

## **2.0 PROJECT DESCRIPTION**

### **2.1 INTRODUCTION**

#### **2.1.1 Overview of Manitoba Hydro's Transmission System**

Manitoba is heavily reliant on hydroelectricity, approximately 70% of which is generated in plants along the Nelson River in the form of alternating current (ac). A small portion of this generation is fed directly to the northern ac transmission system to serve northern areas. The remainder is connected to the Northern ac Collector Transmission System (Map 2-1). This collector system connects the generating stations on the Nelson River to the dc converter stations at Radisson and Henday. Two HVdc lines (Bipole I and II) connect the Radisson and Henday Converter Stations in northern Manitoba to the Dorsey Converter Station, located near Winnipeg. From there, the electricity is distributed throughout much of southern Manitoba through the southern ac transmission system (Map 2-1).

The remaining hydraulic generation is supplied by generating stations on the Winnipeg River, at Grand Rapids on the Saskatchewan River and at Jenpeg on the Upper Nelson River, north of Lake Winnipeg. Generation outlet transmission facilities for the Winnipeg River plants consist of 115 kV ac transmission lines that connect to the southern account transmission system and are not converted to dc due to short distances to stations (Map 2-1).

When operating at full capacity, Manitoba Hydro's hydraulic generation system produces more power than required for today's domestic consumption. High-voltage ac transmission facilities interconnected to Saskatchewan, Ontario and the US make it possible to export power to those jurisdictions. Interconnected transmission facilities also allow Manitoba Hydro to import power during periods of drought and periods during which demand in Manitoba exceeds the supply Manitoba Hydro can generate, thereby strengthening the reliability of the provincial electric system.

## **2.2 PROJECT COMPONENT OVERVIEW**

The Keeyask Transmission Project will consist of the following:

- Construction Power Transmission Line and Construction Power Station.
- Four Unit Transmission Lines that originate at the Keeyask Generating Station and terminate at a new Keeyask Switching Station.
- Keeyask Switching Station.

- Three Generation Outlet Transmission (GOT) Lines link the Keeyask Switching Station to the northern collector system, terminating at the Radisson Converter Station.
- Radisson Converter Station Upgrades

### **2.2.1 Construction Power Transmission Line and Station**

The Project will include a new Construction Power Transmission Line (138 kV and approximately 22 km long) from the existing 138 kV KN36 transmission line to a new 138 kV to 12.47 kV station to be located north of the proposed Keeyask Generation Station. The purpose of the Construction Power Transmission Line and Construction Power Station is to provide power to construct the Keeyask Generation Project. After the Keeyask Generating Station is constructed, the Construction Power Transmission Line will be left in place, as will a portion of the Construction Power Station, to provide a contingency function for a “black start” emergency backup to diesel generation units at the Generating Station.

### **2.2.2 Unit Transmission Lines**

Four 138 kV ac transmission lines (KE1 to 4), called the Unit Transmission Lines, will transmit power from the seven generators located at the Keeyask Generating Station to the new Keeyask Switching Station. Three lines will be double circuit and one line single circuit to accept power from the seven Generating Station turbines. The four lines, each approximately 4 km long, will be located in a single corridor.

### **2.2.3 Keeyask Switching Station**

A new Keeyask Switching Station will accept power from the Generating Station via the four Unit Transmission Lines and transfer that power to three Generation Outlet Transmission lines. The switching station will be located on the south side of the Nelson River. The purpose of the switching station is to provide the terminal facilities for the electrical connection to the Keeyask Generating Station, and to provide flexibility in switching load between incoming Unit Transmission Lines from the Generating Station to the Generation Outlet Transmission Lines going to Radisson Converter Station.

### **2.2.4 Generation Outlet Transmission Lines**

Three 138 kV ac Transmission Lines will transmit power from the Keeyask Switching Station to the existing Radisson Converter Station 138 kV ac switchyard. Known as the Generation Outlet Transmission (GOT) Lines, the three lines, each approximately 38 km long, will be located along a single route. Manitoba Hydro plans to build one of these GOT lines called KR1 to serve as a backup construction power line during construction. After Project construction, the KR1

Transmission Line will be partially salvaged and re-terminated at the Keeyask Switching Station and utilized as a Generation Outlet Transmission Line.

### **2.2.5 Radisson Converter Station Upgrades**

The existing Radisson Converter Station will be upgraded in two stages, as follows:

Stage I: The addition of a 138 kV breaker to accommodate the initial new Generation Outlet Transmission line (KR1) from the Keeyask Switching Station.

Stage II: The addition of equipment including a 138 kV bay (Bay 1) complete with four 138 kV breakers and associated equipment for the termination of two additional GOT lines (KR2 and KR3) from the Keeyask Switching Station. KR2 and KR3 will enter the west side of the Radisson Converter Station and proceed underground around the station and finally terminate to Bay 1.

### **2.2.6 Preferred Routes and Station Sites**

The Preferred Routes and Station Sites are shown on Map 2-2 for the construction and operation phases, respectively.

## **2.3 TRANSMISSION LINES – TECHNICAL DESCRIPTION**

The following sections provide a more detailed life cycle description of the transmission line components included in the Keeyask Transmission Project. The description includes the construction, operation and maintenance phases of each component, as well as prospective decommissioning.

The current Project description information is based on preliminary design and on Manitoba Hydro standards with respect to design and construction, operation and maintenance, and decommissioning. Project development will also adhere to applicable North American Electric Reliability Corporation/Midwest Reliability Organization/Midwest Independent System Operator criteria and Canadian Standard Association (CSA) standards. Subject to approval requirements, details of the final design may vary from the preliminary design on the basis of field conditions, contract requirements and contractor implementation.

### **2.3.1 Unit Transmission Lines**

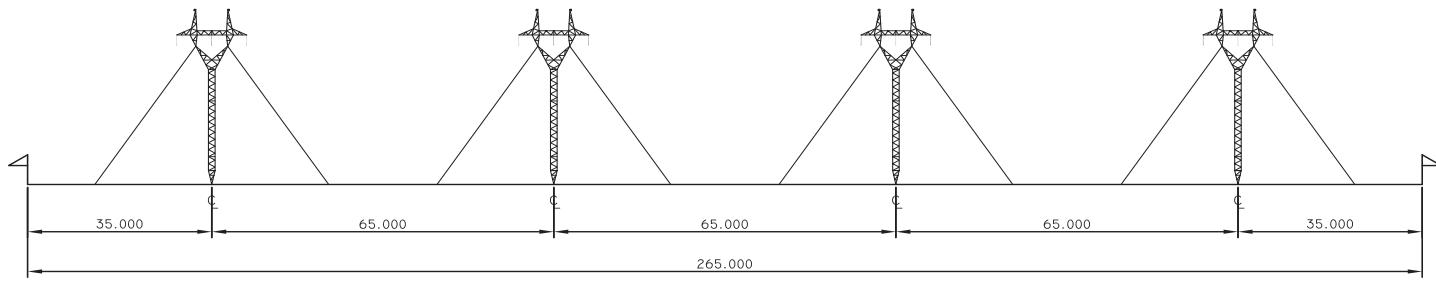
Four 138 kV ac Unit Transmission lines will transmit power from the seven generators located at the Keeyask Generating Station to the new Keeyask Switching Station. The four lines, each approximately 4 km long, will be located in a single 265-m-wide corridor. Figure 2-1 illustrates a typical cross-section for the Unit Transmission Lines.





138 KV KEEYASK SWITCHING STATION   138 KV KEEYASK SWITCHING STATION   138 KV KEEYASK SWITCHING STATION   138 KV KEEYASK SWITCHING STATION  
TRANSMISSION LINE   TRANSMISSION LINE   TRANSMISSION LINE   TRANSMISSION LINE

TYPICAL GUYED LATTICE  
SUSPENSION STRUCTURE



TYPICAL RIGHT OF WAY  
Refer to Section A-A on Map 2-3

**Figure 2-1: Typical 138 kV Unit Transmission Lines Right-of-Way**



### **2.3.1.1 Structure Design and Location**

Based on prior design experience in northern Manitoba, guyed lattice steel structures have been identified as the preliminary design standard for straight (tangent) sections of the transmission lines. Guyed structures provide flexibility for tower construction and maintenance in difficult foundation and terrain conditions. Self-supporting lattice steel structures will be used for all angle or dead-end tower locations.

The conceptual design for a typical guyed lattice suspension structure is illustrated in Figure 2-2. The structure is based on a single point foundation, stabilized by four guy wires placed diagonally to the route of the line. The tangent structures will be approximately 38 m in height. Taller structures with larger footprints will be used where warranted by land use or conditions.

Conceptual design for a typical lattice angle anchor structure is illustrated in Figure 2-3. The structure has four legs requiring individual foundations and a footprint approximately 15 m square. The typical structure height is approximately 30 m. The average span between structures will be approximately 420 m, resulting in approximately 2.4 structures per kilometre. Additional detail respecting span length and tower placement is provided in Section 2.3.4.2.

### **2.3.1.2 Conductors and Insulators**

The structures for the Unit Transmission Lines will carry a three-phase 138 kV ac circuit consisting of three Aluminium Conductor Steel Reinforced phase conductors. The specified phase conductor is a single aluminum conductor steel reinforced conductor, 37.2 mm in diameter.

The conductors will be insulated from the structures by insulator strings consisting of ceramic insulator bells attached to the crossarms of the structures using insulator string assemblies. Conductor clearances are discussed in Section 2.3.4.3.

### **2.3.1.3 Overhead Ground Wires**

Two galvanized steel strand ground conductors having an overall diameter of 9 mm (approximately 0.34 in.) will be strung between the two peaks of the structures to provide lightning protection.

### **2.3.1.4 Switchyard Terminations**

Unit Transmission Lines will be terminated into the 138 kV Intermediate Bus Structure at the Keeyask Switching Station.



