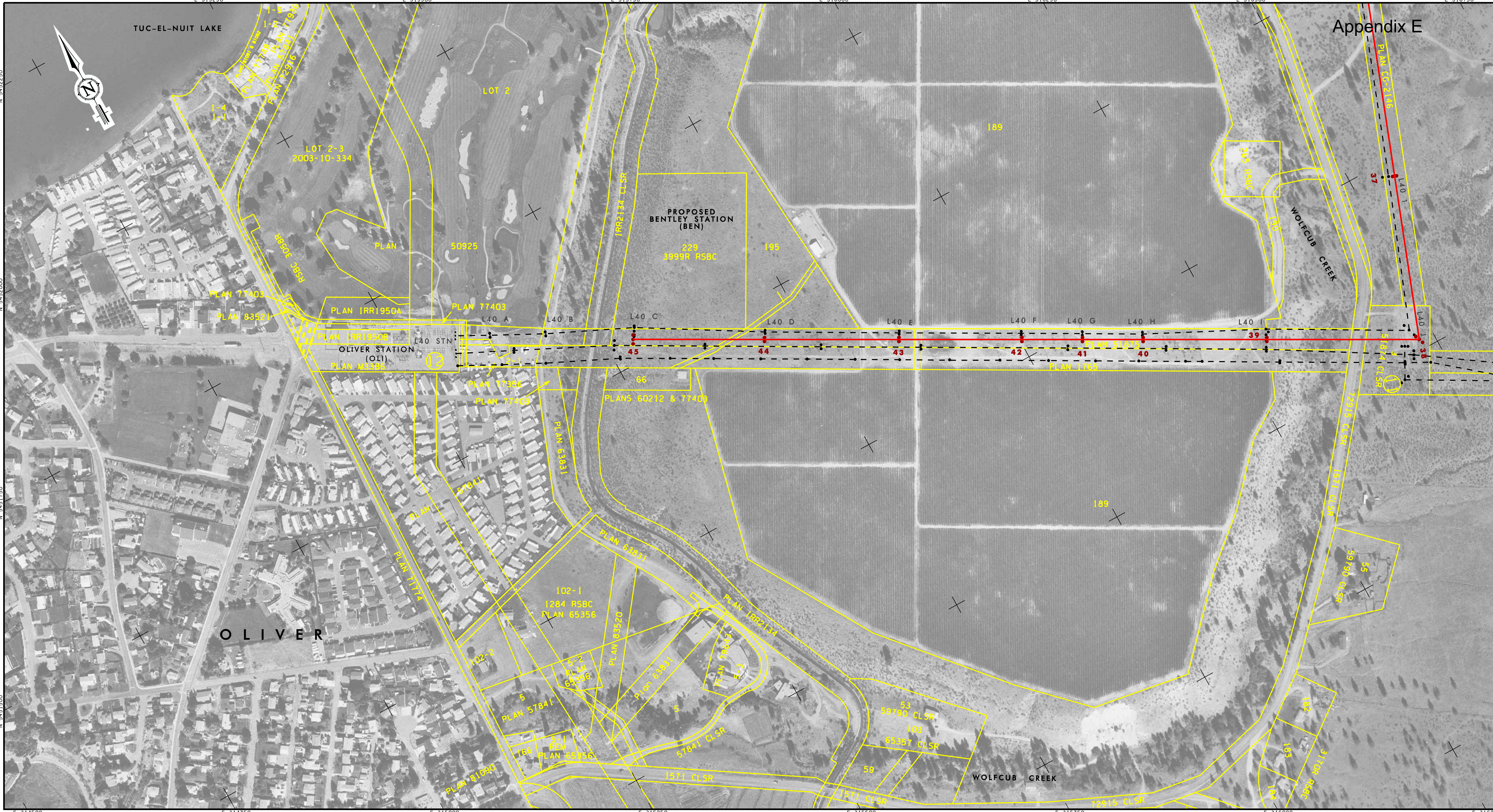
BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP

SHEET 06 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E



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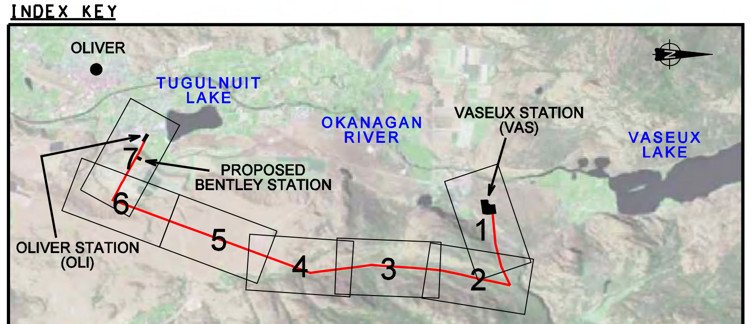

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

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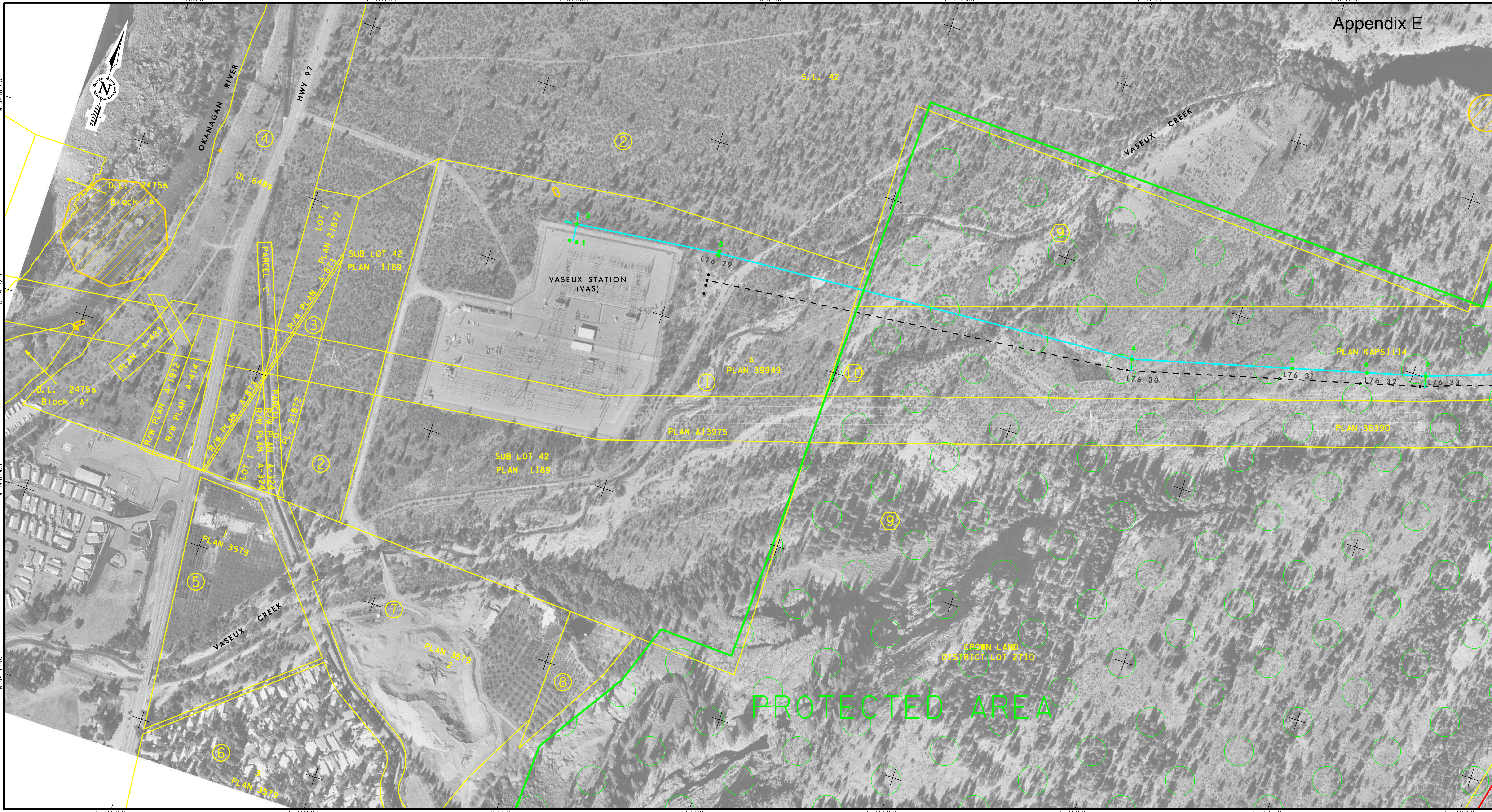
BC hydro ENGINEERING

BC HYDRO DWG NO. 40L - T07 - D3 R G

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
40L VAS - BENTLEY - OLIVER
ORTHOPHOTO MAP
SHEET 07 OF 07

DRAWING NUMBER	REV
40L - T07 - D3	G

Appendix E



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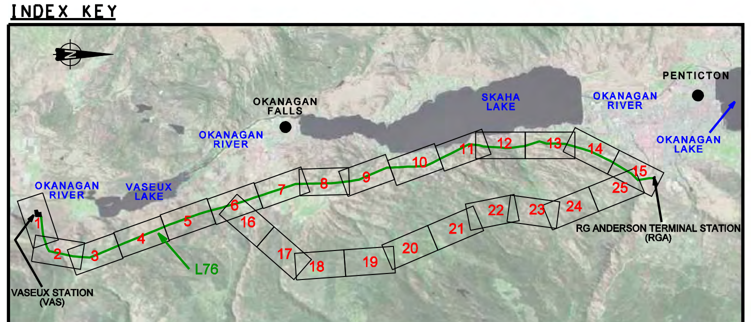

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

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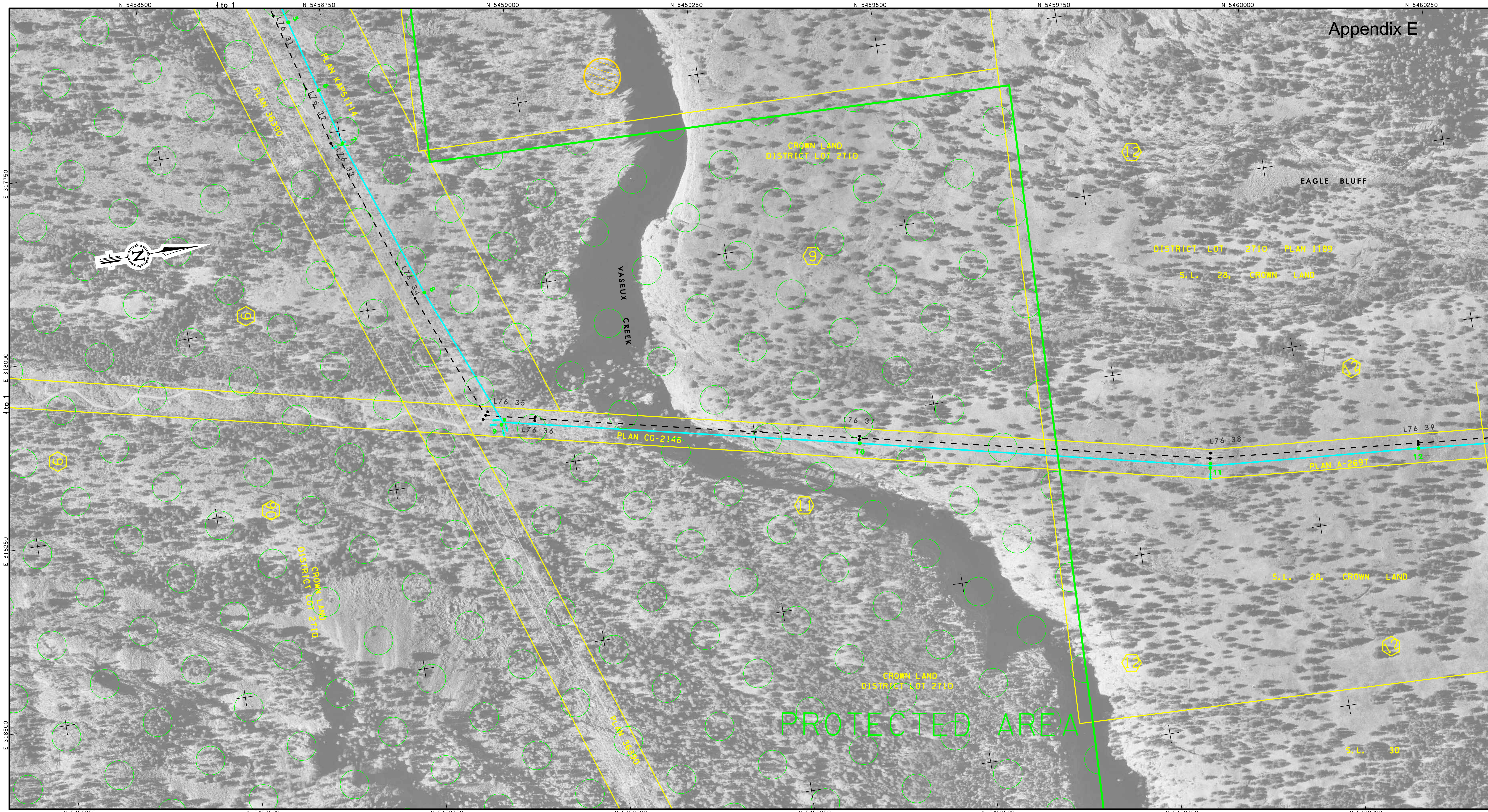
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 01 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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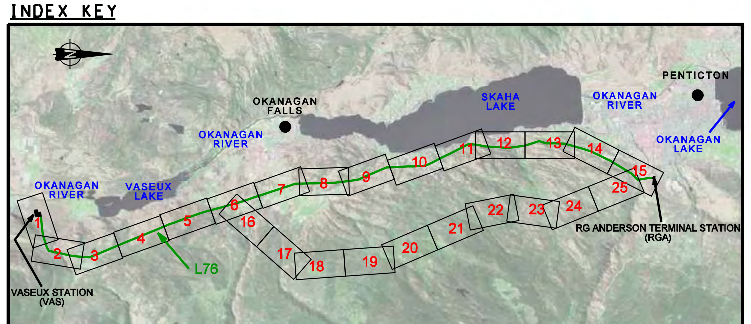

