WUSKWATIM GENERATION PROJECT

ENVIRONMENTAL IMPACT STATEMENT

PROJECT DESCRIPTION
AND
EVALUATION OF ALTERNATIVES

VOLUME 3

Available in accessible formats upon request.

PREFACE

Volume 3 (Project Description and Evaluation of Alternatives) is one of a series of supporting technical volumes for Manitoba Hydro's and Nisichawayasihk Cree Nation's (NCN) application for environmental licensing of the Wuskwatim Generation Project (the Project) which is entitled Wuskwatim Generation Project Environmental Impact Statement, Volume 1 (April 2003).

The Wuskwatim Generation Project EIS is comprised of the following:

- Volume 1 – Wuskwatim Generation Project – Environmental Impact Statement
- Volume 2 – Public Consultation and Involvement
- Volume 3 – Project Description and Evaluation of Alternatives
- Volume 4 – Physical Environment
- Volume 5 – Aquatic Environment
- Volume 6 – Terrestrial Environment
- Volume 7 – Resource Use
- Volume 8 – Socio-Economic Environment
- Volume 9 – Heritage Resources
- Volume 10 – Cumulative Effects Assessment (Framework Approach)

Volume 3 has been prepared by Manitoba Hydro and a support team of Engineering Consultants. The supporting volumes have contributed to the preparation of the summary Environmental Impact Statement (Volume 1) and also provide additional technical and professional supporting information to assist in the technical review of the EIS. The supporting documents have been reviewed by Manitoba Hydro and NCN and are technically consistent with the EIS. They have not been edited for consistency in format, style, or wording with either the Summary EIS (Volume 1) or other supporting volumes.

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1.0 INTRODUCTION

Manitoba Hydro (MH) and the Nisichawayasihk Cree Nation (NCN) have conducted a comprehensive Environmental Impact Assessment of the proposed Wuskwatim Generation Project and prepared a detailed Environmental Impact Statement (EIS) in support of the submission for regulatory approval to proceed with the development. NCN and MH have worked very closely together to develop this EIS and it should be noted that Traditional Knowledge was used in many areas of project planning, in aspects such as the amount of flooding and the location of access road and camp. This spirit of cooperation includes discussions on the possibility of NCN owning up to 33% of the Generation Project, perhaps through a limited partnership. If NCN chooses to become a partner, some of these references in this Volume may more properly be to MH and NCN, or to the limited partnership. This Project Description, including the evaluation of alternatives, is Volume 3 of ten volumes comprising the Wuskwatim Generating Station Environmental Impact Statement. A separate Environmental Impact Statement has been prepared and submitted for the transmission lines component of the Wuskwatim Transmission Project. The Wuskwatim Generation Project EIS is comprised of the following:

- Volume 1 – Wuskwatim Generation Project – Environmental Impact Statement
- Volume 2 - Public Involvement Plan
- Volume 3 - Project Description and Evaluation of Alternatives
- Volume 4 - Physical Environment
- Volume 5 - Aquatic Environment
- Volume 6 - Terrestrial Environment
- Volume 7 - Resource Use
- Volume 8 – Socio-Economic Environment
- Volume 9 - Heritage Resources
- Volume 10 - Cumulative Environmental Effects

Section 2 provides an overview of the Wuskwatim Generating Station, in terms of its location, the lands required for the Project, a summary of the Project components and key parameters, the planning and design assumptions, a summary of the environmental features incorporated into the design of the permanent facilities, and the survey and mapping references.

Section 3 summarizes the studies that have been undertaken to evaluate the alternative station parameters and ways that the generating station could be developed.

Section 4 describes the nature and function of the following:

- the supporting infrastructure and activities required to construct the Wuskwatim Generating Station;
- the Wuskwatim Generating Station and all the associated components; and
- the preparation of the footprint for the on-site permanent switching station.

The permanent switching station and associated transmission components are described separately in the EIS submission for the Wuskwatim Transmission Project.

Section 5 describes how the Project will be operated, maintained and decommissioned.

1.1 INTRODUCTION TO MANITOBA HYDRO

Manitoba Hydro is a Crown Corporation located in Manitoba, Canada (Figure 1.1-1) and owned by the Province of Manitoba. The Utility's mandate is to provide continuous, reliable and economical energy and services (electricity and natural gas) to the citizens of the Province of Manitoba. The utility is responsible for Manitoba's current and future energy requirements, i.e., planning, designing, constructing, operating, and maintaining all the facilities needed to meet those requirements.

Manitoba Hydro generates, transmits and distributes electrical energy and is a distributor of natural gas within Manitoba. In addition, as excess electrical energy is available, the utility undertakes exports to neighbouring provinces and the US markets, which provide revenue enabling continued low rates for domestic customers. Expert utility consulting and training services have been provided to more than 40 foreign countries.

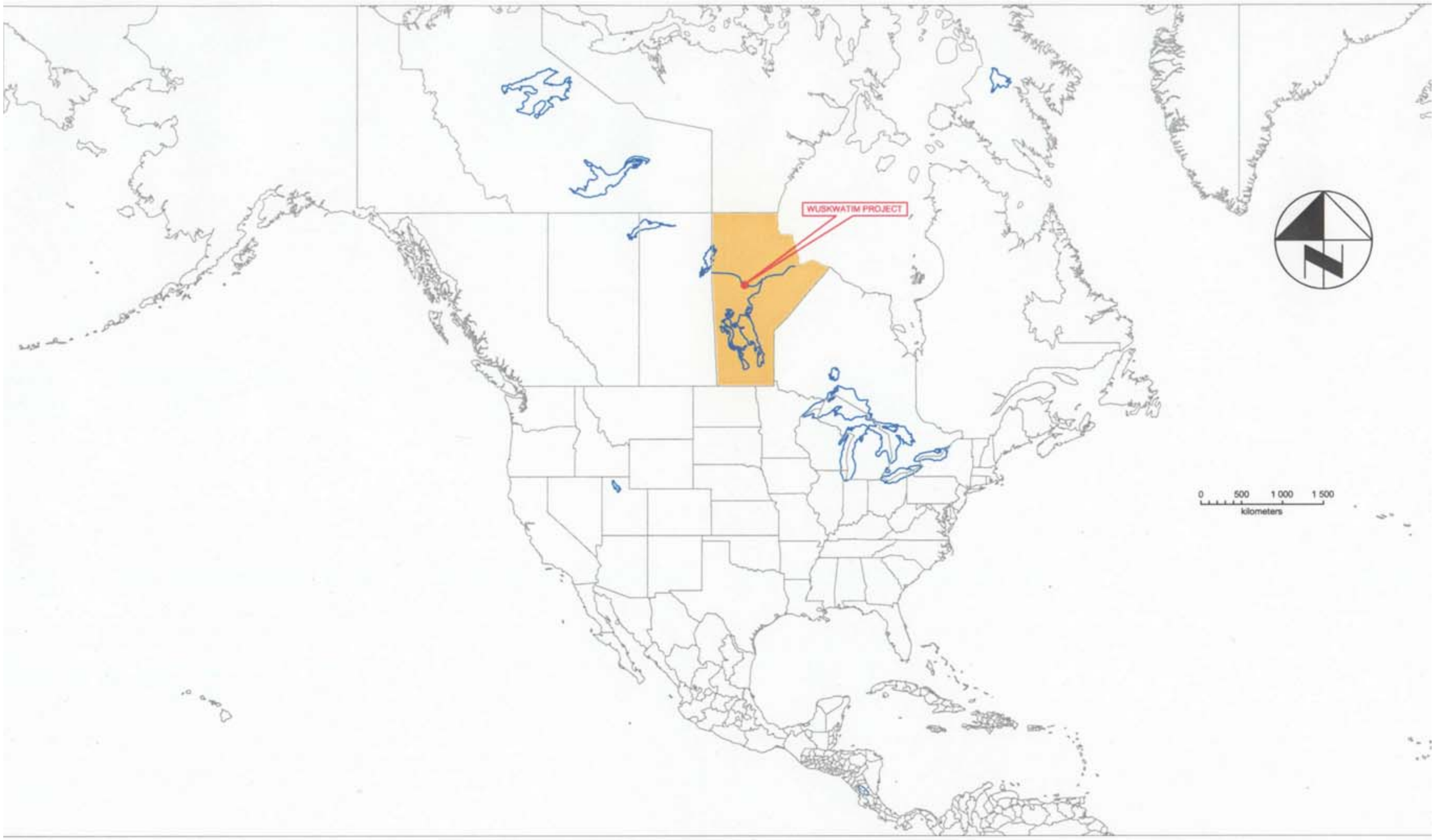

Figure 1.1-1 – Province of Manitoba

The affairs of Manitoba Hydro are administered by a Board appointed by the Provincial Cabinet. The Manitoba Hydro-Electric Board reports to the Minister Responsible for the Manitoba Hydro Act, who, in turn, reports to the Manitoba Legislative Assembly.

Manitoba Hydro currently serves more than 500,000 electricity customers and 249,000 natural gas customers. To provide effective customer service in a territory of 650,000 km^2, Manitoba Hydro has 80 offices located throughout the Province. The Head Office is located in Winnipeg. In 2002, Manitoba Hydro acquired the assets and customers of Winnipeg Hydro from the City of Winnipeg.

Manitoba Hydro employs more than 5,500 people, has assets in excess of $10 billion and annual revenues of more than $1 billion. For more than a century Manitoba Hydro and its predecessor's projects have played a major role in the development of Manitoba and in the overall provincial economy, supporting local business and employment as well as industrial growth. Manitoba Hydro and its staff are key elements in the fabric of Manitoba.

Manitoba Hydro recognizes that its previous northern hydroelectric developments have impacted the environment and the lifestyle of some northern residents. The utility is working with northern First Nations to address past impacts, to conduct joint planning processes and to develop partnerships for future projects.

1.2 MANDATE, VISION & GOALS

Manitoba Hydro's mandate is:

> *"To provide for the continuance of a supply of energy adequate for the needs of the province and to promote economy and efficiency in the development, generation, transmission, distribution, supply, and end-use of energy, and to provide and market, energy and related products and services, within and outside the province."*

The Corporate Vision is:

> *"To be recognized as the best utility in North America with respect to safety, rates, reliability, and customer satisfaction, and to be considerate of all people with whom we have contact."*

The Corporate Goals for 2003 have been established as:

- Continuously improve safety in the work environment.
- Provide customers with exceptional value (rates, service, public safety, reliability and power quality).
- Be a leader in strengthening working relationships with aboriginal peoples.
- Improve Corporate financial strength.
- Maximize export power net revenues.
- Have highly skilled, effective, innovative employees and a diverse workforce that reflects the demographics of Manitoba.
- Be proactive in protecting the environment and be a recognized leader for doing so.
- Be an outstanding corporate citizen.
- Proactively support agencies responsible for business development in Manitoba.

1.3 ENVIRONMENTAL STEWARDSHIP AND SUSTAINABLE DEVELOPMENT PRINCIPLES

Manitoba Hydro is guided by a core set of environmental principles. The Corporation strives to be a leader in environmental stewardship by complying with all regulatory requirements, by minimizing the impacts of our facilities and activities, by providing clean, reliable renewable power and by supporting environmental research. Manitoba Hydro has adopted an environmental management policy, which states:

"Manitoba Hydro is committed to protecting the environment. In full recognition of the fact that Corporate facilities and activities affect the environment, Manitoba Hydro integrates environmentally responsible practices into its business, thereby:

- *Preventing or minimizing adverse impacts, including pollution, on the environment, and enhancing positive impacts;*
- *Meeting or surpassing regulatory requirements and other commitments;*
- *Considering the interests and utilizing the knowledge of our customers, employees, communities and stakeholders who may be affected by our actions;*
- *Reviewing our environmental objectives and targets annually to ensure improvement in our environmental performance;*
- *Continually improving our Environmental Management System; and*
- *Documenting and reporting our activities and environmental performance."*

The Corporation has implemented an ISO 14001 Environmental Management System and is presently completing the registration process for the Corporate, Power Supply, Transmission and Distribution and Customer Services Business Units. Individual generating stations and High Voltage Direct Current (HVDC) stations have been ISO registered for several years.

Manitoba Hydro is an active participant in the Canadian Electricity Association's Environmental Commitment and Responsibility Program (ECR). The ECR program includes four principles:

- To be more efficient in the use of resources;
- To reduce the adverse impacts of our business;
- To be accountable to our stakeholders, and
- To ensure that our employees understand the environmental implications of their actions and have the knowledge and skills to make the right decisions.

Manitoba Hydro applies the principles of sustainable development in all aspects of its planning and operations to achieve environmentally sound and sustainable economic development. Through its decisions and actions, the Corporation endeavours to meet the needs of the present without compromising the ability of future generations to meet their needs. The 13 principles that support Manitoba Hydro's sustainable development policy are presented in Appendix 1.0.

1.4 OVERVIEW OF MANITOBA HYDRO'S ELECTRICITY SYSTEM

Manitoba Hydro operates 14 hydroelectric generating stations located on the Winnipeg, Saskatchewan, Nelson, and Laurie Rivers, which generate over 95 % of the utility's electricity (Table 1.4-1). Electricity is also generated at a coal fired generating station and two combustion turbines located at Brandon, Manitoba and at a gas fired generating station at Selkirk, Manitoba. Four remote northern communities (Brochet, Lac Brochet, Shamattawa and Tadoule Lake) are served by on-site diesel generation. Total generation capability is currently in the order of 5,000 MW. The locations of the Manitoba Hydro's generating stations and associated transmission system in Northern Manitoba are shown relative to the Wuskwatim Project in Figure 1.4-1 Approximately 40% of the electricity currently generated is sold in the export market. Electricity is

Table 1.4-1 MANITOBA HYDRO'S GENERATING STATIONS

STATION	IN-SERVICE DATE[1]	CAPACITY (MW)[2]
Winnipeg River		
Point du Bois[3]	1911	75
Slave Falls[3]	1931 – 1948	68
Seven Sisters	1931 & 1952	155
McArthur Falls	1955	54
Great Falls	1928	129
Pine Falls	1952	88
Saskatchewan River		
Grand Rapids	1968	480
Nelson River		
JenPeg	1979	97
Kelsey	1961 & 1972	215
Kettle	1974	1224
Long Spruce	1979	1020
Limestone	1992	1294
Churchill River		
Laurie River #1	1952 & 1970	5
Laurie River #2	1958	6
Thermal		
Selkirk Units 1 & 2[4]	1961	139
Brandon Unit 5 (Coal)[5]	1970	97
Brandon Units 6 & 7[6]	2002	260
Total		**5406**[7]

Notes
1. Date station was fully in-service, dates of upgrades also indicated.
2. Current capacity.
3. Acquired from Winnipeg Hydro in 2002.
4. Fuel source converted from coal to natural gas in 2002.
5. Brandon Units 1- 4 were mothballed in 1994.
6. Units 6 & 7 are natural gas fired combustion turbines.
7. Does not Includes 10 MW total on-site diesel generation for four remote northern communities.

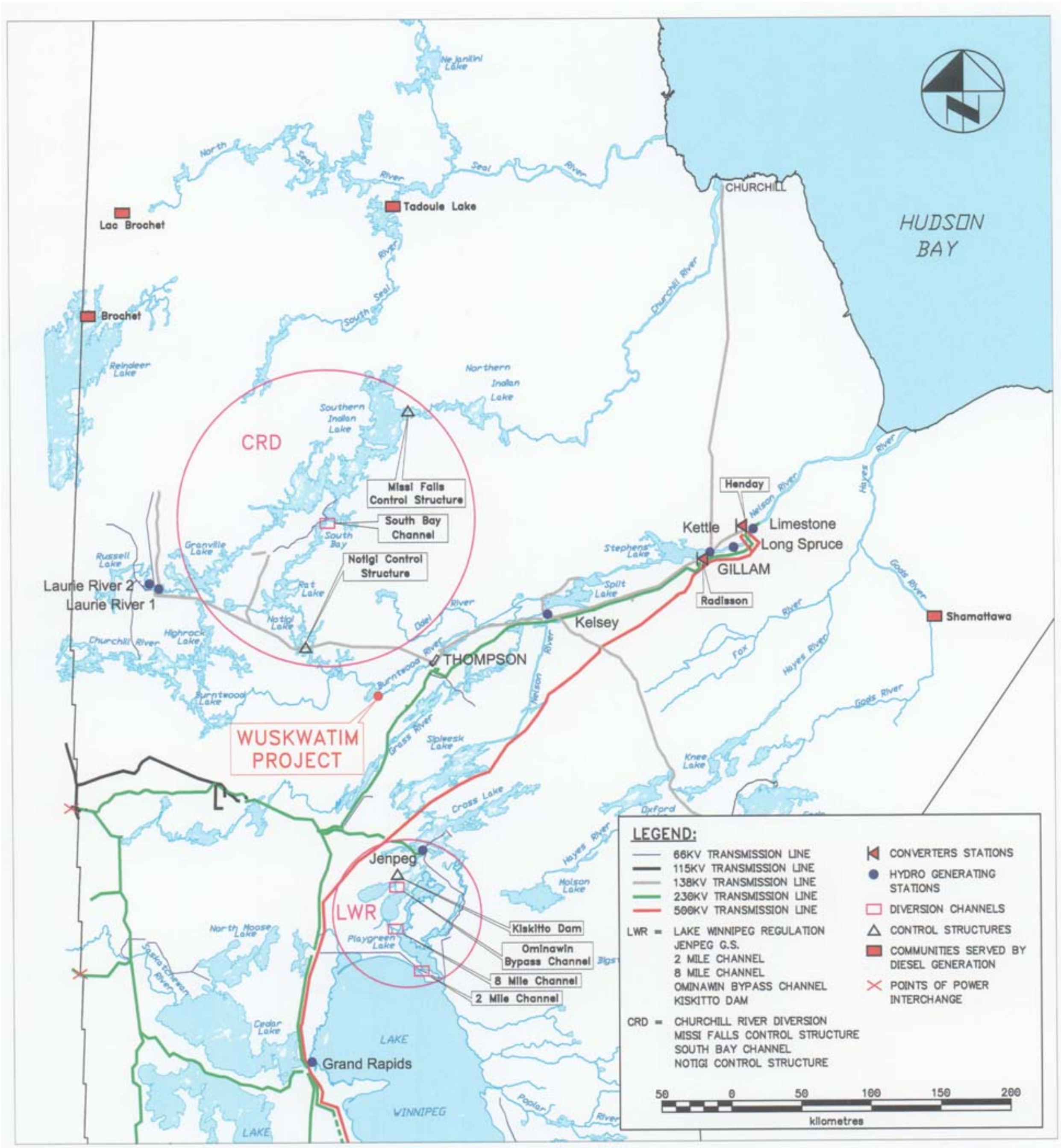

Figure 1.4-1 Manitoba Hydro's system in Northern Manitoba

delivered from the generating stations to the customers over more than 100,000 kilometers of transmission and distribution lines. Manitoba Hydro is internationally renowned for its expertise and long history in Direct Current (DC) transmission. Delivery of electricity to US markets is facilitated by membership in MISO (Mid-West Independent System Operator) and MAPP (Mid-Continent Area Power Pool) (Figure 1.4-2).

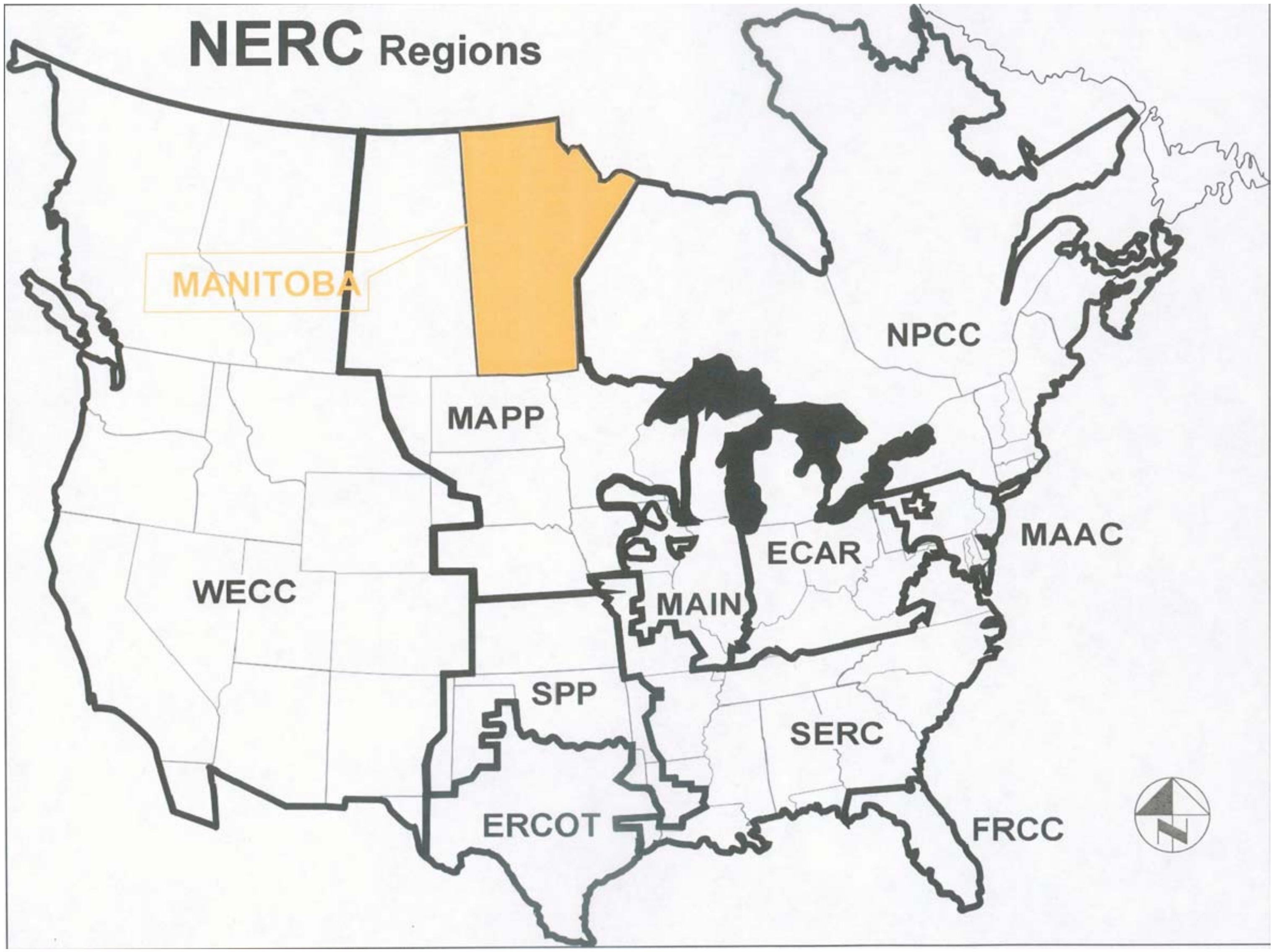

Figure 1.4-2 Manitoba Hydro operates within the Mid-Continent Area Power Pool

1.5 THE HISTORY OF NORTHERN PROJECTS

Power planners have recognized the potential of the Nelson River for hydroelectric generation in northern Manitoba since the turn of the century. It was not until the 1960s however, that high-voltage direct current transmission technology became available to make Nelson River power development feasible. The major Nelson River power sites are approximately 800 km from the City of Winnipeg, the province's largest electrical load centre. During the first half of the 20th century, the power from the north was neither available nor required; Manitoba's industry and population concentration in the south was adequately supplied with hydropower from the Winnipeg River, only 100 km from Winnipeg and from local thermal generation plants.

In the 1950s, when the Winnipeg River's 560 MW were developed, planners looked northward to meet the growing need for electricity. They looked first to Kelsey on the Nelson River in the late 1950s, to serve the needs of the INCO smelter and the community at Thompson. They then looked to Grand Rapids on the Saskatchewan River, where first power was produced in 1965. While the Grand Rapids development, designed to serve loads some 400 km to the south, had been made possible by the introduction of high-voltage alternating current (AC) technology, the Nelson sites were twice the distance and at first seemed unattainable as energy sources for southern Manitoba. Although the transmission lines from Grand Rapids to Winnipeg were designed at double the voltage ever used in the province up to that time, a few years later new HVDC transmission technology became available, making development of the lower Nelson River feasible.

In February 1966, after joint federal-provincial engineering and economic studies, Manitoba Hydro announced its intention to divert the Churchill River into the Nelson River as part of an overall plan of northern hydro development. In 1971 Canada and Manitoba initiated the Lake Winnipeg, Churchill and Nelson Rivers Study (LWCNRS) to investigate the sociological, economic and environmental aspects of the proposed developments associated with **Lake Winnipeg Regulation** (LWR) and **Churchill River Diversion** (CRD).

The primary purpose of LWR is to regulate Lake Winnipeg to provide increased winter outflows for power generation into the Nelson River. A secondary benefit of the Project is the ability to regulate Lake Winnipeg for flood control. The primary purpose of the CRD is to divert water from the Churchill River to the Nelson River to supply the generating stations on the lower Nelson River.

In May 1973, the Water Resources Branch of the Manitoba Department of Mines, Resources and Environmental Management issued a licence to proceed with CRD. CRD was concurrently undertaken with the Lake Winnipeg Regulation Project to more effectively meet the projected electrical demand.

The CRD Project included construction of the following three main components to divert the Churchill River into the Burntwood River;

- A control dam at Missi Falls, the natural outlet of Southern Indian Lake, controls the outflow of the Churchill River and raises the lake level three metres;
- An excavated channel from South Bay of Southern Indian Lake into Issett Lake, enables Churchill River waters to flow into the Rat-Burntwood River system, - a tributary of Nelson River system; and
- A control dam at Notigi Lake on the Rat River regulates the flow into the Burntwood-Nelson system.

Construction contracts were awarded for the CRD & LWR Projects in 1973; the Projects became fully operational in 1977.

In June 1975, the final 13-volume LWCNRS report was released, containing technical findings and recommending mitigation measures. Although Manitoba Hydro had implemented many of the recommended actions that were within its jurisdiction prior to finalization of the report, the five directly affected First Nation Communities (Nelson House, Split Lake, York Landing, Cross Lake and Norway House) expressed concern about several unresolved issues. In 1974, as LWR/CRD development plans matured and construction began, these First Nations formed the Northern Flood Committee, to facilitate joint discussions with Manitoba Hydro and the two levels of government on the Project. The Northern Flood Committee negotiated the Northern Flood Agreement with Manitoba Hydro, the Federal and Provincial governments over the following three years resulting in the signing of the Northern Flood Agreement in 1977.

As indicated in Table 1.4-1, since 1971 four hydroelectric generating stations have been constructed on the Nelson River, one at the outlet of Lake Winnipeg and three on the Lower Nelson.

1.6 WATER POWER DEVELOPMENT IN THE WUSKWATIM LAKE AREA

The Wuskwatim site was identified as one of several potential hydroelectric development sites along the Burntwood River in the 1966 and 1975 Canada/Manitoba studies. Manitoba Hydro has undertaken ongoing studies to determine where, when and what type of hydroelectric development is appropriate for sites on the Burntwood River. Manitoba Hydro's planners continue to develop, review and update design concepts, cost estimates and schedules in a five-step, staged planning approach that produces increasing detail and confidence in project information over time. This process is further described in Section 3.1. The Wuskwatim Project is currently advancing from Stage 4 (Pre-Investment Engineering) into Stage 5 (Final Design/Construction). Available Project information has been used for public consultation and for environmental assessment. At this stage, it is being submitted for licensing processes and will continue to be updated as the Project advances through Stage 5 (Final Design/Construction). The following sections of this Project Description describe the details of the development that is being proposed for approval at this time.

2.0 OVERVIEW OF WUSKWATIM GENERATING STATION

2.1 INTRODUCTION

This Project Description has been developed specifically for the environmental assessment of the impacts that could occur as a result of construction, operations and maintenance. The information in the following sections reflects the most current plans and estimates for the various components of the proposed Wuskwatim GS development. As the detailed design evolves, the confidence in the estimates will increase and some minor changes can be expected.

2.2 LOCATION

The proposed Wuskwatim Generating Station (GS) will be located in northern Manitoba, Canada, at Latitude 55^{o} 32' 29", and Longitude 98 ^{o} 30' 14", as shown in Figure 2.2-1. Wuskwatim GS will be located approximately 48 km southwest of the city of Thompson and approximately 37 km southeast of the community of Nelson House and is within the Nelson House Resource Management Area as shown in Figure 2.2-2. Wuskwatim GS site will be located at Taskinigup Falls, which is 1.5 km downstream of the outlet of Wuskwatim Lake on the Burntwood River as shown in Figure 2.2-3. Wuskwatim GS will be the first hydroelectric generating station to be built on the Burntwood River to utilize the Churchill River Diversion (CRD) flows.

2.3 LANDS REQUIRED

The amounts of land required for the construction, operation and maintenance of Wuskwatim GS excluding the permanent transmission lines and associated works are summarized in Table 2.3-1. Following construction, approximately 120 ha of land will be required for the ongoing operations and maintenance of the Project at site while the remaining land required for construction will be rehabilitated to varying degrees as discussed in Section 4.10.

All required land is currently Provincial Crown Land. Most of the land is within Manitoba Hydro's Churchill River Diversion license area and the Province of Manitoba's Water Power Reserve area except some parts of the access road, construction power transmission line and granular borrow areas. The Wuskwatim GS site is within the Nelson House Resource Management Area (RMA). These boundaries are shown in Figure 2.3-4.