138 kV GENERATION OUTLET  
TRANSMISSION LINE

TYPICAL GUYED LATTICE  
SUSPENSION STRUCTURE

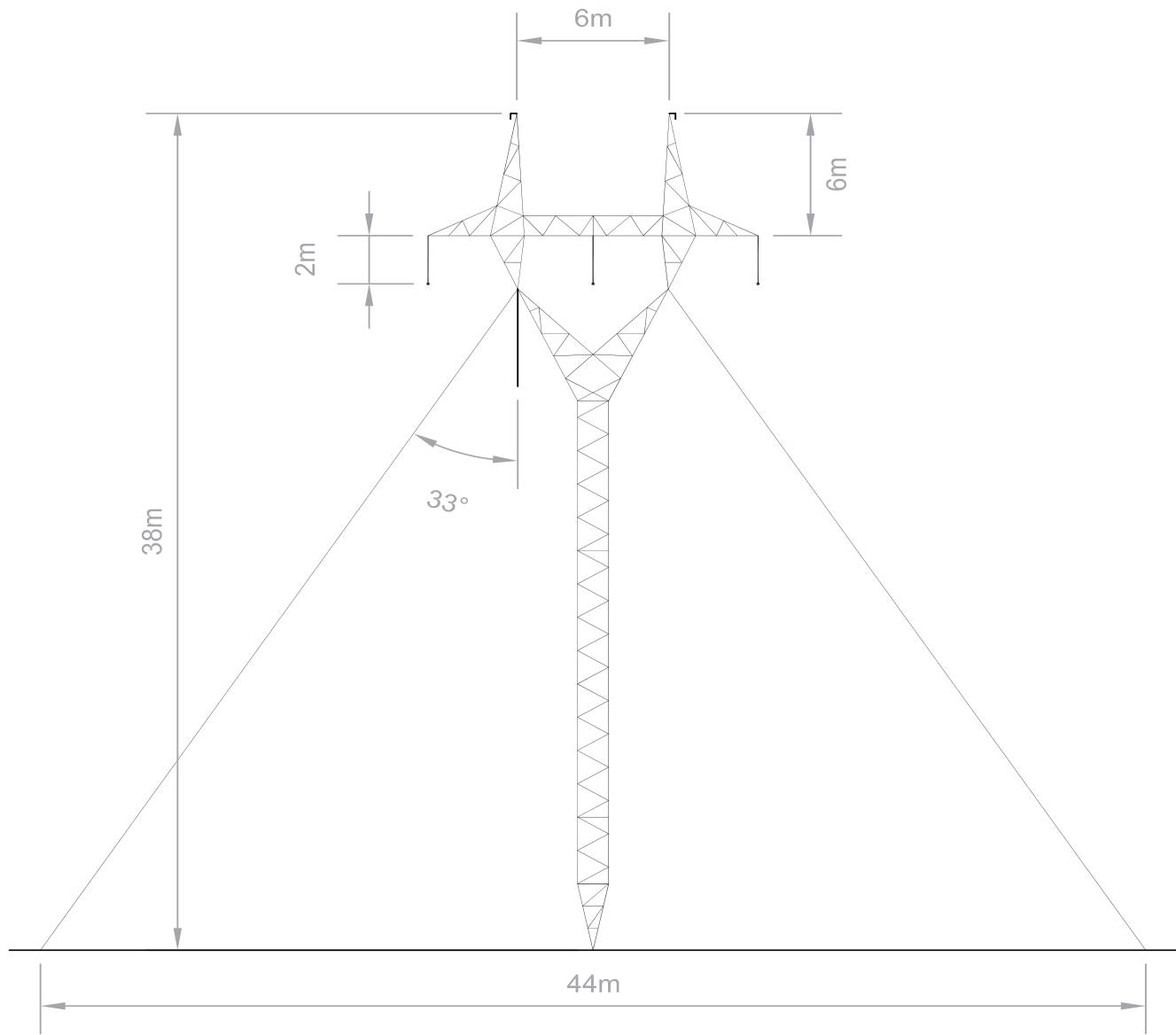


Figure 2-2: Typical Guyed Lattice Suspension Structure

138 KV GENERATION OUTLET  
TRANSMISSION LINE

TYPICAL LATTICE ANGLE ANCHOR STRUCTURE

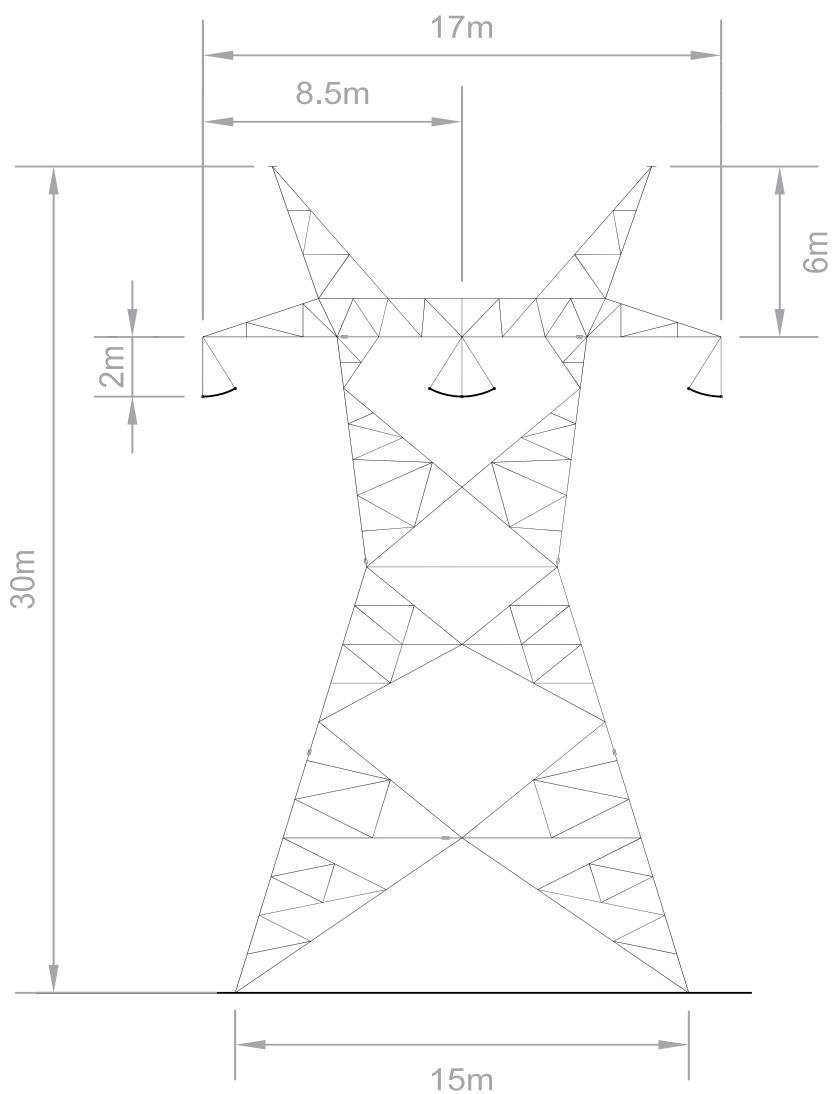


Figure 2-3: Typical Lattice Angle Anchor Structure

## **2.3.2 Generation Outlet Transmission Lines**

Three Generation Outlet Transmission Lines (GOT KR1 to 3) will transmit power from the 138 kV ac switchyard at the Keeyask Switching Station to the 138 kV ac Switchyard at the existing Radisson Converter Station. The three lines will typically be located in a single 200-m-wide corridor about 38 km long (Figure 2-4); however, the width and configuration of the three lines in the corridor will vary, as described in Section 2.3.4.1.

Manitoba Hydro is proposing to prebuild one (KR1) of the three GOT lines from the Radisson Converter Station to the Keeyask Construction Power Station, as a source of backup construction power during the construction of the Keeyask Generation Station Project. Once construction of the generating station is complete, a portion of KR1 from the Construction Power Station back to the Keeyask Switching Station will be salvaged, and KR1 will be terminated into this Switching Station. The additional GOT lines (KR2 and KR3) will be built from the existing Radisson Converter Station 138 ac switchyard to the new Keeyask Switching Station.

### **2.3.2.1 Structure Design and Location**

Based on prior design experience in northern Manitoba, guyed lattice steel structures have been identified as the preliminary design standard for straight (tangent) sections of the transmission lines. Guyed structures provide flexibility for tower construction and maintenance in difficult foundation and terrain conditions. Self-supporting lattice steel structures will be used for all angle or dead-end tower locations.

The conceptual design for a typical guyed lattice suspension structure is illustrated in Figure 2-2. The structure is based on a single point foundation, stabilized by four guy wires placed diagonally to the route of the line. The tangent structures will be approximately 38 m in height. Taller structures with larger footprints will be used where warranted by land use or conditions.

The conceptual design for a typical lattice angle anchor structure is illustrated in Figure 2-3. The structure has four legs requiring individual foundations and a footprint of approximately 13.7 m<sup>2</sup> square. The typical structure height is approximately 30 m. The average span between structures will be approximately 470 m, resulting in approximately 2.1 structures per kilometre. Additional detail respecting span length and tower placement is provided in Section 2.3.4.2.

### **2.3.2.2 Conductors and Insulators**

The structures for the Generation Outlet Transmission Lines will carry a three-phase 138 kV ac circuit consisting of three Aluminum Conductor Steel Reinforced phase conductors.