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

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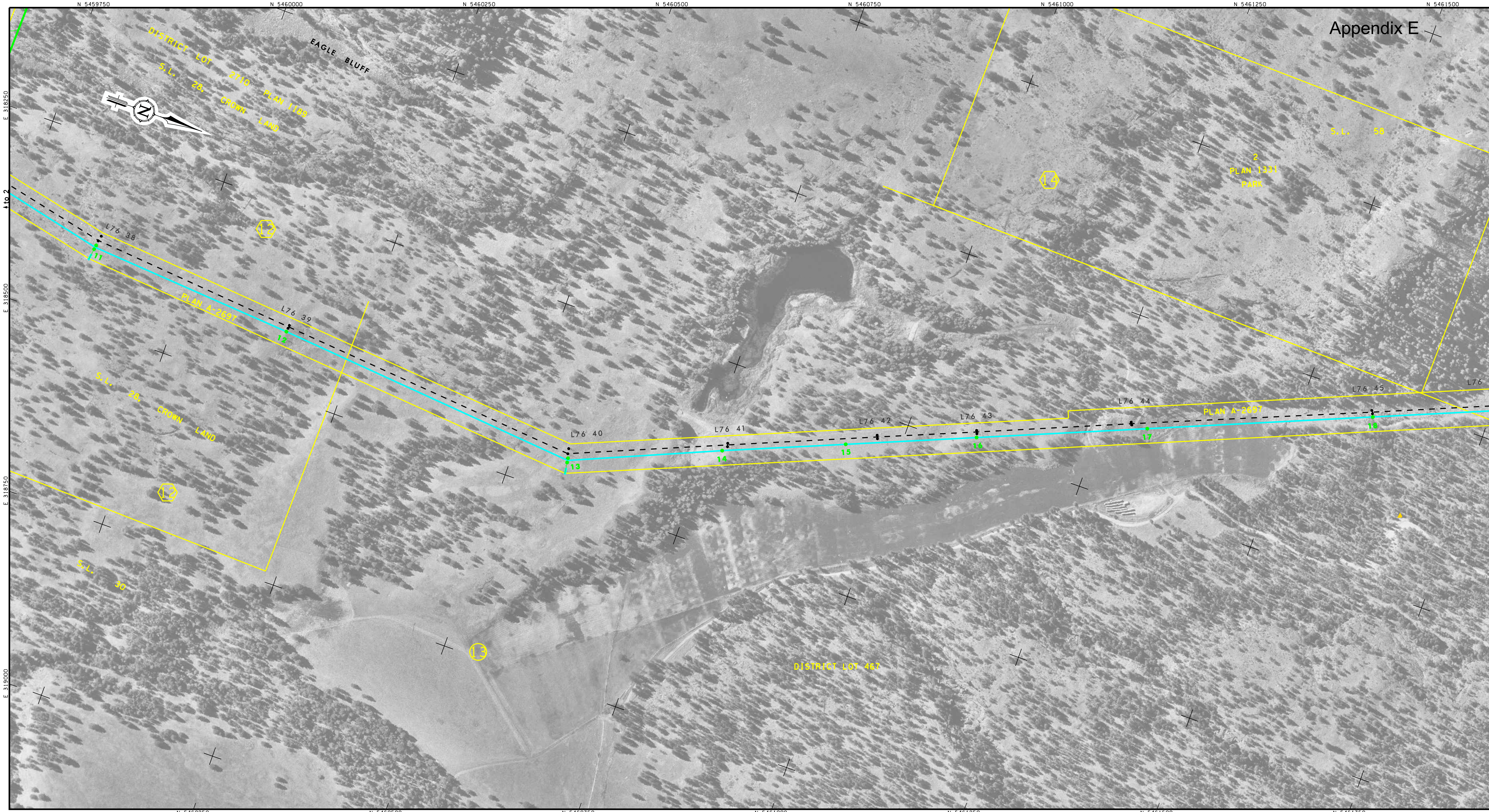
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 02 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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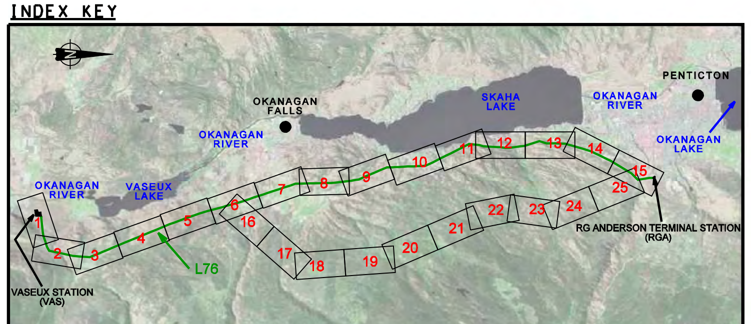

LEGEND

EXISTING TRANSMISSION CIRCUIT
- STEEL STRUCTURES: RIGID, GUY: STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT
- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES

- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

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BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 03 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E

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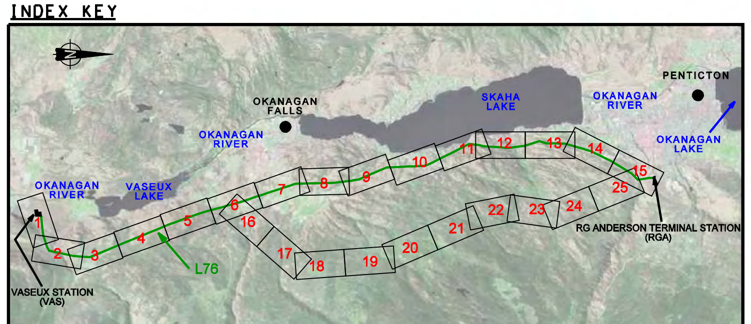

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

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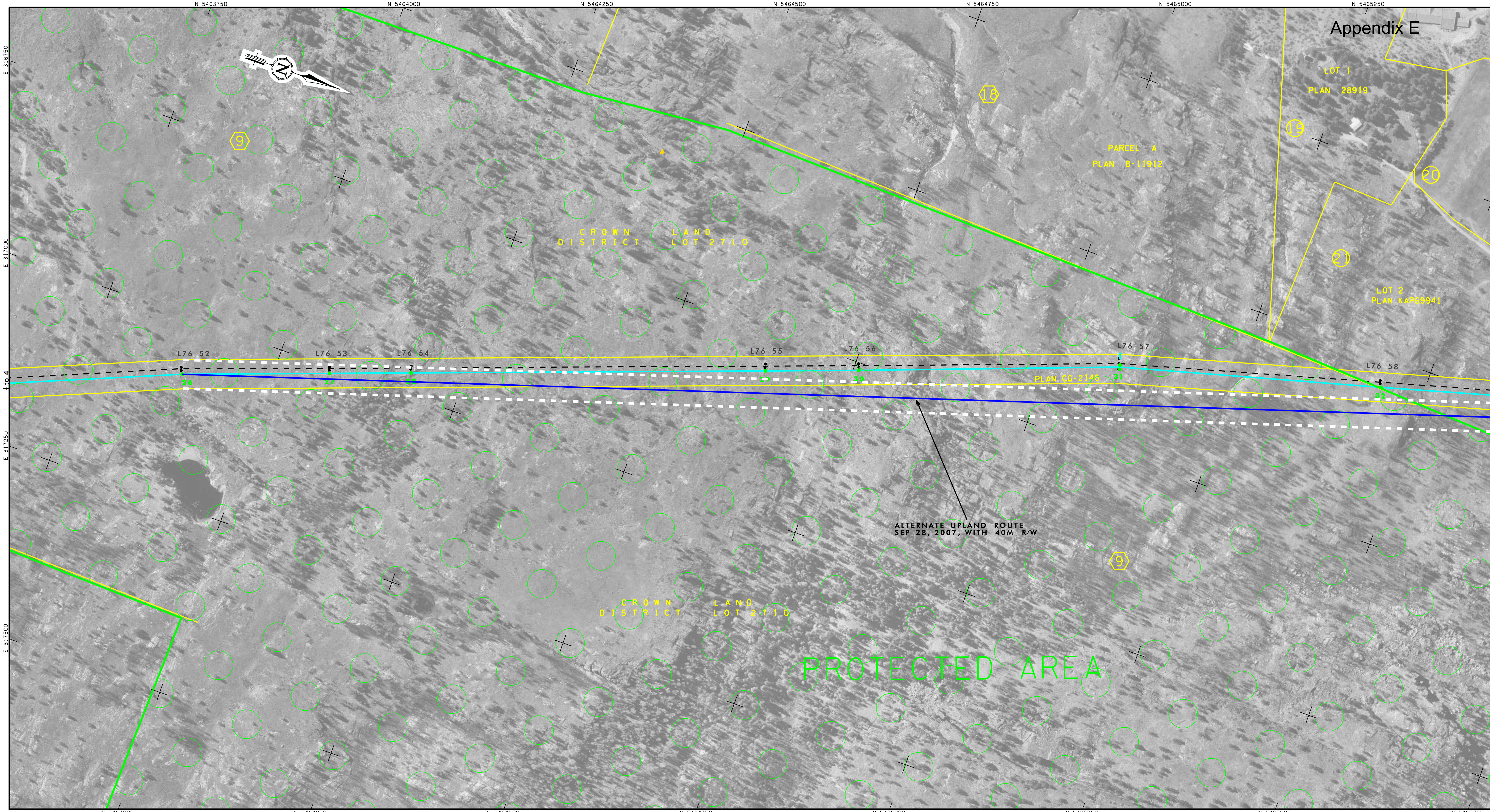
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 04 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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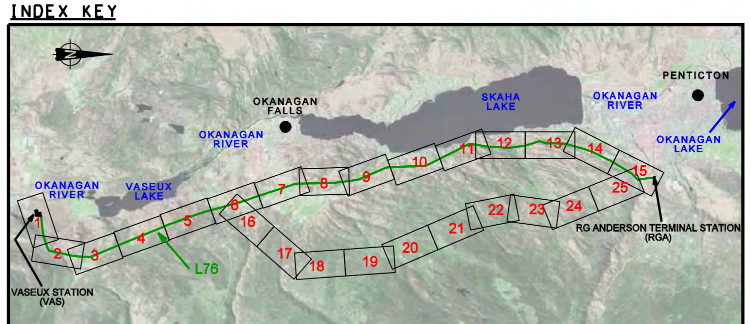

LEGEND

EXISTING TRANSMISSION CIRCUIT	PROPOSED CIRCUIT
STEEL STRUCTURES: RIGID, GUY: STEEL	STRUCTURES: POLES, GUY LINE AND ANCHOR
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE	STRUCTURE NUMBER — 2/3
HORIZONTAL INSULATOR POLE	CENTRELINE TRANSMISSION LINE
STRUCTURE NUMBER — 2/3	ARCHAEOLOGICAL SITES
CENTRELINE TRANSMISSION LINE	CADASTRAL BOUNDARY
	PROPERTY LINE LIST NUMBER

100 0 100 200m

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BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 05 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