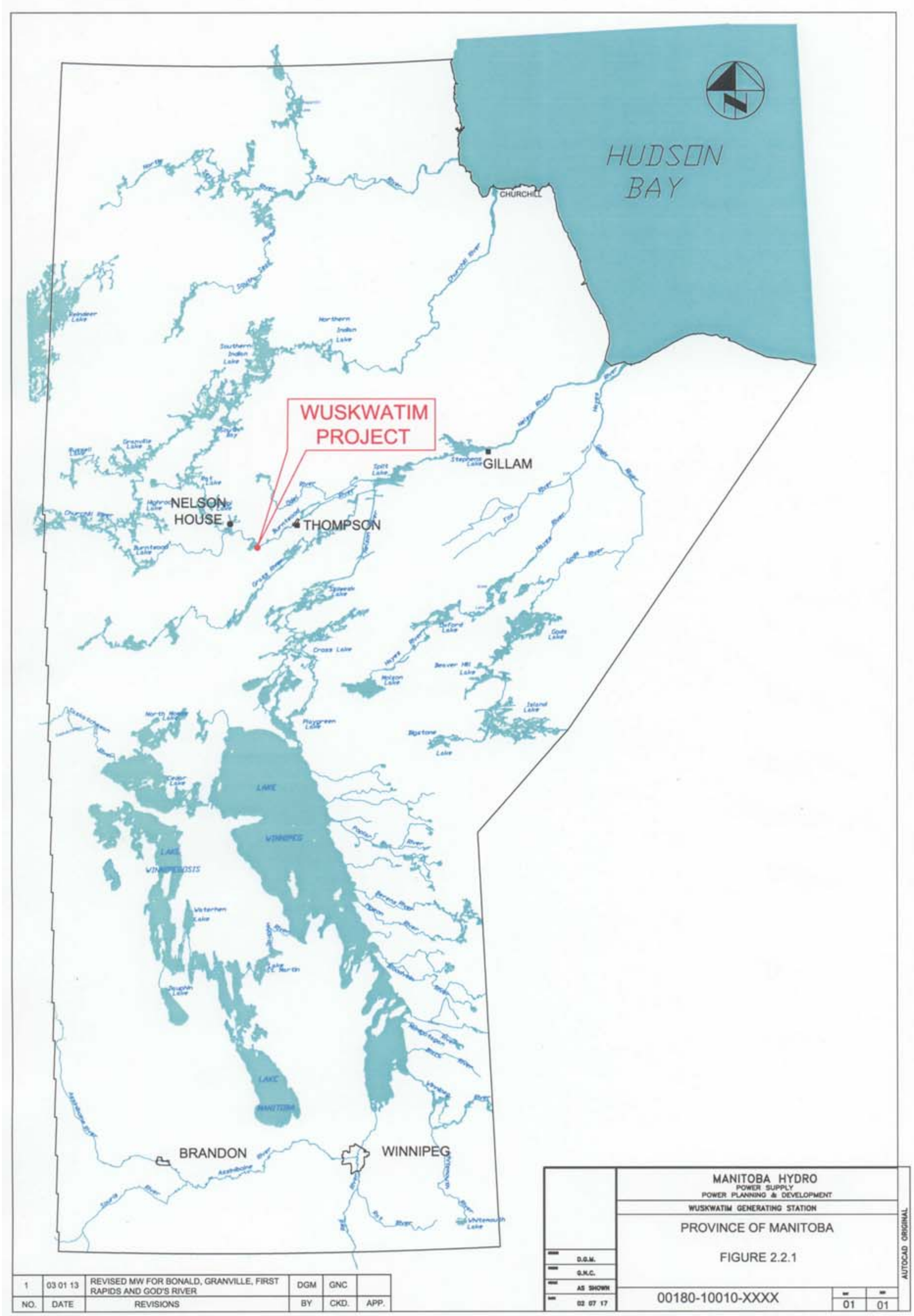

Figure 2.2-1 – Province of Manitoba

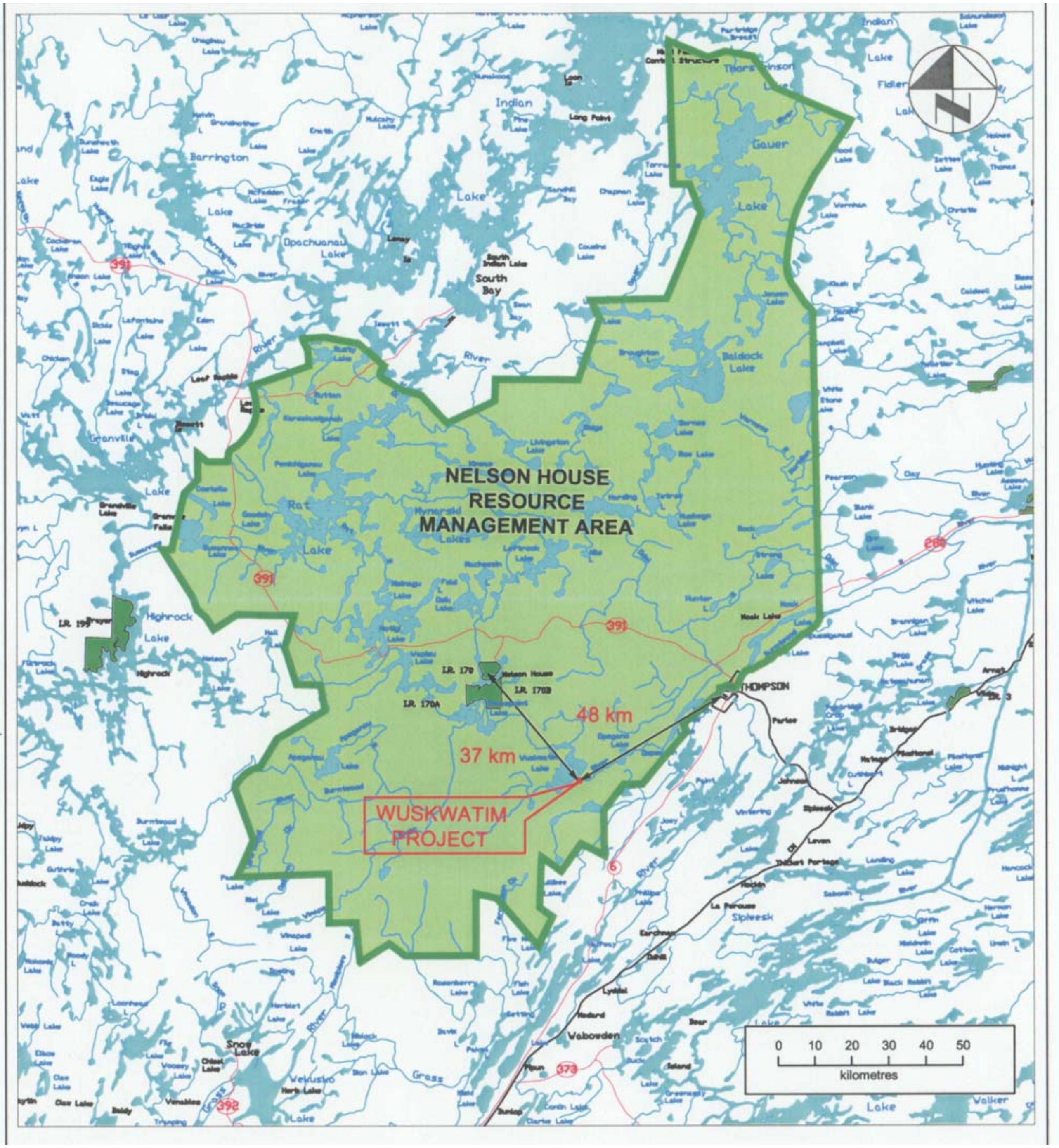

Figure 2.2-2 – Regional Location Plan

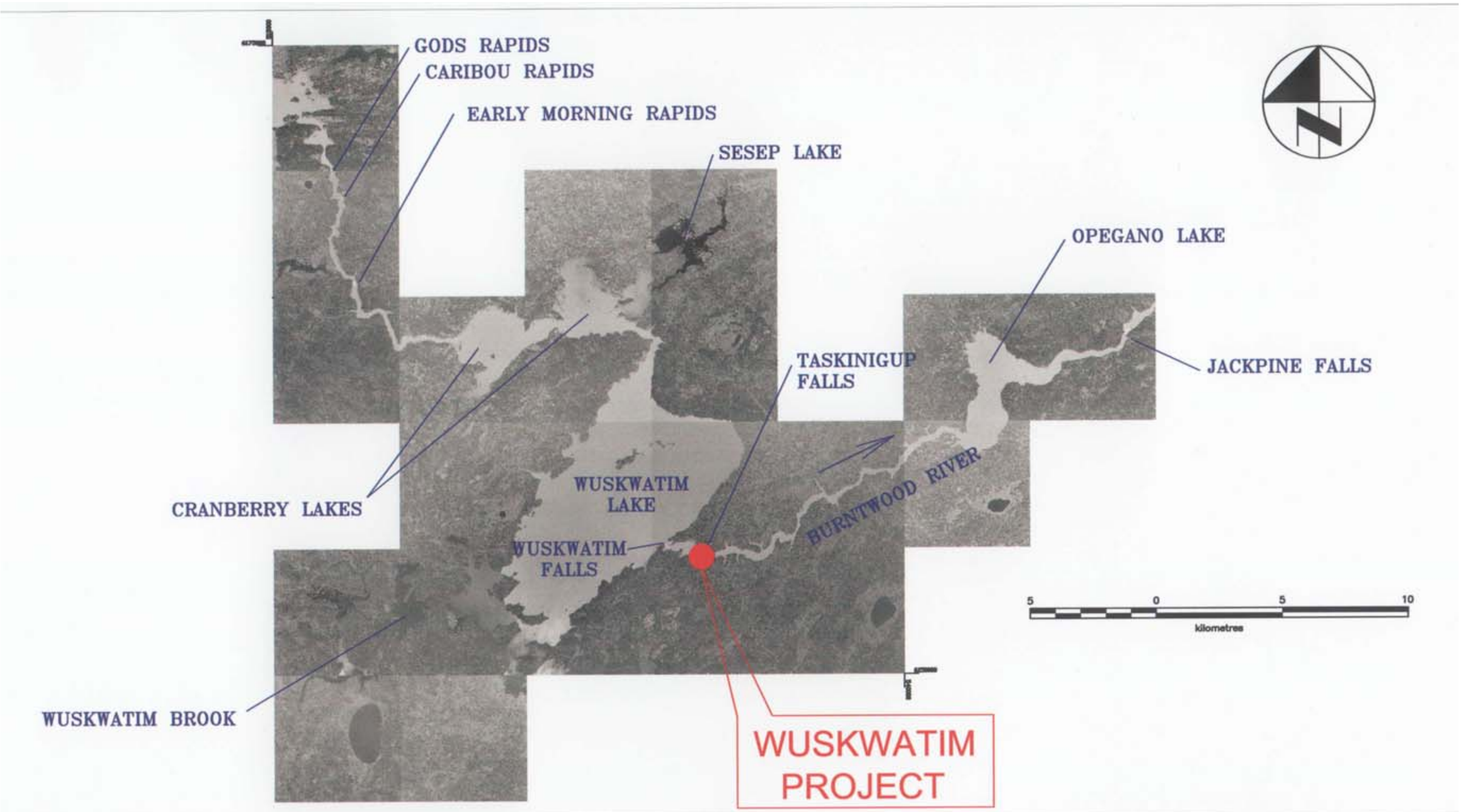

Figure 2.2-3 – Wuskwatim Project General Location Plan

There are currently several NCN Treaty Land Entitlement land selections within the Project area, some of which encumber the lands required for the Project as shown in Figure 2.3-5. Manitoba Hydro and NCN are working on the land ownership issues (Volume 8).

Table 2.3-1
Summary of Lands Required for Wuskwatim GS

Description	Reference Figure	Amount of Land (ha)
Access Road (48 km long road with a 100 metre ROW, between GS site and PR 391)	2.3-1	479
Construction Power Transmission Line (46 km transmission line with a 60 metre ROW, between GS site and Thompson)	2.3-1	272
Granular Borrow Areas (Borrow areas G,H & J - Not all of the areas will be required for construction purposes but for assessment purposes it is assumed that all the borrow areas except J-1 will be required)	2.3-1	654
Impervious Borrow Areas (Borrow areas in the Primary Structures Area and area SA-A - Not all of the areas will be required for construction but for assessment purposes all of the borrow areas will be assumed to be required)	2.3-2	26
Construction of Infrastructure & Permanent Facilities at the GS (relatively conservative estimate as it includes 9.5 Ha of high bedrock areas which are not expected to be required for any of the activities)	2.3-2	147
Flooded Area (land area between Wuskwatim Falls and Taskinigup Falls that will be inundated as a result of construction of the generating station)	2.3-2	37
Approximate Area of Site Disturbance (approximate 100 metre buffer area around the construction site area)	2.3-2	487
Water Storage Area (A setback line will be established around the reservoir in accordance with accepted procedures to define a safe and practical distance beyond which development could proceed. The setback line forms the upper limits of an easement area which is referred to as the Lands Required for Water Storage Purposes. The lower level of the easement area is the reservoir Full Supply Level of 234.0 m)	2.3-3	2750

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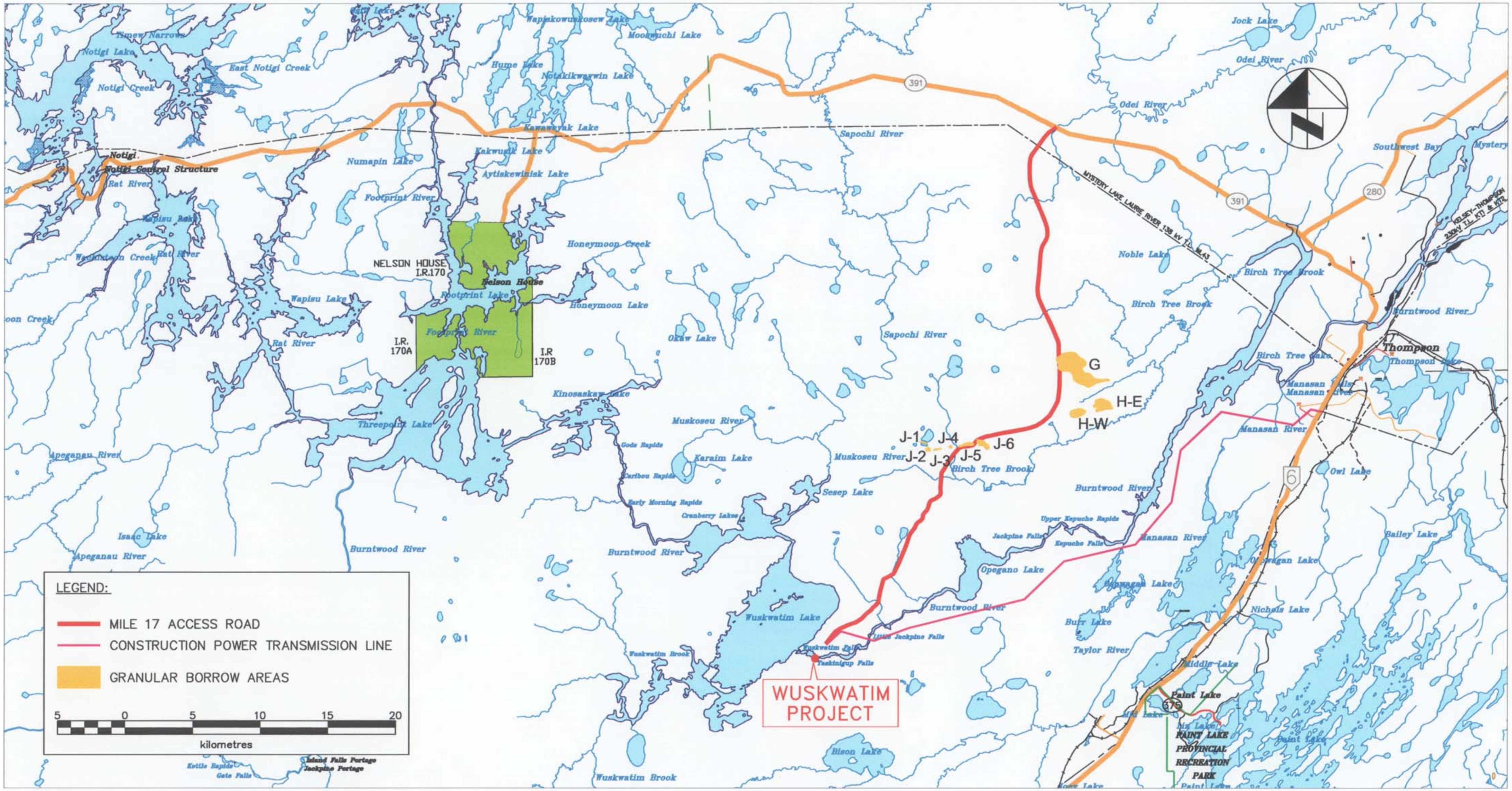


Figure 2.3-1 – Location of lands required for Access Road from PR 391 to Wuskwatim site, Granular Borrow areas and Construction Power Transmission Line.

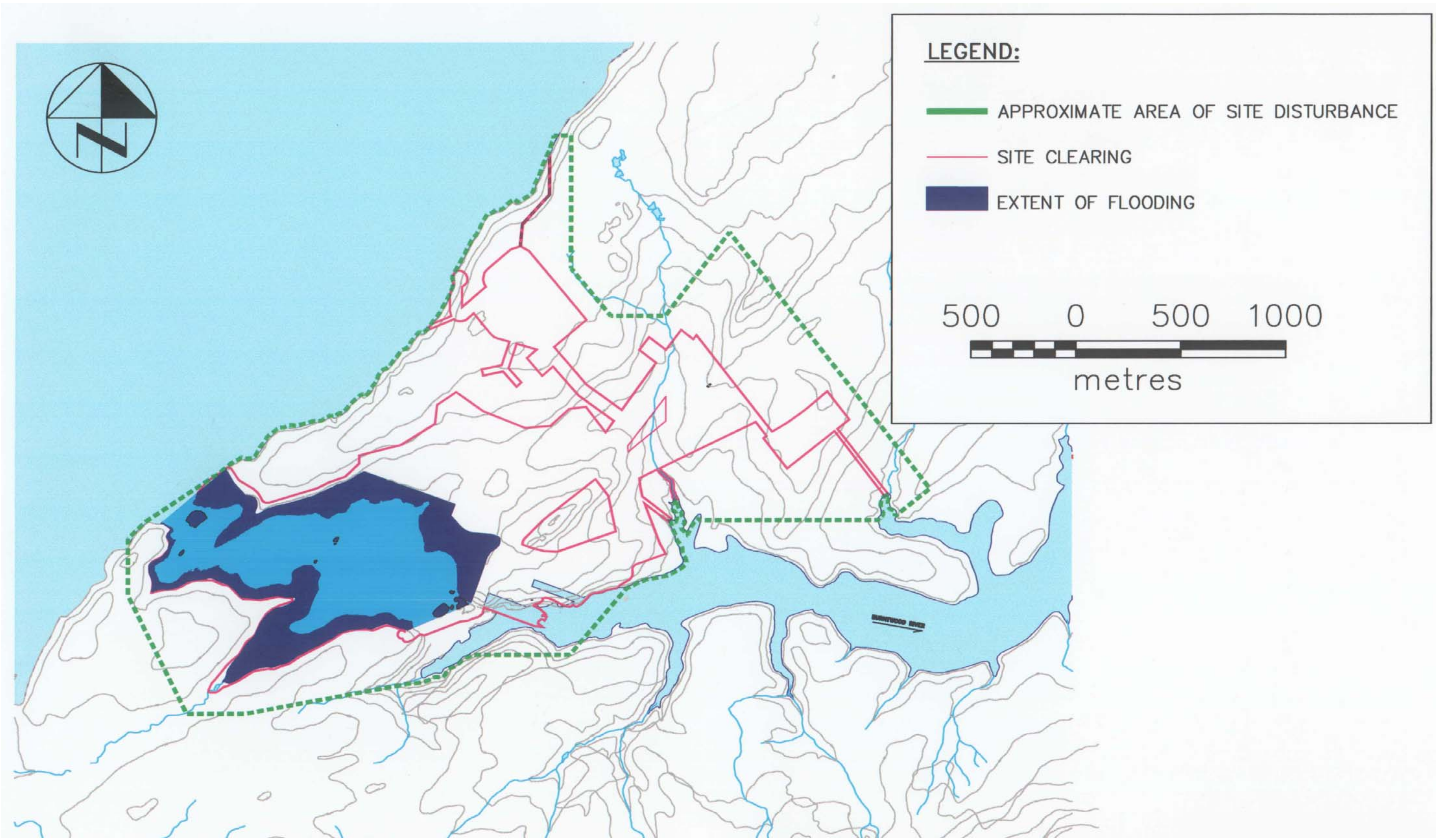


Figure 2.3-2 – Location of lands required for impervious borrow areas, site infrastructure and permanent works clearing area, flooded area, area of site disturbance.

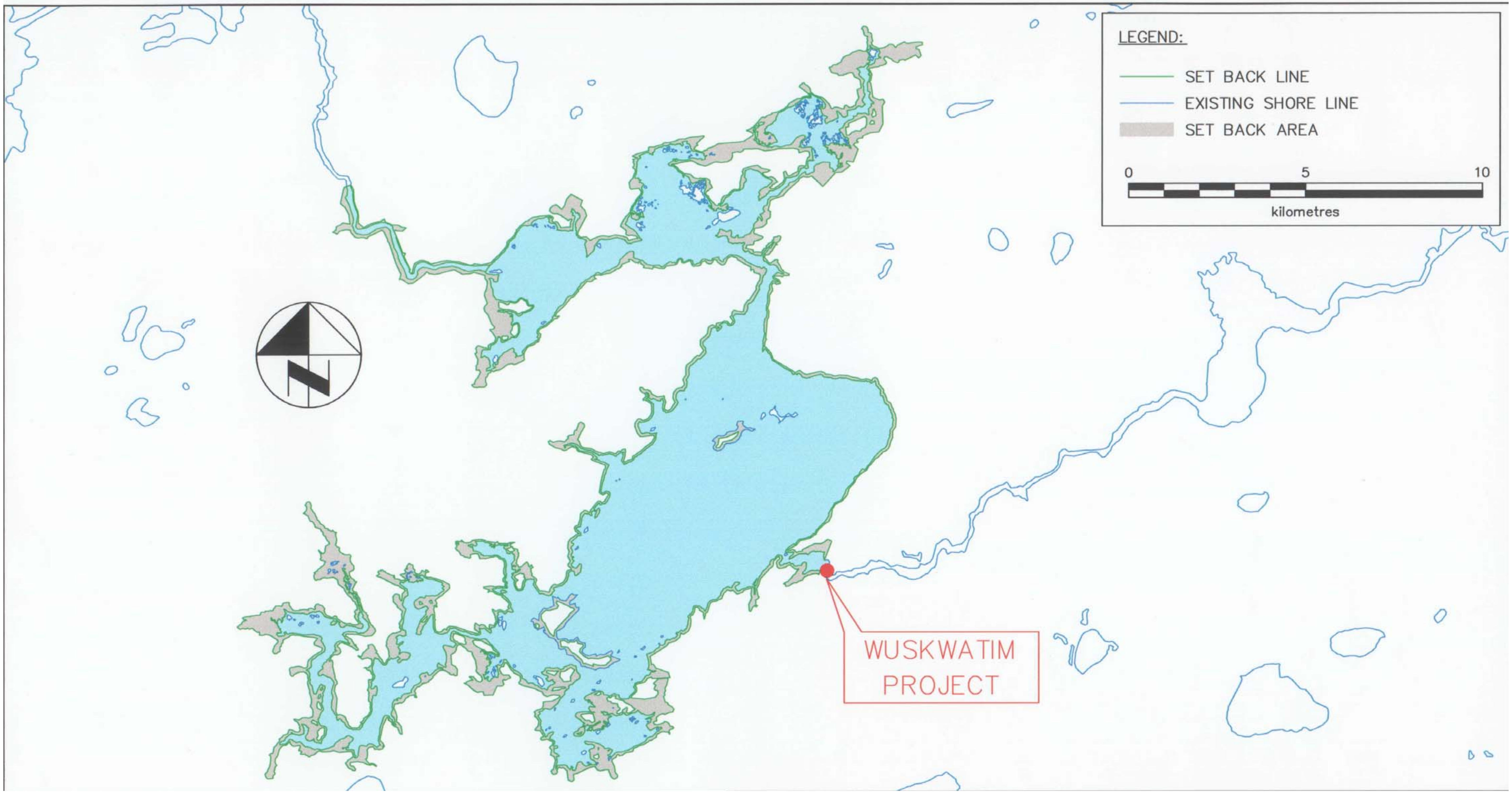


Figure 2.3-3 – Location of lands required for Water Storage Purposes.

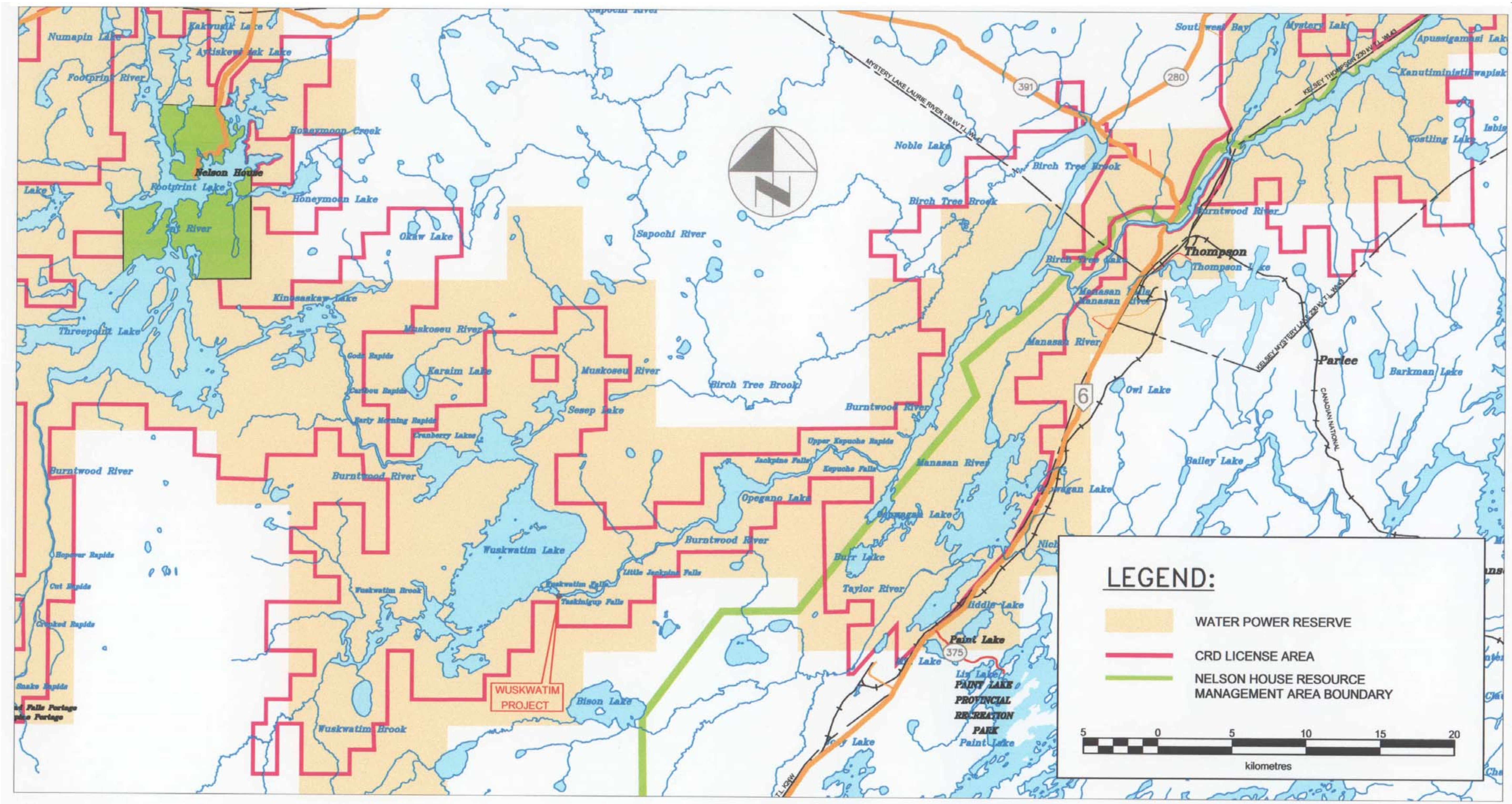


Figure 2.3-4 – Ownership and Management Areas within the Project area

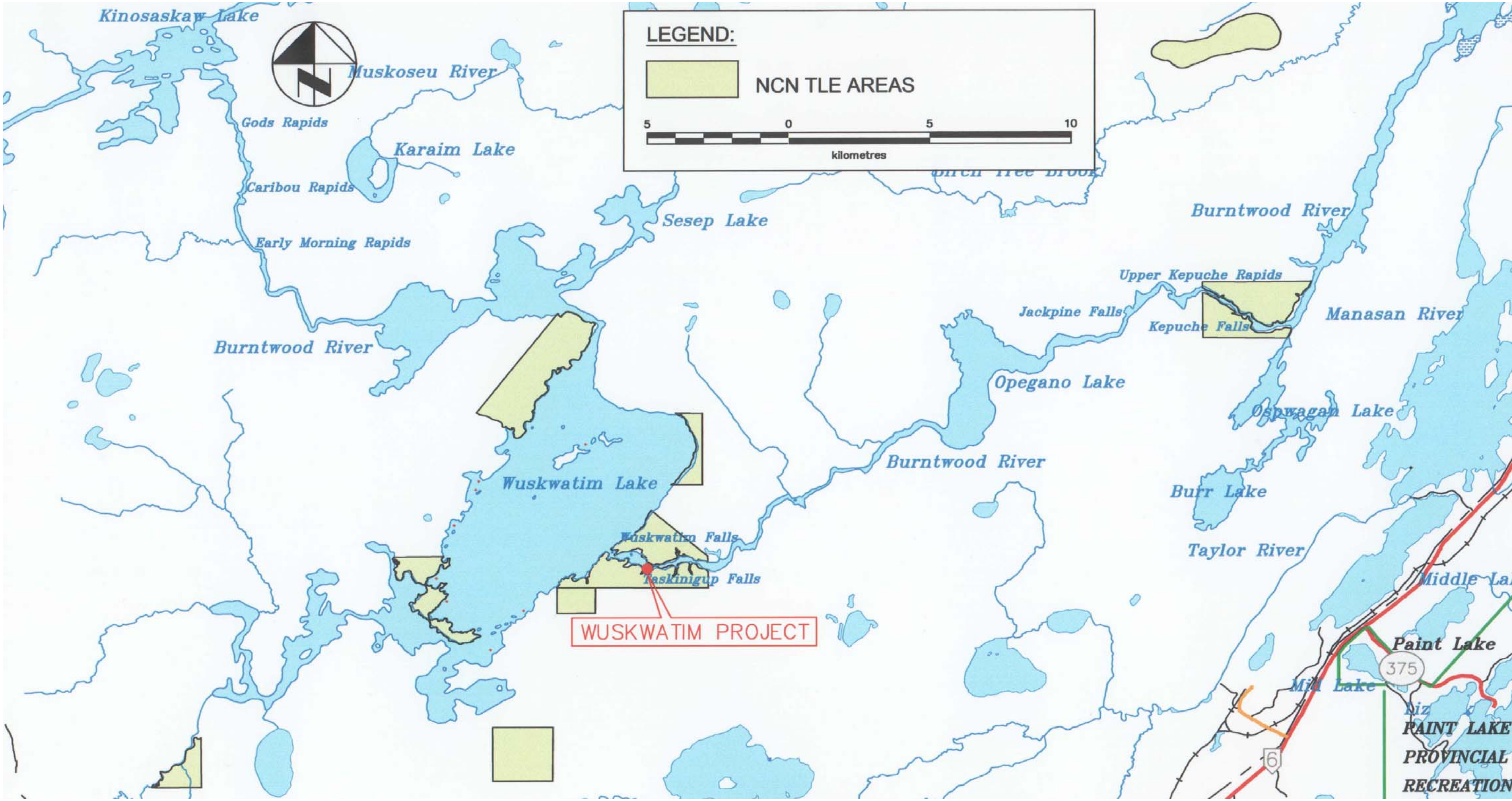


Figure 2.3-5 – Treaty Land Entitlement selection areas within the Project Area

2.4 SUMMARY OF PROJECT COMPONENTS & KEY PARAMETERS

The Wuskwatim GS will be constructed across the Burntwood River to harness the Churchill River Diversion's flow currently passing over the approximately 22 m combined elevation drop between Wuskwatim Falls and Taskinigup Falls. The **rated plant discharge** has been selected to be 1,100 cubic metres per second (m^3/s). Wuskwatim GS will therefore be capable of producing as much as 200 MW of **power** at any time. Due to existing CRD flow variations from the Notigi Control Structure, Wuskwatim GS will not be able to produce 200 MW all the time. The generating station **capacity factor** is estimated to be over 85 percent, which means the generating station average power production will be about 180 MW. Over a year, Wuskwatim GS will be able to typically produce approximately 1,550 gigawatts of **energy**.