The specified phase conductor is a single aluminum conductor steel reinforced conductor, 39.3 mm (1.55 in.) in diameter. The conductors will be insulated from the structures by insulator

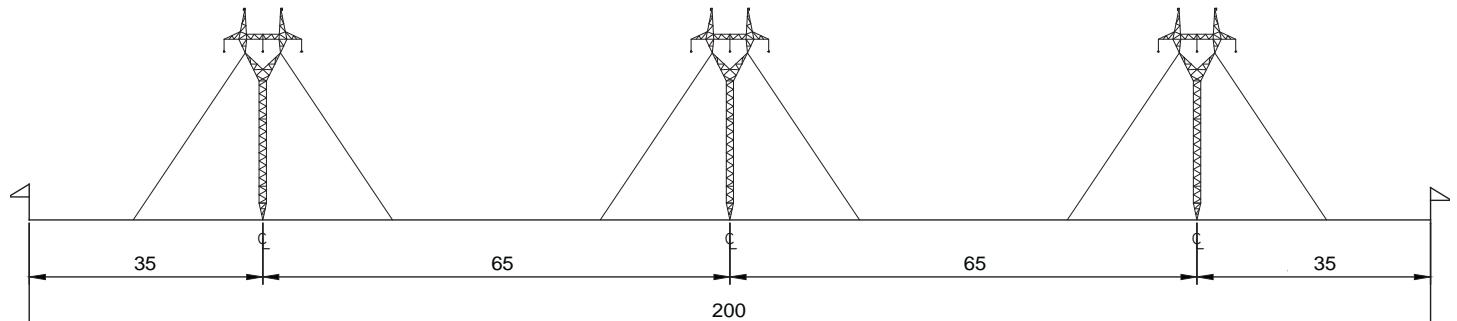




138 KV KEEYASK GEN. OUTLET  
TRANSMISSION LINES  
TYPICAL GUYED LATTICE SUSP. STR.

138 KV KEEYASK GEN. OUTLET  
TRANSMISSION LINES  
TYPICAL GUYED LATTICE SUSP. STR.

138 KV KEEYASK GEN. OUTLET  
TRANSMISSION LINES  
TYPICAL GUYED LATTICE SUSP. STR.



TYPICAL RIGHT OF WAY

KEEYASK GENERATION OUTLET TRANSMISSION LINES

PROPOSED ALIGNMENT OF KEEYASK S.S.-  
RADISSON 138KV TRANSMISSION LINES

**Figure 2-4: Typical Cross Section of Generation Outlet Transmission Line Right-of-Way**



strings consisting of ceramic insulator bells attached to the cross arms of the structures using insulator string assemblies. Conductor clearances are discussed in Section 2.3.4.3.

### **2.3.2.3        Overhead Ground Wires**

One galvanized steel strand ground conductor having an overall diameter of 9 mm (approximately 0.34 in.) will be strung between the peaks of the structures to provide lightning protection. In addition, an optical ground wire (OPGW) will be strung between and attached to the peaks of the towers in place of one of the ground wires on KR1. The optical ground wire will serve both to provide grounding and lightning protection, and to transmit communications for line control and protection.

### **2.3.2.4        Switchyard Terminations**

Terminating the Generation Outlet Transmission Lines will require the retrofit of one existing bay for KR1 and the addition of one bay for KR2 and KR3 at the Radisson Converter Station. The related installations are similar and incremental to the existing development and operation of these facilities.

## **2.3.3        Construction Power Transmission Line**

Construction power will be supplied by a 21-km, 138 kV Construction Power Transmission Line which will tap the Kelsey to Radisson (KN36) 138 kv transmission line between Ilford Station and the tap to Gillam Station. The tap point along KN36 is approximately 33 km from Ilford Station and 29 km from the Gillam Station tap. The width of the right-of-way will be 60 m for most of its length (Figure 2-5), except for the locations where the line will share a right-of-way with GOT lines, as described in Section 2.3.4.1.

### **2.3.3.1        Structure Design and Location**

Guyed tubular suspension structures will be used for straight (tangent) sections (as illustrated in Figure 2-6). Tubular angle anchor structures will be used for angle or dead-end towers (Figure 2-7).

The average span between structures will be approximately 350 m, resulting in approximately 2.9 structures per kilometre. Additional detail respecting span length and tower placement is provided in Section 2.3.4.2.

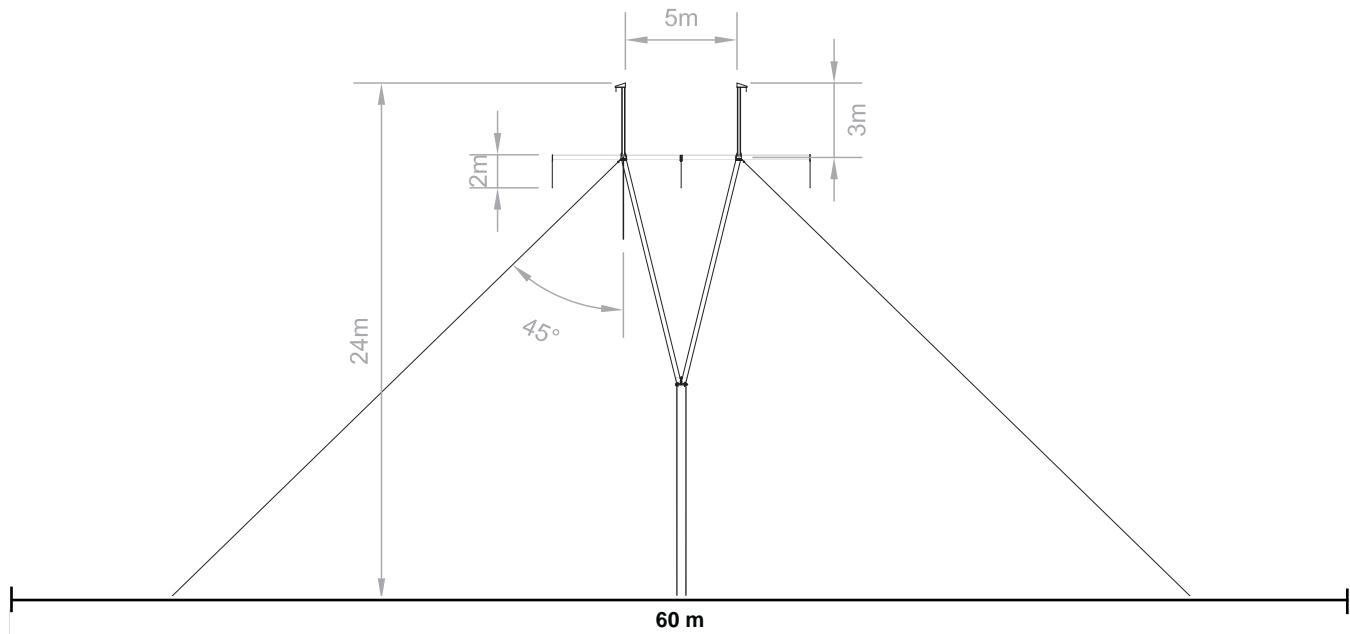
### **2.3.3.2        Conductors and Insulators**

The structures will carry a three-phase 138 kV ac circuit consisting of three aluminum conductor steel reinforced phase conductors, each 18.3 mm in diameter.