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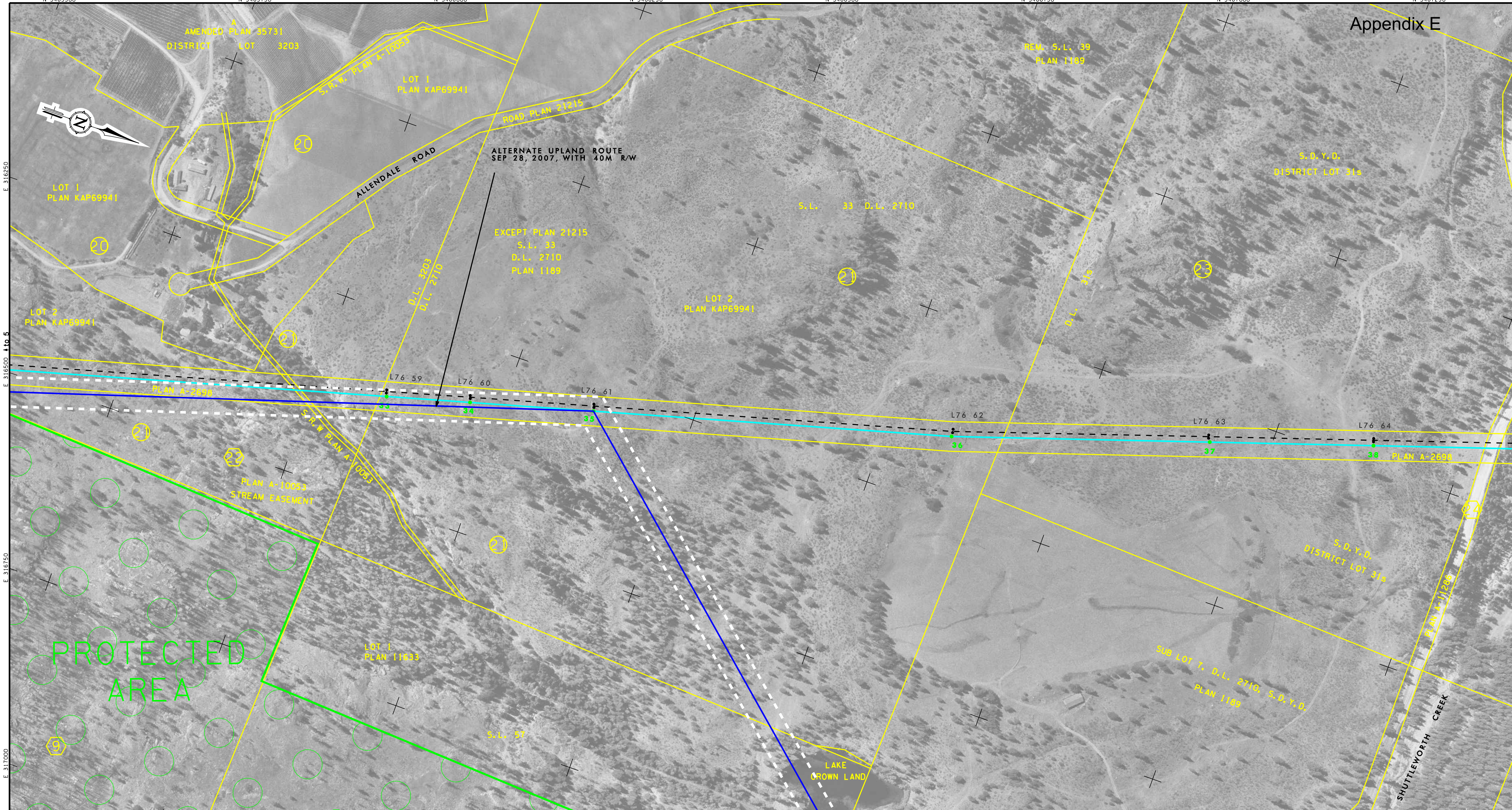

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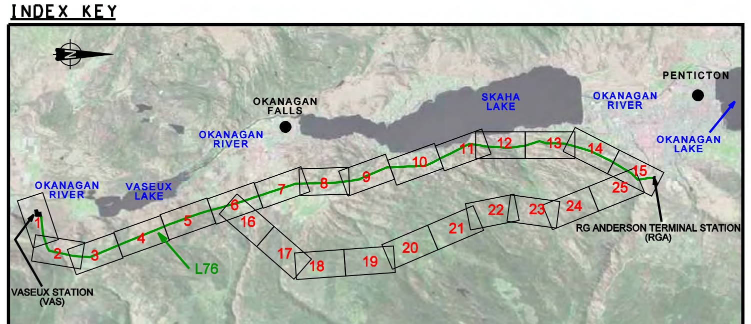

LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL
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- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES

- CADASTRAL BOUNDARY
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BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

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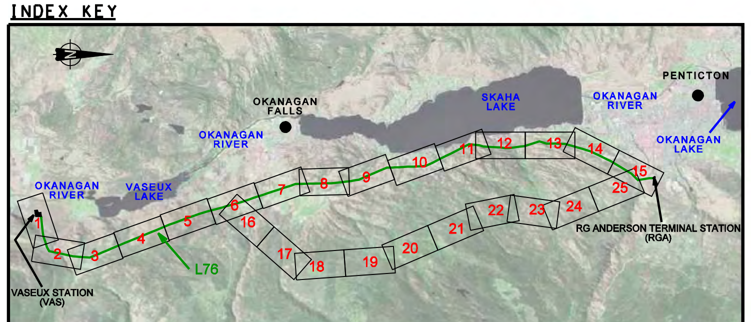

LEGEND

EXISTING TRANSMISSION CIRCUIT

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HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

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BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 07 OF 25

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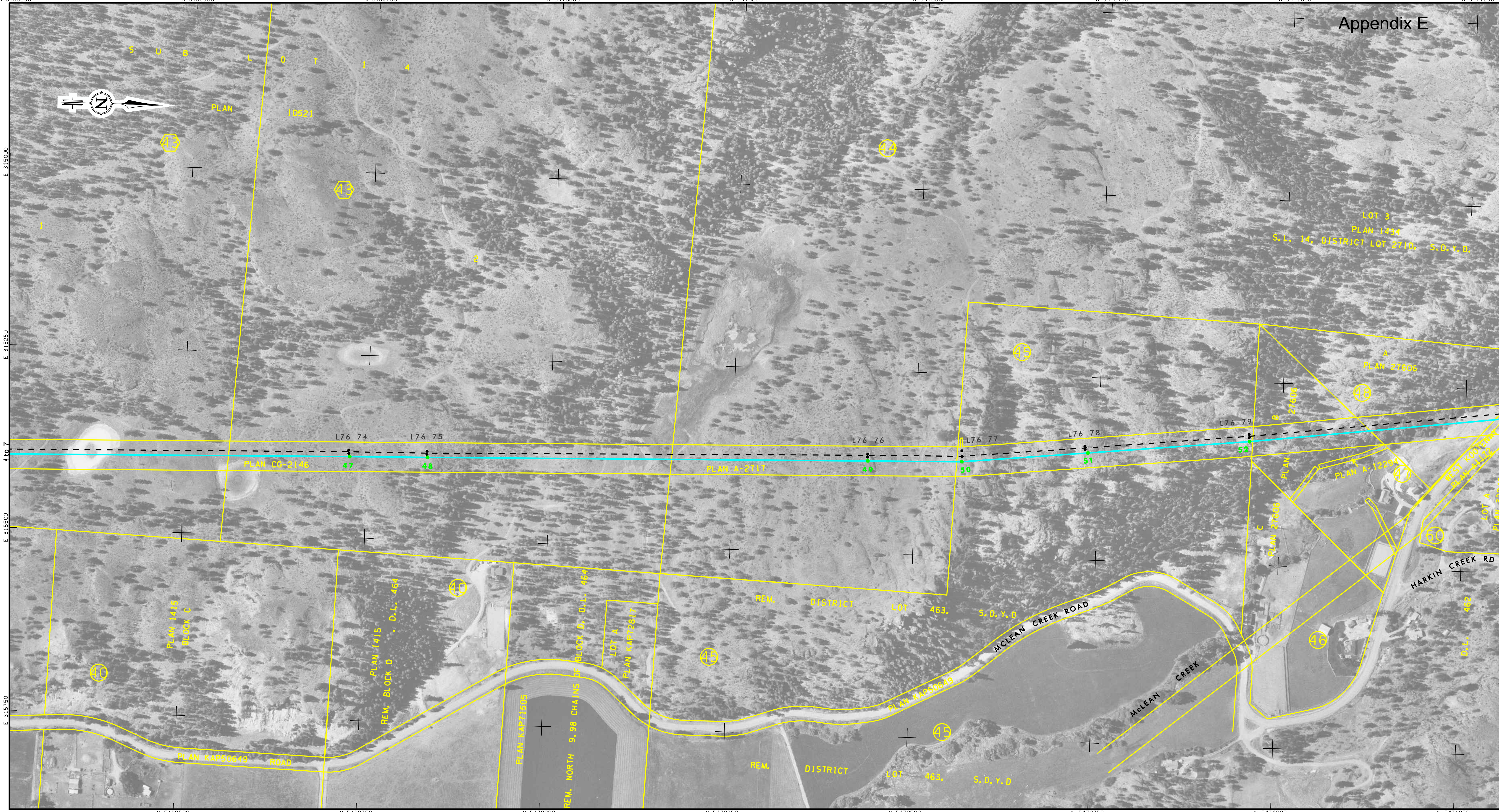

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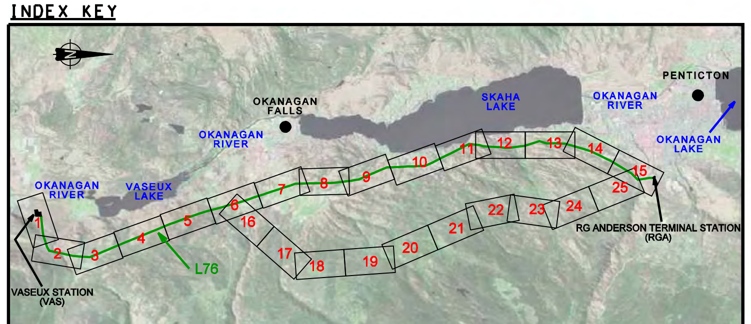

LEGEND

EXISTING TRANSMISSION CIRCUIT
- STEEL STRUCTURES: RIGID, GUY, STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT
- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES
- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

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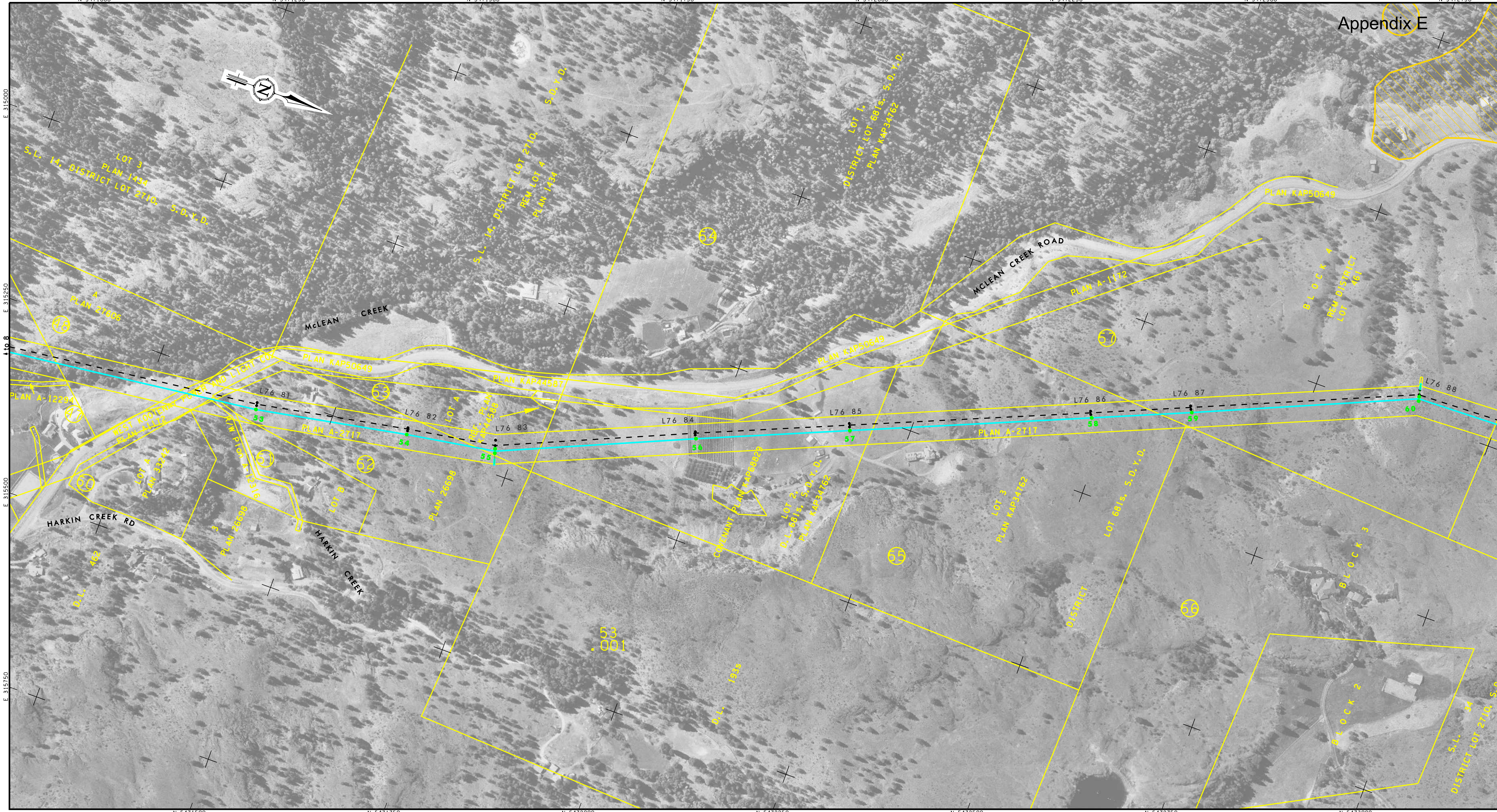
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 08 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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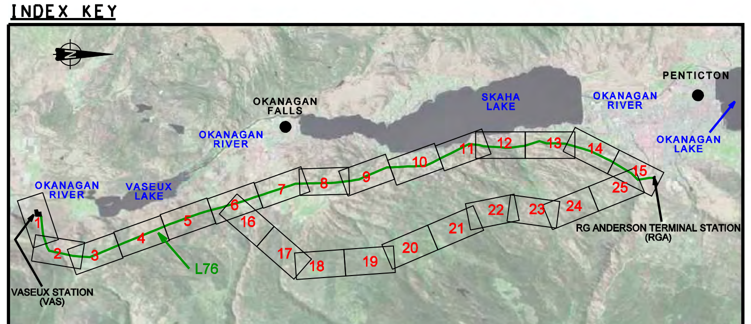

LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY, STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES
- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services, BC Hydro Accuracy +/- 0.25 metres.