The main Wuskwatim GS components are referred to as **Primary** and **Secondary** Structures. These structures are shown completed in computer rendered form in Figure 2.4-1. The Main Dam, Powerhouse, Service Bay, Spillway and North Dyke are referred to as the Primary Structures. The Channel Excavation Area and the Excavated Materials Placement Area are considered to be Secondary Structures. These structures, in addition to the temporary supporting infrastructure, are shown in plan view in Figure 2.4-2. Detailed descriptions for these facilities are found in Section 4. The description of how the generating station is proposed to be operated is found in Section 5.

The Main Dam, the three-unit Intake/Powerhouse/Service Bay complex, the three bay Spillway, the North Dyke and the Excavated Materials Placement Area act together to contain the immediate forebay area which is the area between Wuskwatim Falls and Taskinigup Falls. Channel excavations will be made at Wuskwatim Falls to improve outflow conditions from the lake and thus increase the station's efficiency.

The reservoir created by the development is comprised of the immediate forebay area and Wuskwatim Lake. The normal **Full Supply Level (FSL)** for the reservoir as measured on Wuskwatim Lake has been selected to be 234.0 m **ASL** (wind eliminated water level). The reservoir is also referred to typically as the 'forebay'. Water levels will rise approximately 7 m in the immediate forebay area as a direct result of the Project. Water levels on Wuskwatim Lake will not rise above the previously established High Water Mark. Wuskwatim Lake water levels will be stabilized within the existing (post CRD) Wuskwatim Lake water regime near the FSL most of the time. The Wuskwatim Lake existing water regime and the proposed post Wuskwatim GS range of operation are shown in Figure 2.4-3. The typical daily water level fluctuation that is expected on

Wuskwatim Lake is highlighted as a band just below the FSL on the figure. There will be exceptions to the normal or typical operation as a result of abnormal conditions such as large flood events that will result in progressively higher levels of surcharge beyond the FSL (Section 2.5).

It is estimated that 37 ha of land will be flooded as a result of the construction of Wuskwatim GS in the immediate forebay area (Table 2.3-1 and Figure 2.3-2).

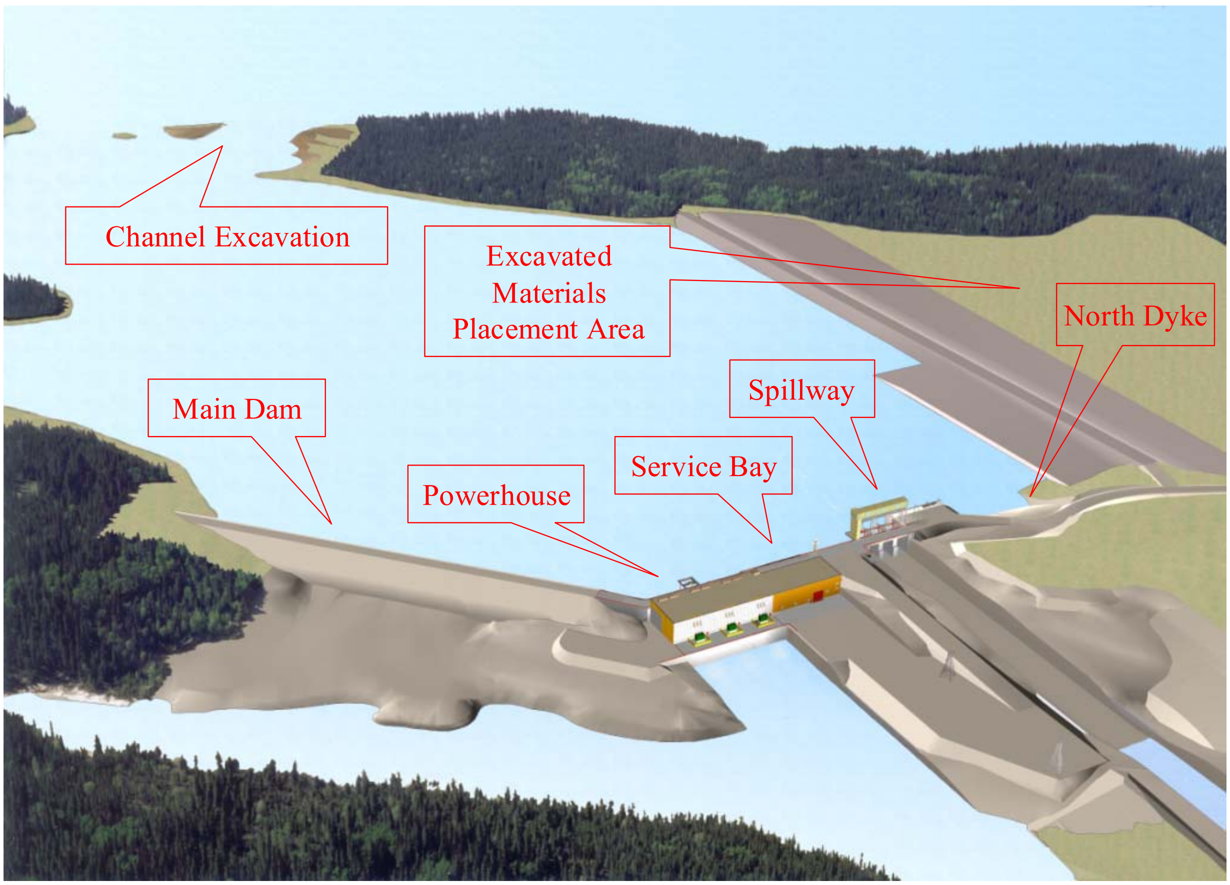


Figure 2.4-1
Computer Rendering of the General Arrangement of the Primary & Secondary Structures for the Wuskwatim Generating Station.

The GS will normally be operated in what is referred to as a **modified run-of-river** mode of operation (see further description in Sections 3 & 5). The normal mode of operation will result in relatively stable water levels upstream of the GS. In the reservoir, the water level will be at, or very near the FSL of 234 m ASL as shown in Figure 2.4-3. The forebay will normally be managed within the top 25 centimeters, from 233.75 m to 234.0 m ASL, with typical daily water level fluctuations in the reservoir expected to be

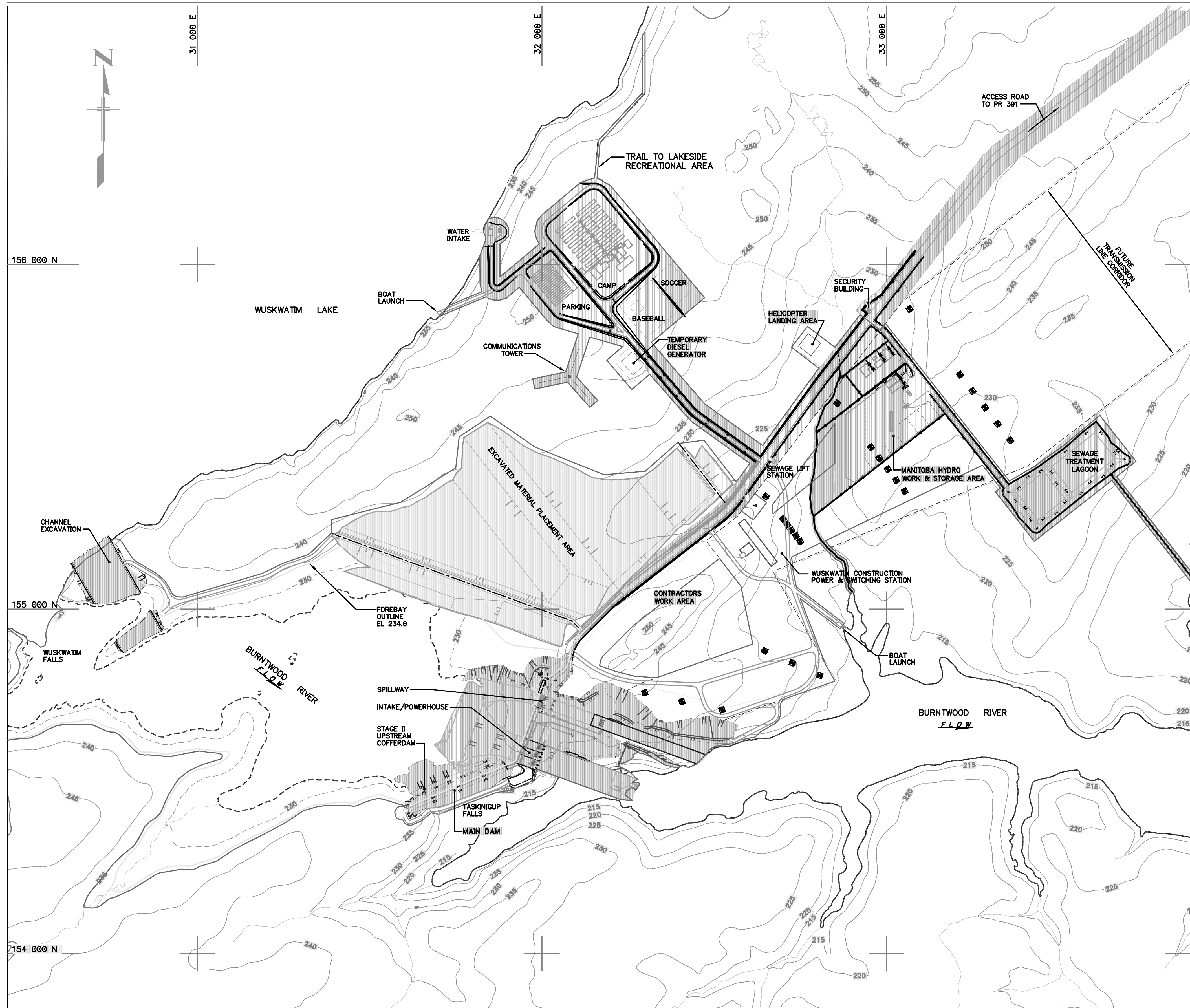


Figure 2.4-2 Plan View of Construction Site

less than 0.1 metres (0.06 m) not including the effects of wind and waves. The GS mode of operation will result in daily water level fluctuations downstream of the GS in the Burntwood River. The daily water level fluctuations diminish with distance downstream from the GS. The typical daily water level fluctuations are dampened to the point that they are not noticeable at Birch Tree Lake and would be difficult to distinguish from wind generated waves.

Up to one metre of storage has been designated for utilization under abnormal conditions when power demand is high in either the Manitoba Hydro system or that of its neighbours and when inflows are very low. During these times, there will be increased usage of the storage to supplement inflows, drawing Wuskwatim Lake as low as 233.0 m (Section 5).

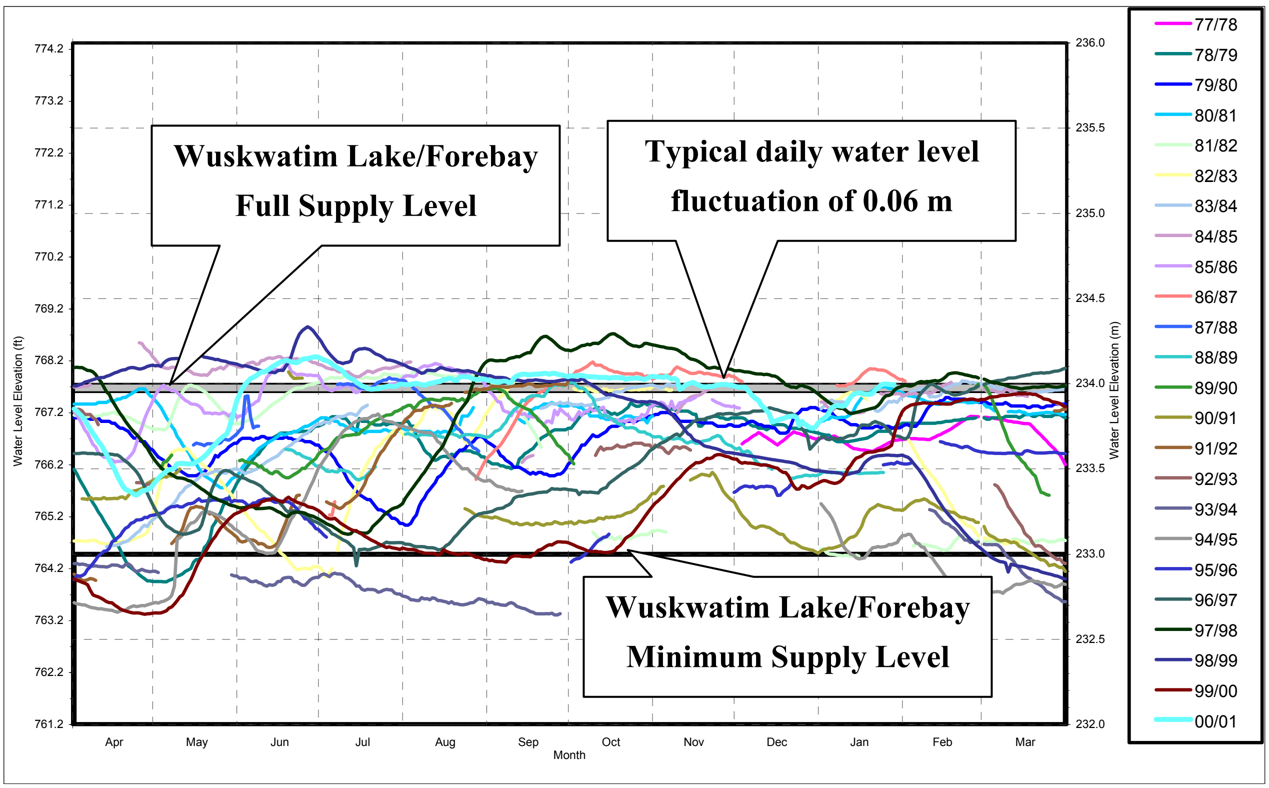


Figure 2.4-3 Wuskwatim Lake Existing Water Regime with post-Wuskwatim GS Water Regime

2.5 FUNDAMENTAL PLANNING & DESIGN ASSUMPTIONS

The design and planning for Wuskwatim GS assumes that the **CRD** will continue to operate as it is has been operated to date and therefore the **CRD water regime** will remain unchanged.

The terms and conditions described in the CRD 1973 Interim Water Power License (Water Resources Branch 1973) as modified by the annual CRD Augmented Flow Program, the 1976 City of Thompson Agreement (City of Thompson 1976), the Northern Flood Agreement (**NFA**, Northern Flood Agreement 1977), and the 1996 NFA Implementation Agreement (NFA Implementation Agreement 1996) and any downstream water related agreements will not change as a result of the Wuskwatim Project.

The water management action plan for safe passage of river flows throughout the construction period, as well as throughout the life of the Project, are based on Manitoba Hydro experience and Canadian Dam Association guidelines (Canadian Dam Association 1997). The Notigi Control Structure is assumed to be operating normally and its operation will not be altered to accommodate the passage of the design floods.

The **Construction Design flood** (**CDF**) has been established having an annual probability of exceedance of 1:20 years or less (i.e., 5% annual probability of exceedance). The **CDF** is used to determine the elevations of the various Cofferdams that will be required to protect the site during construction. Several scenarios, including lesser flows under winter ice conditions have also been reviewed as part of the investigation.

The **Inflow Design Flood** (**IDF**) has been set to be equal to the **Probable Maximum Flood** (**PMF**). The PMF is an estimate of the most severe "reasonably possible" flood at a particular location, as derived from detailed meteorological and hydrological studies. The PMF is derived from coincident occurrence of a series of worst case **antecedent** meteorological conditions and a design rainfall/snow melt event in the upstream watershed. This event has an annual probability of exceedance of approximately 1:10,000 years. The **IDF** is used to determine the appropriate elevations of the **Primary** and **Secondary** structures. During the passage of the **PMF**, the Wuskwatim immediate forebay would surcharge by 1.5 m above the FSL, to 235.5 m. Due to the backwater effect through the Wuskwatim Falls channel excavation area, the level of Wuskwatim Lake would rise to 235.6 m during this event.

2.6 ENVIRONMENTAL FEATURES INCORPORATED INTO THE DESIGN OF THE PERMANENT FACILITIES

A number of features have been incorporated into the design of Wuskwatim GS to minimize potential adverse environmental effects. These are summarized briefly below.

2.6.1 Forebay Level and Flooded Area

The Wuskwatim GS was redesigned so that the forebay level for the development would be within the existing water regime (Volume 4, Section 4.2.3) on Wuskwatim Lake and therefore also minimize the amount of flooding. This decision was made to reduce the impact on the existing environment. Figure 2.4-3 clearly demonstrates that the 234.0 m ASL forebay operating level is within the post 1977 experience to-date. The proposed Wuskwatim design eliminates flooding on Wuskwatim Lake, with only minimal flooding in the immediate forebay area.

As a result of the Project, the water levels will rise about 7 metres in the immediate forebay area between Wuskwatim Falls and Taskinigup Falls which will result in less than ½ sq. kilometre of flooded land (37 ha, as shown in Figure 2.3-2). The amount of flooded land was further minimized by placing all the excavated materials not required for the construction of the Wuskwatim GS into a low-lying area immediately upstream of the Wuskwatim GS, on the north bank of the Burntwood River. The placement of the material in this location prevents flooding of this low area, as shown in Figure 2.4-1 (Section 2.6.4).

2.6.2 Plant Outflow Capability

Wuskwatim GS was redesigned so that the **rated plant discharge** for this development would be within the existing flow regime of Wuskwatim Lake. This decision was made to reduce the impact on the existing environment by not changing the **channel-forming flow** (Volume 4, Section 7). Figure 2.6-1 illustrates a **duration curve** of all the daily inflows from December 1977 through June 2001 (generally referred to as the Existing [post-CRD] Inflows for Wuskwatim Lake) and a duration curve of the monthly inflows expected in the long-term (generally referred to as the project inflows (Volume 4, Section 4.2.1 & 4.3.1). This figure clearly demonstrates that the **rated plant discharge** of 1,100 m^3/s is within the range of existing inflows as well as within the range of project inflows.

2.6.3 Mode of Operation

The Wuskwatim GS was redesigned so that the mode of operation for the development would work within the current flow range established by the operation of the CRD and would not significantly affect the existing environment. The **modified run-of-river** mode of operation was selected because it results in relatively moderate downstream water level changes within the day superimposed upon the monthly and seasonal water level changes that currently occur. These monthly and seasonal changes will continue to occur as a result of the regulation of the CRD. Wuskwatim GS mode of operation will result in much smaller water level and flow changes within the day than would be possible with a truly peaking plant.

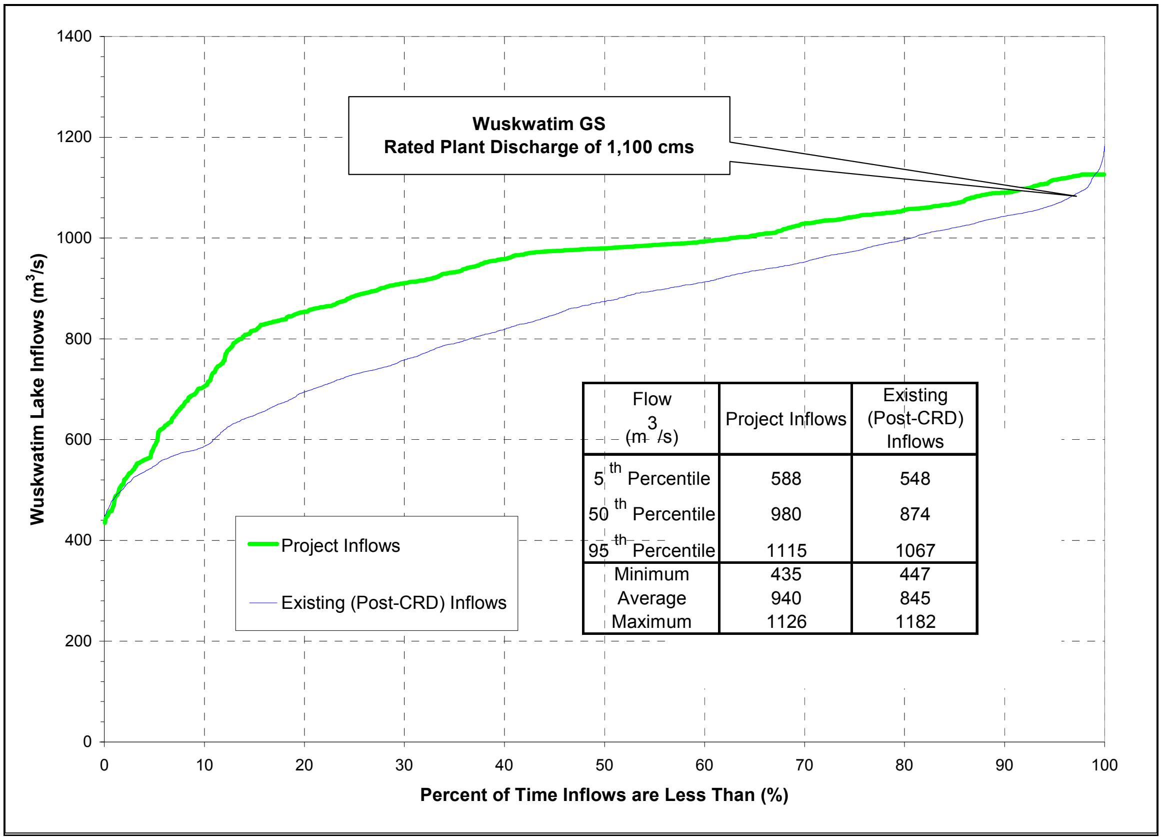


Figure 2.6-1 Distribution of project inflows and existing inflows into Wuskwatim Lake

2.6.4 Excavated Materials Placement Area

The area designated to receive the excess material produced from the excavations was redesigned to prevent additional land from being flooded and to include a top layer of organic material rather than a top layer of excess rock from the excavations. (Section 4.5.1 and Figure 4.5-1). The design was improved by moving the southern berm that bounds the placement area further south to coincide with approximate edge of the existing shoreline. This reduced the amount of low-lying land that would have been flooded by approximately 2 ha. The redesign also includes plans to recycle the organic material that currently covers the area for use as the surface layer over the excavated materials. The organic material is expected to assist in promotion of the natural re-vegetation of the area.

2.6.5 Station Equipment Design

Environmental protection considerations will be applied in the design and specification of all electrical and mechanical systems for the Wuskwatim GS. All equipment will be specified to exclude the use of PCBs, freons, asbestos, mercury and cadmium in the completed equipment or in the manufacturing process. Where feasible, electronic equipment will be specified to use lead-free solders. The use of environmentally safe lubricants (non-petroleum based) will also be considered, whenever practicable.

- Switchgear will be specified to minimize the use of oil within the station (such as vacuum or SF_6 type). The use of non-oil-filled equipment will be assessed at the tender stage, in order to reduce the risk of accidental oil discharge.
- Equipment manufacturers will be required to identify recyclable material in the supplied equipment, in order to enhance the recycling process.
- The station's lighting systems will be designed to be energy-efficient and have zonal lighting controls to reduce in-house energy requirements and reduce energy consumption at the GS.
- Self-lubricated bushings will be employed on the turbine wicket gates to eliminate minor sources of water pollution, which are typical of greased wicket gate bushings.
- Double walled heat exchangers will be used for the turbine and generator cooling systems to reduce the risk that cooling coil failure will discharge oil into the water.

2.6.6 Oil Spill Prevention and Containment

Where feasible, permanent equipment will be specified to be oil free, as discussed above. Alternatively, it shall be designed to minimize the volume of contained oil. Permanent equipment, which must be oil-filled, will be equipped with its own containment system or provided with secondary containment.

The station will incorporate a permanent oil-containment system, designed to guard against the possible contamination of the waterway in the event of an accidental spill of oil or other petroleum based liquids.

The station oil containment and separation system will be composed of:

- station sumps and primary interceptor;
- efficient oil/water separator;
- containment curbs and drip trays; and
- a waste oil sump/tank.

All drainage from potentially oil contaminated areas will be directed to the oil interceptor/separator system. Drainage from lower levels of the station will be directed to one of the main station sumps and will then be pumped to the interceptor/separator. Individual containment cells will be located around the main transformers on the Powerhouse tailrace deck. In addition, a barrier will be incorporated into the handrail at the downstream edge of the tailrace deck. This system will be designed to prevent any transformer oil spills from entering the river. Drainage from the containment cells and the tailrace deck will be directed to the oil interceptor/separator system.

The Powerhouse's oil storage room will have a spill containment area of sufficient volume to hold the contents of the largest single container in the room. An inverted drain trap will be provided to permit draining of the area to the oil interceptor/separator system. Pipes to and from tanks in the room will terminate at dry disconnect hose connections, to further reduce the risk of spills.

The pumping systems for the governors will be surrounded by trenches or, alternatively, the area will be curbed, to allow drainage via the trench or sump to the oil interceptor/separator system.

Diesel fuel tanks in the diesel generator room and fire pump room will each have secondary containment and a ramp at the door to provide containment within the room. All tanks or drums which are to be transported within the station will employ pallets or carts, which will provide secondary containment.

Any rooms with risk of an oil spill will have containment curbs or door ramps installed. In general, containment will be as close as possible to the potential source of the leak or spill.

Water leaving the oil/water separator will be monitored for oil contamination. In the event of contamination, an alarm will be activated.

2.6.7 Sewage Treatment

The station will be provided with a packaged sewage treatment plant to accommodate 20 staff. The sewage treatment plant will not use chlorine in the disinfecting process. Final treatment of the effluent will rely on exposure to UV light and will meet all provincial regulations.

2.6.8 Slope Protection and Site Drainage

All of the slopes of the permanent earthfill dams and dykes, as well as permanently exposed slopes in overburden, will have suitable erosion protection using a cover layer of granular or rockfill. Alternatively, slopes may be protected by means of a vegetative surface layer where the slopes are relatively flat and not subject to wave erosion. Ditching will be provided to direct surface runoff away from the excavation slopes and to convey it at suitable gradients in a controlled manner to the river. Armoring (the placement of non-erodible material) of critical areas of ditches, settling ponds and silt fences will be provided, if required, to prevent silt from entering the waterway.

The immediate forebay area will be cleared of all trees at the ground level up to contour 235.0 m ASL. This area will not be grubbed. The Excavated Materials Placement Area will be protected by rip-rap along the shoreline. The Contractor will build an access road to the Channel Excavation Area at Wuskwatim Falls parallel to the shoreline, which will be left in place in order to provide shoreline protection. The south shore of the immediate forebay area will be left in its natural state.

2.6.9 Access and Safety

Safety for employees and the general public represents Manitoba Hydro's most important goal and is the foundation of the Corporate Vision and Operating Principles. Safety is closely associated with site access. During construction, access to the GS site will be restricted and controlled to ensure public safety. An Access Management Plan (Section 3.6) for the Project area will be prepared and issued by Manitoba Hydro and NCN prior to completion of the GS.

Ladders and doors will be installed to provide a safe means of egress for personnel working at the facility from the various areas of the Powerhouse and Spillway, including roofs.

Safety Plans include the following;

- Fencing off certain areas of the Project site to ensure the safety of the general public and wildlife. Areas near vertical cuts in the bedrock which form the Spillway discharge channel and the tailrace channel will be fenced. The side slopes of these channels represent a fall hazard into the water. Other areas like the Spillway deck, Powerhouse forebay deck and the Main Dam and tailrace deck will have safety railings to control and limit access.
- Pedestrian and vehicle access will be allowed on the upstream portions of the GS facilities to provide access across the river. A turn-around area and parking area will be provided on the south side of the river. The Access Management Plan will define the details.
- Large (roughly 1 metre by 2.5 metre) signs will be posted on both sides of the river on the upstream and downstream side of the GS facilities warning of the potentially dangerous boating and swimming conditions and prohibiting access within specified areas.
- A siren and/or warning light system will be installed to provide advance warning of any movements of the Spillway gates.
- An upstream boat landing dock and boat launch area located approximately 1.8 km from the GS facilities on Wuskwatim Lake will remain following completion of construction to continue to provide safe access to Wuskwatim Lake.
- A downstream boat landing dock and boat launch area located on the first creek downstream of the GS on the north side of the river will remain following completion of construction. This boat landing dock will continue to provide safe access for staff to the downstream area of the river for emergency and maintenance purposes. This area of the river will continue to be very dangerous and travel will not be recommended due to the high river velocities resulting from the operation of the GS and the steep gradient in the river.