138 kV CONSTRUCTION POWER TRANSMISSION LINE

TYPICAL GUYED TUBULAR SUSPENSION STRUCTURE



TYPICAL RIGHT OF WAY

**Figure 2-5: Typical Cross Section of Construction Power Transmission Line Right-of-Way**

138kV CONSTRUCTION POWER  
TRANSMISSION LINE

TYPICAL GUYED TUBULAR  
SUSPENSION STRUCTURE

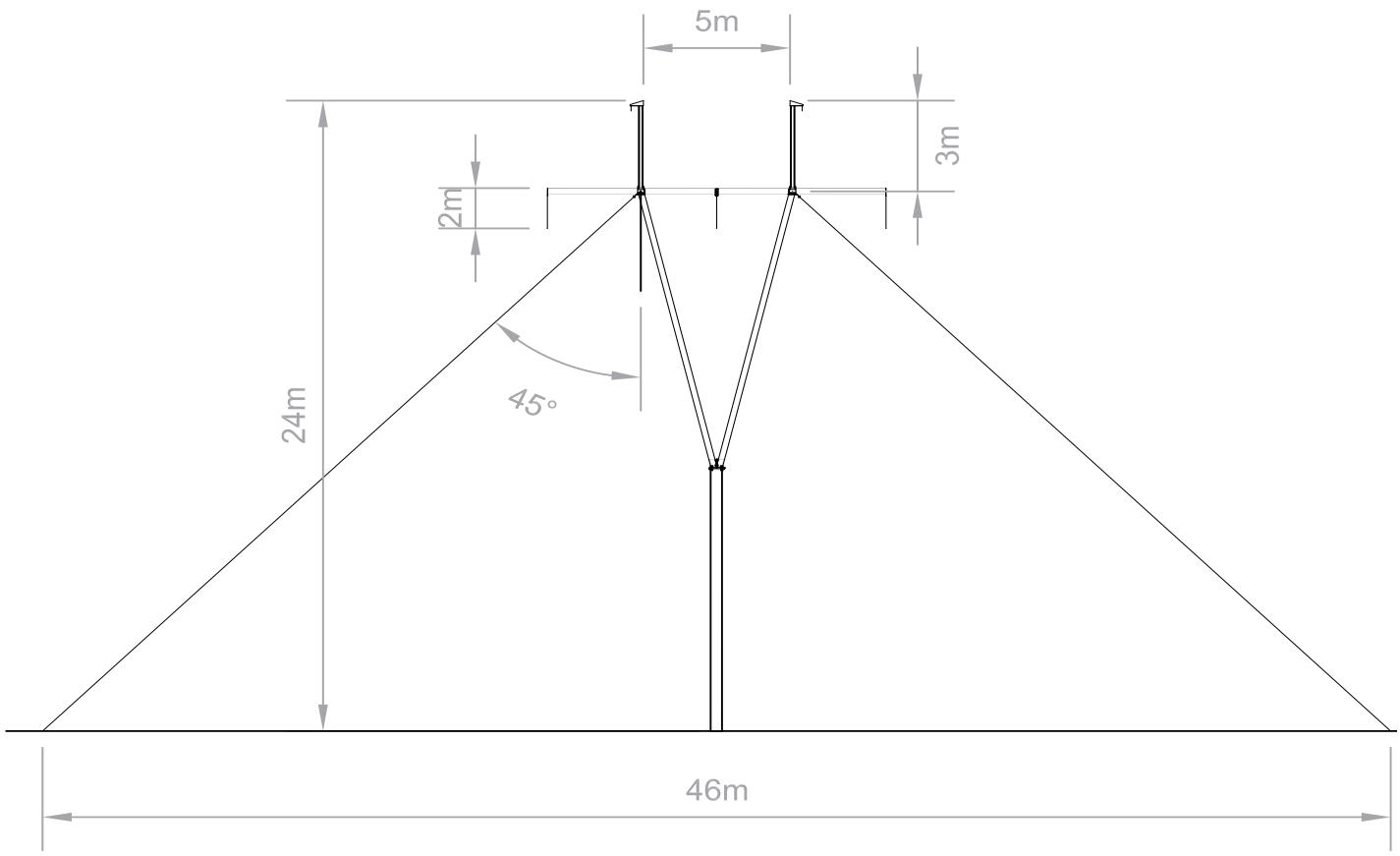


Figure 2-6: Typical Guyed Tubular Suspension Structure

138 kV CONSTRUCTION POWER  
TRANSMISSION LINE

TYPICAL TUBULAR ANGLE ANCHOR STRUCTURE

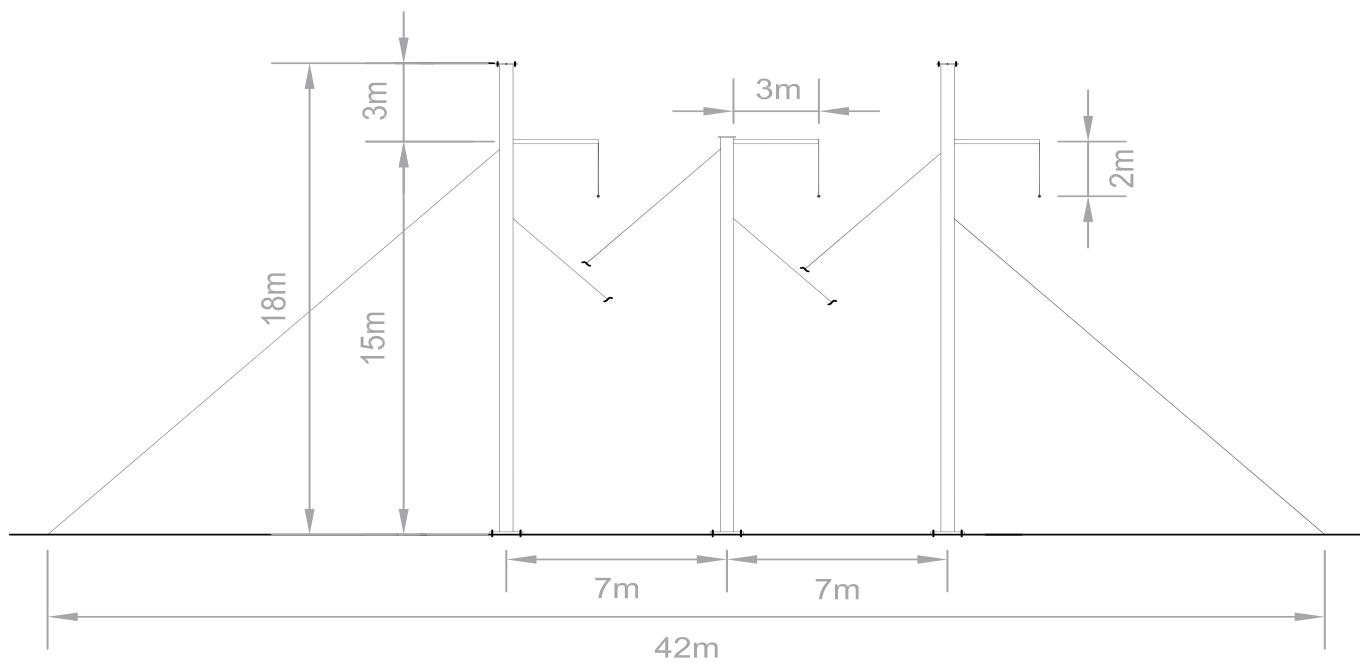


Figure 2-7: Typical Tubular Angle Anchor Structure



Conductors will be insulated from the structures by an insulator string consisting of eight ceramic insulator bells.

### **2.3.3.3 Overhead Ground Wires**

Two galvanized steel strand ground conductors having an overall diameter of 9 mm (approximately 0.34 in.) will be strung between the two peaks of the structures to provide lightning protection.

## **2.3.4 General Transmission Line Design Considerations**

### **2.3.4.1 Rights-of-way and Structure Configuration**

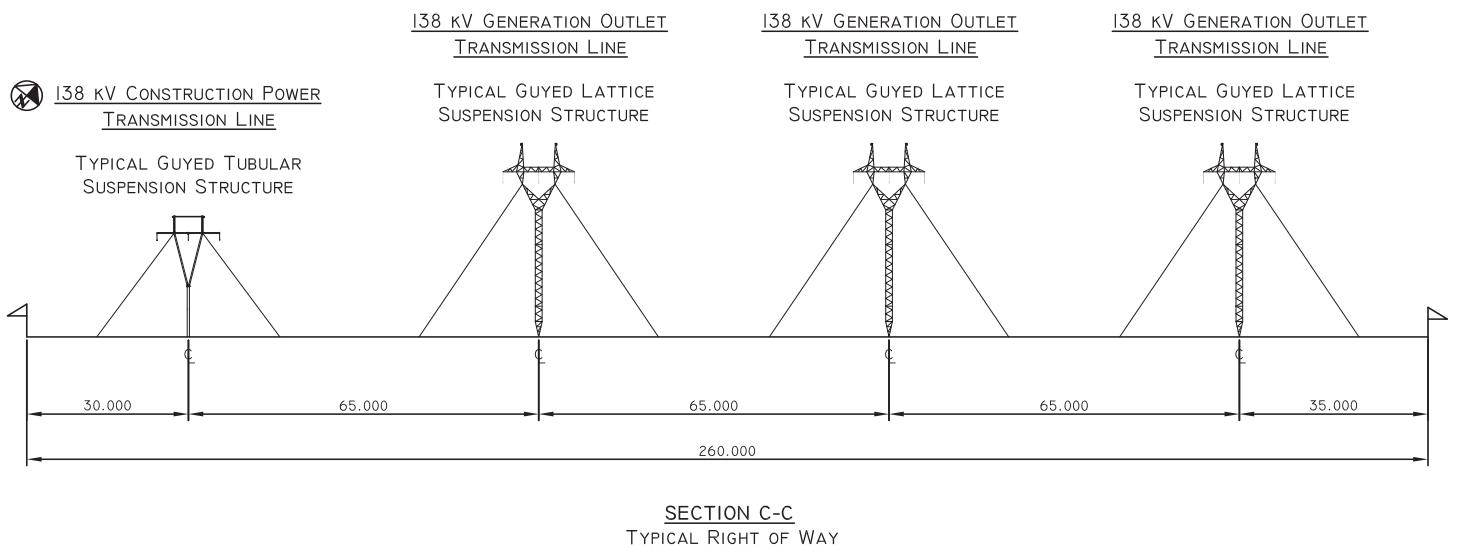
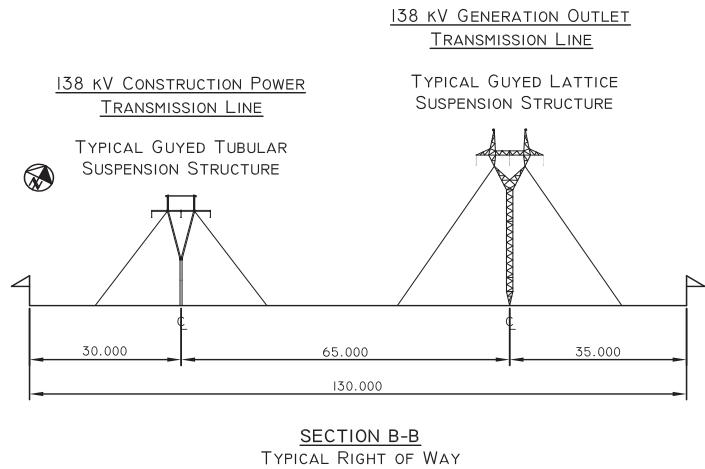
The width of rights-of-way will vary for the transmission line, particularly on those segments where they share common corridors. Map 2-3 indicates locations where the rights-of-way will change and Figures 2-8 to 2-11 show the structure locations across the rights-of-way at these locations.

Detailed engineering design for transmission facilities will be undertaken after receipt of Project environmental approvals, and following right-of-way acquisition and detailed field survey. Precise tower locations and required conductor-to-ground clearances will be established at that time.