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND RECTIFICATION BASED ON DEM COMPILED FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY, TAKEN SEP 17, 2005

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BC HYDRO DWG NO. 76L - T07 - D2 R K

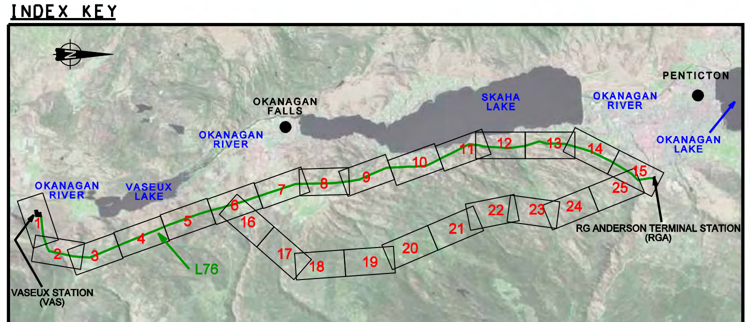
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 09 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E

INDEX KEY



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY; STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES
CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
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BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND RECTIFICATION BASED ON DEM COMPILED FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY, TAKEN SEP 17, 2005

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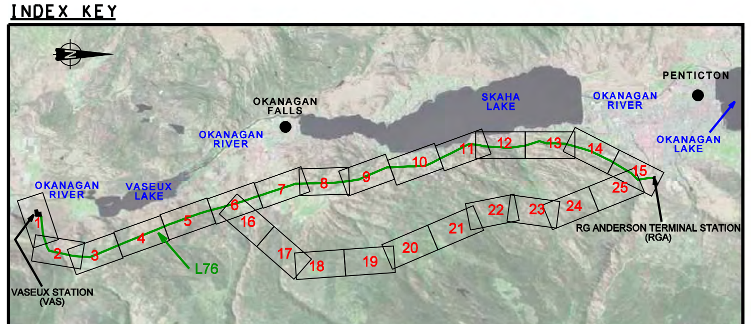
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 10 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E

INDEX KEY



LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES

- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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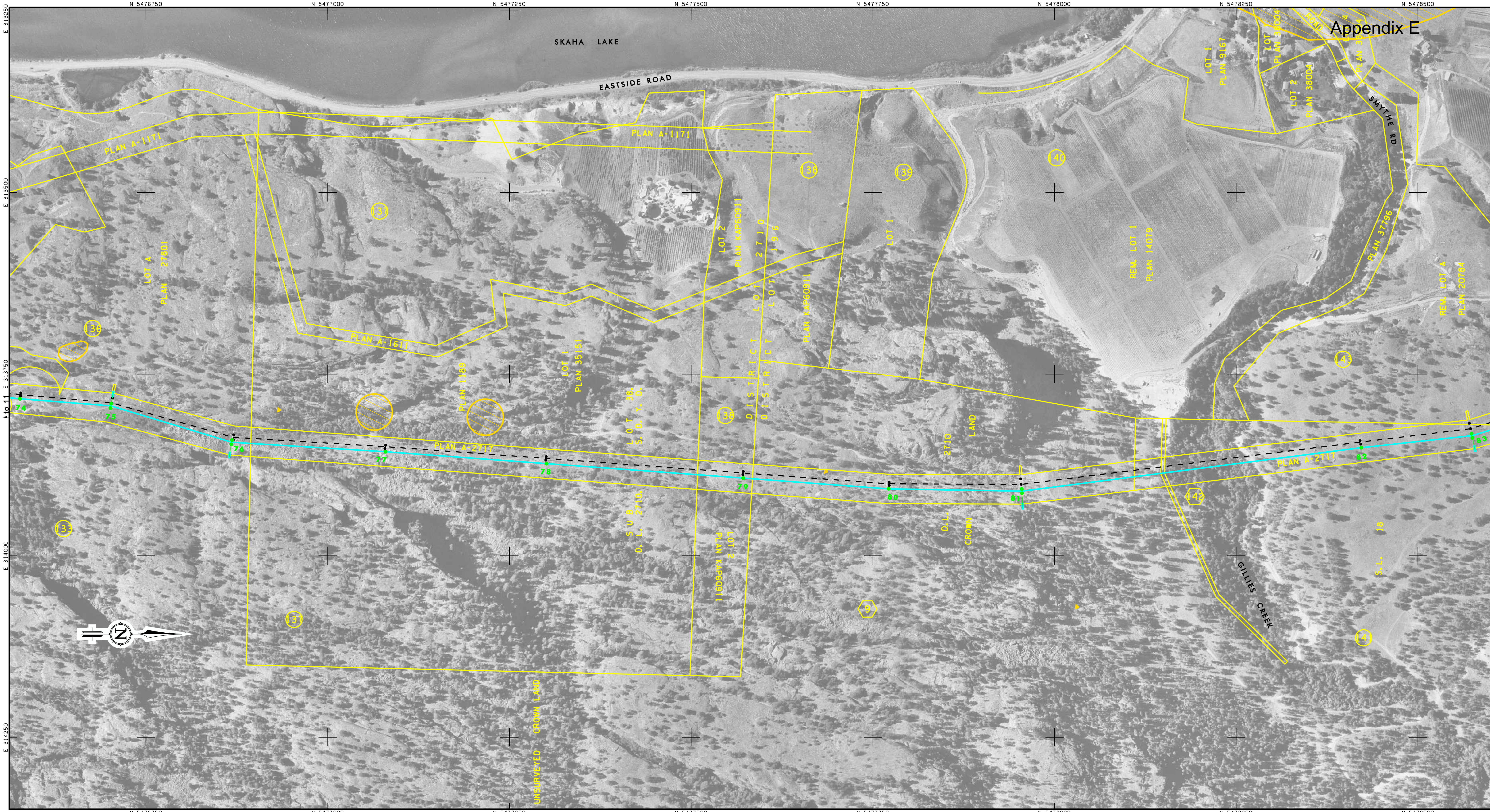
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 11 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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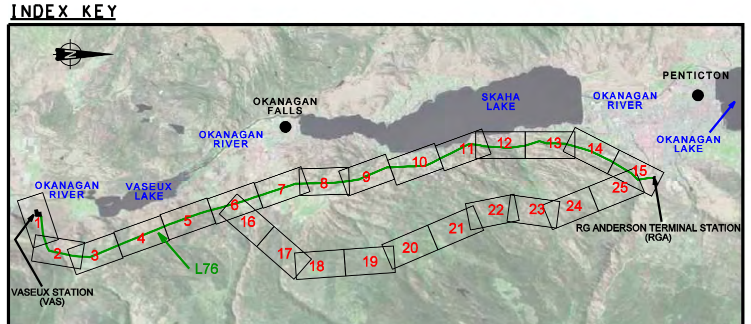

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY, STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
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FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

BC hydro ENGINEERING

BC HYDRO DWG NO. 76L - T07 - D2 R K

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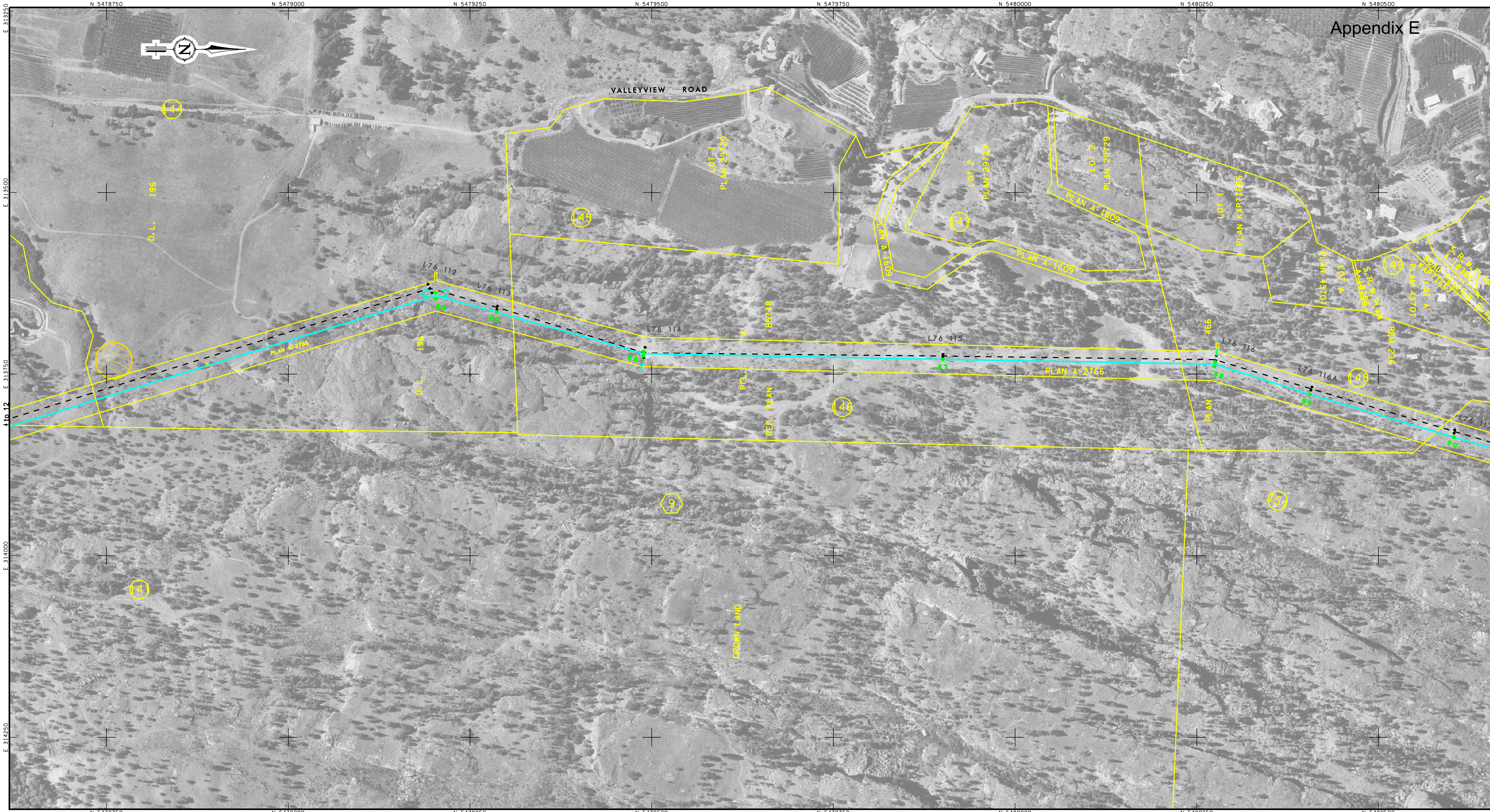
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 12 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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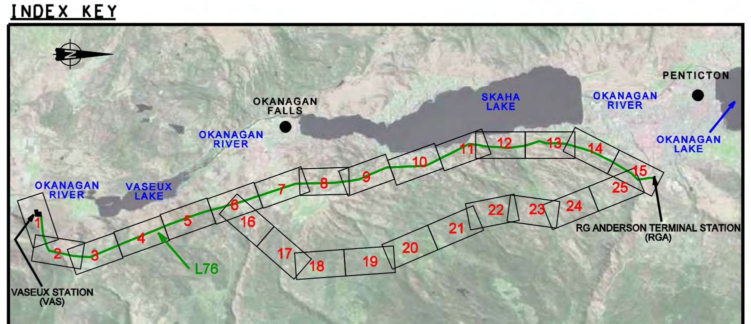