It must be noted that a Safety Boom, Ice Boom and Trash Boom will not be installed across the upstream area. Manitoba Hydro does not install safety booms immediately upstream of any of its generating stations because the flow velocity in the immediate forebay areas is generally sufficiently low such that there is no safety concern. If a boat drifts into the immediate area, there would not be an immediate threat to life unless the boat was to capsize or if someone was to try to swim in the area. An Ice Boom will not be installed across the upstream area because ice is expected to form on Wuskwatim Lake and the immediate forebay area without the assistance of an ice boom (Volume 4, Section 5). A Trash Boom will not be installed across the upstream area because trash and debris are expected to be managed as per Manitoba Hydro's Debris Management Program (Volume 4, Section 9).

2.6.10 Environmental Enhancements in Stage 5 Engineering

The following environmental enhancements have been identified in the current Stage 5 Engineering Design Activities to further protect the environment and will most likely be incorporated into the final design. No details are available at this time, as the designs are presently being developed.

- Spillway discharge channel realignment – the plan is to reduce the potential for erosion of the south bank of the Burntwood River directly opposite where the channel connects with the Burntwood River.
- Lagoon access road realignment – the plan is to improve local road safety during construction by amalgamation of two 'tee' road intersections into one 4 way intersection.
- Water Treatment Plant relocation – the plan is to reduce the potential for spill hazard during chemical and fuel delivery.
- Water Treatment Plant operation - the plan is to improve environmental protection by diverting the system backwash into the lagoon rather than Wuskwatim Lake.

2.7 VERTICAL DATUM, HORIZONTAL CONTROL & MAPPING

The vertical survey control, topographic mapping, geotechnical and water level information required for the planning and design of the Wuskwatim GS has been based upon the Geodetic Survey of Canada, Canadian Geodetic Vertical Datum 1928, 1971 Local Adjustment (GS of C CGVD28, 1971 Local Adjustment), which Manitoba Hydro generally refers to as GS of C CGVD28, 1969 Local Adjustment. Information about the benchmarks that were established at Wuskwatim GS by the Geodetic Survey of Canada at the request of Manitoba Hydro was published in Geodetic Survey of Canada - Vertical Control Data, Quadrangle Sheet No. 55098, Revision 3, March 1971.

All water levels referenced in this document are to be inferred as measured in terms of elevations Above Sea Level (ASL), GS of C CGVD28, 1971 Local Adjustment.

Horizontal survey control in the immediate Project area has been established for planning, explorations, design and construction using a local planar grid referred to as the Revised Station Grid. Permanent control monuments (survey bench-marks) have been established at the site using various survey techniques and are correlated to the regional geo-reference system.

Horizontal survey control has also been established in the region using Global Positioning System (GPS) techniques. Most of the early surveys utilized the North American Datum 1927 (NAD27), and the Universal Transverse Mercator (UTM) Projection, Zone 14. Recent surveys have utilized the Canadian Spatial Reference System based on the North American Datum 1983 (NAD83 (CSRS)), and the Universal Transverse Mercator (UTM) Projection, Zone 14. All regional geo-referenced information has been transformed to NAD83 (CSRS), UTM Zone 14. All Geographic Information System (GIS) support information that has been collected or generated for this Project has been geo-referenced using NAD83 (CSRS), UTM Zone 14.

Vertical and Horizontal Control for the planning of the access road has been established by the Department of Transportation and Government Services using GPS techniques. The access road control has been established based on the regional control established by Manitoba Hydro and uses the same vertical and horizontal reference systems as described above.

The topographic mapping for the Wuskwatim GS site has been prepared from air photos taken in 1986 at a photo scale of 1:10,000 and used to produce a topographic map at a scale of 1:2,000. Contours, based on GS of C CGVD28, 1971 Local Adjustment, were established at an interval of one metre. This information has been used as the basis for all quantity take offs.

3.0 EVALUATION OF ALTERNATIVES

3.1 INTRODUCTION

Manitoba Hydro's Planning Departments are involved in ongoing assessments of various locations and configurations of potential hydroelectric facilities in Manitoba. As locations and configurations match the upcoming needs of the Corporation, successively greater levels of detail are applied to these studies, including cost estimates and schedules. Several studies have been undertaken to determine what type of hydroelectric development is appropriate for the Burntwood River and where that development should begin. The development of concepts, costs and schedules has typically followed a staged approach that was formalized as the Generation Planning Procedures in 1979. The staged approach means that the confidence in the Project information increases as more effort is expended in the definition of the concept. Stage 1 of the planning process is an inventory stage, followed by Stage 2, the feasibility stage, followed by Stage 3, the concept stage. The next to last step in the process is Stage 4, the pre-investment stage which is the last stage that is completed before entering into Stage 5, the final design/construction stage. The Project is currently at Stage 4 and the Project information developed at the Stage 4 level is used as the input into the public consultation and Environmental Review, Licensing Process, and approval processes.

The conceptual and preliminary design process followed for the Wuskwatim Generating Station involved determining the most economic, efficient, safe and functional way of developing the site while balancing a number of related issues and concerns such as engineering, environmental, economics and social.

The purpose of this section of the Project Description is to provide a brief background on the alternatives that have been studied and to provide some insight into the background for the final general arrangement and operating parameters selected for Wuskwatim G.S.

3.2 BACKGROUND

Manitoba Hydro has conducted various field and office planning studies to investigate several potential sites for hydroelectric development on the Burntwood River over the last few decades. These investigations continue today as part of Manitoba Hydro's ongoing planning process.

The earliest study that identified Wuskwatim as a potential hydroelectric development was in 1966 as part of the studies that identified the concept of the Churchill River Diversion which was announced in 1966 by the federal and provincial governments.

In the early 1970s, as planning for the Lake Winnipeg Regulation/Churchill River Diversion (**LWR/CRD**) Projects proceeded, discussions began with potentially affected northern communities. In order to address the various sociological, economic and environmental interests, the governments of Canada and Manitoba in 1971 initiated the Lake Winnipeg, Churchill and Nelson Rivers Study (Manitoba-Canada 1975) to look at the aspects of northern hydroelectric development and to recommend modifications, remedial measures, and mitigating works. The 13-volume Study Board Report was released on June 30 1975 and Manitoba Hydro has implemented a number of the recommendations within its responsibility.

In 1978, Manitoba Hydro produced updated concepts for a Wuskwatim Project, based on key subsurface information, for different arrangements of structures, and for a number of forebay levels and plant discharges. The information was published as part of a series of reports on hydroelectric concepts for the development of the Burntwood River. These interim reports were collected together as Appendix 4 of the "Burntwood River Study", dated May 1978" (Manitoba Hydro 1978).

Following the interim reports, Manitoba Hydro prepared System Planning Division Report No. 80-3 entitled Wuskwatim Generating Station Concept Report - (Stage III), dated April (Manitoba Hydro 1980). This report looked at several alternatives including options that required a relaxation of the constraints contained within the Northern Flood Agreement (Section 1.5).

Further studies related to the 1980 concept led to the 1983 Manitoba Hydro, System Planning Division, Report No. SPD 83-5 (Manitoba Hydro 1983), which described a development of a 350 MW (approximate) plant at Wuskwatim at a forebay elevation of 243.2 m (140 km^2 of flooding) which would satisfy the constraint imposed by the NFA at

Nelson House i.e., that the level of Threepoint Lake should not exceed elevation 244.4 m (802 ft).

In 1983, the Burntwood River Environmental Overview Study (MacLaren et al 1984) was completed. The report examined environmental, socio-economic, economic and engineering factors associated with various alternative options for developing the Burntwood River and concluded that full reach development could be best achieved by the development of generating stations at Wuskwatim, Manasan and First Rapids.

In 1987, the "Potential Environmental Issues Related to Wuskwatim Development Report" (Delthi 1986) was issued, which described processes to identify and resolve issued associated with development of the Wuskwatim GS.

An ensuing review carried out in 1987 concluded that the basic general arrangement of structures first recommended in the concept report of 1980 with a forebay of 243.2 m was still valid. The review also identified the need for further and detailed geotechnical investigations at the site.

In 1989 Manitoba initiated an environmental impact assessment of the Wuskwatim GS and its associated transmission facilities, however, it was cancelled because of a commitment by Manitoba Hydro to sell the output of the Conawapa GS to Ontario Hydro.

Completion of the negotiations for the Nelson House (NFA) Implementation Agreement occurred in 1995 with ratification occurring in 1996 leading to resolution of many of the outstanding commitments of the NFA originally signed in 1977 and setting the stage for joint future planning.

In 1994, following early discussions with NCN about future development in the area, new alternatives evolved for the Wuskwatim GS. The key new feature of these alternatives was a much lower forebay. A Wuskwatim Lake elevation of 235.0 m, corresponding to the 1 in 100 flood level on Wuskwatim Lake, was selected. The 1995 study examined both **peaking** and **modified run-of-river (shaping)** modes of operation.

In 1997 a cost and concept review was again undertaken to confirm which concepts were practical for use in broader based planning studies. The high head and low head options with peaking operation continued to both be practical options.

In late 1998/early 1999, as part of preparations for broader planning consultations evolving from the 1996 Nelson House Implementation Agreement, Manitoba Hydro reviewed the options that had been identified to date and concluded that the 234.0 m development with the modified run-of-river mode of operation should be advanced for additional consultations with NCN and to the next engineering phase (Stage 4).

In 1999, Manitoba Hydro retained Acres Manitoba Limited to work with Manitoba Hydro to advance the Project from the Stage 3 conceptual design to the Stage 4 pre-investment level of study. This study included work on the following Project components:

- Forebay levels;
- Mode of operation;
- Arrangement of Primary Structures;
- Access Road;
- Construction Camp; and
- Construction Materials Location.

The following sections describe the background and the rationale for the selection of the preferred alternatives for these components.

3.3 FOREBAY LEVELS

The forebay elevation chosen for development at Wuskwatim G.S. was selected from a number of options that were feasible at this site. All elevations above the average (1977 to 2001) Wuskwatim Lake elevation of 233.6 m have been identified as being technically feasible and provide various degrees of economic attractiveness and hydroelectric potential, up to and including options that would require re-negotiation of legal constraints that have evolved as part of the CRD. The forebay options that have been identified and studied in various levels of detail between 1966 and the present include the following:

- 246.9 m advanced to Stage 2 Level of Study;
- 246.4 m advanced to Stage 2 Level of Study;
- 245.0 m advanced to Stage 2 Level of Study;
- 243.2 m advanced to Stage 3 Level of Study;
- 235.0 m advanced to Stage 2/3 Level of Study; and
- 234.0 m advanced to Stage 4 Level of Study.

After numerous studies as described above, a FSL forebay elevation of 234.0 m ASL was selected as the option that was best suited for this site. The option was selected on the basis that it provided a number of benefits and advantages, which are listed below, while remaining economically attractive and technically feasible. More specifically, the option selected minimizes the negative features associated with the Project as compared to the higher levels of development that had previously been considered. The option was judged to be as environmentally friendly and benign an option as was possible at the site and was judged to fit Manitoba Hydro's sustainable development principles. These features worked towards garnering the support of the NCN community, which was an important consideration. The following summarizes some of the benefits, which were identified during the selection process:

- Development will be within the Water Regime on Wuskwatim Lake;
- Less Flooding;
- No significant increase in methyl mercury levels;
- Less impact on land and shoreline;
- Less erosion;
- Smaller resulting volumes of debris;
- Lower impact on fish;
- Decreased loss of terrestrial wildlife habitat;
- Decreased risk of archeological and cultural sites damage; and
- Lower levels of social and socio-economic concern.

Water Regime

The selected option was judged to be a very good fit into the existing range of water levels (water regime) on Wuskwatim Lake (Figure 2.4-3) on the basis that the new forebay level would be within the existing water regime. The FSL selected would result in Wuskwatim Lake water levels being normally near the top end of the existing water regime, and the water levels would not normally exceed the maximum water level experienced to date on Wuskwatim Lake. The water levels on Wuskwatim Lake would no longer follow the seasonal and monthly trends that result from the operation of the CRD but would be relatively stable at or just below the FSL of 234.0 m. The Project requires improvements in the outflow channel from the lake to reduce the hydraulic losses that result from existing constrictions. The hydraulic conveyance improvements are necessary to maximize the hydraulic head at the plant, given the relatively low forebay level proposed for development.

Less Flooding

The flooding will be limited to the short reach of river located between the dam's axis and Wuskwatim Falls, as highlighted in Figure 2.3-2. This limited amount of flooding is necessary to allow the 22 metres of hydraulic head to be developed. The development of the permanent facilities will raise the water levels approximately 7 m in this area, which will cause inundation of approximately 37 ha (0.37 km^2) of land. The flooded land between the plant and Wuskwatim Falls will be cleared of trees before inundation. (The 243.2 m ASL "high head" option could produce as much as 350 MW but would result in 140 km^2 of flooding)

Other Aspects

Less impact on land and shoreline, less methyl mercury concerns, less erosion, smaller resulting volumes of debris, lower impact on fish, decreased loss of terrestrial wildlife habitat, decreased risk of archeological and cultural sites damage and lower levels of social and socio-economic concern all are indirectly related to the Water Regime. The forebay elevation was specifically selected within the range of existing water levels (post CRD experience to date) so that this development would truly be a good fit within the existing environment and not exacerbate the current conditions with respect the above issues. It was judged that higher levels of development would cause greater degrees of impacts with respect to the preceding concerns and hence the selection of the 234.0 m FSL.

3.4 GENERATING STATION - MODE OF OPERATION

The preferred mode of operation for the Wuskwatim G.S. has been selected from a number of options that were developable at this site. The mode of operation for a generating station defines the outflow pattern of how the river flows will be regulated within any given day to produce electricity. The typical options that can be developed at a hydro development site are: peaking, modified run-or-river (shaping) and run-of-river. Each of the options provides varying levels of 'fit' into the supply side of the electrical power system. The varying levels of 'fit' refer to how close the supply option can match the timing of the load demand. All electrical power systems experience varying load demand, with the higher loads occurring in the peak period when customers require more electricity, usually between the hours of 6 am and 10 pm. The off-peak period is that time when the load demand is generally lower, with off-peak load typically between 40 and 70 percent of the on-peak load. The off-peak period is usually between the hours of 10 pm and 6 am. A peaking plant provides a good fit into an electrical system as it can vary the production of electricity as the demand varies. A **run-of-river** plant provides a poorer fit into an electrical system as the plant can only provide the base load portion of the load and the plant is not capable of adapting to varying demand. A modified run-of-river plant provides a degree of fit somewhere between peaking and run-of-river.

The selection of the mode of operation also inherently includes the selection of the **rated plant discharge**, and the type and number of turbine units. The mode of operation for the Wuskwatim G.S. was selected from over 20 different combinations of options. These included the following:

- two types of turbines (vertical-shaft propeller - adjustable [Kaplan] or fixed blade);
- three modes (peaking, modified run-of-river [shaping] and run of river);
- three different numbers of units (2, 3 or 4); and
- four rated plant discharges (1050, 1100, 1200 and 1400 m3/s).

Following a thorough review process similar to that undertaken for the forebay selection, the modified run-of-river mode of operation was selected as the option that best suited this site. This mode of operation incorporates a modest cycling pattern, with generally smaller water level fluctuations than what would be possible under a peaking mode of operation and more water level fluctuations than what would be possible under a run-of-river mode of operation. The modified run-of-river mode of operation was selected as the best option as it was judged:

- to provide a minimum level of flexibility of operation required to support Manitoba Hydro's electrical system;
- to be technically possible to construct and operate and economically attractive; and
- to produce less environmental concerns and impacts than the most advantageous mode of operation, the peaking mode.

The final decision was based on a balance between the economics of capacity and the energy production requirements, environmental concerns, and the cost of the Project. The decision also took into consideration the following:

- the option must be robust and be capable of handling many different conditions;
- the option should not require a change to the CRD license or operation;
- the option should be sensitive to the potential environmental impacts of fluctuating forebay and tailwater levels; and
- the option should also be able to perform reliably as designed.

The relatively large 'forebay' (including Wuskwatim Lake) provides an ideal situation for both the peaking and modified run-of-river modes of operation. Both of these modes of operation would have moderate effects on the daily water level changes in the forebay. With the modified run-of-river mode of operation, the daily water level changes in the forebay are smaller, but it is the downstream daily water level changes that are dramatically reduced compared to those that would occur with a peaking mode of operation.

The CRD flows that arrive from the Notigi Control Structure will enter Wuskwatim Lake and will be regulated through the Powerhouse in such a way that the lake's outflow over the day will equal the lake's inflow over the day. This balancing of the outflows to the inflows means that the resulting mode of operation is essentially a daily balance cycle, very similar to a run-of-river mode of operation. The significant difference between a modified run-of-river mode of operation and a run-of-river mode of operation is that the minute by minute outflows are adjusted so that the plant's units are operated at or near the point of peak efficiency. A run-of-river mode of operation generally has specialized units that can be adjusted to operate efficiently at what ever flow is coming down the river. The units selected for installation at Wuskwatim do not have that type of capability and operate efficiently at selected operating points. Outflows are scheduled to match the efficient operating points and the daily balance is accomplished by operating more units during the on-peak period than during the off-peak period. The on-peak time duration and the off-peak time duration vary with the inflow condition.

The lakes and river located to the downstream of the Wuskwatim GS moderate and attenuate the flow changes made at the Wuskwatim GS, such that the daily water level changes diminish with distance downstream. The rules governing the modified run-of-river mode of operation are such that typical daily downstream water level fluctuations through Birch Tree Lake will be relatively small, significantly less than 0.1 m on a daily basis. This is in contrast to what would happen under the peaking mode of operation, where there are typically not any limits to the flow change.

The size of the units plays a role in the degree of downstream flow changes and environmental effects of the plant operation. The larger unit sizes (i.e., the more water that can be passed through the turbine), require fewer units to attain the desired flow range; and are generally the least costly alternative. Larger units typically result in larger flow changes. For a two large-unit plant, this would result in normal flow changes of about 525 m^3/s. The smaller unit sizes require more units to attain the desired flow range; and generally result in higher construction costs than the larger units. Smaller units typically result in smaller flow changes. For a three-unit plant, this would result in normal flow changes of about 330 m^3/s for inflows less than 990 m^3/s (Section 5.2.5.2).

The type of unit also influences the costs. The more flexible Kaplan units, which have the ability to adjust the blade pitch to maintain high efficiency for various flow and head conditions, cost significantly more to install and generally have higher maintenance requirements (longer and more frequent outages). The fixed blade units have slightly less flexibility, but cost less and have lower maintenance requirements.

The selection process determined that three.fixed-blade vertical shaft propeller turbines provided the best balance between generation benefits, reliability and minimization of environmental effects for this site. The fixed blade vertical shaft propeller type turbines are the same type of turbine that exists at many of Manitoba Hydro's generating stations. This configuration of turbine, the turbine's rotating speed and the highly efficient design of the turbine passage-way are conditions which are known to be conducive to the successful passage of various species of fish through the turbine assembly (Volume 5).

These turbines have a narrow range of flows at which they operate efficiently. The most efficient setting is called the "**best gate setting**" and is where each unit will be operated most of the time with one, two or three units on line. The plant will also operate at its full plant discharge (full gate) at various times, particularly when there is more flow in the river system than required for three units at best gate, but also at other times, when additional power is required during on-peak periods.

The station's operation will follow the requirement of typically shutting down or starting up one unit during flow changes, to minimize the impacts on downstream water levels. The forebay elevation will typically vary slightly over the day, as the outflows are shaped. The selected mode of operation will create a flow pattern that will result in moderate water level changes, as described in Section 5.

3.5 GENERAL ARRANGEMENT OF PRIMARY STRUCTURES

Six alternative engineering layouts were developed and evaluated in the Stage 4 studies, with the most desirable alternative being presented in Section 4 of this document. Evaluations of all of these options were based on considerations of scheduling and constructability aspects, cost and technical issues, as well as in consideration of environmental issues and concerns.

Each of the options were assessed to determine which option would minimize the environmental impact of the construction, considering the amount of land that would be disturbed, the amount of land required to dispose of the excavated materials and the amount of work that would be done "in the wet" (i.e., within the flowing river).

Opportunities were identified to reduce the volumes of rock and overburden excavation by interchanging the locations of the Powerhouse and Spillway. Opportunities were also identified to reduce excavation quantities further by moving the Powerhouse and Spillway southwest along the original Principal Structure's axis until the right side of the Powerhouse coincided, approximately, with the right side of the chute which forms the left extremity of Taskinigup Falls.

The optimum arrangement selected resulted in a minimization of excavation quantities which reduced costs and also has the environmental benefit of minimizing the amount of land disturbed and minimizing the amount of material to be disposed. The arrangement selected also made it possible to construct a rockfill Cofferdam across the river upstream of the discharge point of the Spillway Channel Thus, all the Powerhouse tailwater channel excavation can be completed "in the dry", thereby minimizing the amount of in-stream work that will be undertaken.

3.6 ACCESS ROAD

Manitoba Hydro and NCN formed an Alternatives Committee and collaboratively formulated, considered, evaluated, and selected a preferred route for the proposed Wuskwatim access road. A summary of the output from this committee can be found in Appendix 2. The Alternatives Committee evaluated a number of alternative road corridors, one that connected the site to Provincial Trunk Highway No. 6 crossing the Taylor River and the Burntwood River, a number of options which connected the site to Provincial Road 391, referred to by the distance in miles from downtown Thompson, as well as a number of options that connected the site to the Nelson House area:

- Taylor River;
- Mile 5;
- Mile 20;
- Mile 33;
- Mile 37; and
- Nelson House (3 Alternatives).

The alternative road corridors were evaluated using the following agreed upon criteria focusing on three main issues;

- impact on NCN – What benefits and drawbacks would there be for NCN?
- impact on the environment – How would the environment be affected?
- impact on the Project – For potential partners (NCN and Manitoba Hydro), how do the routes compare in terms of cost and schedule?

Eight evaluation criteria were examined to compare the impact of the route alternatives on NCN. Of these, impacts on important cultural sites, particularly Eagle Hill and a nearby artesian water source, were considered the most important.

Nine evaluation criteria were examined to compare the impact of the route alternatives on the environment. Of these, woodland caribou and moose were considered most important.

Twelve evaluation criteria were examined to compare the impact of the route alternatives on the Project. Of these, safety and the affect of terrain type on construction and maintenance of the road were found to be the most important.

The alternatives selection process included input from technical specialists (including overflights and ground-based environmental investigations of potential routes), in-depth meetings and workshops, consultation with NCN members through two open house events and development of new information.

Following initial analyses, the potential corridors were screened down to routes between Mile 5 and Mile 33 along PR 391. From this initial screening, six possible centreline right-of-way alternatives were developed as shown in Figure 3.6-1. The Alternatives Committee assessed these right-of-way alternatives using the criteria previously described. The process concluded the “Mile 17 route” located 32 kilometres west of Thompson, on PR 391 to be the preferred option. Mile 17 appeared to offer the most benefits to NCN, the least adverse impacts to the environment, and was among the lowest cost options, had good technical potential for a safe route design and provided fewer risks to the construction schedule as compared to other options.

The evaluation also revealed that the unavoidable provision of access into the area/site was a key issue common to all of the alternative road alignments. An Access Management Committee (including Manitoba Hydro and NCN members) was therefore subsequently formed to address access-related issues and concerns and have agreed on objectives for the management of access. The limited partnership for this Project (which includes representation from both Manitoba Hydro and NCN) will develop the Access Management Plan. The limited partnership will finalize the construction portion of the Access Plan before construction begins in late 2003/early 2004 and will include among other measures, a security gate (staffed 24 hours per day) at the junction with PR 391 to control access to the site. By 2008, the limited partnership is scheduled to complete an access plan to address the post construction period (i.e., operational phase of the generating station). This plan will be developed in consultation with the Nelson House Resource Management Board (to account for their land use/resource plans yet to be developed). To date, the parties have identified a range of possible options to meet their management objectives and a process to develop the details of the overall Access Management Plan (Appendix 3)

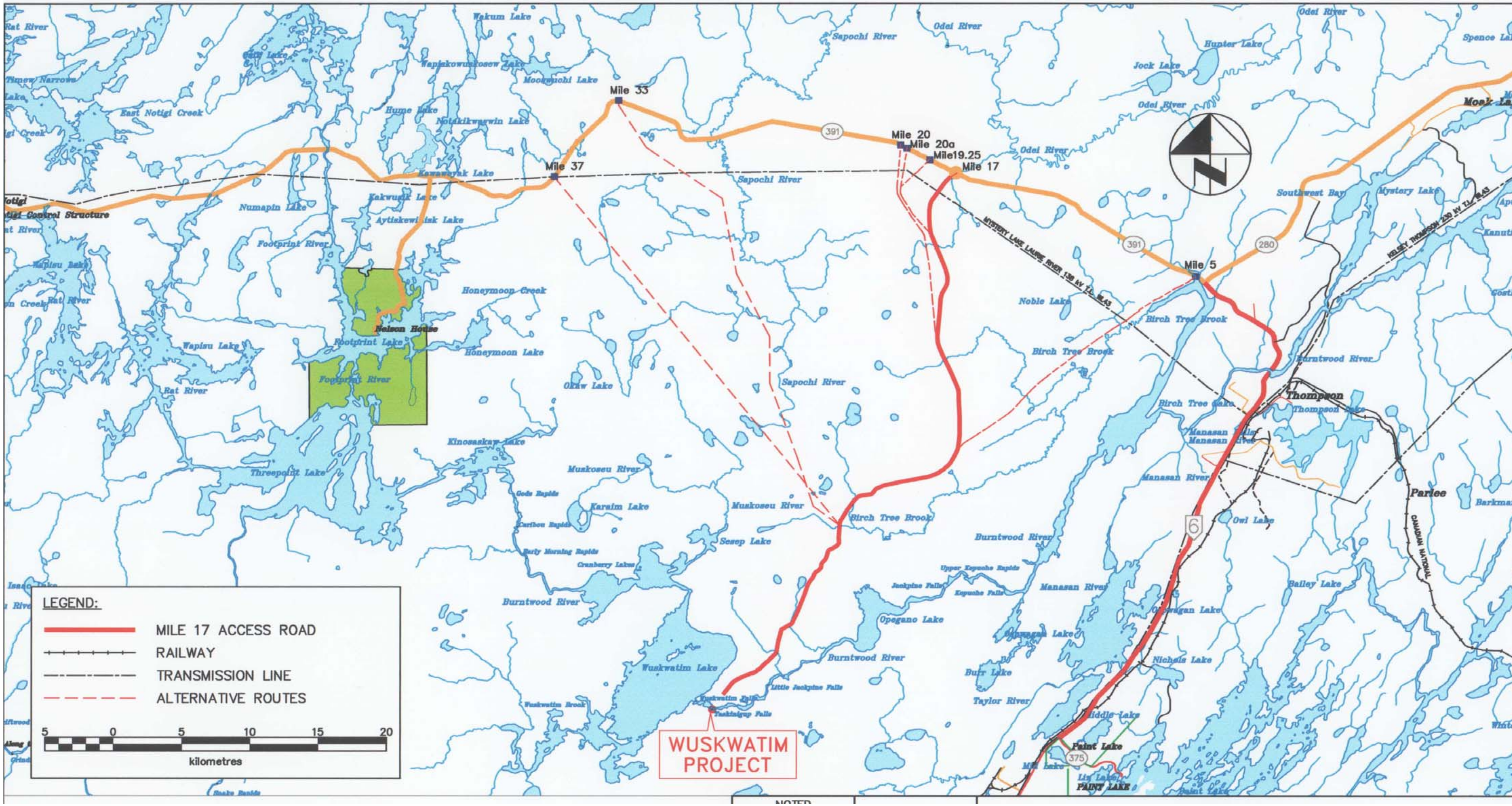


Figure 3.6-1 – Proposed Access Road route and alternatives

3.7 CONSTRUCTION CAMP

Manitoba Hydro and NCN formed an Alternatives Committee and collaboratively formulated, considered, evaluated, and selected a preferred location for the proposed Wuskwatim construction camp. A summary of the output from this committee can be found in Appendix 2.

The Alternatives Committee evaluated and compared the following construction camp location options:

- full camp at the Wuskwatim Generating Station site;
- split camp – with main camp at the Wuskwatim Generating Station and sleeping accommodations, second kitchen, and other facilities located remotely from the work area:
    - near Nelson House; and
    - near the junction of PR 280 and PT 391, approximately eight kilometres north-west of Thompson.

The Alternatives Committee compared the options using the same criteria and issues as were used in the selection process for the access road.

- impact on NCN – What benefits and drawbacks would there be for NCN?
- impact on the environment – How would the environment be affected?
- impact on the Project – For potential partners (NCN and Manitoba Hydro), how do the locations compare in terms of cost and schedule?

The Alternatives Committee determined that a construction camp at the Wuskwatim site was considered best. It avoided the cost of duplicating some facilities in two locations. It also avoided concerns about potential adverse social effects associated with having a camp near the community. It avoided effects on workers due to the long daily commute from the second camp to the Project work site. Finally, NCN's anticipated economic benefits from a second camp appeared not to be as great as initially thought. Therefore, a camp location at the Project site was selected.

3.8 CONSTRUCTION MATERIALS

Site investigations conducted over the years, by Manitoba Hydro and others, have identified a number of nearby natural sources of impervious and granular materials which could be used in the construction of the supporting infrastructure and the Wuskwatim GS. The regional extent and locations of the granular sources are indicated in Figure 3.8-1. Unlimited quantities of impervious materials are available close to the site so consequently most of the borrow sources off site will be required to supply only granular materials.

The construction of Wuskwatim GS will require the following specific types of construction materials (material utilization is discussed in Section 4):

- impervious fill;
- granular fill;
- rockfill;
- riprap; and
- concrete aggregates.