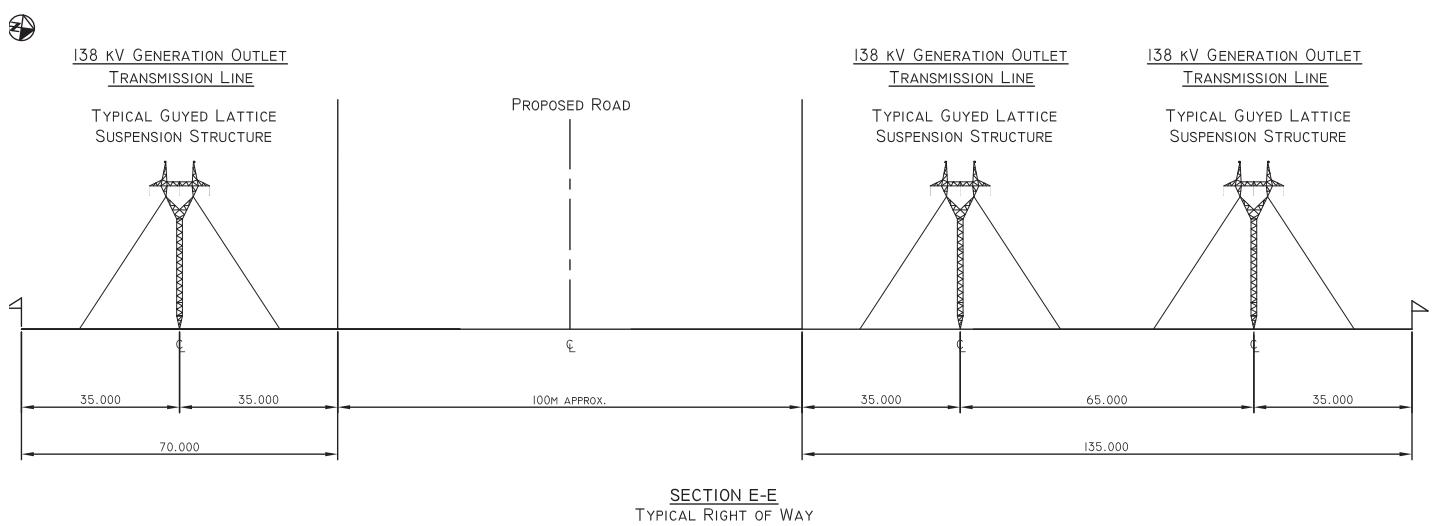
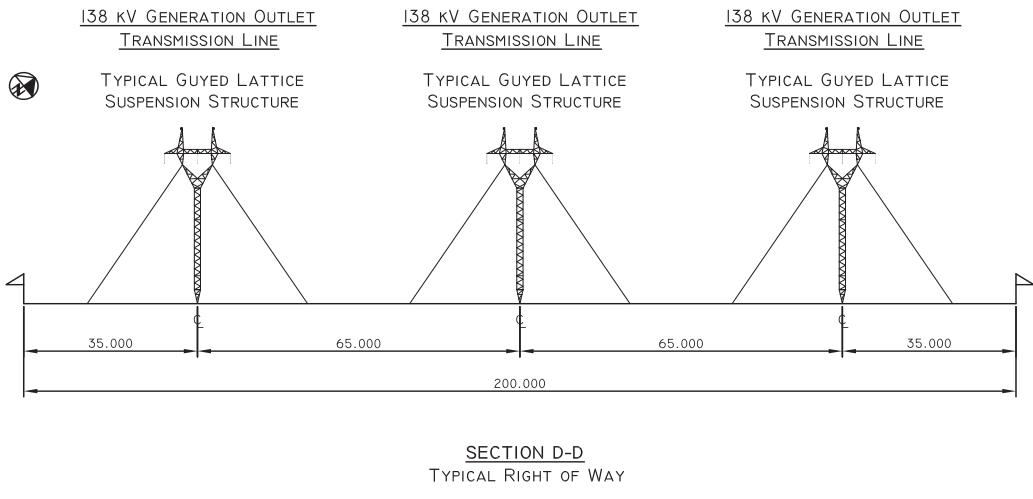
### **2.3.4.2 Tower Spacing and Span Length**

Special crossing structures will be necessary in specific circumstances (e.g., long-span crossings of Nelson River, road crossings, or crossings of other transmission lines). Such structures will typically require greater height, greater strength and heavier construction, but will otherwise be similar to other suspension structures on the line. Final structure locations will be determined on the basis of field surveys, and will reflect detailed engineering and economic analysis with respect to span length, local soil conditions, topographic and geological features, and proximity to existing infrastructure. Subject to detailed engineering analysis, tower location (tower “spotting”) has been identified as a potential mitigation measure to reduce adverse environmental and aesthetic effects. Location preferences identified in the course of the SSEA process (including more detailed pre-construction evaluation of the selected rights-of-way) will be included in the engineering analysis and, where technically and economically feasible, incorporated in the final structure placement decision during the pre-construction phase of the Project.

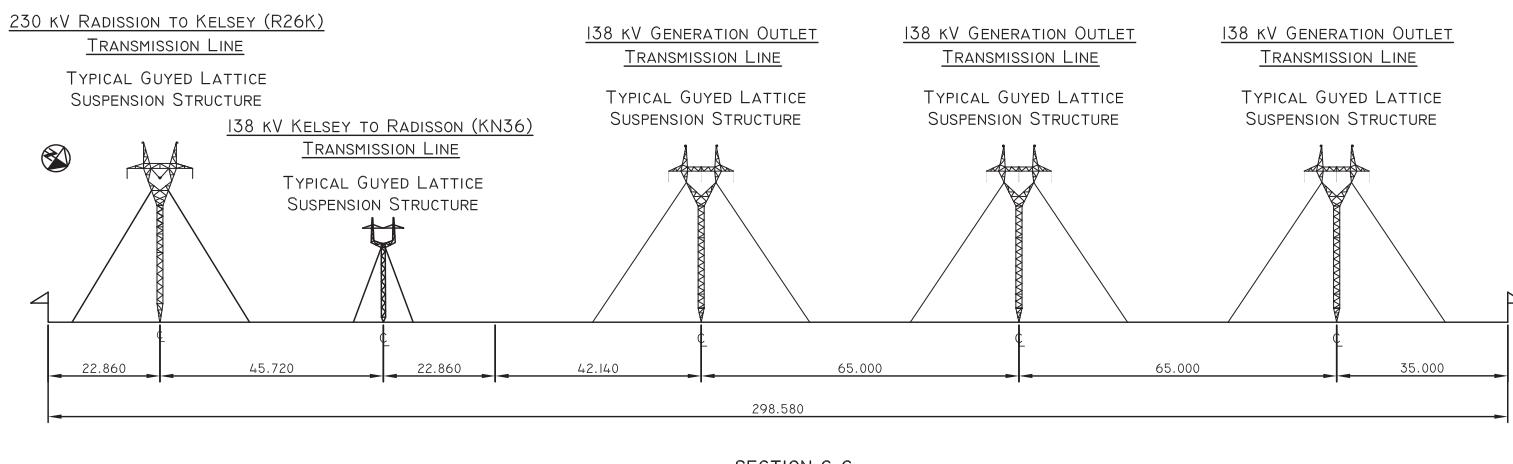
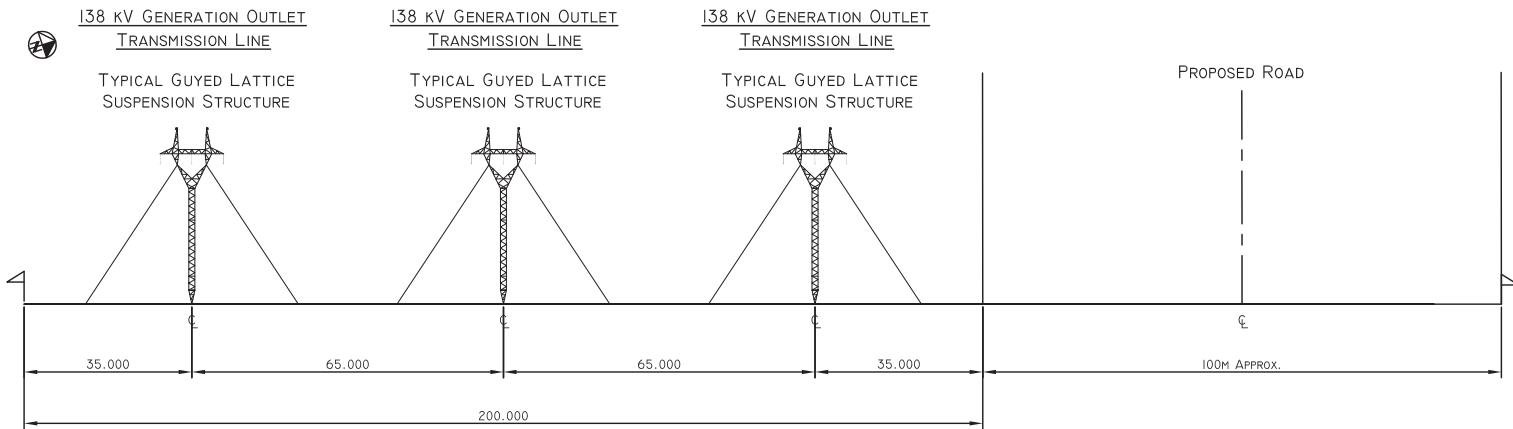