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
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BCGS REFERENCE: 82E
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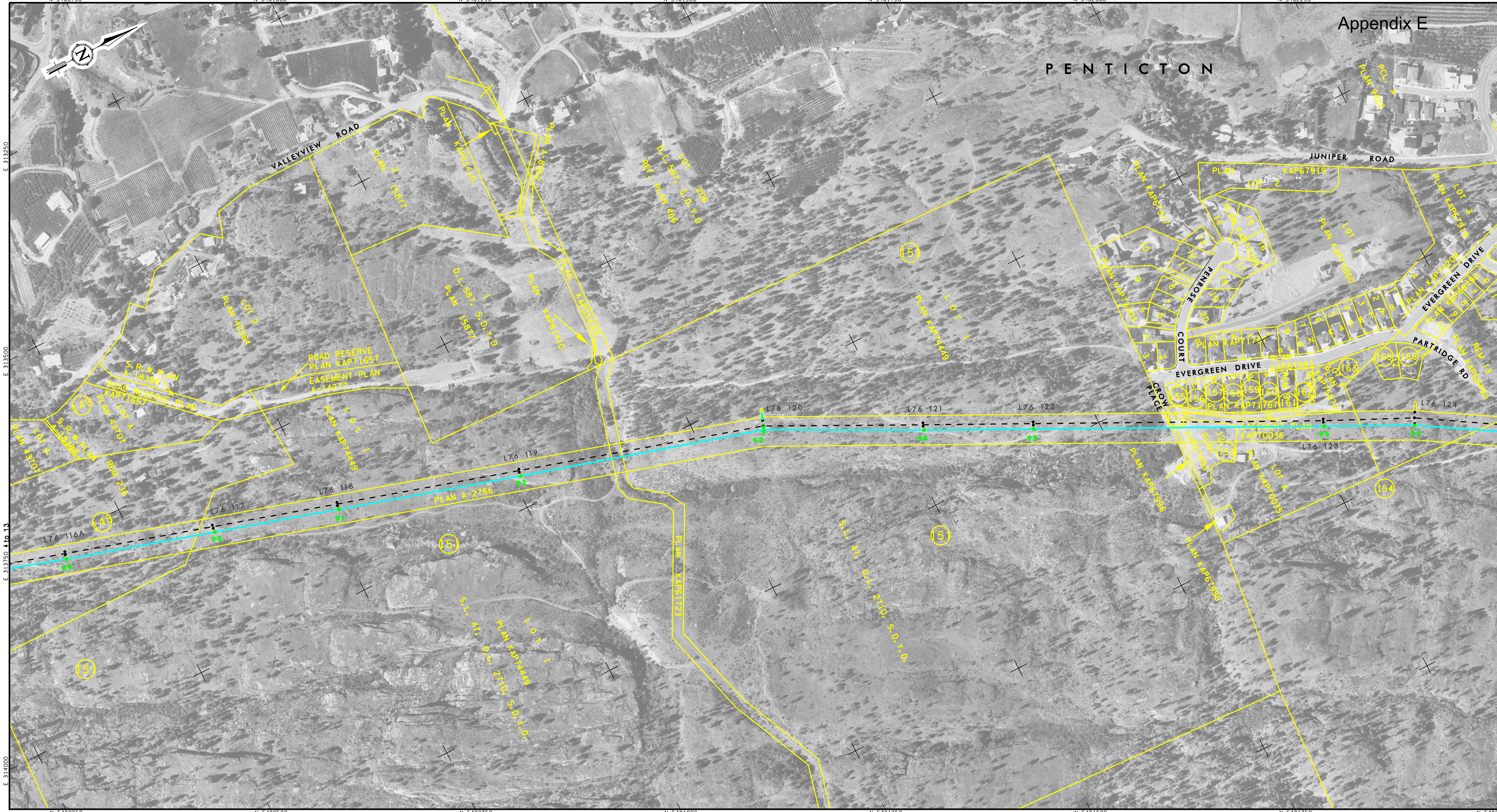
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 13 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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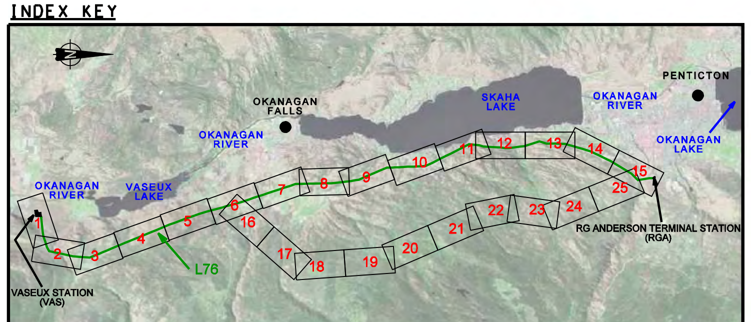

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:
1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
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BC HYDRO DWG NO. 76L - T07 - D2 R K

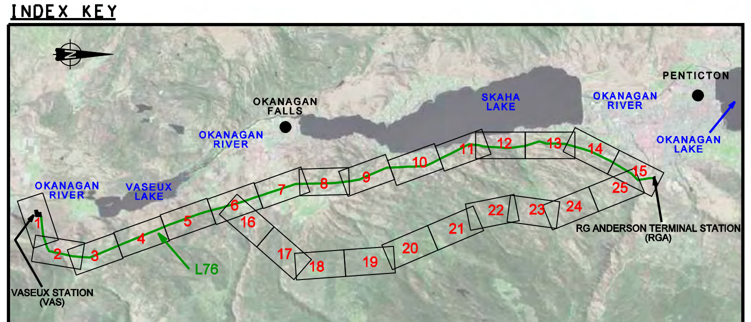
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 14 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E

INDEX KEY



LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES: RIGID, GUY, STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services, BC Hydro Accuracy +/- 0.25 metres.

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ORTHOPHOTO GENERATED AND RECTIFICATION BASED ON DEM COMPILED FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY, TAKEN SEP 17, 2005

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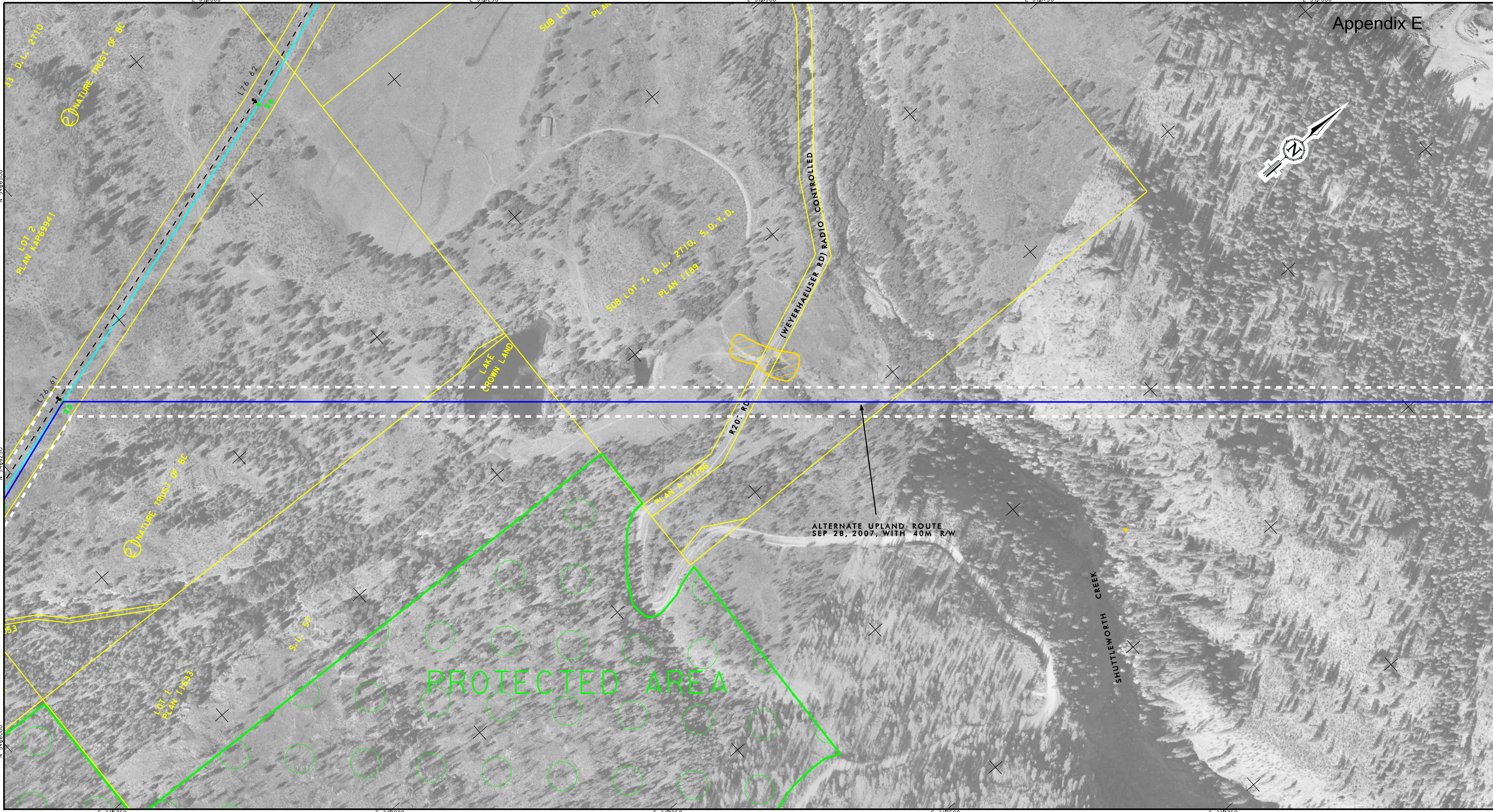
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 15 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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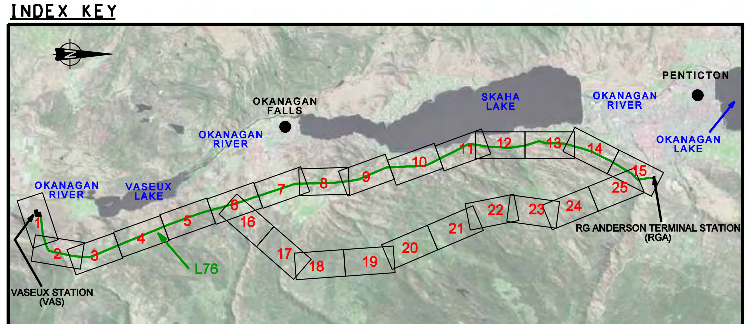

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
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BCGS REFERENCE: 82E
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FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

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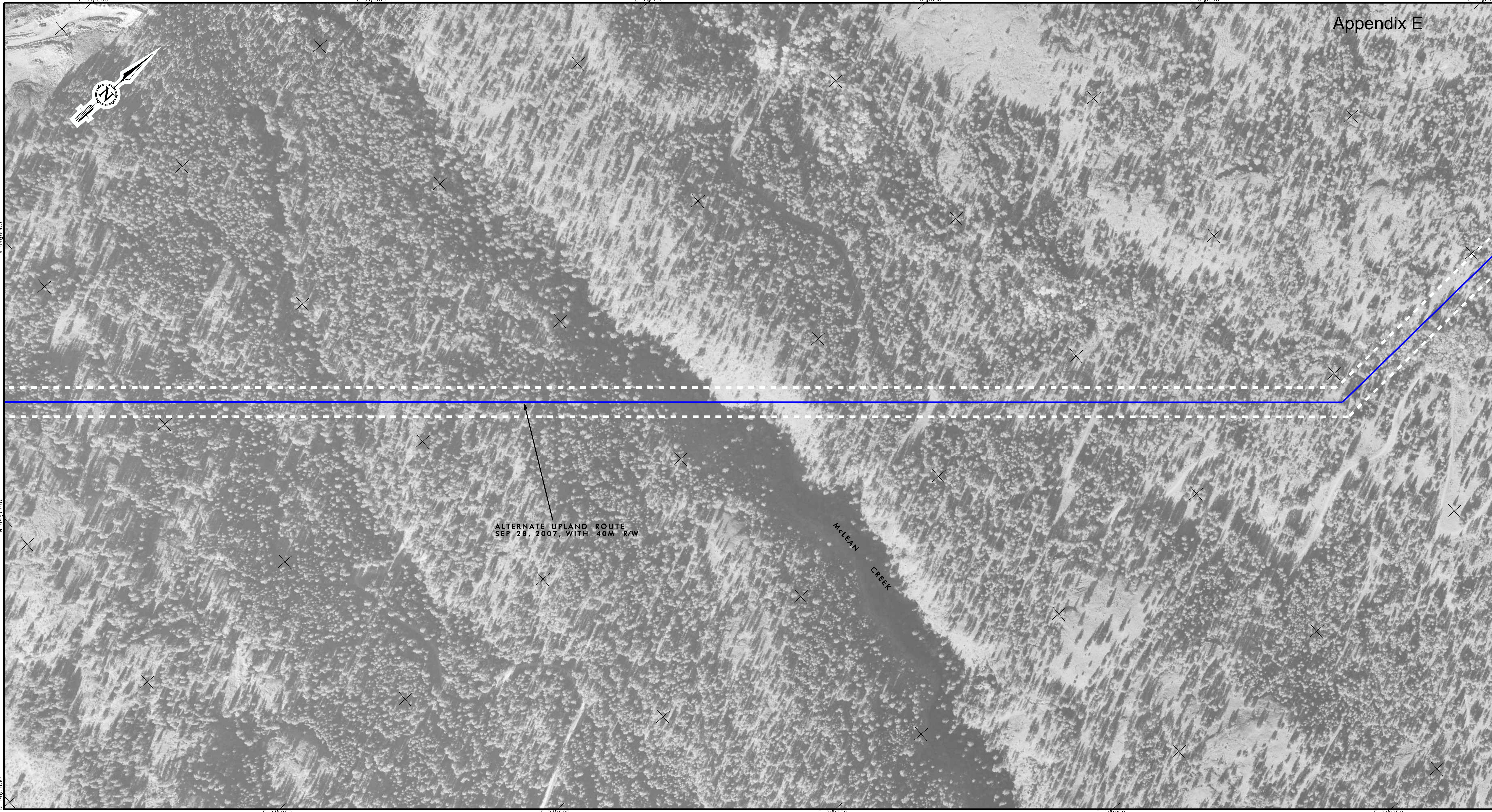
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 16 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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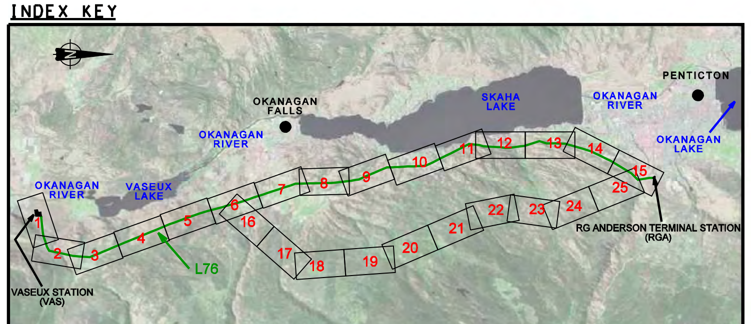