Granular fill material will have to be trucked in for the construction of the supporting infrastructure from one of the nearby granular borrow areas, as the large scale excavation required for the generating station will not be started until after the camp and work areas are prepared. At this time, it is assumed that the granular materials required for the construction of the supporting infrastructure will come from the closest and most readily accessible location, Deposits J4 and J6, which are located adjacent to the access road (Figure 3.8-2).

There is an excess of impervious fill, rockfill and riprap available from the excavations required for the construction of the Primary Concrete Structures. The plan is to maximize the use of the local materials, which is the most efficient and economic approach, as long as the materials are environmentally acceptable. The impervious overburden and the excavated rock material can be processed in the contractor's work area to meet all of the impervious fill, rockfill and riprap required in the construction of the temporary and permanent structures.

The remaining granular materials required for the construction of the temporary and permanent structures will come from the nearest, most economic source, as long as the

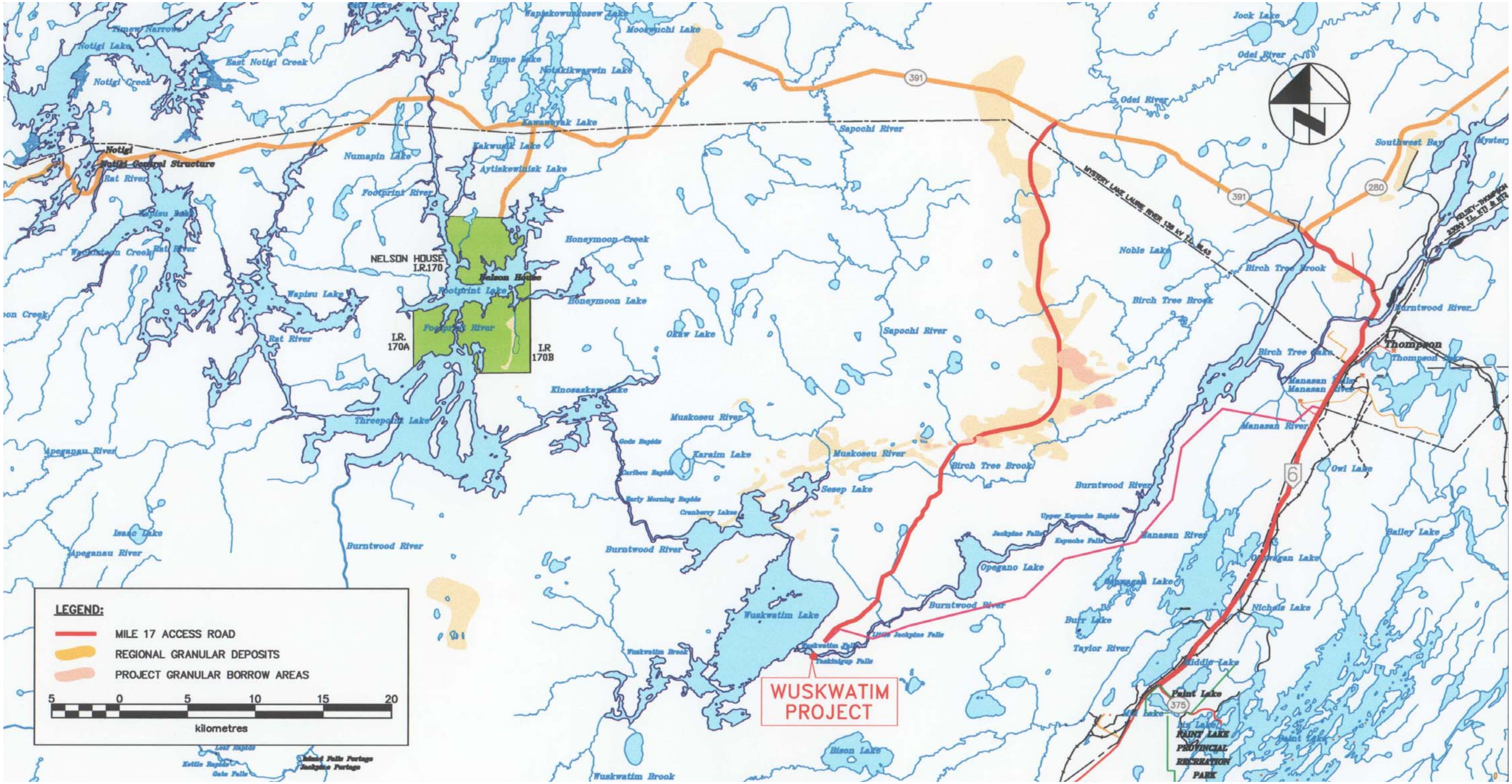


Figure 3.8-1 – Regional Granular Deposits

quality meets the specific use requirements and as long as the materials are environmentally acceptable. Deposits J4 and J6 are again the most logical choices at this time. (Figure 3.8-2). Otherwise, granular material will be obtained from the larger, more distant, and hence, more expensive sources like Deposits G, H or other J deposits.

The materials required for the access road construction will also maximize use of materials obtained from sources located within the right-of-way, adjacent to the route. Additional granular materials will most likely come from either granular Deposits G, H or J, as shown in Figure 3.8-2.

In general, the ultimate decision with respect to the selection and utilization of borrow areas will remain the responsibility of the contractors. The Environmental Protection Plans and technical specifications within the contract documents will state clearly the requirements for the protection of streams, ground water, wildlife habitat and adjacent vegetation during exploitation by the contractor, as well as the nature and methods for the rehabilitation of the areas after usage.

Physical material testing is currently under way to ensure that all materials are structurally acceptable for use in both the permanent and temporary structures. Chemical testing has also been undertaken. Both sand borrow and rock samples have been chemically tested for their suitability for placement in an aquatic environment (Volume 4, Section 3). Interim results indicate a relatively low potential for metal leachate generation and hence no environmental concerns are expected.

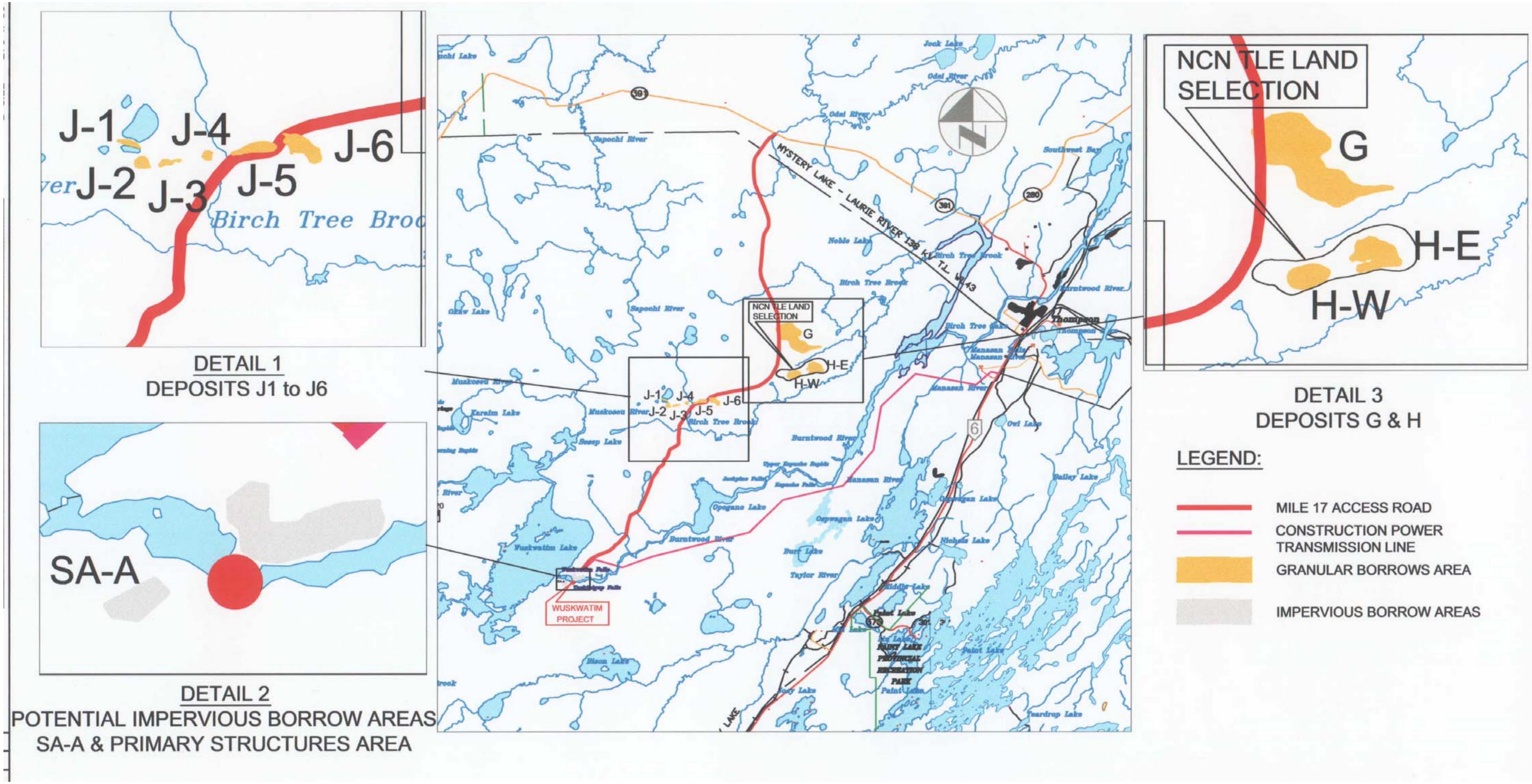


Figure 3.8-2 Granular and Impervious Borrow Areas

4.0 CONSTRUCTION ACTIVITIES

4.1 OVERVIEW

This section of the EIS Project Description provides an overview of the Wuskwatim GS construction activities. Sections 4.2 and 4.3 discuss the sequence of construction activities and organization structure for the Project. These sections are followed by Sections 4.4, 4.5, and 4.6 which outline the site clearing activities, construction material source utilization plans and infrastructure development that will be undertaken prior to starting work on the Primary Structures. Sections 4.7 and 4.8 provide a detailed description of the Primary and Secondary Structures that will comprise the generating station. Section 4.9 provides an overview of the site preparations and construction details for the Switching Station foundation that will be built in conjunction with the generating station and Section 4.10 provides an overview of the site clean-up and decommissioning of the construction infrastructure.

Environmental monitoring during construction is a fundamental component of the Project, and will be described in the Environmental Protection Plans (to be finalized after receipt of the various license and approval conditions).

Manitoba Hydro's Project Manager will be accountable for environmental protection compliance. The roles of "Environmental Inspector" will be assigned to individual supervisors for discrete areas of work. The Project Manager, together with the "Environmental Inspectors" will ensure that the actual work carried out complies with the regulatory requirements, approval conditions, and the Environmental Protection Plans.

4.2 CONSTRUCTION SEQUENCE

The plan is to construct Wuskwatim GS over a period of six years, as shown in the Summary Construction Schedule - Figure 4.2-1. The construction activities are described in detail in Sections 4.6 – 4.8. The following section provides a brief overview of the proposed sequence of activities. A schematic figure is included for each time period, to assist in the description.

Initial activities are associated with the development of supporting infrastructure for the Project and will start in January of 2004 with the construction of an access road and a transmission line, as shown in Figure 4.2-2. The proposed all-weather road to the site will pass over extensive granular deposits and near three granular borrow sources, which could be utilized for the construction of the access road, the main camp and the work area. By June 2004, a winter trail to the site will have been constructed, an initial "start-up camp" installed, and the first phase of clearing completed.

During the summer of 2004, work on the access road and camp site infrastructure will continue as shown in Figure 4.2-3. By November 2004, a "**limited all-weather"** access road will be completed and the preparations for the camp site will also be completed. Activities associated with the construction camp and Manitoba Hydro work area infrastructure will consist of local roadwork and site grading, construction of water and sewer services, installation of works and camp buildings, communications system, and a power distribution system for the site infrastructure.

The Main Camp and construction power support infrastructure will be completed by March 2005 (Figure 4.2-1) and the access road will be nearing completion (scheduled for September) as shown in Figure 4.2-4 so that the generating station site will then be ready for the General Civil Contractor to commence work.

By June of 2005, the General Civil Contractor will have mobilized to the site to begin construction of the generating station by early July 2005. One of the first tasks will be the start of the river management activities, with the construction of the Stage I Cofferdams (upstream and downstream of Taskinigup Falls) and the undertaking of overburden and rock excavation for the Primary Structures (Spillway, Powerhouse, Main Dam, etc.) within this enclosed area, as shown in Figure 4.2-5 and Figure 4.2-5a. By December, the Stage I Cofferdams and excavation are scheduled for completion.

In 2006, activities undertaken will be primarily associated with manufacturing and placement of concrete for the primary structures contained within the excavation, as shown in Figure 4.2-6. Work will begin on the Spillway, Intakes and Powerhouse, Service Bay, South Transition Structure, Wing Walls and Chute Walls.