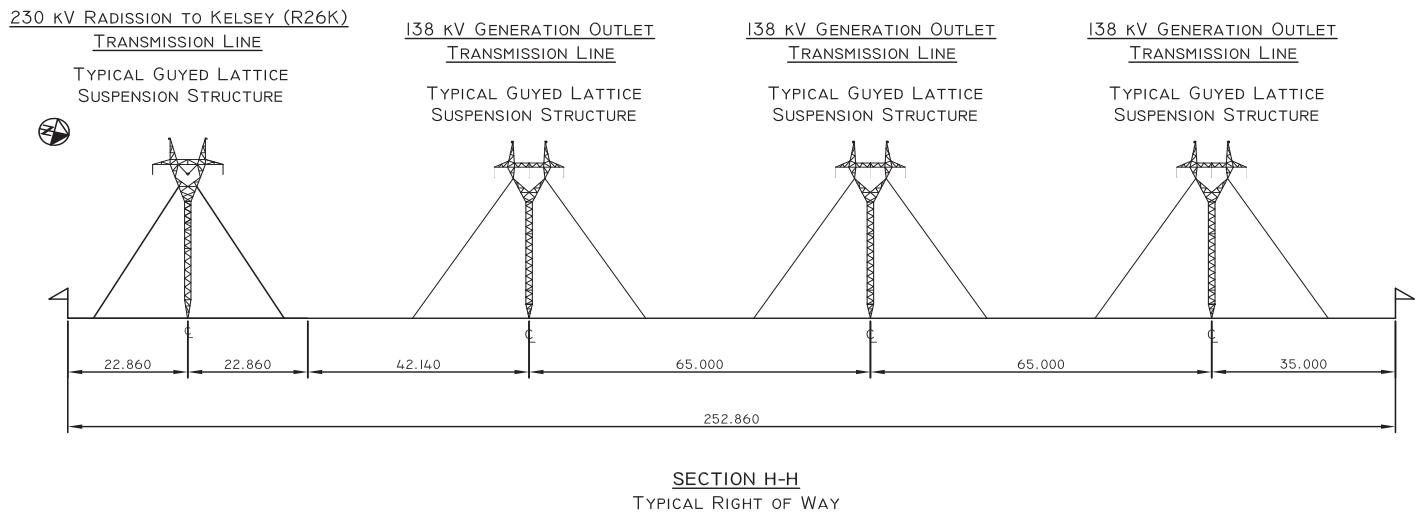
**Figure 2-8: Rights-of-Way for Sections B-B and C-C**



**Figure 2-9: Rights-of-Way for Sections D-D and E-E**



**Figure 2-10: Rights-of-Way for Sections F-F and G-G**



**Figure 2-11: Rights-of-Way for Section H-H**

### **2.3.4.3 Conductor Clearance**

All new 138 kV transmission lines including Unit, Generation Outlet and Construction Power will be designed to the following minimum conductor-to-ground clearances shown in Table 2-1, which will meet or exceed C22.3 No. 1" Overhead Systems" values.

**Table 2-1: Minimum Conductor to Ground Clearances**

<b>Condition</b>	<b>138 kV ac Line</b>
Farmland	7.3 m / 24 ft. (CSA 5.5 m / 18 ft.)
Roads, Highways and Street Crossings	10.7 m / 35 ft. (CSA 5.5 m / 18 ft.)
Railway Crossings	10.7 m / 35 ft. (CSA 8.4 m / 28 ft.)
Underground Pipeline Crossings	7.3 m / 24 ft. (CSA 5.5 m / 18 ft.)
Nelson River Clearance	17.3 m / 57 ft.

### **2.3.5 Construction Power Station**

A new 138 kV to 12.47 kV permanent wood-pole/steel Construction Power Station, located on the north side of the Nelson River, will be needed for construction power. The Construction Power Station will be built on a 2.25-ha site that will be developed to accommodate three transformer banks T1-3 and will supply the necessary power (22 MVA) for the construction of the Keeyask Generating Station (Figure 2-12).

#### **2.3.5.1 138 kV Structures and Equipment**

The 138 kV structures will be composed of steel. The Construction Power Transmission Line will terminate at transformers T1 and T2 and the backup Construction Power Transmission Line (KR1) from Radisson Converter station will be terminate at transformer T3.

#### **2.3.5.2 12 kV Structures and Equipment**

The 12 kV wood pole structures will be developed to distribute power to the construction site and will have five feeders and four 2,400 KVAR capacitor banks. The Construction Power Station will have capacity to expand to three more feeders if required during construction. The line egress for the five feeders will be built underground.



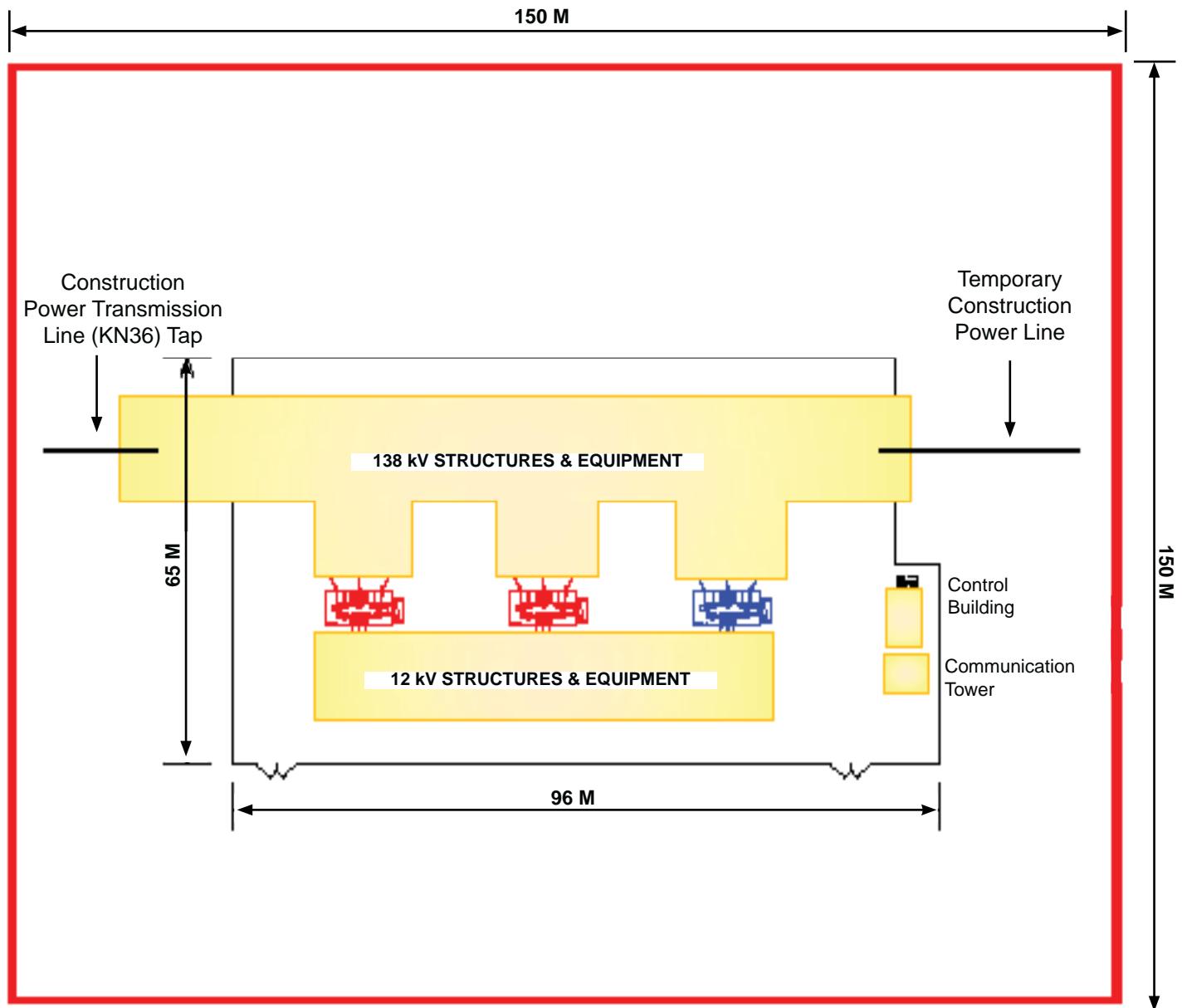


Figure 2-12: Schematic of Construction Power Station Concept



### **2.3.5.3        Site Security**

The Construction Power Station site will be enclosed within a single continuous perimeter fence, consisting of heavy chain link fabric extending to an approximate height of 2.1 m, with a top guard of at least three strands of barbed wire extending to an overall height of approximately 2.4 m.

### **2.3.5.4        Station Grounding System**

The Construction Power Station site will include a subsurface ground grid for personnel and equipment safety, conforming to Manitoba Hydro best practices for station design.

The station ground grid will be placed under the insulating stone surface and will extend just beyond the perimeter fence in accordance with the applicable standards. The subsurface ground grid at the site will consist of numerous copper clad steel ground rods (approximately three metres in length) driven into the ground and connected together below the surface with bare copper wire. The ground grid will also connect to metallic objects within the station site such as the perimeter fence, steel structures, equipment structures and foundations, transformers, buildings, pipes, cables, etc.

### **2.3.5.5        Communications Facilities**

The Construction Power Station will require communications to extend local voice and data services. These communication pathways will generally be comprised of fibre optic networks. An underground cable installed along the station access road from PR 280 will extend optical communications from the existing Manitoba Hydro optical cable running parallel to PR 280 at the junction with the North Access Road. The station will also require a communications tower and antenna to provide for local wireless voice and data communications.

### **2.3.5.6        138 kV ac Disconnect Switches**

High-voltage circuit disconnect switches are required to carry load current, to switch equipment and lines in and out of service as operating conditions dictate, and to isolate faulty equipment connected to, or within, the switchyard.

### **2.3.5.7        Service Transformers**

Service transformers will be required to serve the auxiliary power requirements of the station including the ac switchyard, control building and equipment. Auxiliary power requirements include electrical loads such as building heating and cooling, process cooling systems, lighting, and various other support systems needed for station operation. Two single-phase, two-winding, 12.47 kV service transformers will be required, each will be an insulating oil type.