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

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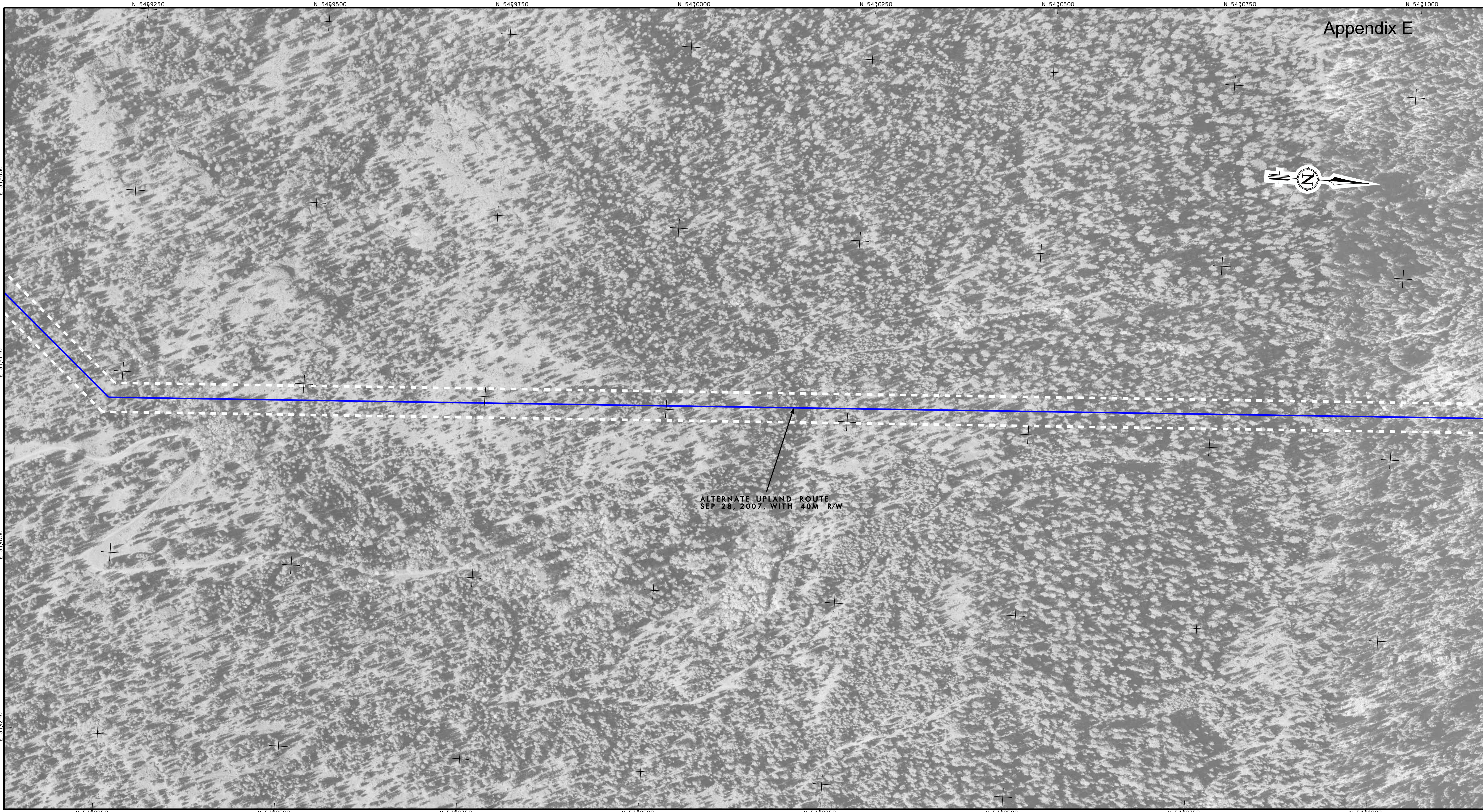
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 17 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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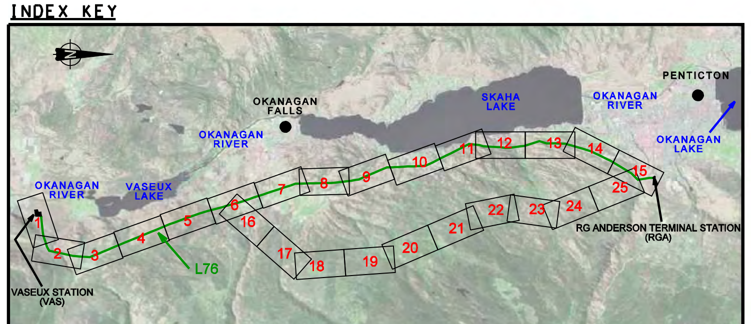

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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DIGITAL ORTHOPHOTO METRIC MAP
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TAKEN SEP 17, 2005

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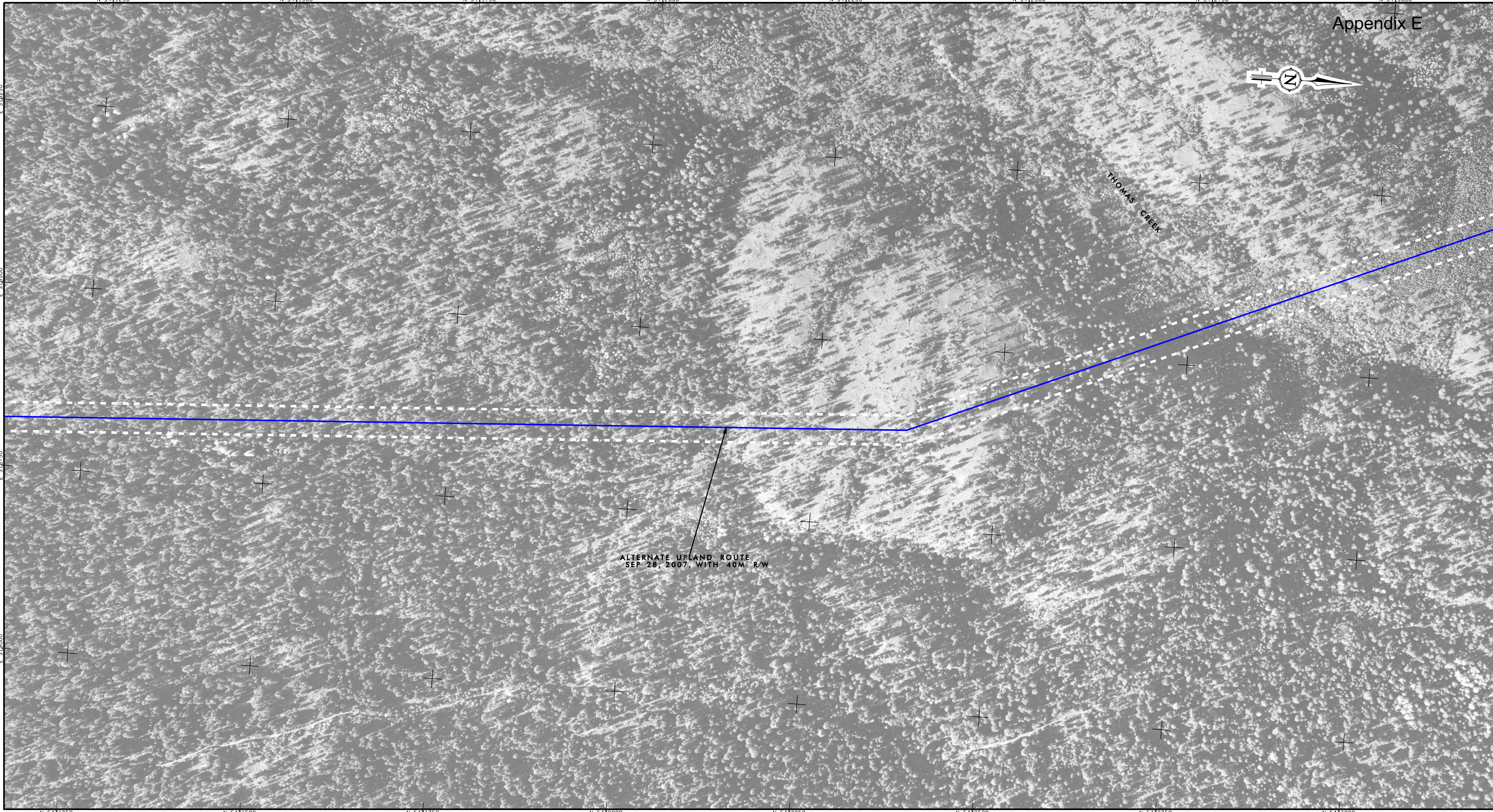
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 18 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L



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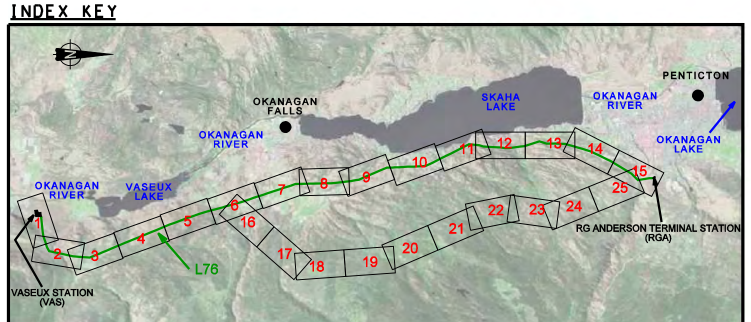

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

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BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

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								DRAWN BY	GJB	
								CHECKED BY		
								APPROVED BY		

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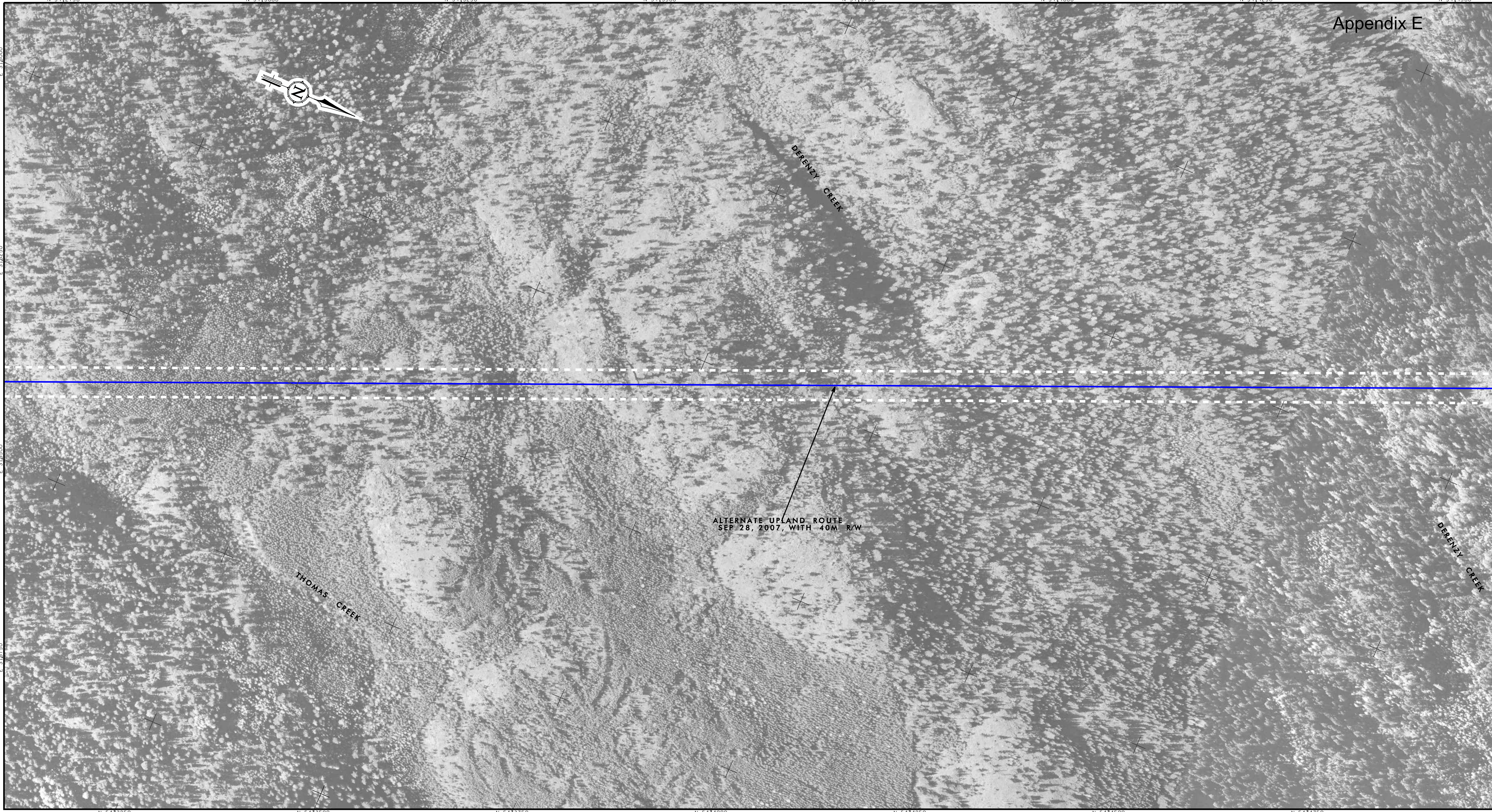
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP
SHEET 19 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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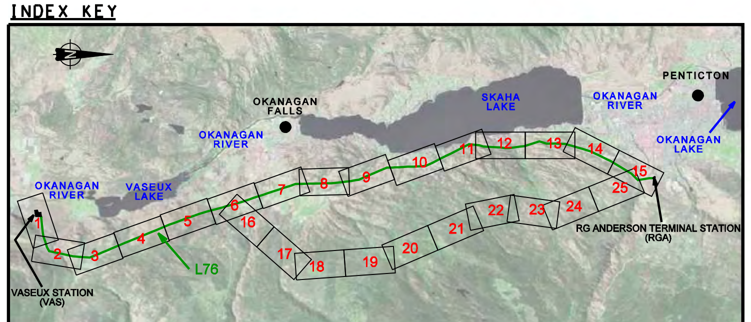