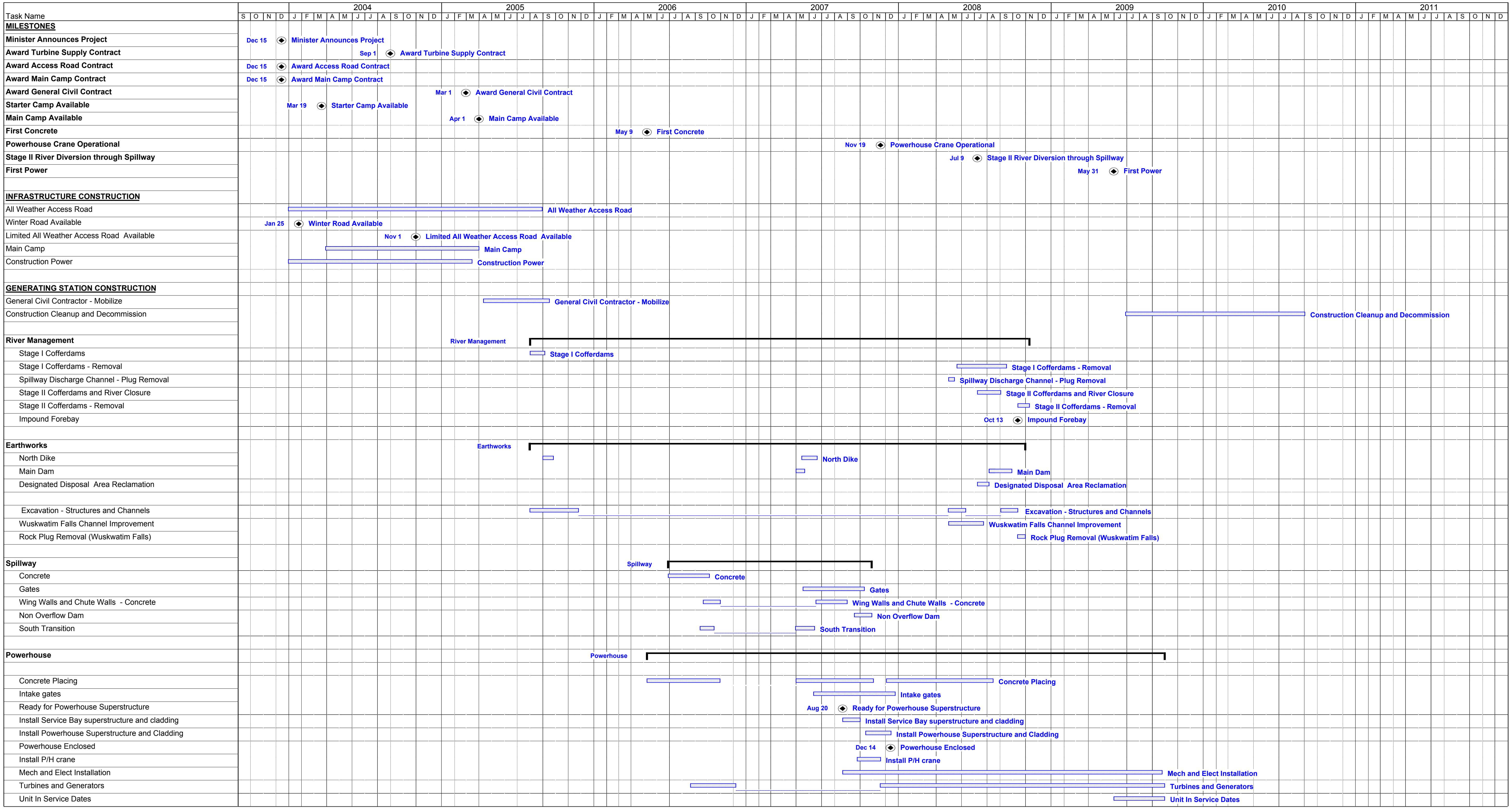


Figure 4.2-1 Summary Construction Schedule

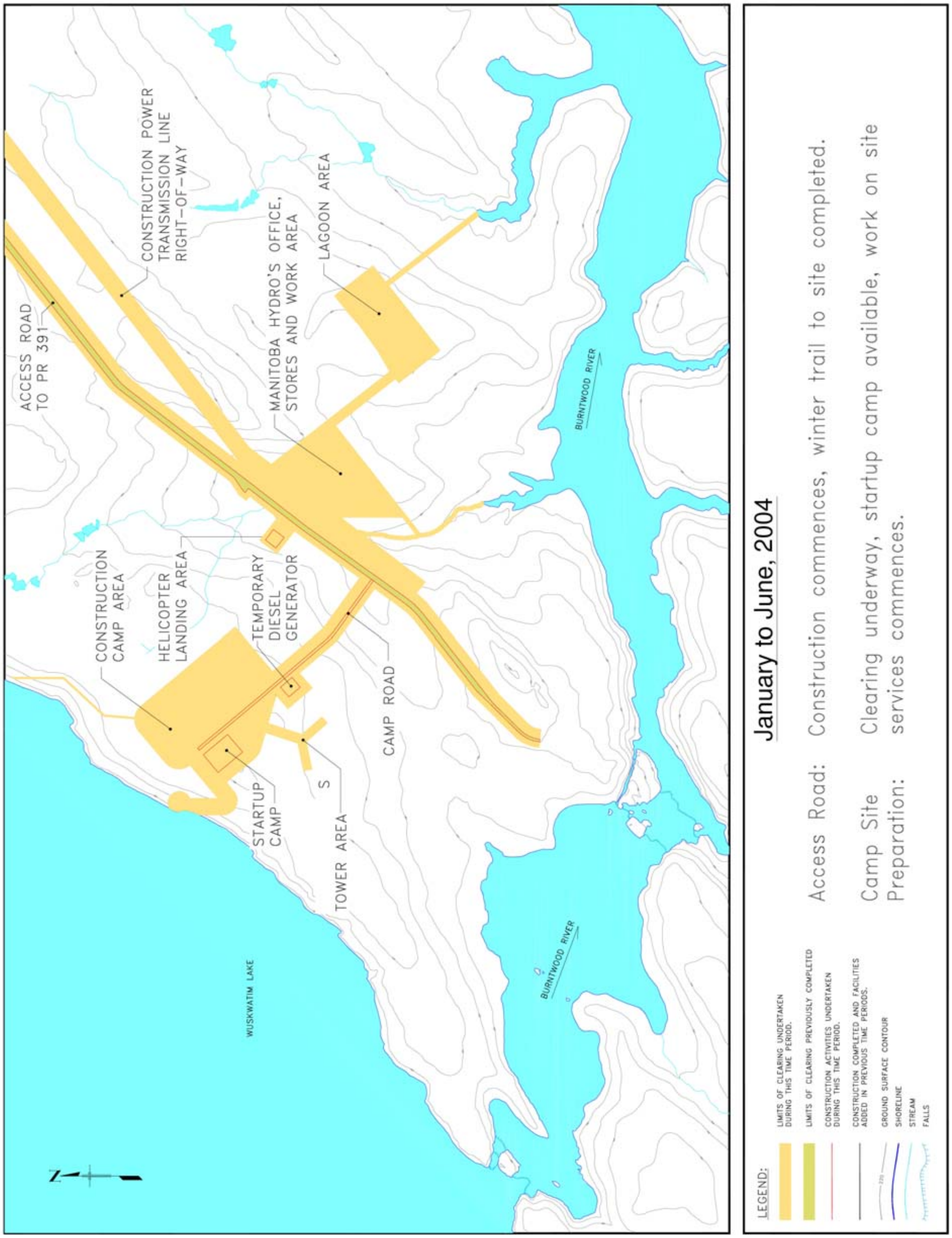


Figure 4.2-2 Proposed Construction Activities - January to June 2004

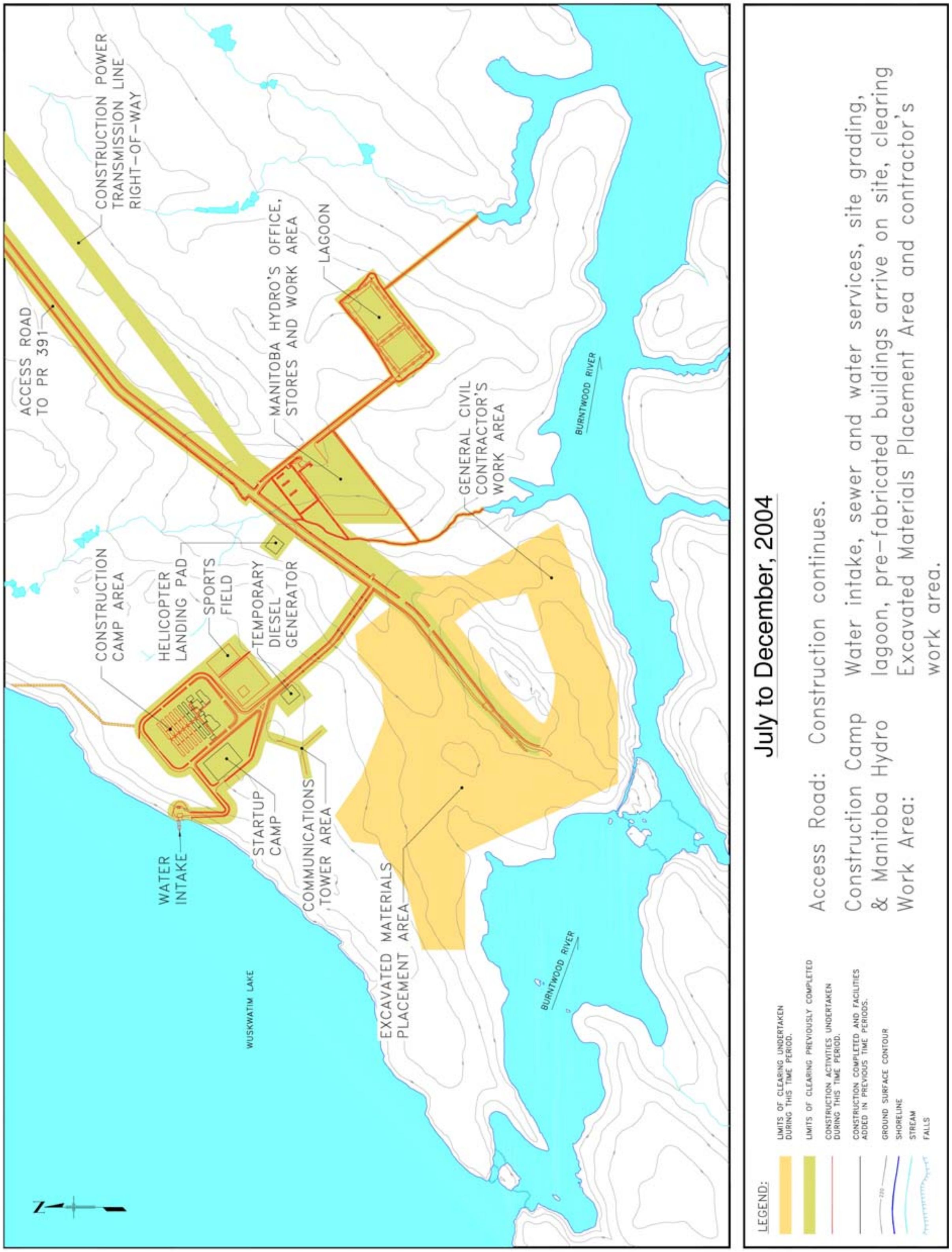


Figure 4.2-3 Proposed Construction Activities - July to December 2004

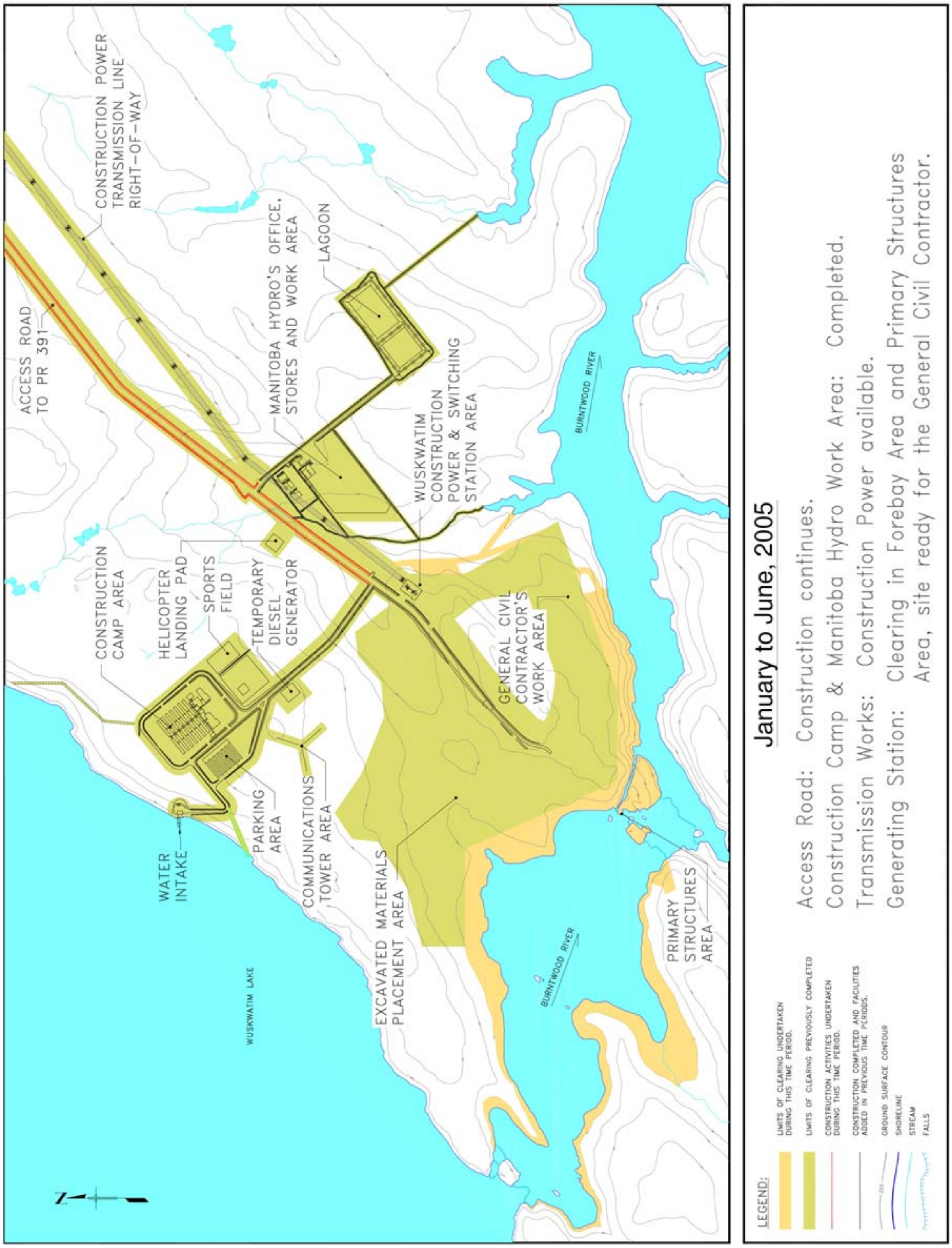


Figure 4.2-4 Proposed Construction Activities - January to June 2005

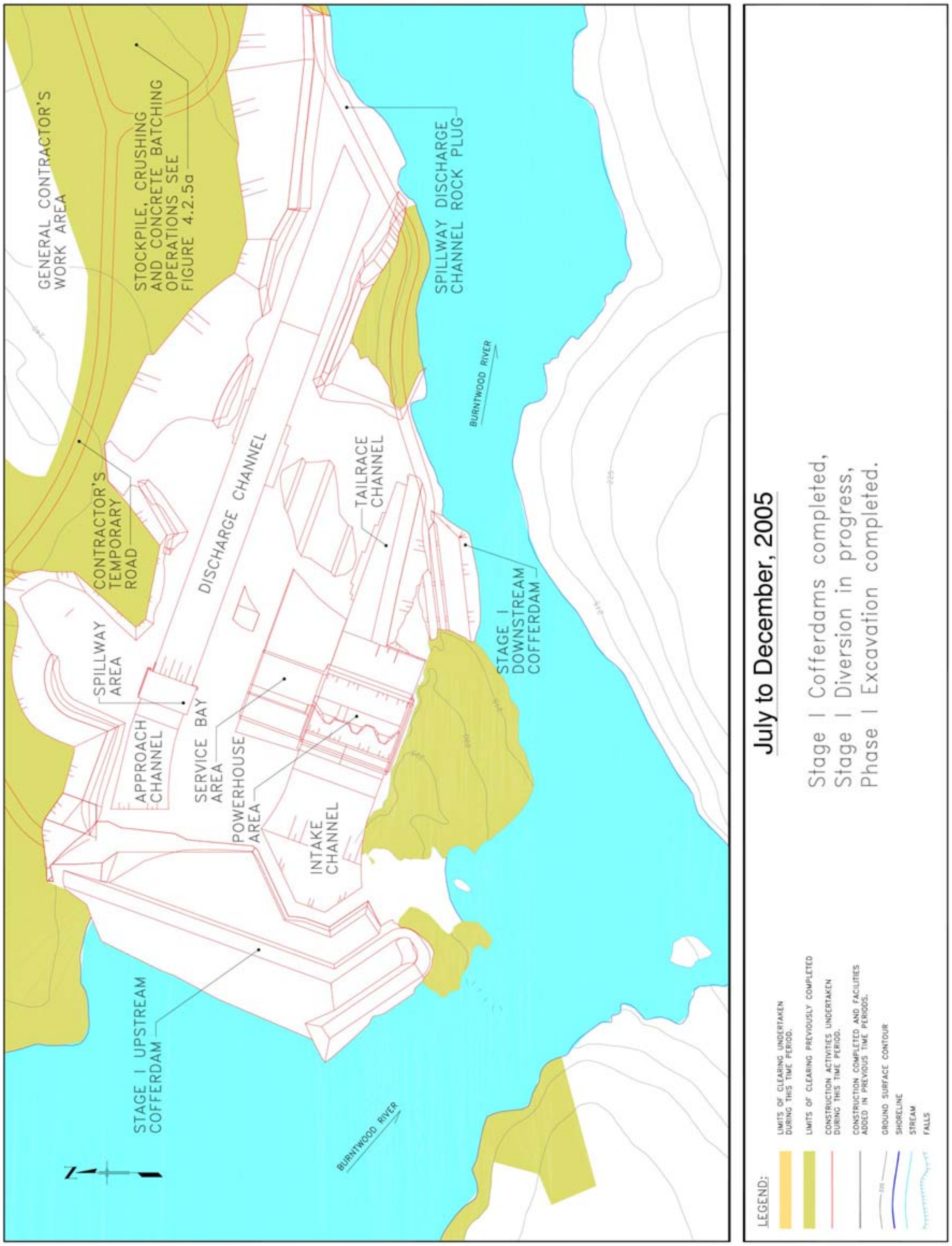


Figure 4.2-5 Proposed Construction Activities - July to December 2005

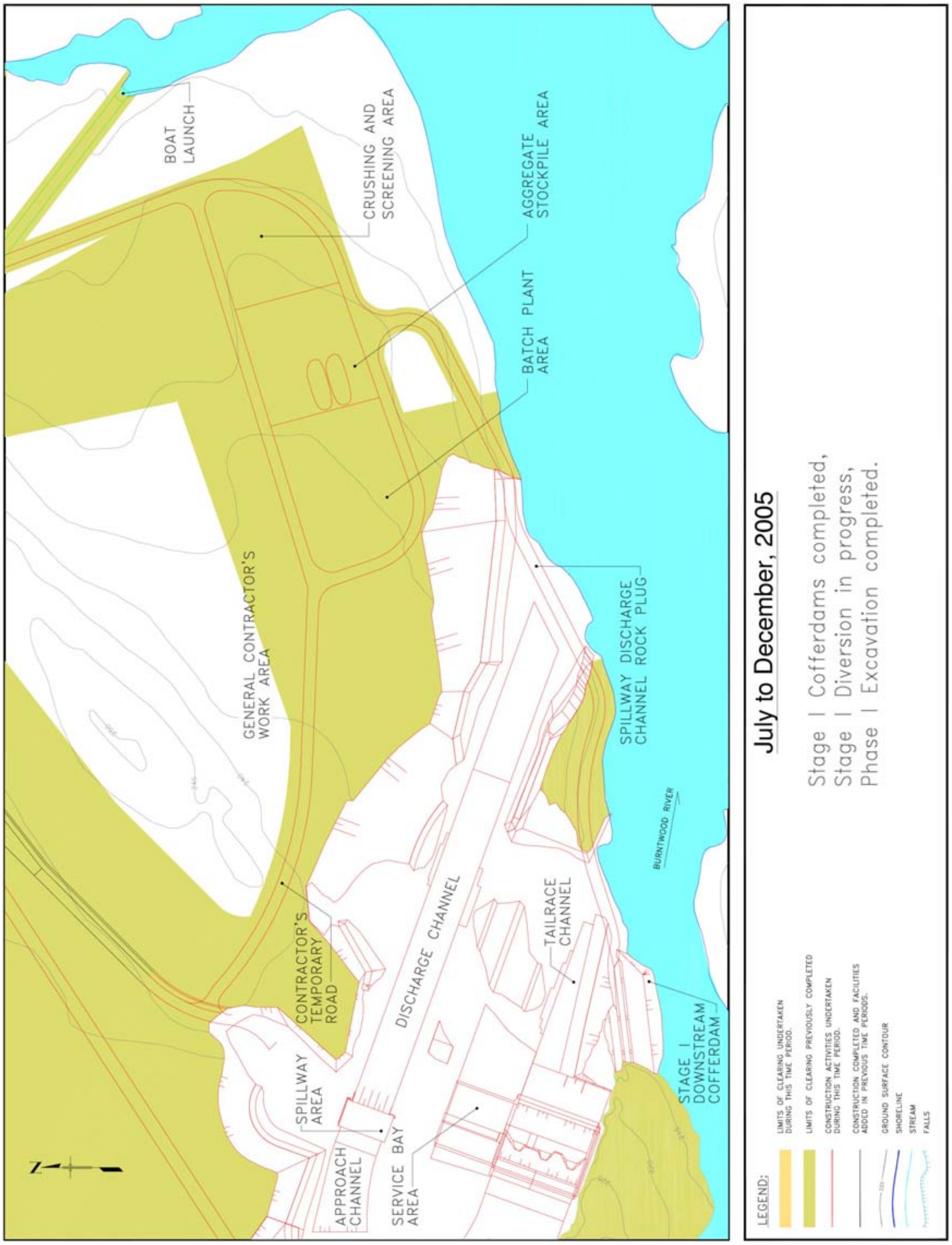


Figure 4.2-5a Proposed Construction Activities - July to December 2005

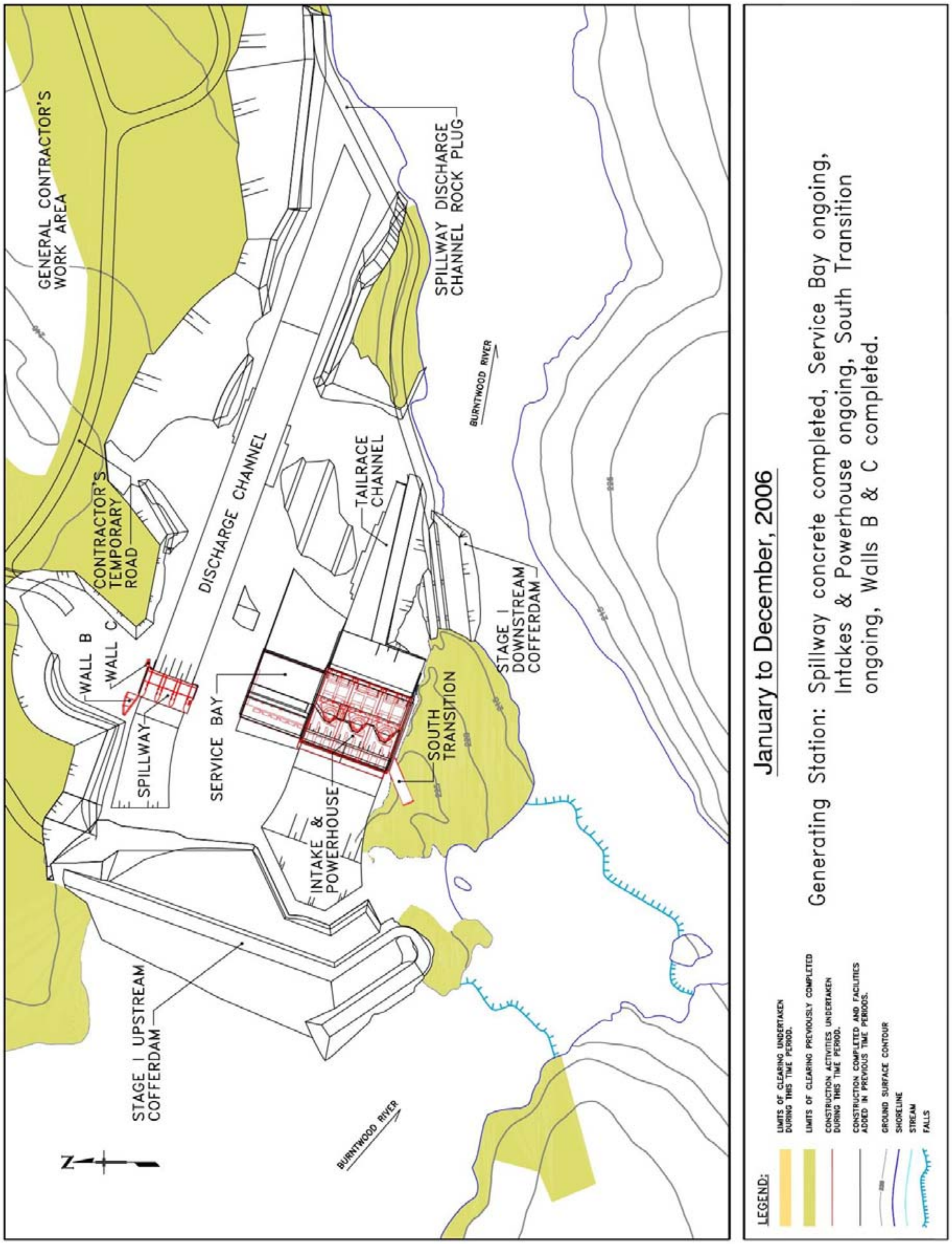


Figure 4.2-6 Proposed Construction Activities - January to December 2006

In 2007, work will continue on the Primary Structures, as shown in Figure 4.2-7. The South Transition Structure is scheduled for completion in June, followed by the Wing Walls and Chute Walls in August and the Gates and Non Overflow Dam by October, completing the Spillway structure. By the autumn of 2007, the Powerhouse Crane will be operational and work will be completed for the Powerhouse and Service Bay superstructures. As the Powerhouse and Service Bay are being enclosed, the Electrical and Mechanical Installation Contractor will mobilize to start the installation of the electrical and mechanical systems. Work will also begin on installing the Turbines and Generators. Finally, in preparation for Stage II Diversion in the following year, work will start on a short section of the Main Dam adjacent to the South Transition. A short portion of the Stage II Upstream Cofferdam will also be constructed in the dry.

Major activities that would be accomplished in 2008 include the completion of the remaining forebay clearing, Stage II Diversion, Wuskwatim Falls Channel Improvement and the construction of the Main Dam. One of the first activities will be the partial construction of the Wuskwatim Falls channel improvement at the outlet from Wuskwatim Lake. This activity will involve clearing and overburden and rock excavation across the peninsula adjacent to Wuskwatim Falls, from May to July. The Stage II Diversion will involve construction of a Stage II Upstream Cofferdam in July, opening of the Spillway Discharge Channel and removal of the Stage I Upstream Cofferdam in September, as shown in Figure 4.2-8. The river will then be diverted through the Spillway. Once river closure has been achieved, work will start on the construction of the Main Dam and the Stage II Downstream Cofferdam will be constructed across the downstream end of the Powerhouse Tailrace Channel. The area between the Stage II Upstream and Downstream Cofferdams will then be dewatered to allow the remaining excavation of the Tailrace Channel to be undertaken in dry conditions and the Main Dam to be completed. The Stage II Downstream Cofferdam will be removed late in 2008, following completion of the Tailrace Channel excavation, as shown in Figure 4.2-8a and the by the end of the year, the site will be as shown in Figure 4.2-8b.

In the final year of construction, key activities will include the completion and commissioning of electrical and mechanical systems installations, final assembly of the turbine and generator units, impounding of the reservoir and the removal of the rock plug at the Wuskwatim Falls Channel Excavation (improvement) area. These areas are shown in Figure 4.2-9. The first unit will be commissioned and on line in May 2009, a second unit will be on line in July 2009 and the final unit will be on line in late September 2009.

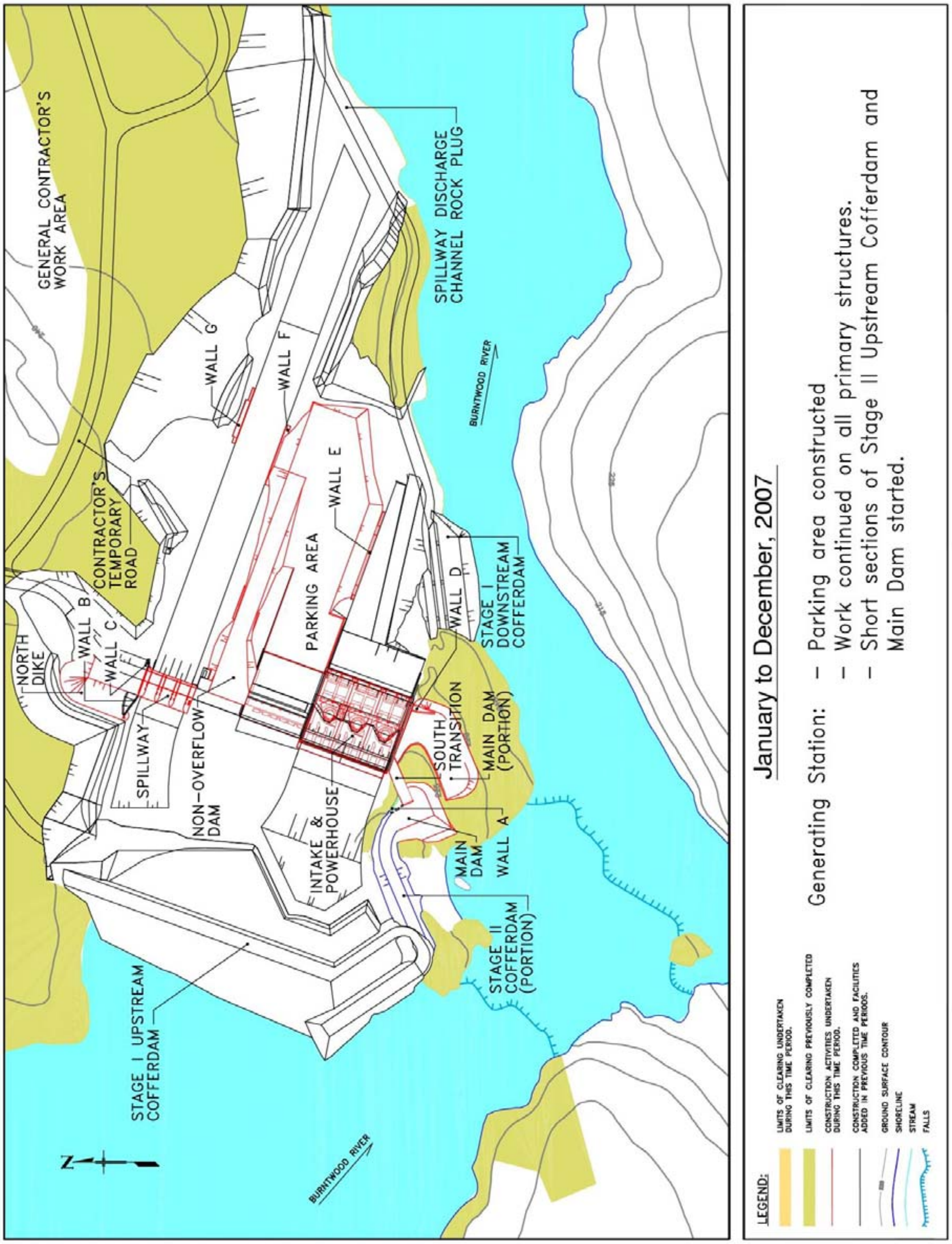


Figure 4.2-7 Proposed Construction Activities - January to December 2007

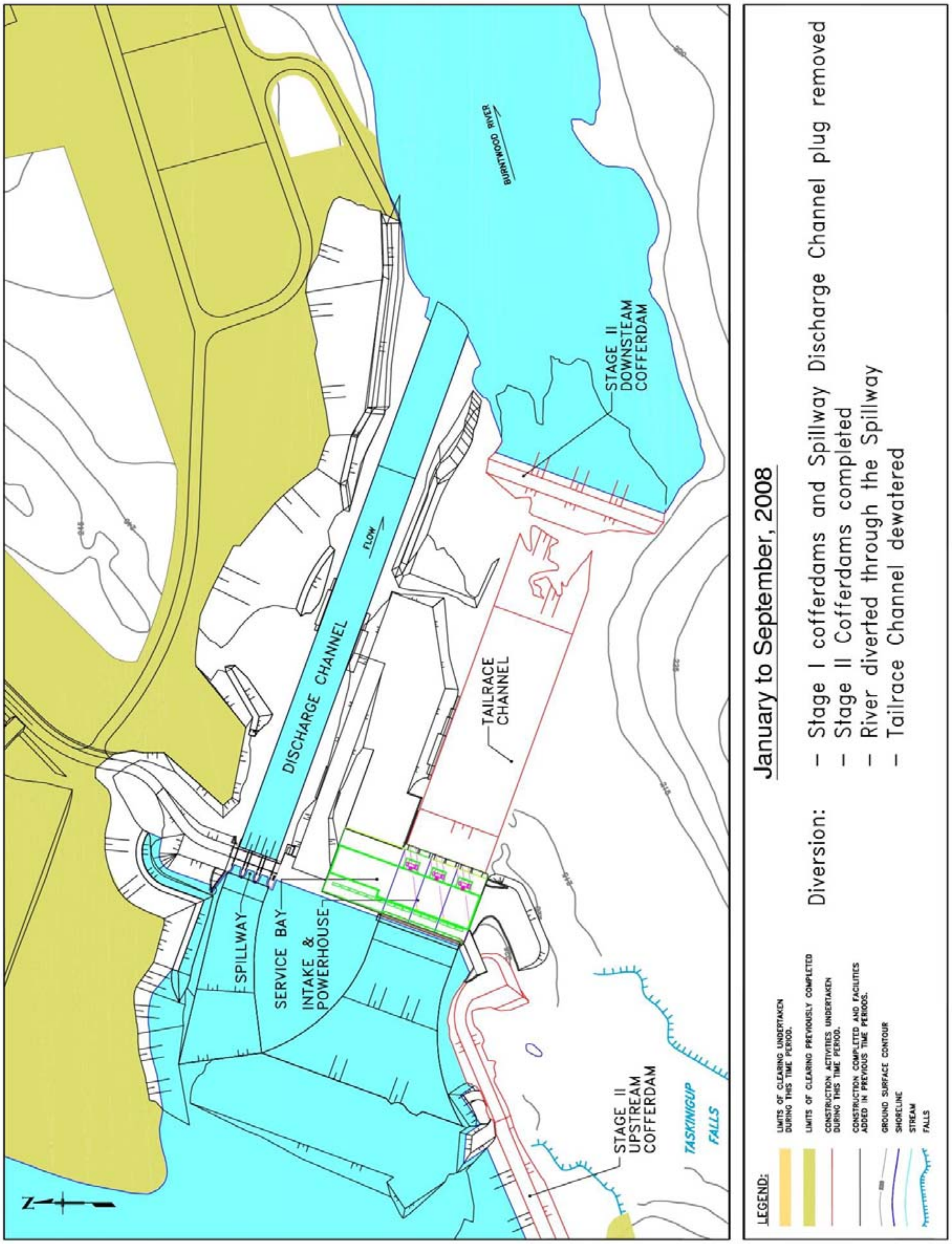


Figure 4.2-8 Proposed Construction Activities - January to September 2008

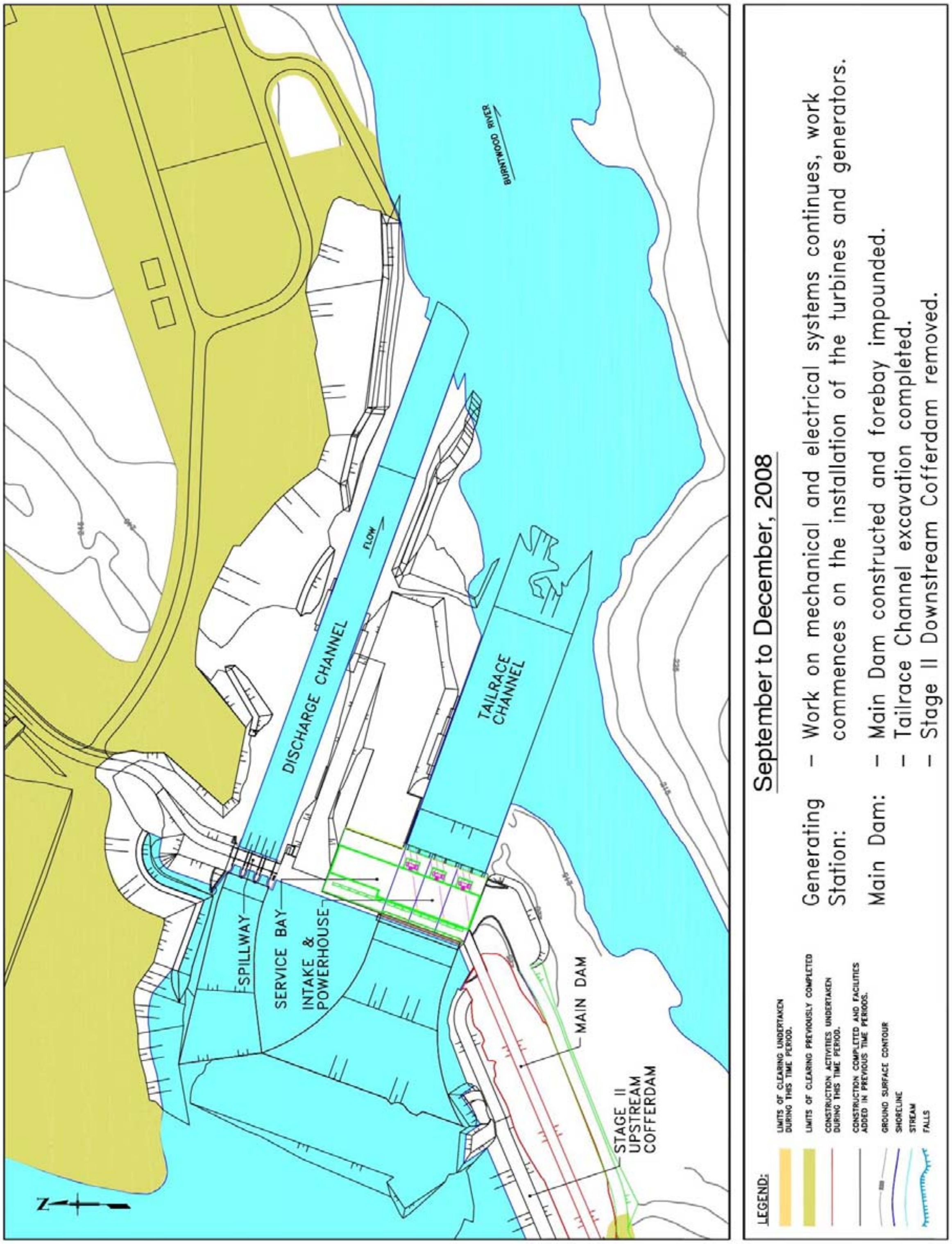


Figure 4.2-8a Proposed Construction Activities – September to December 2008

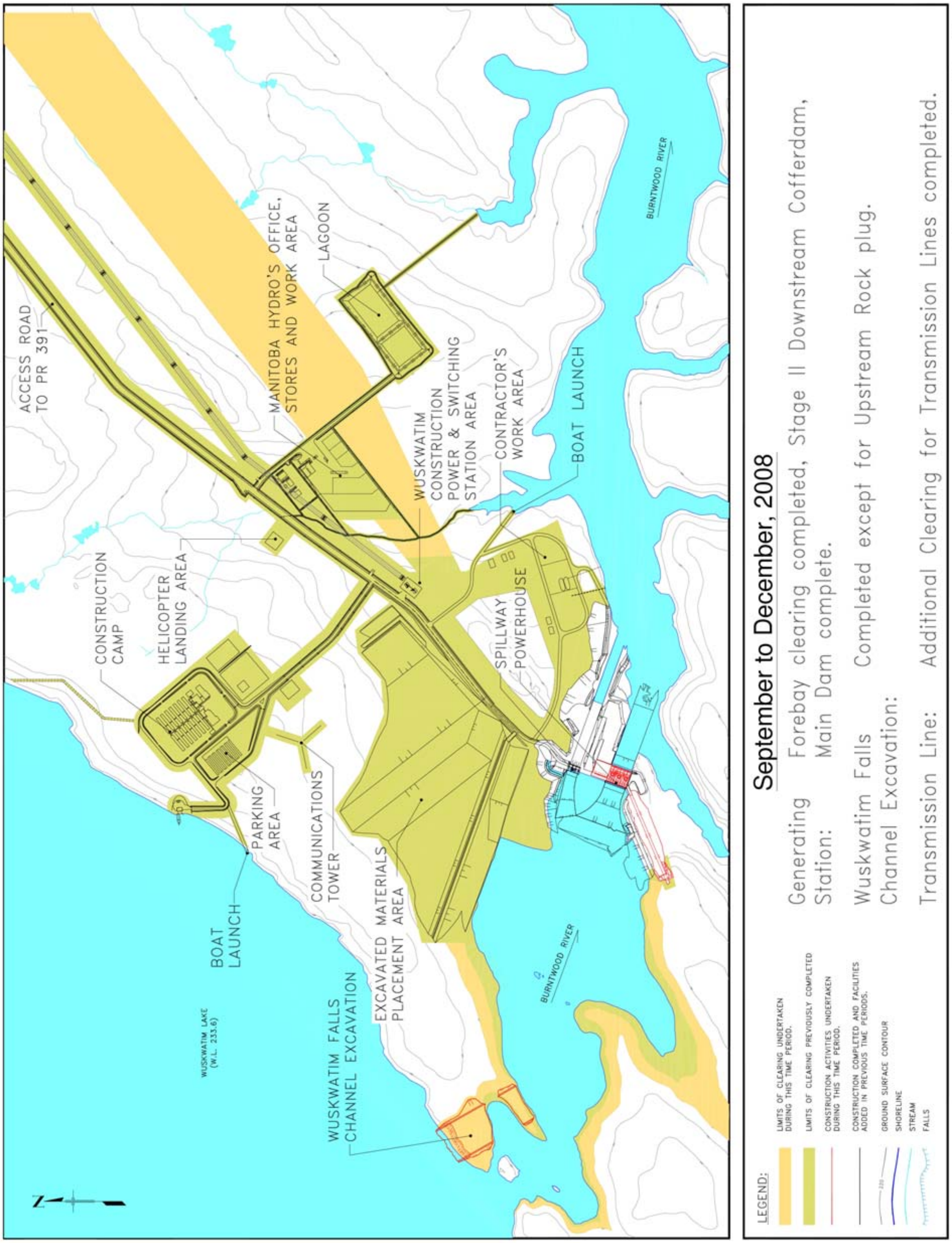


Figure 4.2-8b Proposed Construction Activities - September to December 2008

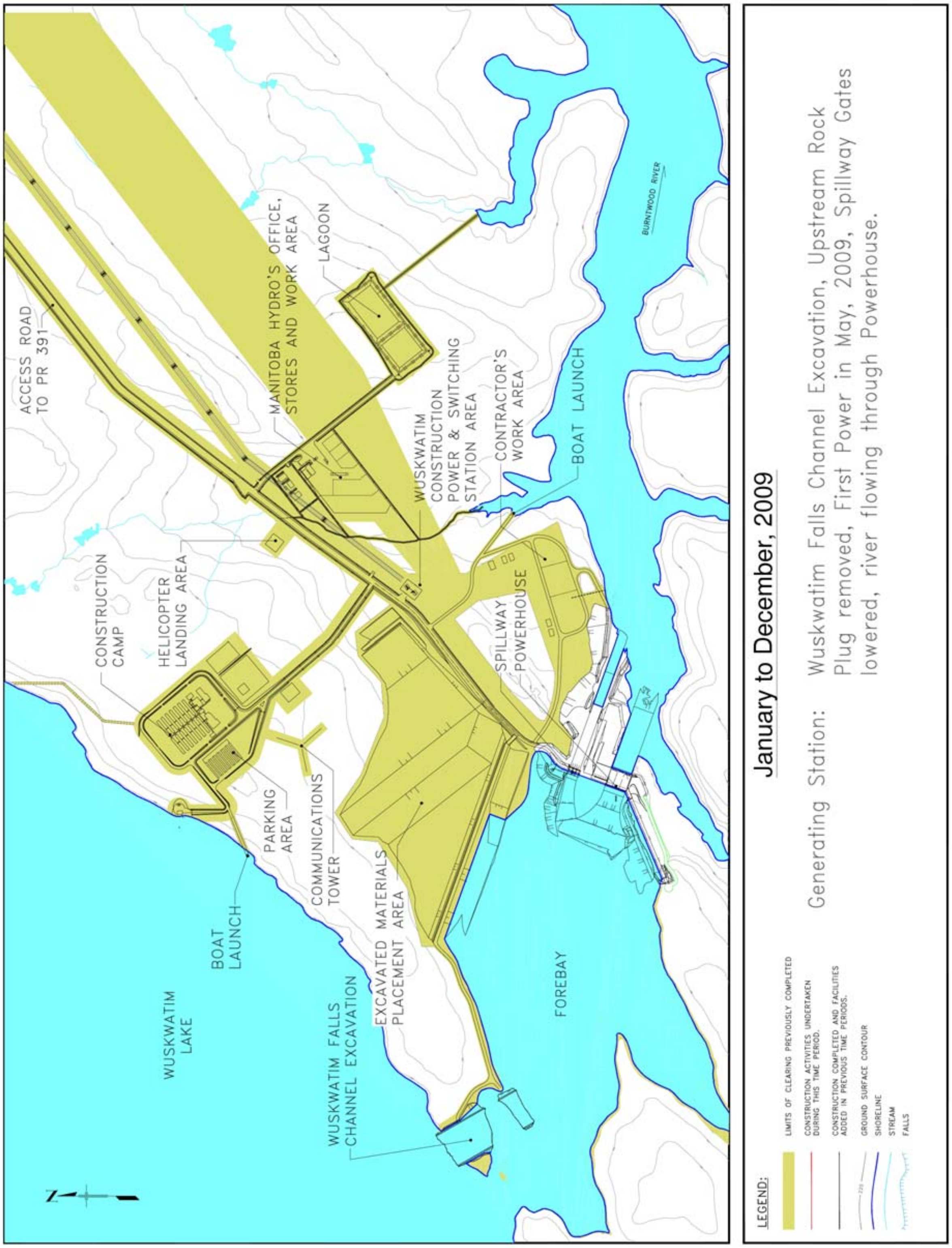


Figure 4.2-9 Construction Status - January to December 2009

Upon completion of construction of the generating station, all buildings and temporary infrastructure will be removed from the site except for the stores buildings and the site will be decommissioned. This includes the reclamation of all roads and borrow areas that will not be required for the operation of the generating station. The rehabilitation will be in accordance with the Environmental Protection Plans (Section 4.11).