### **2.3.5.8 Control Buildings**

One building will be required to house the control, protection, and communications equipment necessary for Construction Power Station operation. Cables will connect the control buildings to the ac apparatus. The control buildings typically contain battery banks to meet the power requirements for the electrical equipment installed within the building. Approximately 1,300 litres of lead-acid battery acid will be contained within the batteries in the control building. A separate battery storage room within the control building will be designed in accordance with Institute of Electrical and Electronic Engineers (IEEE) Standards Std 484-2002, IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications, Item 4.2 (a), 2003. The control buildings will also be equipped with heating and air handling equipment to control the building ambient temperature.

### **2.3.5.9 Oil Containment**

The final design of the station will incorporate an oil containment system based on the results of an assessment done in accordance with Manitoba Hydro's Transformer Oil Assessment Manual (1993). No polychlorinated biphenyl (PCB)-containing equipment or oil will be used.

### **2.3.5.10 Decommissioning**

This station will be required to provide a backup source of power to the Keeyask Generating Station black start/emergency system and local distribution power. Once Keeyask Generating Station construction is complete, the T3 transformer will be salvaged as well as the 12 kV bus B, bus tie switches and feeder 4.

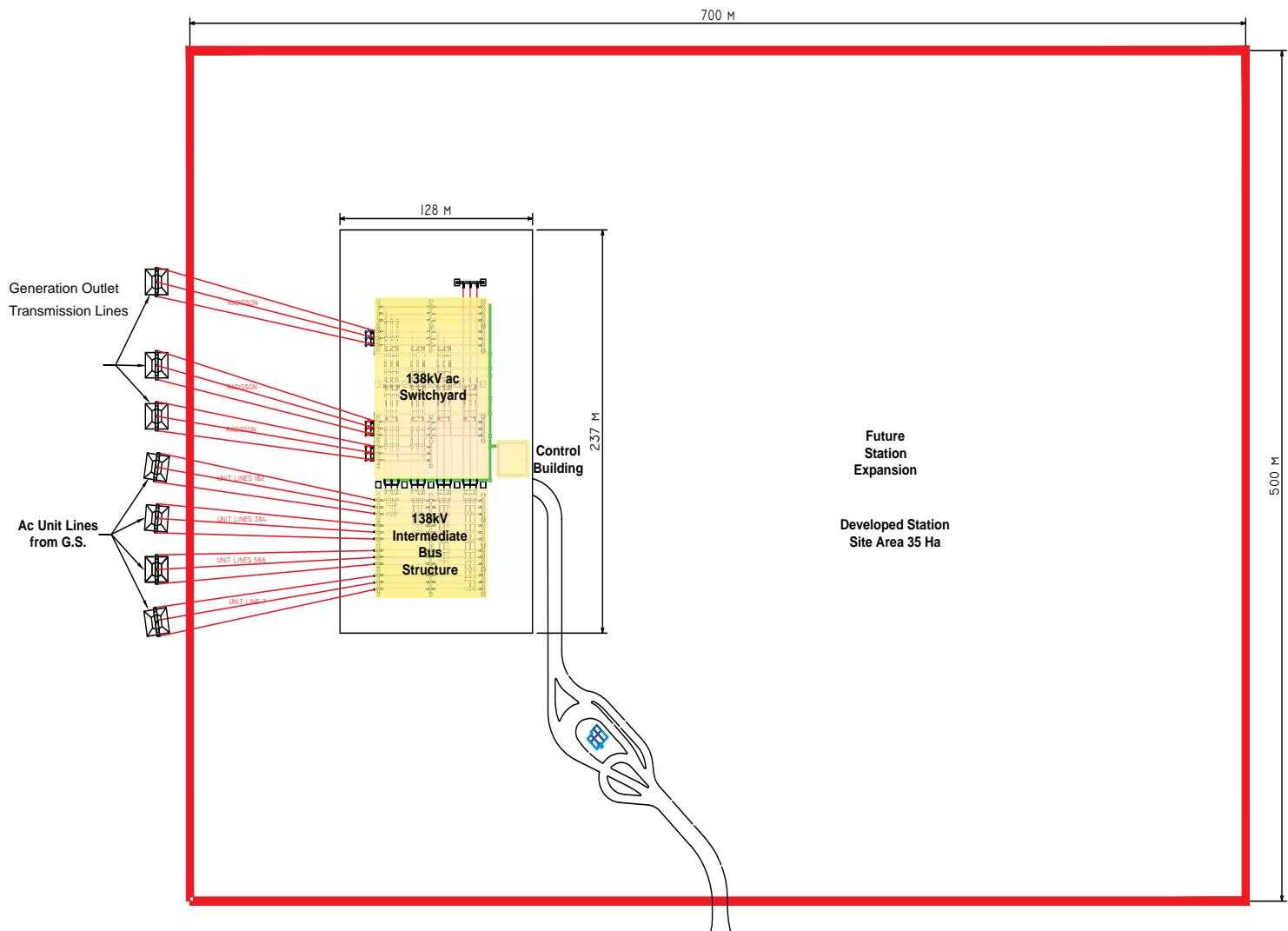
## **2.3.6 Keeyask Switching Station**

A new Keeyask Switching Station is proposed to be located on the south side of the Nelson River. Power from the proposed Keeyask Generating Station will be delivered to the switching station by the four (KE1-4) 138 kV Unit Transmission Lines (Figure 2-13).

The 138 kV switching station development will provide the terminal and related facilities needed to establish the connection between the four 138 kV Unit Transmission Lines and the three 138 kV GOT lines to Radisson Converter Station.

### **2.3.6.1 138 kV ac switchyard and Intermediate Bus Structure**

Components within the 138 kV ac switchyard will include all the necessary concrete foundations, steel structures, equipment supports and station service transformers. Equipment foundations will range from concrete slab-on-grade to deep-piled foundations, depending on equipment weight and geotechnical conditions. Steel structures will be placed on the foundations and will support electrical apparatus, electrical conductors, and hardware



**Figure 2-13: Schematic of Keeyask Switching Station Concept**



associated with the switchyard and transformer functions. Service transformers and other equipment structures will also be placed on concrete foundations. The switchyard will be air-insulated. Detailed numbers and ratings of the switchyard electrical apparatus to be located within the ac switchyard will not be known until final design is complete.

#### **2.3.6.2 Site Security**

The Keeyask Switching Station site will be enclosed within a single continuous perimeter fence, consisting of heavy chain link fabric extending to an approximate height of 2.1 m, with a top guard of at least three strands of barbed wire extending to an overall height of approximately 2.4 m. A security building will be located at the primary access gate for security personnel, and will house closed circuit television monitoring equipment, computer equipment, and other systems needed to support site security operations. The security building will be constructed above grade and will include electric heating and air conditioning systems.

#### **2.3.6.3 Station Grounding System**

The Keeyask Switching Station site will include a subsurface ground grid for personnel and equipment safety, conforming to Manitoba Hydro best practices for station design.

The station ground grid will be placed under the insulating stone surface and will extend just beyond the perimeter fence in accordance with the standard. The subsurface ground grid at the site will consist of numerous copper clad steel ground rods (approximately 3 m in length) driven into the ground and connected together below the surface with bare copper wire. The ground grid will also connect to metallic objects within the station site such as the perimeter fence, steel structures, equipment structures and foundations, transformers, buildings, pipes and cables, etc.

#### **2.3.6.4 Communications Facilities**

The Keeyask Switching Station will require multiple communications paths to facilitate reliable integration into the existing Manitoba Hydro power system. These communication pathways will generally be comprised of fibre optic networks. A combination of optical ground wire and underground optical cabling will provide communication pathways for ac system control and operation.

#### **2.3.6.5 138 kV ac Circuit Breakers and Disconnect Switches**

High-voltage circuit breakers are required to carry load current, to switch equipment and lines in and out of service as operating conditions dictate, and to isolate faulty equipment connected to, or within, the switchyard. Modern high voltage ac circuit breakers contain a sealed mixture of sulphur hexafluoride ( $SF_6$ ) and carbon tetrafluoride ( $CF_4$ ) or nitrogen ( $N_2$ ) gases as the insulating medium inside the breaker.

Seven three-phase 138 kV circuit breakers will be required for the ac switchyard. Each breaker will contain approximately 75 kg of insulating gas, comprised of approximately 50% SF<sub>6</sub> and 50% CF<sub>4</sub> or N<sub>2</sub>.

#### **2.3.6.6 Station Service Lines and Transformers**

Two overhead station service lines from the Keeyask Generating Station at 12.47 kV will supply operational power to the switching station service transformers. These transformers are required to serve the auxiliary power requirements of the switching station including the ac switchyard, control building and equipment. Auxiliary power requirements include electrical loads such as building heating and cooling, process cooling systems, lighting, and various other support systems needed for station operation. Two three-phase, 12.47 kV station service transformers will be required, each be a dry type with no insulating oil.

#### **2.3.6.7 Control Buildings**

One building will be required to house the control, protection, and communications equipment necessary for its operation. Cables will connect the control buildings to the ac switchyard apparatus. The control buildings typically contain battery banks to meet the power requirements for the electrical equipment installed within the building. Approximately 1,300 litres of (lead-acid) battery acid will be contained within the batteries in each control building containment systems. The control buildings will also require heating and air handling equipment to control the building ambient temperature.

#### **2.3.6.8 Oil Containment**

No oil containment is required for the Keeyask Switching Station as no insulating oils are used in site equipment.

### **2.3.7 Existing Radisson Converter Station Upgrade**

The existing Radisson Converter Station will undergo upgrades to prepare it for Keeyask Generating Station output. The modifications at the Radisson Converter Station are contained within the existing station fence line and will utilize existing foundation and oil containment infrastructure (Figure 2-14).

The existing Radisson Converter Station will be upgraded in two stages, as follows:

Stage I: Addition of a 138 kV breaker to accommodate the initial new 138 kV transmission line KR1 from Keeyask Switching Station.