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

PRELIMINARY

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								DRAWN BY	GJB
								CHECKED BY	
								APPROVED BY	

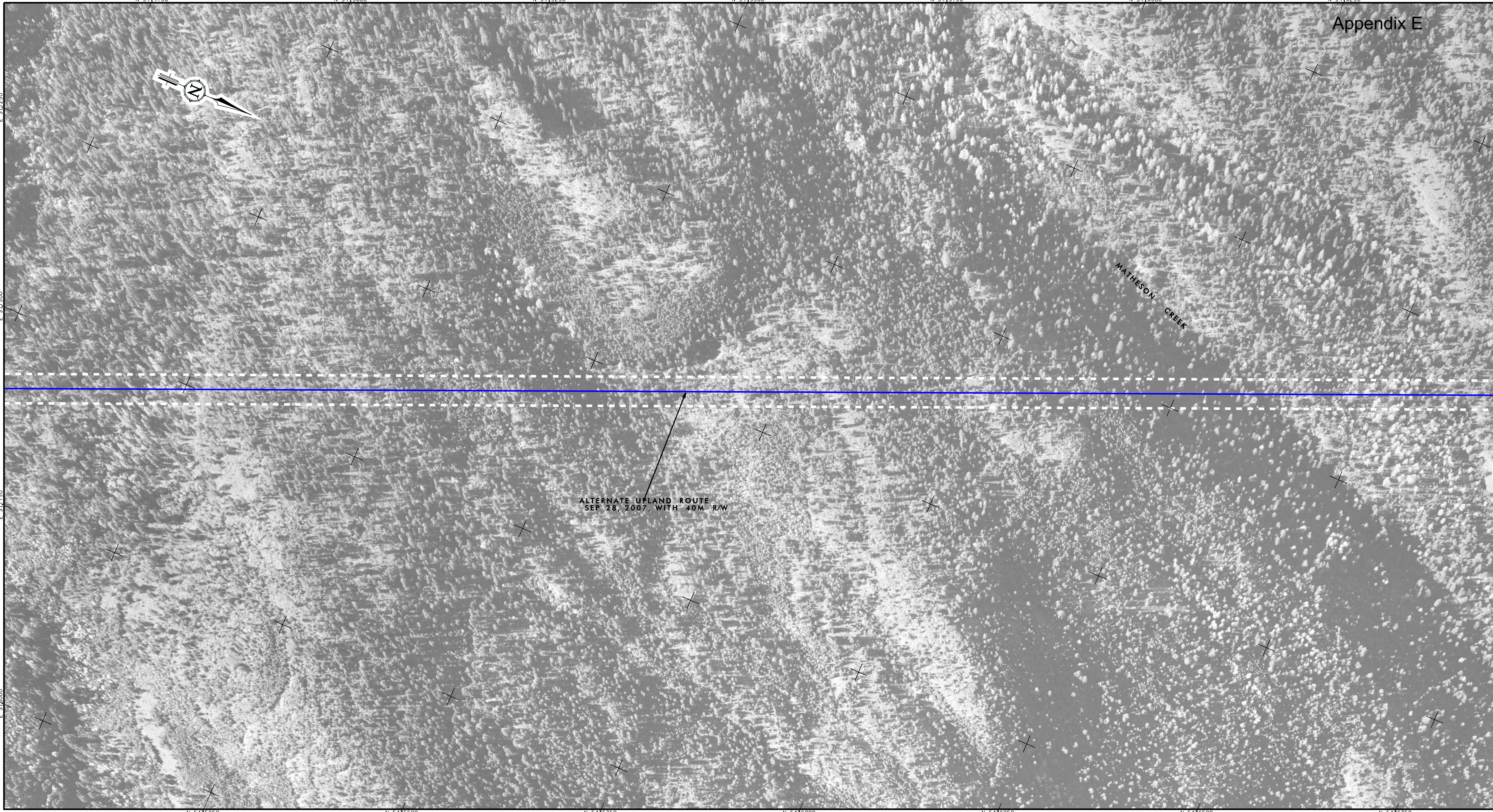
FORTISBC

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 20 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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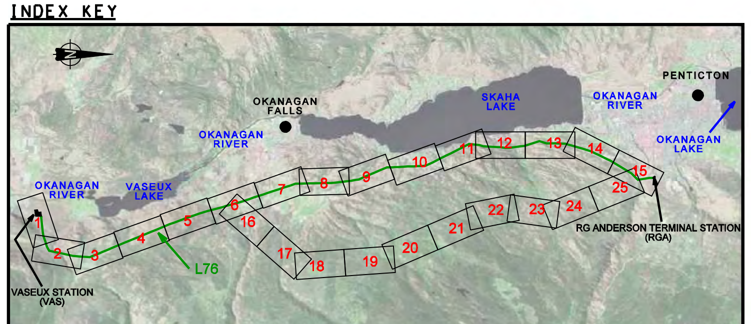

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

1) Cadastre was computed by Survey Services. BC Hydro Accuracy +/- 0.25 metres.

PRODUCED BY PHOTOGRAMMETRY SERVICES, BC HYDRO
DIGITAL ORTHOPHOTO METRIC MAP
UTM ZONE 11, NAD83
BCGS REFERENCE: 82E
ORTHOPHOTO GENERATED AND
RECTIFICATION BASED ON DEM COMPILED
FROM 1:20,000 SCALE AERIAL PHOTOGRAPHY,
TAKEN SEP 17, 2005

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								DRAWN BY	GJB
								CHECKED BY	
								APPROVED BY	

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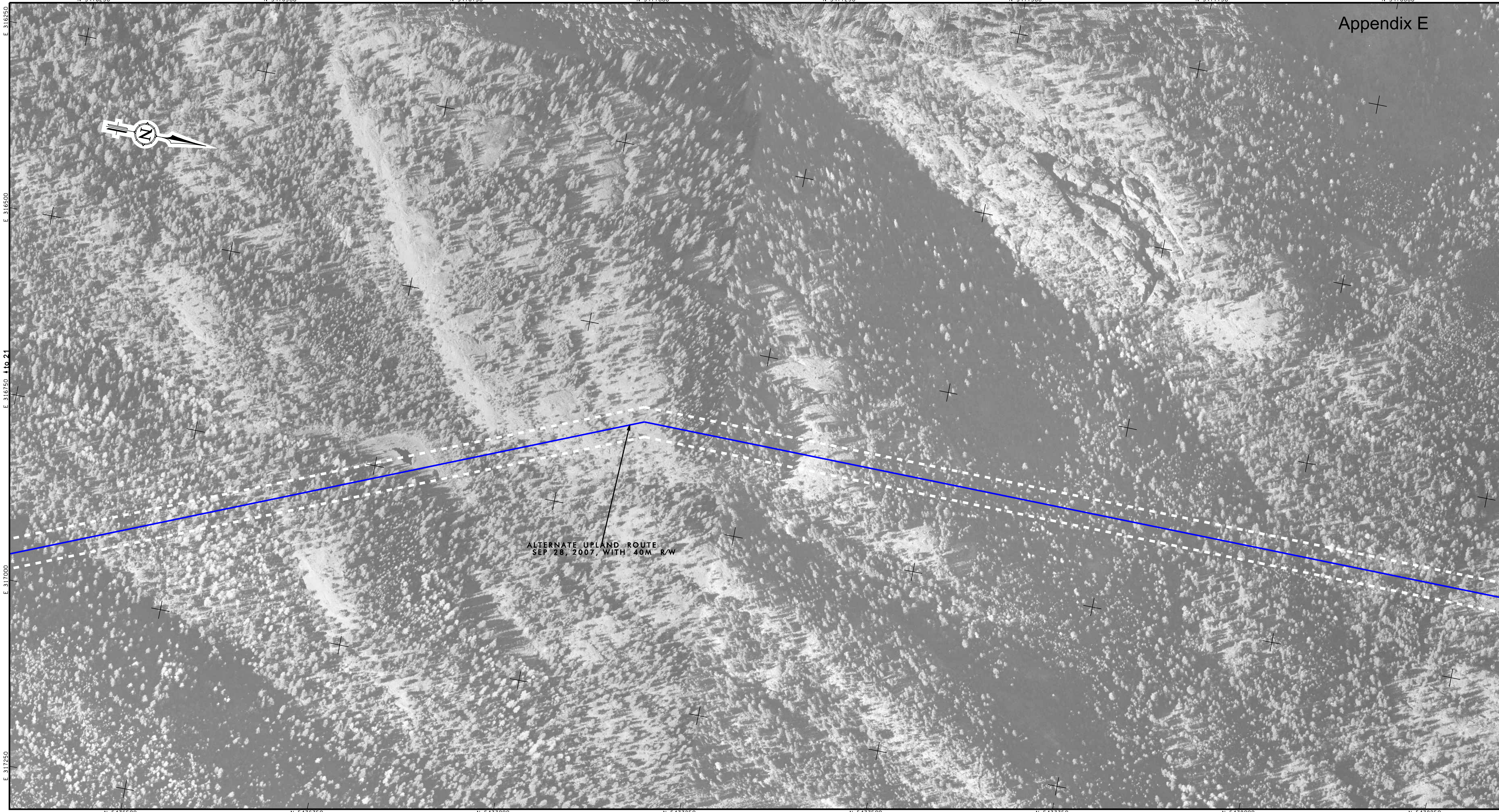
FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 21 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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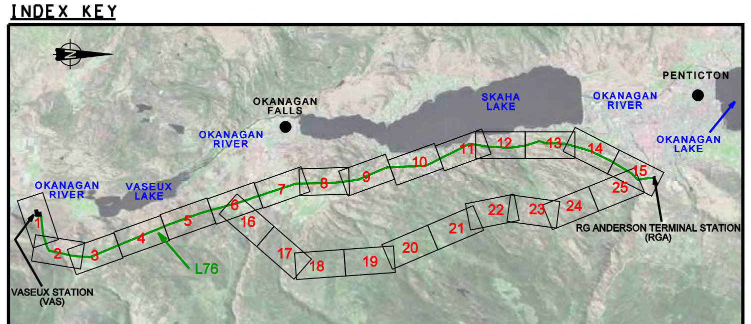

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL
WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
HORIZONTAL INSULATOR POLE
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR
STRUCTURE NUMBER — 2/3
CENTRELINE TRANSMISSION LINE
ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY
PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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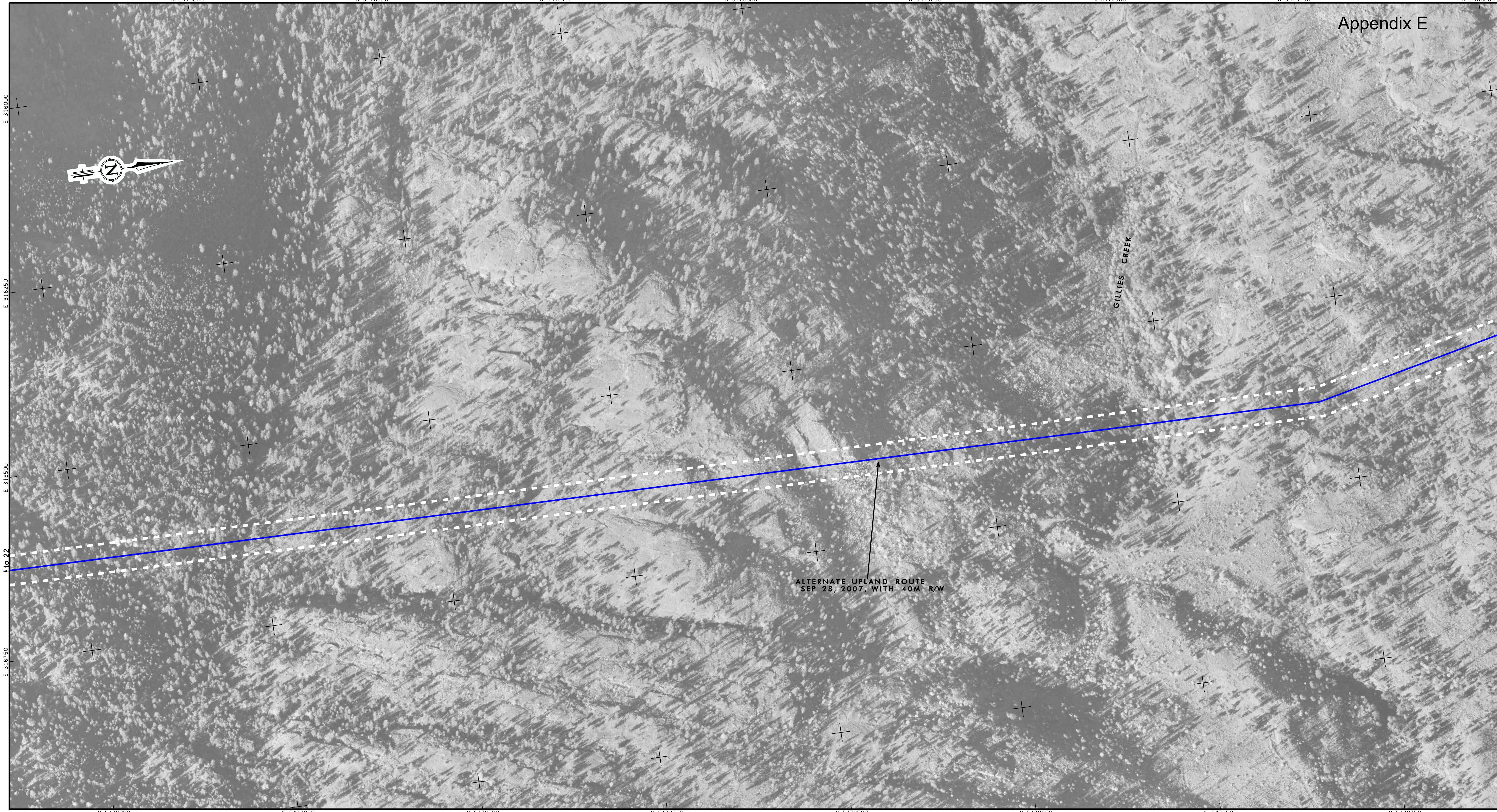
BC HYDRO DWG NO. 76L - TO7 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 22 OF 25