4.3 ORGANIZATIONAL STRUCTURE

4.3.1 Workforce

For a number of reasons, it is essential that the Project be very carefully scheduled and avoids any lengthy delays. Work at the Project site will be covered by a collective bargaining agreement (CBA) known as the Burntwood-Nelson Agreement (BNA), which is intended to ensure labour stability (i.e. no strikes or lock-outs during construction) and provide cost-competitive wages and benefits. All jobs filled through the job order process will be covered by this agreement, which among other things, will set out wages, employee benefits, work hours, overtime pay, the referral process, hiring preferences, trainee/apprenticeship ratios, the lay-off process and the grievance process. The CBA will be negotiated by the Hydro Project Management Association, which represents Manitoba Hydro and contractors, and the Allied Hydro Council, which represents the construction unions. Parties to the negotiation process have to agree on and approve the conditions of employment, such as the hiring preference, referral and hiring system, and on-the-job training provisions for the Project. All contractor employees that will be covered under the CBA will be required to become a union member once they are hired to work on the Project, if they are not already union members.

As indicated, Project work will be tightly scheduled. The typical work week is expected to consist of six work days of 9 hours per day, typically on a Monday to Saturday schedule. Employees will be expected to work on statutory holidays. A worker can take an unpaid leave of up to 6 days after 45 days on the job. Overtime is paid after 40 to 45 hours per week depending on the trade. Employees can live at no cost to them in the construction camp. Those who choose to live in a nearby community and commute to the job site are responsible for their own transportation costs. A modest housing allowance may be provided in those circumstances.

Figure 4.3-1 illustrates the estimated workforce requirements for the generating station construction, by quarter, over the course of the construction period. The darker shaded area shows the number of Designated Trades required, or those positions requiring apprenticeship training. The figure shows the highest, or peak, number of positions estimated to be required during the quarter, and not all of these positions would last for the entire duration of the quarter. As a result, the information in the figure should not be used as an indicator of the person-years of employment on the Project. The workforce estimates include contractor positions that would be within the scope of the collective bargaining agreement for the Project. The estimates do not include senior contractor supervisory and management staff, Manitoba Hydro staff, camp operation staff, nor any positions related to transmission line construction.

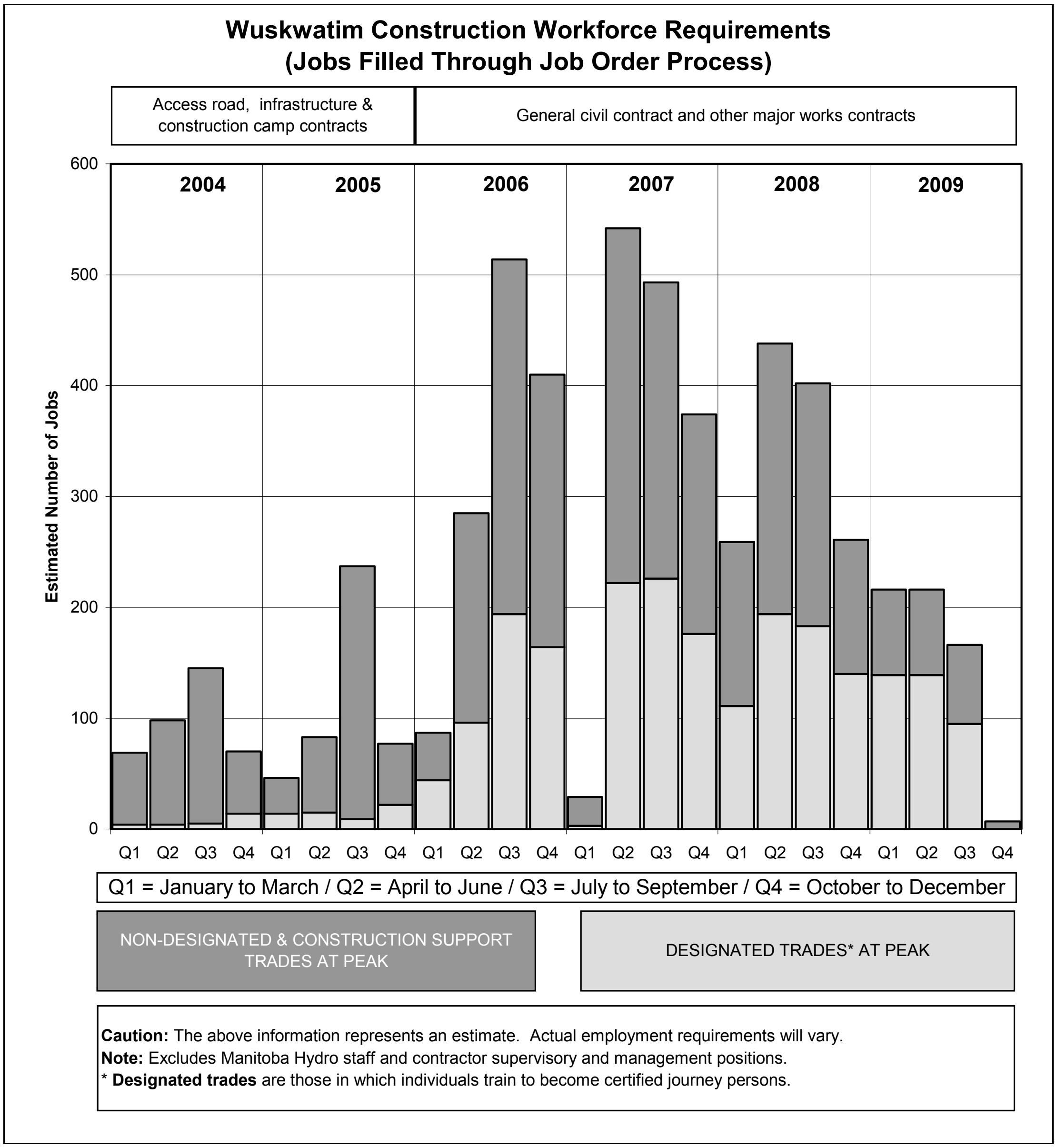


Figure 4.3-1 Summary of Workforce Requirements

As indicated in Section 4.2, the access road and construction camp infrastructure and installation work extends for the entire first year (2004) of construction and for the first two quarters of the second year. The majority of the initial construction takes place during the summer season of the first year, with an estimated workforce requirement at the peak of construction activity of approximately 140 positions. During the off-season (in the winter months), the estimated peak workforce requirement declines to between 50 and 75 positions. The construction camp is scheduled to be operational by early in the second year (2005) to allow for the start of work on the general civil contract.

The contractor for the general civil construction is expected to start work during the early to middle part of the second year. Initial general civil work will consist of site preparation and excavation during the summer construction season of the second year with a relatively small estimated workforce requirement of approximately 175 positions at peak. There would also be approximately 60 workers still working on the infrastructure construction during this time. The first concrete work is anticipated in the second quarter of the third year (2006) of construction, following which the workforce requirement increases to a maximum of approximately 510 positions in the late summer. Construction during the winter off-season at the beginning of the fourth year will be limited, with the peak workforce requirement declining to approximately 20-30 positions. The Powerhouse is scheduled to be enclosed in the fourth year (2007) of construction, which will result in a more level/stable workforce requirement over the winter season of that year. The enclosure of the Powerhouse, and the continued work that it will allow during the winter, will ensure that all concrete structures are ready for the second stage of water diversion in the summer construction season of the fifth year (2008). The fourth year of construction has the largest workforce requirement, with a peak number of positions estimated at approximately 540 in the summer construction season. From that point on the workforce will gradually decrease until the generation of first power is achieved in the second quarter of the sixth year (2009). The number of positions required will continue to drop until all work is substantially completed in the latter quarters of the sixth year of construction and the decommissioning of the site and rehabilitation is complete.

In addition to the positions described above, which would be hired through the job order process, there will be a small number of positions for contractor supervisory and management staff and Manitoba Hydro personnel. These positions are expected to represent no more than ten to fifteen per cent of the total workforce, and would be outside the scope of the BNA.

4.3.2 Safety, Security and Emergency Response During Construction

The vision statement in Manitoba Hydro's Corporate Strategic Plan states the intention ***"…to be recognized as the best utility in North America with respect to safety, rates,***

reliability, and customer satisfaction, and to be considerate of all people with whom we have contact."(Section 1.2) Safety represents the Corporation's most important goal and supersedes all other considerations. Employee safety is aligned with the Vision Statement and Operating Principles, which represent the aims of Manitoba Hydro and its collective values. The safety and well being of its employees is of primary importance to the Corporation. As well, fewer accidents mean higher productivity, lower costs, and increased corporate effectiveness.

All construction activities and specific safety requirements will be contained in the contract packages. The contractors must comply with current provincial Health and Safety regulations. It is the responsibility of the Project Manager to ensure that all Contractors comply with these requirements.

Emergency response programs will be developed to include procedures to address all foreseeable situations that may occur during the construction period and once the station is in operation. A helicopter landing area will be located at the work site to provide a means for emergency access.

Environmental issues such as spills will be discribed in the Environmental Protection Plans. Spill response programs and equipment will be in place for spillage or leaks of any oils or contaminants. All materials will be stored and handled in accordance with established policies and regulations. During construction, on-site emergency response teams will receive training with respect to fuel spill containment, clean up and other emergency measures.

The transportation of dangerous goods will be carried out as required by legislation/regulation. Road transportation of dangerous goods will only be undertaken by licensed carriers.

An on-site Safety Supervisor will be employed during the construction period to ensure that Manitoba Hydro’s staff receive training and that all Contractors comply with the required regulations.

During the construction period security officers will provide roving security and fire watch patrols throughout the camp and Manitoba Hydro work areas and related facilities. The security personnel will operate access gates for approved personnel and vehicles and maintain surveillance of a remote monitor on a 24-hour basis.

No firearms will be allowed on the camp/Project site. All firearms will be declared and checked-in at the PR 391 security gatehouse. For safety reasons, no hunting areas will be established within 5 km of the camp/Project site and within the road right-of-way. Special arrangements will be made for NCN members wanting to hunt in the RMA (excluding the no hunting areas defined for construction safety). These details will be addressed by Manitoba Hydro and NCN, in consultation with the Nelson House Resource Management Board prior to construction.

4.4 SITE PREPARATION

4.4.1 Clearing and Grubbing

Clearing will be required for the construction of the access road, construction power transmission line, camp, work areas for Manitoba Hydro and contractors, the immediate forebay area, and for the Powerhouse, Powerhouse tailrace, Spillway, Spillway discharge channel and the Excavated Materials Placement Area. Clearing will be the first activity to occur, and will commence in January 2004 and carry on until some time in the fall of 2004. The majority of the clearing work will be done during the winter, however, some clearing may be done during the period from May to July. As discussed in Volume 6, particular care will be taken during this time to minimize disturbances to wildlife wherever possible. The final clearing of the immediate forebay will be undertaken later in 2008 before forebay impoundment. This will provide a natural buffer between the construction activities and the water body prior to forebay impoundment. The following is a summary of key clearing activities:

- Access Road likely cleared between January and March 2004.
- Granular Borrow areas likely cleared between January and March 2004.
- Camp & Work areas likely cleared between January and March 2004.
- Forebay clearing will generally take place in the winter.

Equipment used for clearing ranges from brush mowers to large tractor type crawlers using shear blades. Other equipment used for clearing activities includes all-terrain vehicles, bulldozers, rubber-tired skidders, logging trucks and pick-up trucks. The clearing will be largely undertaken with heavy machinery, except in environmentally sensitive areas, where hand clearing will be employed.

Figures 4.2-2 to 4.2-9 show the estimated extent of the clearing required for the Wuskwatim Project and the time period in which the clearing is estimated to occur. The maximum areas that will be cleared are summarized in Table 4.4-1.

Table 4.4-1 Clearing Areas	
Feature	**Clearing Area** (ha)
Local Roads	23.1
Camp Area	12.9
Manitoba Hydro Work and Storage Area	8.5
Sewage Lagoon and Outfall	7.2
Construction Power Right-of-Way and Substation	3.7
Primary Structures – 18 ha, Excavated Materials Placement Area – 42.8 ha and Transmission Corridor Right of Way - 21.4 ha	82.2
High Rock areas – encircled by infrastructure that may be disturbed	9.5
Flooded Area – of which 5.5 ha is the upstream channel excavation area	37
Sub Total at Site	184.1
Access Road from PR 391 to site – assumes 100 m ROW Access Road Composite Borrow pits (South – 139, North 69)	479 208
Construction Power Transmission Line from Thompson to site (assumes 60 m ROW, see Wuskwatim Transmission Project EIS for details)	272
Granular Borrow Areas (G, H and J)	+5.6% of 654

Grubbing is the removal of the roots of vegetation and will only be undertaken where essential, including the area where the access road and drainage ditches are located and the site infrastructure area. The flooded areas will be cleared of vegetation but not grubbed. Equipment used for grubbing includes bulldozers with hydraulic rippers.

Clearing, grubbing and disposal of non-merchantable timber will be undertaken in compliance with all governing rules and regulations, including any seasonal restrictions, and in accordance with the Environmental Protection Plans (Section 4.11).

First rights to purchase the timber in the Wuskwatim Project area are held by Tolko Industries Ltd. Suitable arrangements will be made to salvage merchantable timber during the balance of the clearing operation. (This is discussed further in Volume 6 in the Forestry Section).

Clearing will be required for the access road. Typically an average of 80 m (ranging from 60 m to the full 100 m) of the 100 m road right-of-way will be required to be cleared and will be one of the first tasks undertaken during the access road construction schedule. Buffer zone widths adjacent to watercourses will be a minimum of 10 metres plus 1.5 times the slope gradient in accordance with Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat (Manitoba Government 1996).

Clearing will be required for the construction power transmission line and is discussed in the Wuskwatim Transmission Project EIS.

Clearing of vegetation will also be required in the granular borrow areas to facilitate the borrow area utilization. Approximately 17.9 ha or 2.7% of the total granular borrow areas (see Table 2.3.1) will be utilized for the supply of granular materials at the GS. About 18.8 ha or 2.9% of the total granular borrow areas will be utilized for the supply of granular materials for the access road. An additional very small area (much less than a fraction of 1 %) of the total granular borrow area will be utilized for the supply of granular materials for the construction power sub-station foundation preparation.

4.4.2 Site Drainage

Drainage plans will be developed for the various construction activities including the stockpile of aggregate materials. Some of the drainage water will be reabsorbed and the runoff from the drainage catchment area will be channeled away and eventually continue to flow naturally to the river. Streams will not be blocked, and culverts will be installed as required. All site drainage, erosion, and sedimentation management will be in accordance with the Environmental Protection Plans.

4.5 CONSTRUCTION MATERIAL SOURCES

Materials required for the construction of Wuskwatim Project are broken down into two groups: materials for the GS and the supporting infrastructure at site, and materials for the access road.

The materials required for the GS and the supporting infrastructure at site will include impervious fill, granular fill/crushed rock, rockfill, riprap and concrete aggregates. Site investigations have identified a number of natural sources for impervious and granular materials (shown in Figure 3.8-2). However, during construction of the temporary and permanent structures, the intent is to maximize the use of rock and impervious materials obtained from the excavations required for the construction of the Primary Concrete Structures. Consequently, the borrow sources off site will be required to supply only granular materials. The exact location and details for processing granular material will be left to the discretion of the contractor. The contractor will be required to comply with provincial and federal regulations. Typical equipment used in the development and operation of borrow areas and quarries includes crawler-tractors, front-end loaders, drills, screens, crushers, washers and gravel trucks. The construction requirements for the GS consist of the following:

- **Granular Fill/Crushed Rock -** Three granular deposits, Deposits G, H (NCN TLE land selection) and J, have been identified to date and investigated as potential sources of granular construction materials as shown in Details 2 & 3 of Figure 3.8-2. Deposits G and H are located approximately 27 km northeast of the site. Deposit H consists of two large dome-shaped areas, identified as Deposit H-East and Deposit H-West. Deposit J is located approximately 18-23 km northeast of the site and consists of six separate areas. Depending on the economics of crushed rock production versus haul, some of the granular fill requirements may be met by the crushing of bedrock obtained from the required excavations or from local quarry. The potential quarry would be located within the Project's transmission line corridor, immediately to the north east of the area set aside for Manitoba Hydro's offices and storage area.
- **Rockfill -** Rock required for the production of all rockfill and riprap materials required for the construction of the permanent facilities will be available from the excavations for the primary structures and channels. Some rock, for rockfill used in the construction of the supporting infrastructure may be sourced from the potential quarry site located within the transmission line corridor.
- **Impervious Fill -** Silty clay, required for use as impervious fill in the temporary and permanent dam and dyke, is available from the excavated material identified in borrow areas SA-A and the area of the primary structures (Figure 3.8-2).
- **Coarse Aggregates for Concrete -** Rock from the required excavations for the concrete structures and channels will be suitable for use as coarse aggregate, following crushing and processing.
- **Fine Aggregate for Concrete -** The anticipated source of the concrete fine aggregate will be Deposit J-4, which contains adequate quantities of material to meet the requirements for the concrete. Screening, washing and stockpiling will be required to process the fine aggregates.

The materials required for the construction of the access road (Table 4.6-2) will include impervious fill, granular fill, rip-rap, sub-grade granular materials, sub-base granular or rockfill materials, traffic gravel and culvert gravel. Site investigations have identified a number of natural sources for impervious, granular and rockfill materials (Figure 3.8-2) as discussed above. However, the intent is to maximize the use of local granular materials, impervious materials and rock obtained from the excavations within the access road right-of-way or from the transmission line corridor. Typical equipment used in the development and operation of borrow areas includes bulldozers, front-end loaders, screens, crushers, washers and gravel trucks. The construction requirements for the access road consist of the following:

- **Local Fill -** Silty clay or local granular materials will be required for use as fill in the preparation of the sub-grade. A good portion of the access road will be located along the eastern flank of very significant granular outwash glacial deposits which will provide an excellent source of local granular materials for sub-grade preparation. The access road will then follow along the north side of pronounced granular ridges that are part of an esker that runs north east to south west which will also provide an excellent source of local granular materials for sub-grade preparation. The road will then head south-west to the GS site where the road will traverse mostly silt, clay, peat and fen areas where there is significant local silty clay available for sub-grade preparation.
- **Granular Materials/Crushed Rock -** Three granular borrow deposits, Deposits G, H, and J, have been identified to date and investigated as potential sources of granular construction materials, as shown in Details 2 and 3 of Figure 3.8-2. Deposits G and H are located approximately 27 km northeast of the site. Deposit H consists of two large dome-shaped areas, identified as Deposit H-East and Deposit H-West. Deposit J begins approximately 18-23 km northeast of the site and consists of six separate areas. A potential rock quarry site is located within the transmission line corridor next to the area set aside for Manitoba Hydro's offices and storage area. These areas will be utilized as sources of the prepared granular/crushed rock materials used in the installation of the culverts, the access road sub-base and the traffic gravel.
- **Riprap –** Riprap will come from the rock excavation along the road right-of-way or from crushing of the over-sized material or selected materials at the granular borrow area.

The construction materials data obtained from the field and laboratory testing will be used during the process of final design for the earthfill structures and a more detailed borrow utilization plan will be prepared. This plan will identify the extent and depth of the material sources with, in some cases, the identification of the amounts of materials or identifiable areas, which are to be protected for specific use. In general, the ultimate decision with respect to the selection and development of borrow areas will remain the responsibility of the contractors, subject to the appropriate approvals. The Environmental Protection Plans and technical specifications within the contract documents will state clearly the requirements for the protection of streams, ground water, wildlife habitat and adjacent vegetation, during development by the contractor, as well as the nature and methods for the rehabilitation of the areas after usage. These requirements will be described in the Environmental Protection Plans (Section 4.11). Table 4.5-1 provides a preliminary utilization plan for the GS and supporting infrastructure, not including the access road.

Table 4.5-1
GS & Site Infrastructure Preliminary Material Utilization Plan
(See Section 4.6.3 for access road granular requirements.)

Structure	Required Volume at Source	Estimated Material Sources and Quantities (cubic metres)					
		Preliminary Construction Excavations	Required Unclassified Excavations: Wet Clay	Required Unclassified Excavations: Dry Clay	Required Bedrock Excavations	Deposit J-6	Deposit J-4
Total Available =		**60 000**	**733 000**	**84 000**	**806 000**	**1 300 000**	**300 000**
Preliminary Construction (Lagoon, Local Site Roads, etc.)							
- Impervious Fill	60 000	60 000					
- Granular Fill	169 000					169 000	
- Rockfill	128 000				128 000		
Impervious Fill	147 000		79 000	67 000			
Granular Fill	69 000					24 000	45 000
Coarse Filter/Drain (Crushed Rock)	14 000				14 000		
Riprap Bedding (Select Rockfill)	6 000				6 000		
Common Rockfill	168 000				168 000		
Riprap	19 000				19 000		
Road Topping	5 000				5 000		
Concrete Fine Aggregate (Sand)	91 000						91 000
Concrete Coarse Aggregate (Crushed Rock)	74 000				74 000		
Total Required =		**60 000**	**79 000**	**67 000**	**414 000**	**193 000**	**136 000**
Surplus [1] =		**0**	**654 000**	**17 000**	**392 000**	**1 107 000**	**164 000**

1. Surplus from the required excavations will be placed in the Excavated Materials Placement Area

4.5.1 Disposal Areas

During construction of the site, a considerable amount of earth and rock materials will be excavated. A good portion of the excavated materials will be used in construction; the placement of the remaining amount is discussed below.

It is estimated that approximately 1,060,000 m^3 of excavated earth and rock materials will require disposal in the immediate site vicinity. These materials will be placed, within an area located immediately to the north of the generating station site (Figure 4.5-1). The Excavated Materials Placement Area will be approximately 1,100 m long by 600 m wide and material will be placed to a height of up to 8 m.

The Excavated Materials Placement Area will consist of a central portion largely composed of impervious silts and clays and will have very shallow (<5%) outer slopes. Rock filled berms will be used at the toe of the disposal area to prevent erosion. The majority of drainage water will be reabsorbed within the immediate area and runoff will naturally flow towards the Burntwood River. Organic material removed during the excavation will be stock-piled and used in the rehabilitation of borrow areas, temporary roads and disposal areas. The Excavated Materials Placement Area will be covered with salvaged organics and soils to provide an erosion resistant surficial layer and to promote the re-growth of natural vegetation. The Excavated Materials Placement Area will ultimately settle at non-uniform rates and will result in high and low areas that will contain some local run-off that will further assist re-growth of natural vegetation.

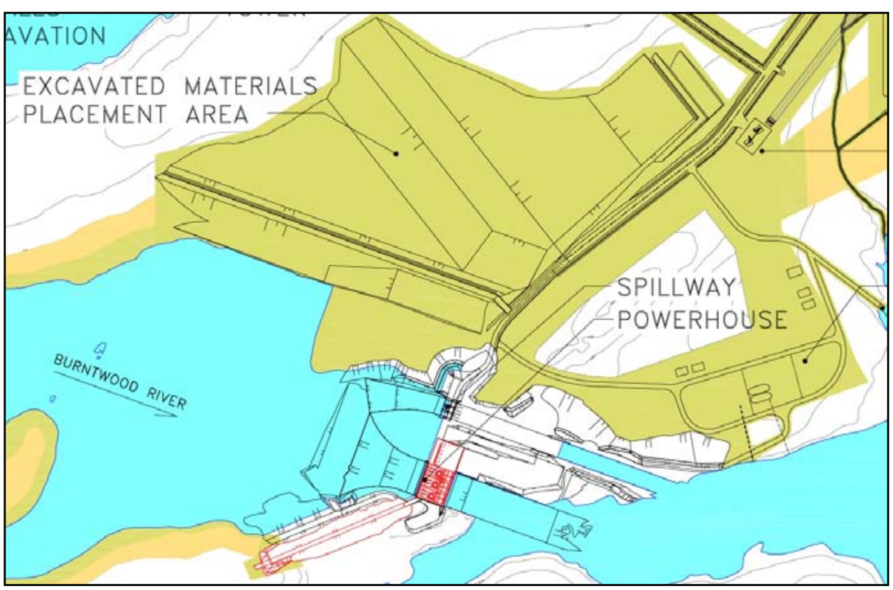


Figure 4.5-1 Excavated Materials Placement Area

4.6 SUPPORTING INFRASTRUCTURE

4.6.1 Construction Power Services

Electrical power required for the construction of the Project will be provided by Manitoba Hydro by pre-building one of the Project's permanent 230 kilovolt (kV) transmission lines from Thompson to Wuskwatim GS. The power will come from Thompson by connecting into an existing 230 kV transmission line (K24W) between Kelsey and Thompson at the site of the proposed Birchtree Station. The 60-m width right-of-way will terminate at a compact, modular, construction power sub-station located on the construction site, just north of the proposed permanent switching station, as shown in Figure 4.6-1. The modular construction power sub-station will require a significantly smaller footprint than that which would be required for a conventional construction power sub-station.

Prior to the completion of the construction power line to the site a self-contained diesel generator will be supplied to support the set-up activities. The temporary diesel generator will be located near the Construction Camp area as shown previously in Figure 4.2-2. All fuel at site will be stored in accordance with applicable regulations. The temporary diesel generator will be kept on site during construction as an emergency power source.

4.6.2 Initial Construction Camps and Work Areas

Self-contained, temporary start-up camps will be required for the construction of infrastructure facilities. The camps will accommodate the work forces involved in the initial construction activities, such as the crews involved in the access road construction, construction-power construction, GS site clearing, main construction camp area preparation and the installation of the main construction camp buildings.

The access road start-up camp is discussed in Section 4.6.3.3 (Start-up Camp). The start-up camp at the GS site will consist of mobile modular structures, likely located on the parking lot of the camp area.

Water will be trucked in and stored in approved potable water containers. All solid and sewage wastes will be collected in holding tanks and removed from the site to licensed disposal/treatment facilities. Grey water (wash water from showers, etc) may be routed into sullage pits. The camp will be installed and operated in accordance with all applicable regulations.

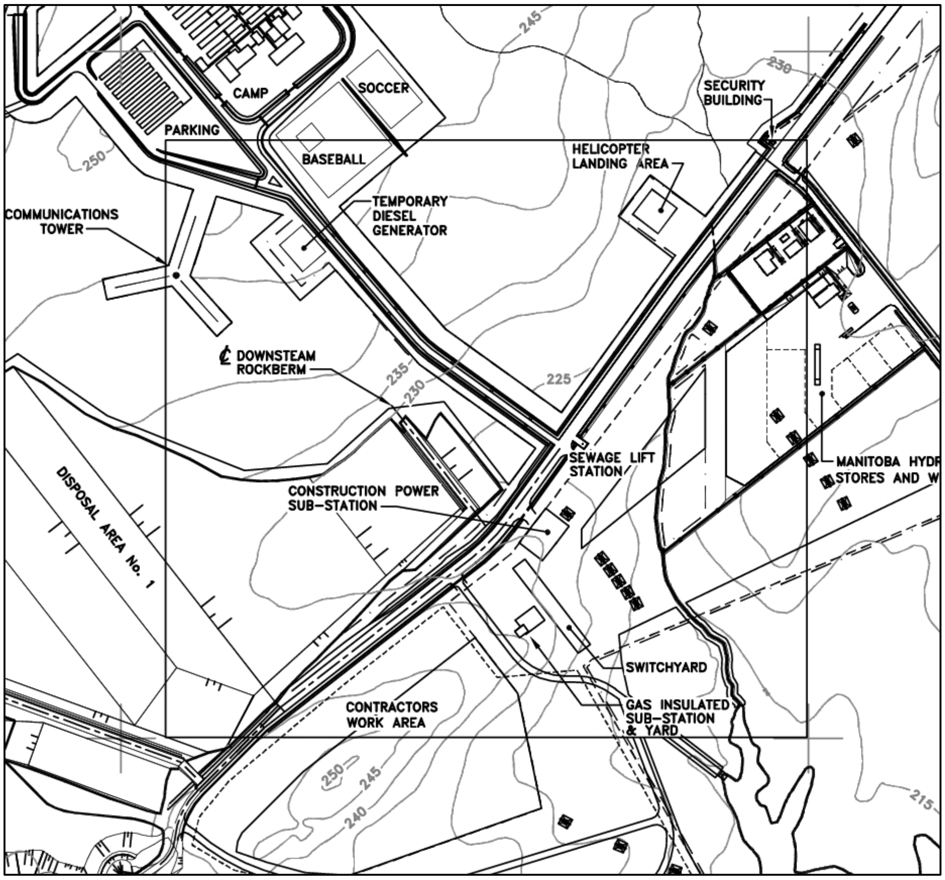


Figure 4.6-1 Insert of Plan View of Construction Site Layout (Figure 2.4-2), detailing the Construction Power sub-station and the Permanent Switching Station (Gas Insulated sub-station and Swithyard).

4.6.3 Access Road

4.6.3.1 Background

A new access road is required to build, operate and maintain the Wuskwatim GS. The all-weather road will be the primary source of access required to transport materials, equipment and workers between Provincial Road 391 (PR 391) and the Project site at Taskinigup Falls.

The Mile 17 access road route was selected through an extensive route selection process (Section 3.6). The Mile 17 access road begins at PR 391, about 32 kilometres west of

Thompson and will extend 48 kilometres southwest from PR 391 to the Wuskwatim Project site. The proposed access road route was shown previously in Figure 2.3-1.

After the final route was selected in December 2001, a preliminary road centreline was determined using air photo interpretation. In February 2002, a field exploration program was conducted along the Mile 17 centreline to confirm air photo interpretation and to collect topographic and soil information required for the design of the access road. The existing winter trail (Mile 20) was utilized for access from PR 391 to the temporary camp set up for the exploration program.