Stage II: Station equipment will include the addition of a 138 kV bay (Bay 1) complete with four 138 kV breakers and associated equipment for the termination of two additional lines (KR2 and

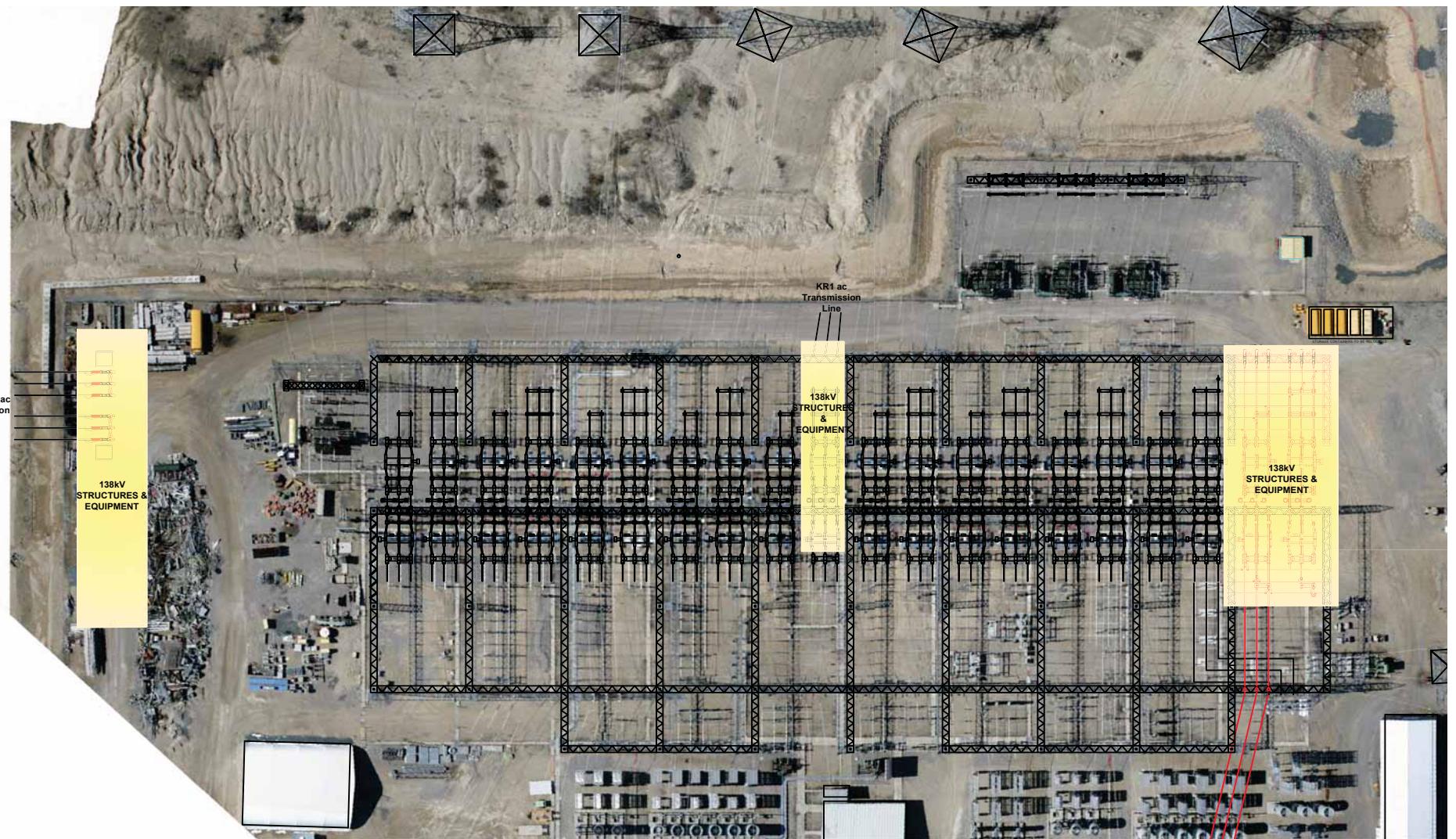


Figure 2-14: Existing Radisson Converter Station: Proposed Work Areas



KR3) from the Keeyask Switching Station. KR2 and KR3 will enter the west side of the station utilizing dead-ended steel structure with line switches. KR2 and KR3 lines will proceed to underground around the station and finally terminate to Bay 1. This is done to avoid complex line crossings into the station. Thirty-one 138 kV ac breakers will also need to be replaced due to fault levels exceeding existing breaker ratings.

### **2.3.7.1        138 kV ac Switchyard**

Components within the 138 kV ac switchyard will include all the necessary concrete foundations, steel structures and equipment supports, and station service transformers. Equipment foundations will range from concrete slab-on-grade to deep-piled foundations, depending on equipment weight and geotechnical conditions. Steel structures will be placed on the foundations and will support electrical apparatus and electrical conductors, and hardware associated with the switchyard and transformer functions. Detailed numbers and ratings of the switchyard electrical apparatus to be located within the ac switchyard will not be known until final design is complete.

### **2.3.7.2        138 kV ac Circuit Breakers and Disconnect Switches**

The design and structure of circuit breakers and disconnect switches for the Radisson Converter Station is comparable to those intended for the Keeyask Switching Station. Thirty-six three-phase 138 kV circuit breakers will be required for the Radisson ac switchyard. Each breaker will contain approximately 75 kg of insulating gas, comprised of approximately 50% SF<sub>6</sub> and 50% CF<sub>4</sub> or N<sub>2</sub>.

### **2.3.7.3        Station Grounding**

The current Radisson Converter Station includes installation of a station ground grid throughout most of the larger station area. The grid comprises numerous copper clad steel ground rods (approximately three metres in length) driven into the ground, connected together below the insulating stone surface with bare copper wire, and also connected to metallic objects such as steel structures, equipment structures and foundations, transformers, buildings, pipes, cables, etc.

The Keeyask Transmission Project will require extension of the ground grid to the 138 kV ac switchyard areas. The ground grid is required for personnel and equipment safety, and will conform to Manitoba Hydro best practices for station design. The extension will be integrated with and, where necessary, will supplement the existing ground grid network.

#### **2.3.7.4        Communications Facilities**

The Radisson Converter Station has existing communication infrastructure at the site. This infrastructure facilitates reliable integration of the Radisson Converter Station into the existing Manitoba Hydro Communication System, and is generally comprised of fibre optic networks.

Optical ground wire, as described in Section 2.3.6.4, will provide the primary communication pathway to Keeyask Switching Station for control and operation of the Generation Outlet Transmission system.

#### **2.3.7.5        Oil Containment**

The current Radisson Converter Station includes all principal components of the station oil containment system. These include a combination of point-source containment and non-point-source containment for oil-filled equipment, all in conformance with applicable oil containment standards.

Additional primary containment will be required for large Keeyask Transmission Project equipment located within the expanded 138 kV ac switchyard. Primary containment at the equipment location will be provided for equipment containing greater than 5,000 litres of oil. This containment will utilize a concrete, clay or synthetic membrane barrier, extending a minimum of 1.5 m beyond the edge of any the equipment. The majority of the primary containment facilities will be connected to the oil-water separator building using fast drain piping.

The extended oil containment facilities will also collect rain, snow melt and water for the fire suppression systems. Water collected in the oil containment system from these sources will undergo oil/water separation in the separator building.

### **2.4            LAND REQUIREMENTS FOR PROJECT**

Manitoba Hydro determines the widths of its rights-of-way to allow for safe conductor “swing out” (i.e., to provide sufficient lateral distance to any object located at the edge of the rights-of-way to avoid flashover under windy conditions), to provide sufficient distance between the line and the rights-of-way edge (and between adjacent lines), to avoid damage in the event of a structure failure, to limit radio interference (based on Canadian Standards Association [CSA] standards respecting radio interference), and, in the case of remote rights-of-way, to facilitate helicopter access for line maintenance or repair.

The proposed 138 kV transmission lines and stations will traverse provincial Crown land. As Crown land is involved, Manitoba Hydro will secure the necessary station and transmission line rights-of-way through Crown Land Reservations and easement agreements with the Province of Manitoba.

## **2.4.1      Transmission Lines**

The width of the right-of-way for the Construction Power line will be 60 m. A 265-m width will be required for the four Unit Transmission Lines between the Keeyask Generating Station and the Keeyask Switching Station. A 200-m width will be required for the three Generation Outlet Transmission lines proposed between the Keeyask Switching Station and Radisson Converter Station. The estimated total cleared area required for all Project transmission lines rights-of-way is approximately 744 ha.

## **2.4.2      Stations**

The proposed Keeyask Switching Station will require 13 ha of land for Project development and an adjacent 22 ha of land will be acquired for possible future expansion, for a total site area of 35 ha. The Construction Power Station will require 2.25 ha of land. No additional land is required for the Radisson Station upgrade.

# **2.5           CONSTRUCTION ACTIVITIES**

## **2.5.1      Overall Schedule**

The overall construction schedule is shown on Figure 2-15.

### **2.5.1.1    Construction Power**

The Construction Power Transmission Line and Construction Power Station are proposed to be in service by May 2015. The property acquisition is scheduled to be completed by February 2014, with construction of the Construction Power Station beginning in April 2014, and the Construction Transmission Line beginning October 2014. No construction will begin until all regulatory approvals and property reservations are completed. The earliest clearing and construction would start in November 2013; the exact start date is subject to regulatory approval of the Keeyask Generation Project. The Keeyask Construction Power 138 kV Transmission Line and Station is proposed to be in service by July 2015.

The initial 138 kV Generation Outlet Transmission line (KR1), designed for backup construction power supply from Radisson to the Construction Power Station, is scheduled to be completed by May 2015. It is expected due to time and weather constraints that only the right-of-way for KR1 will be cleared at this time and KR2 and KR3 will be cleared prior to 2017 when construction is expected to begin.