DRAWING NUMBER	REV
76L - TO7 - D2	L

Appendix E



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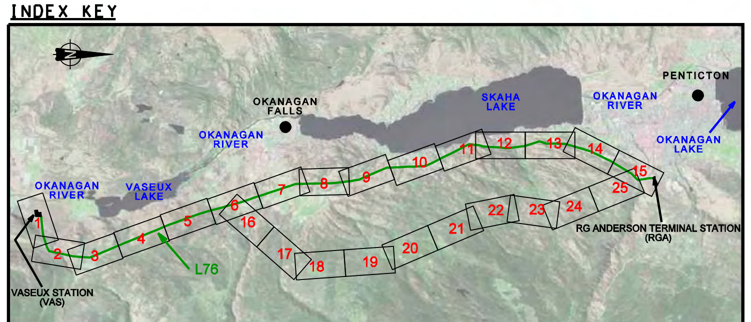

LEGEND

EXISTING TRANSMISSION CIRCUIT

STEEL STRUCTURES:
RIGID, GUY: STEEL

WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE

HORIZONTAL INSULATOR POLE

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

STRUCTURES: POLES, GUY LINE AND ANCHOR

STRUCTURE NUMBER — 2/3

CENTRELINE TRANSMISSION LINE

ARCHAEOLOGICAL SITES

CADASTRAL BOUNDARY

PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

NOTE:

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DIGITAL ORTHOPHOTO METRIC MAP
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BC hydro ENGINEERING

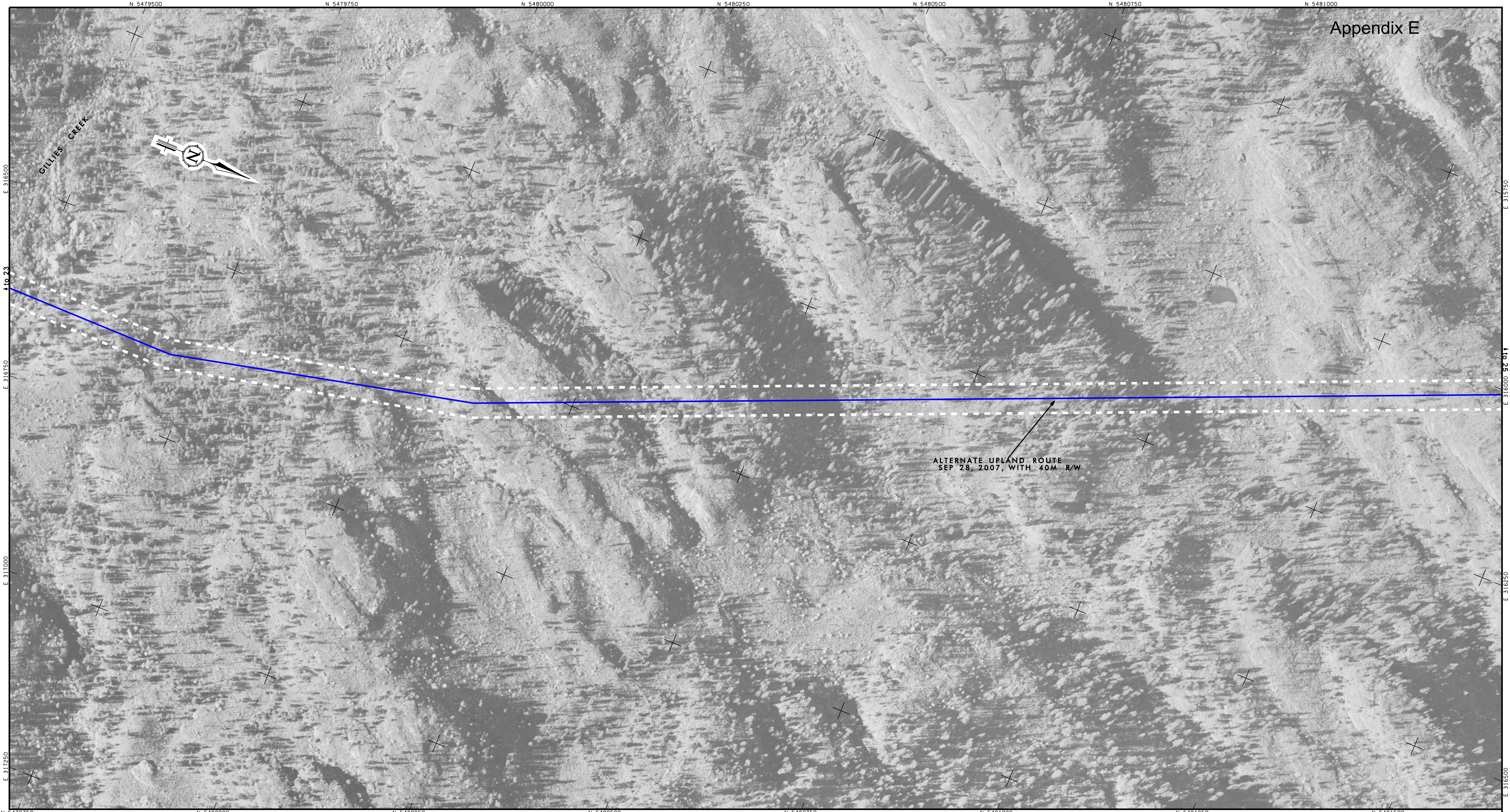
BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 23 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L

Appendix E



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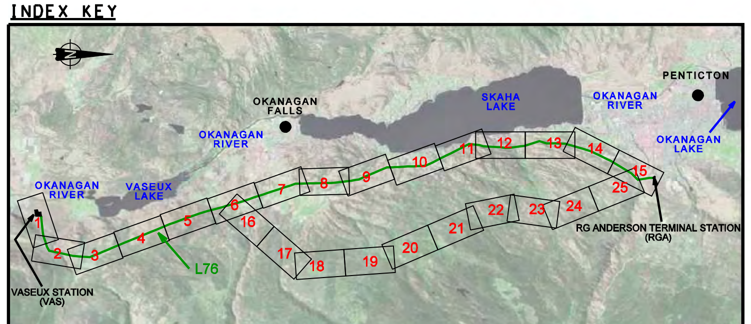

LEGEND

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

PROPOSED CIRCUIT	
STRUCTURES: POLES, GUY LINE AND ANCHOR	
STRUCTURE NUMBER	2/3
CENTRELINE TRANSMISSION LINE	
ARCHAEOLOGICAL SITES	
CADASTRAL BOUNDARY	
PROPERTY LINE LIST NUMBER	

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

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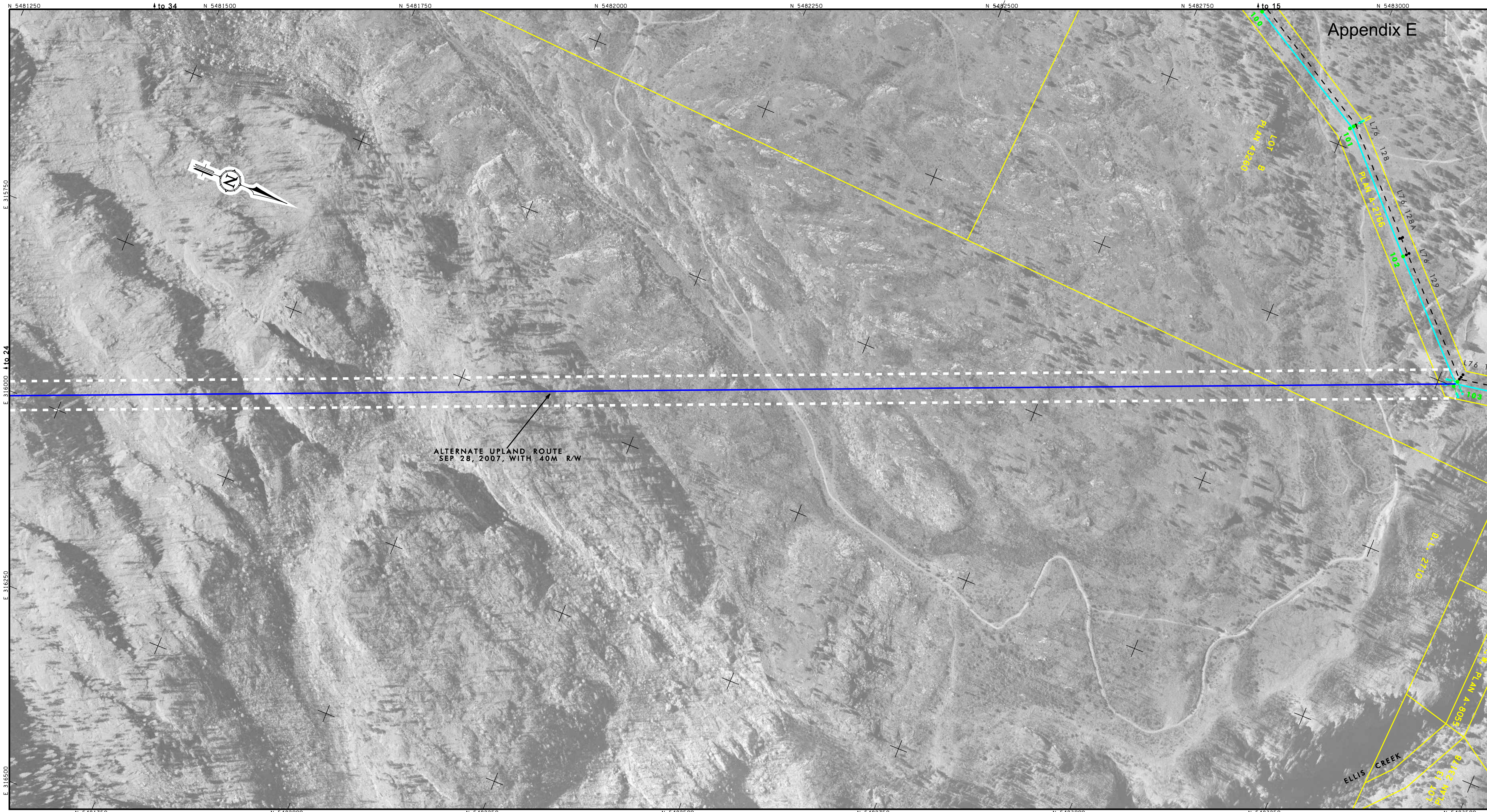
BC HYDRO DWG NO. 76L - TO7 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 24 OF 25

DRAWING NUMBER	REV
76L - TO7 - D2	L

Appendix E



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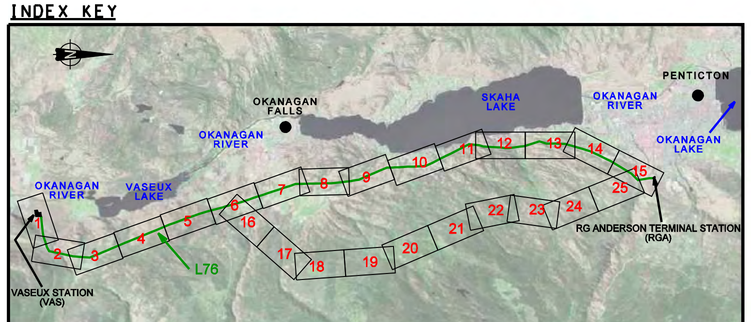

LEGEND

EXISTING TRANSMISSION CIRCUIT

- STEEL STRUCTURES: RIGID, GUY: STEEL
- WOODEN STRUCTURES: POLE, PIN TOP, WISHBONE
- HORIZONTAL INSULATOR POLE
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE

PROPOSED CIRCUIT

- STRUCTURES: POLES, GUY LINE AND ANCHOR
- STRUCTURE NUMBER — 2/3
- CENTRELINE TRANSMISSION LINE
- ARCHAEOLOGICAL SITES
- CADASTRAL BOUNDARY
- PROPERTY LINE LIST NUMBER

100 0 100 200m

REDUCTION OF ORIGINAL APPROX. SCALE: 1:5000

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BC HYDRO DWG NO. 76L - T07 - D2 R K

FORTIS BC - OTR PROJECT
TRANSMISSION RELOCATION
76L VAS - RGA
ORTHOPHOTO MAP

SHEET 25 OF 25

DRAWING NUMBER	REV
76L - T07 - D2	L