4.6.3.2 Design Criteria

The access road will be designed to current Manitoba Transportation and Government Services Provincial road design standards. The design speed will be 100 km/h and the posted speed will be 90 km/h. In addition to standard road signs, distance markers will be installed at every kilometer for safety purposes.

The access road will be designed with two separate road widths to accommodate anticipated truck traffic hauling granular material between Deposit "G" and the Wuskwatim Project site. From the intersection of the access road at PR 391 to granular deposit "G" (approximately 18 kilometres), the roadwidth will be 10.5 metres wide. From granular deposit "G" to the Wuskwatim Project site (approximately 30 kilometres), the road width will be 13.4 metres. Cross-sections of the proposed road are shown in Figure 4.6-2.

The road traverses eight stream crossings located as shown in Figure 4.6-3. The stream crossings will consist of single or double corrugated metal pipe culverts. No bridge structures are required. Culvert sizing has been based on hydraulic analysis using a 2% flood frequency and a 50 year return period. The largest culvert size required is 1.8 metres in diameter.

These stream crossings have been identified as possible fish bearing streams (Volume 5). The stream crossings will be designed to accommodate fish passage by using culvert flow velocity criteria defined in the Manitoba Stream Crossing Guidelines as published by the Department of Fisheries and Oceans.

4.6.3.3 Construction Methodology

Interim Access

At the beginning of road construction, it is likely, subject to discussions between NCN and Manitoba Hydro that the existing Mile 20 winter trail will be used as the interim access route to re-establish the Mile 17 exploration trail to the site and to set-up the temporary start-up camps. To maintain an adequate buffer around environmentally sensitive areas, traffic will be diverted eastward onto the existing Mile 17 exploration trail, approximately 5 km south of PR 391. From this point to the Project site, traffic will remain on the Mile 17 route. Interim access along the existing Mile 20 winter trail is not expected to be required after April 2004 at which time the trail will be decommissioned. After that time, access to site will be established via the Mile 17/PR 391 intersection.

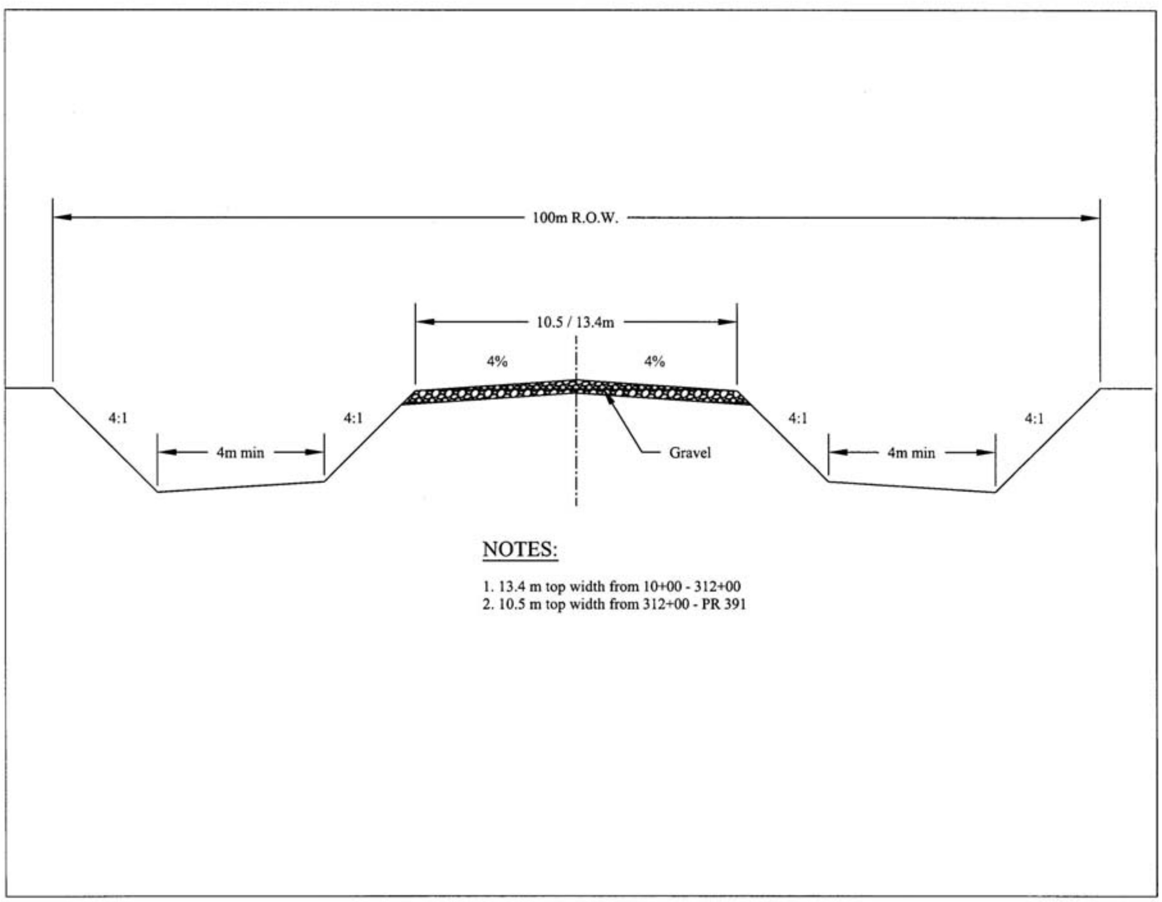
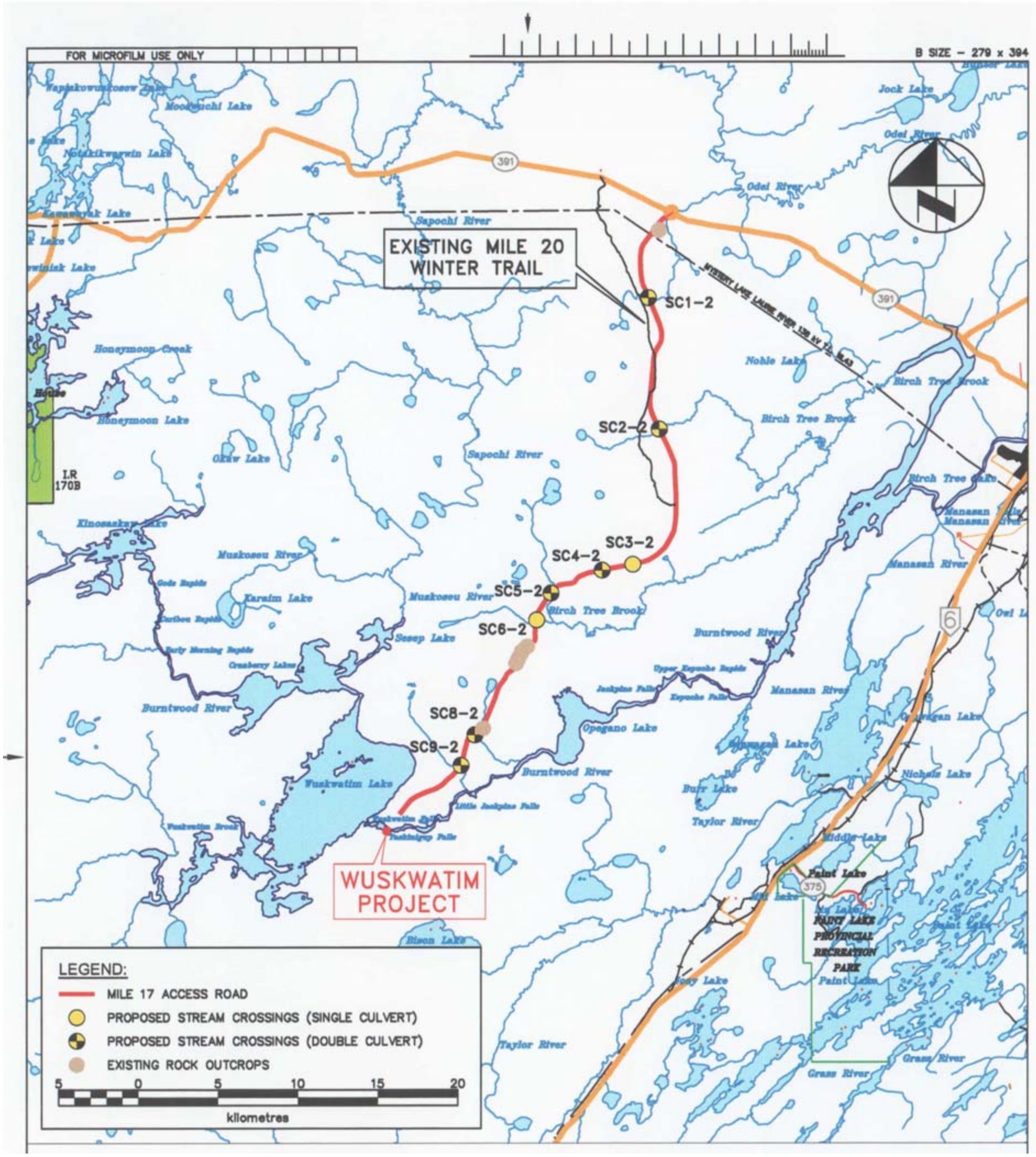


Figure 4.6-2 Proposed access road cross section



4.6-3 Location of stream crossings and rock outcrops along Mile 17 access road

Clearing

The road right-of-way will be 100 metres. Construction of the road will require a cleared width varying from 60 to 100 metres, depending on the road curvature and terrain. The total estimated clearing required for the entire access road is approximately 686 ha.

In addition to the actual roadway, clearing will be required to obtain borrow material to construct the road. It is estimated that the additional area of clearing required for borrow pits could range from zero to 5 ha per kilometre of road. The estimated clearing required for the access road is summarized in Table 4.6-1.

Table 4.6-1
Access Road Clearing Summary

		Cleared Area (ha)
Access Road		479
Borrow Pits	South half	138
	North half[1]	69
TOTAL		686

Note: 1. Assumes borrow requirements are 50% of south half of road

Tolko Industries Limited has the first right to purchase any merchantable timber cleared for the access road. Non-merchantable timber may be disposed of by cutting, piling and burning during winter months. Non-merchantable timber may also be made available to NCN residents for fuel.

Roadway Embankment

In general, road construction methods will follow Manitoba Transportation and Government Services' "Grading and Surfacing Specifications" (Manitoba Government 2002). The road embankment will be constructed using a combination of "side-casting" and borrow pit excavation. Side-casting involves removing a layer of waste material to access usable material within the right-of-way limits.

The usable material will be excavated from the ditches and backslopes and compacted into the embankment. This would supplement material excavated from borrow pits located outside the right-of-way limits and hauled to the embankment fill areas as required. The waste material, including slash and surface organics, will be placed on the spoil banks at the top of the backslope to promote vegetation growth.

Required borrow pits would be located within 100 to 150 metres of the road right-of-way and will be constructed with a minimum 30 metre buffer area between the edges of the right-of-way and the borrow area.

Known cultural and environmentally sensitive areas to be avoided will be identified in the Environmental Protection Plans, in advance of construction. All borrow pits will be sited at least 100 metres from active stream channels.

Topsoil which supports vegetation will be stockpiled for replacement after required borrow material has been excavated.

Temporary soil erosion and sedimentation control measures will be implemented at all times during the construction as dictated by local conditions. Erosion control measures will be consistent with Manitoba Transportation and Government Services "Manual of Erosion and Sedimentation Control" (Manitoba Government 2000) and "Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat". They could include:

- placing slash material on stockpiled topsoil and borrow pit slopes and bottom;
- placing commercially manufactured erosion control blankets on stockpiled topsoil or borrow pit slopes and bottoms;
- modifying slopes by flattening slopes to reduce velocities of surface water runoff; and
- diverting runoff to vegetated areas that will act to filter it en-route to adjacent natural watercourses.

Borrow pit sites would be rehabilitated in accordance with the Environmental Protection Plans. It is expected that after the road is constructed, between three and five of these borrow pit areas would be used to stockpile granular material for road maintenance.

On the southern half of the access road, it is estimated that the maximum amount of borrow material would be approximately 50,000 m^3 per kilometre. Each borrow pit would be approximately 12,000 to 15,000 m^3 in volume with an estimated 3 to 4 borrow pits (ranging from 1 to 3 metres in depth) required per kilometre.

In general, as much dry usable material as possible would be utilized from within the right-of-way corridor, with borrow material used to make up any shortage.

The northern half of the access road will be constructed with up to 50% of the amount of borrow material estimated for the south half of the road. It is expected that most of the material will be obtained within the road right-of-way ("side-casting"). However, if the Contractor encounters poor material or wet weather conditions, the use of borrow pits provides flexibility and economy in constructing the road. As a result, the exact amount of borrow in the north half of the road is difficult to estimate.

Construction of the roadway embankment in wetland areas will begin by placing a layer of geotextile material along the proposed alignment of the road. Clean granular fill ("pit-run") will then progressively end-dumped over the geotextile and pushed forward using a dozer. End dumping will continue until there is no longer any material settlement.

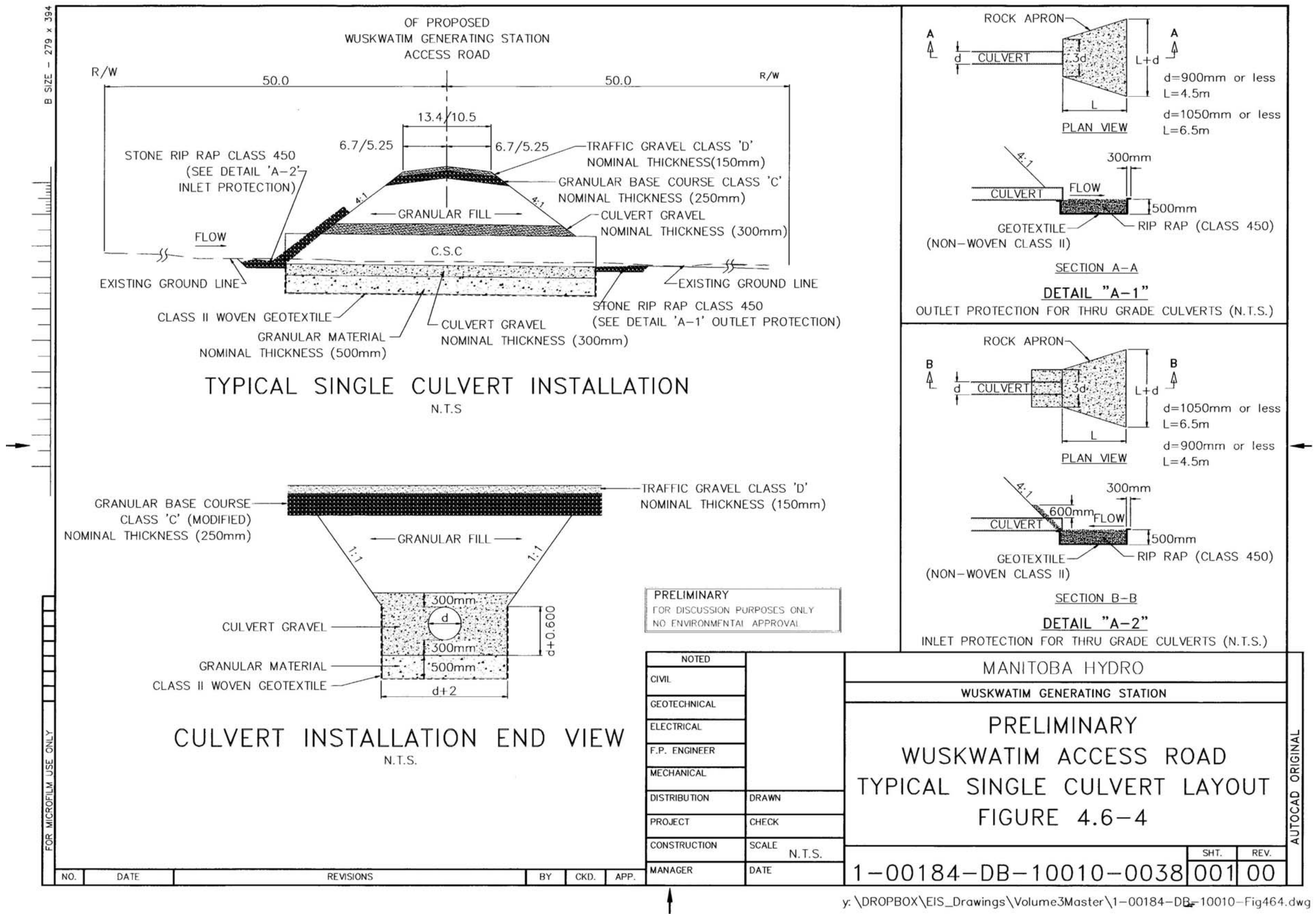
Blasting

The access road passes through three main rock outcrop areas. In the north half of the road, the rock outcrop area is located approximately 1.5 kilometers south of PR 391. At the south end of the road, the rock outcrops are located between 34 to 36 and at 40 kilometers south of PR 391 as shown in Figure 4.6-3.

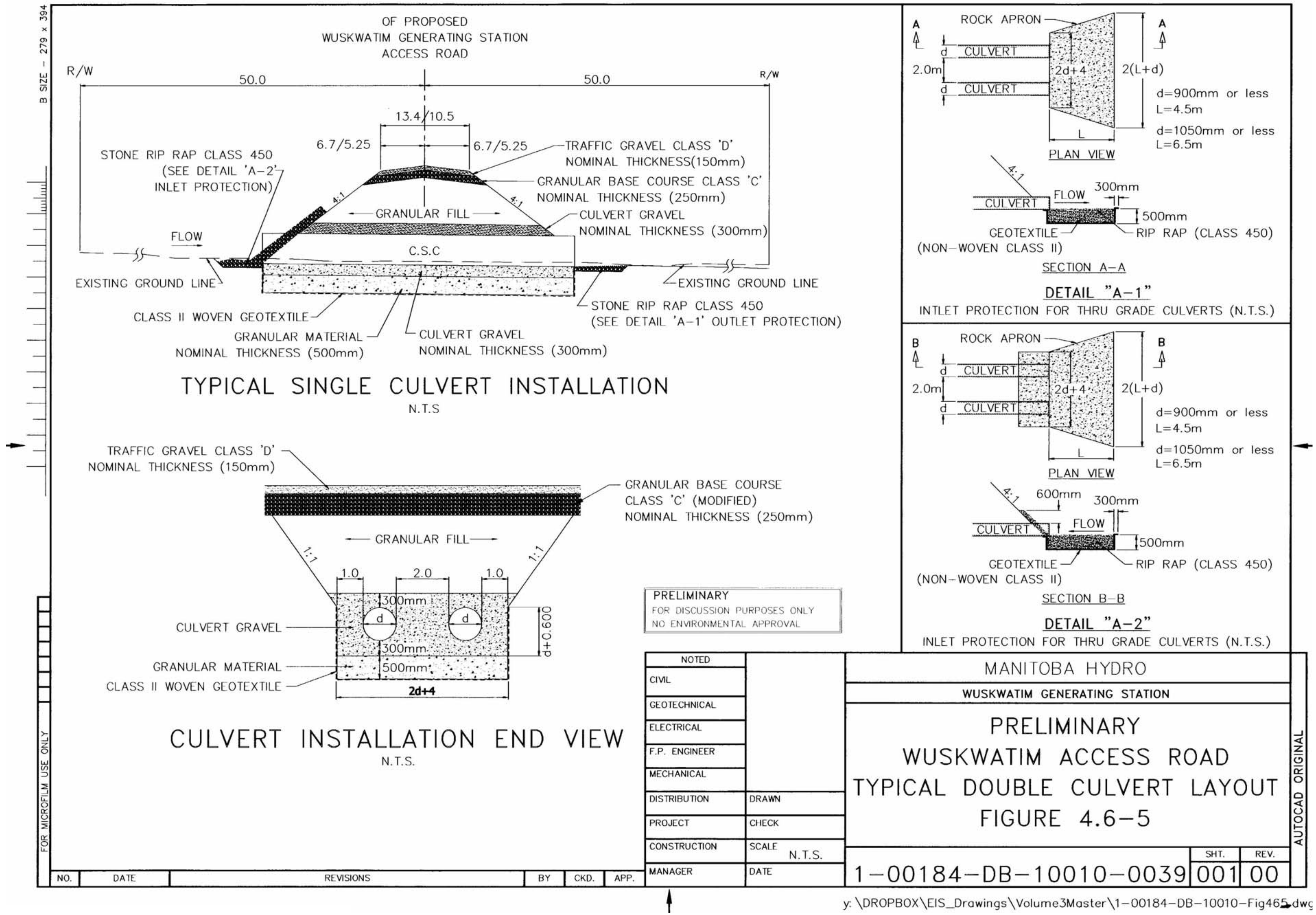
Approximately 46,000 m^3 of rock excavation will be required to construct the access road through these areas. Rock excavation will be done by drilling and controlled blasting. During blasting of the solid rock, blasting mats will be used to contain the force of the explosion and avoid damage. Rock excavation material will be crushed and used to construct the road embankment. The timing of the blasting activities will at the discretion of the contractor, but shall be in accordance with applicable provincial and federal regulations.

Stream Crossings

Culverts will be installed at stream crossings. The largest creek will need two culverts and the two culverts will be spaced two-metres apart. The diameter of the culverts will range from a minimum of 0.9 metres to a maximum of 1.8 metres. All stream-crossing embankments will be constructed with clean granular fill material. Construction of stream crossings will be scheduled to take place in the winter and early spring, before runoff. Construction procedures at stream crossings will minimize in-stream time and disturbance of the watercourse bed and banks. A minimum buffer zone of 10 metres will be left at stream crossings. Erosion protection measures are outlined in the construction drawings and specifications and are based on the "Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat". Details of the proposed stream crossings are shown in Figure 4.6-4 and 5.



4.6-4 Preliminary Wuskwatim Access Road Typical Single Culvert Layout



4.6-5 Preliminary Wuskwatim Access Road Typical Double Culvert Layout

Erosion Control

In general, erosion control measures are outlined in the construction drawings and specifications. These may include seeding of all exposed areas, stone rip-rap at culvert inverts and on steep ditch slopes, straw or coconut fibre erosion control blankets on grade and back-slopes constructed with soils of high erodibility and silt fence barriers to prevent sediment from entering natural watercourses. The grass mixture used to seed ditches will only contain native and/or non-invasive introduced grasses (i.e., will not contain sweet clover [*Melilotus offincianilis*] or other herbs).

Granular Requirements

Granular material for aggregate production will be required for the base course, road topping and culvert gravel. In addition to aggregate production, granular material will be required for granular fill to construct the embankment over stream crossings and through permafrost affected areas.

Granular deposits "G", "H" and "J" have been identified as potential sources to produce aggregate and retrieve granular fill material. Table 4.6-2 summarizes the estimated quantities in m^3 and probable locations for sourcing granular material requirements.

Table 4.6-2 Access Road Estimated Granular Requirement by Deposit Location

Material	Deposit "G"	Deposit "H"	Deposit "J"	Total (m^3)
Granular Base Course, Class "C"	205,000	0	0	205,000
Traffic Gravel, Class "A"	147,000	0	0	147,000
Culvert Gravel	10,000	0	0	10,000
Granular Fill (Stream Crossings)	105,000	0	105,000	210,000
Granular Fill (Permafrost)	130,000	0	0	130,000
Total (m^3)	597,000	0	105,000	702,000

Note: 1. Quantities for Granular Base Course "C", Traffic Gravel "A" and culvert gravel do not include by-product volumes. Add approximately 50% to the values shown above to determine volumes required for processing.
2. Granular Base Course conversion factor = 2.162 t/m^3
3. Traffic gravel conversion factor = 2.00 t/m^3
4. Each deposit volume is based on the shortest haul distance
5. All aggregate processing is assumed at Deposit "G"
6. Add an additional 100,000m^3 of granular fill if the winter road "limited all-weather" access is required

Other possible granular sources could be the existing gravel pit at Mile 20 (NW,SW,SE ¼ Sec. TWP. 80 RGE 6WPM), located on PR 391, approximately 4 kilometres west of the proposed access road intersection and a proposed rock quarry approximately 300m northeast of the Manitoba Hydro work area. At this time it is not certain if these other sources will be used, however, it remains an option to provide flexibility to the Contractor.

Permafrost

A geotechnical assessment of the access road has revealed select ice rich zones and sporadic permafrost regions, approximately 17 kilometres south of PR 391. To address this issue, an embankment will be constructed using granular fill material placed directly on top of the unstripped peat over a continuous 2.5 kilometre stretch. To mitigate the anticipated subsidence (settlement) of this section of the road, additional granular fill will be placed as required during construction.

Equipment

Equipment to construct a road typically includes rubber tired earth moving scrapers, crawler tractors, hydraulic excavators, dump trucks, compaction equipment, motor graders, rubber-tired loaders and water tank trucks. Granular processing operations will require a gravel crusher, screeners and conveyers.

Start up Camp

A temporary 200-person camp will be required for the road construction workers. This self-contained camp will likely be established near Deposit "G" and will comply with provincial regulations and conditions for "temporary campsites".

Schedule

To maintain the 2009 Wuskwatim GS in-service date, the schedule is extremely tight and following receipt of an environmental license, construction of the access road would commence in early January 2004. A "limited all-weather" access road, which is required to transport supplies to camp, will be completed by November 2004. Final completion of the access road is anticipated by September 2005.

Clearing for the construction of the access road is scheduled to begin soon after the receipt of the environmental license, as described in Section 4.4.1. At the same time, the existing Mile 20 winter trail will be re-established for the northernmost 5 km. This will provide immediate interim winter access to the Mile 17 centreline, and to the stream crossings and camp at the Project site. Stream crossings will be constructed between January 2004 and April 2004. Excavation and grading of the roadway embankment will commence by February 2004 and continue until August 2005. The road surfacing (crushing and depositing) is scheduled to begin in May 2004 and continue until August 2005. Crushing for culvert gravel will commence by late January 2004. The proposed schedule for the construction of the access road is shown in Figure 4.6-6.

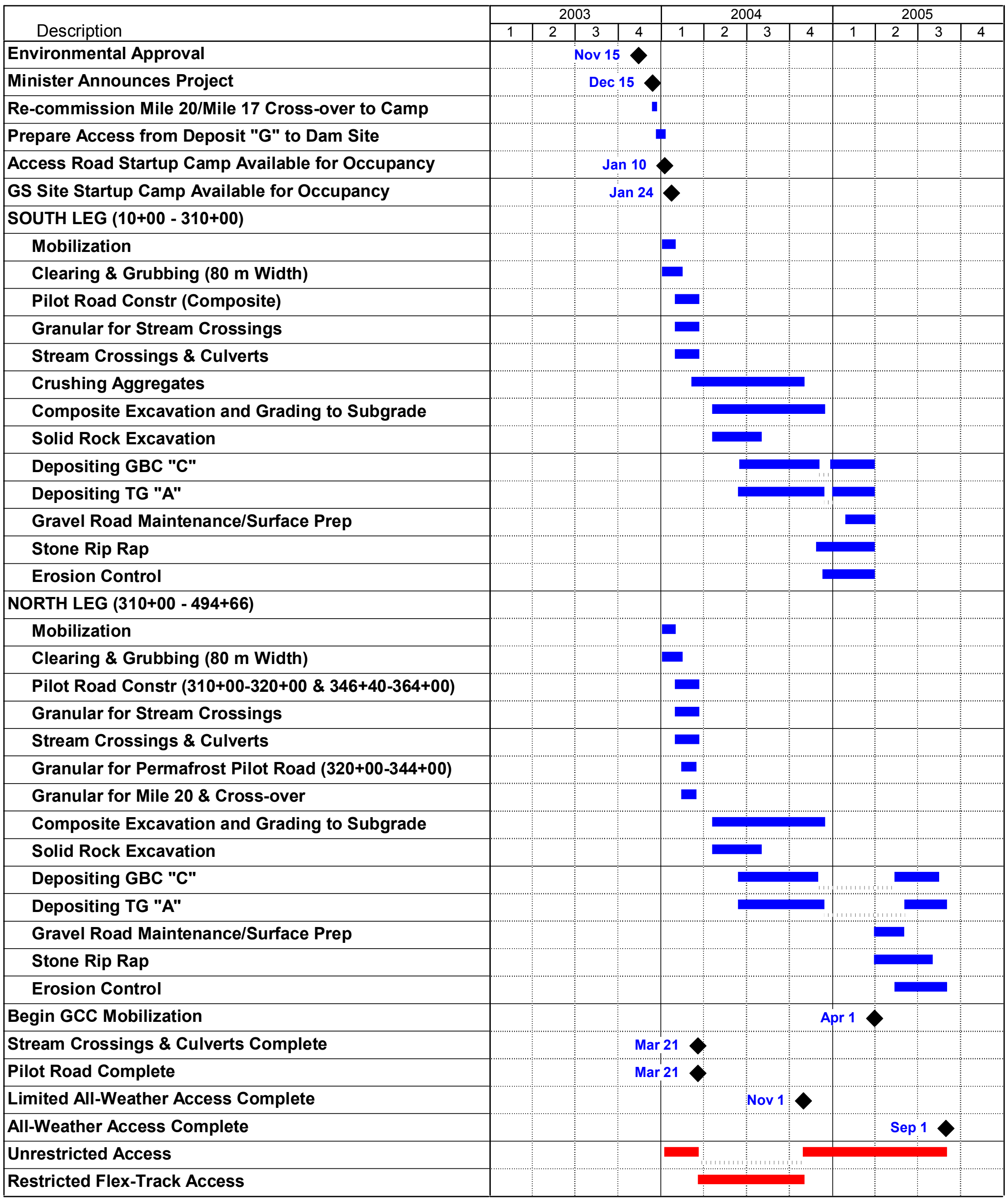


Figure 4.6-6 Access Road Construction Schedule

Access Control

It is expected that the Wuskwatim Project access road will be a private road possibly owned by the proposed NCN/Manitoba Hydro partnership. During the construction phase of the generating station and associated infrastructure, the access road will be closed to the general public for safety reasons. A 24-hour supervised security gate located near the intersection of PR 391 will control access to the road. The gate will be located at least 30 metres south of PR 391 to allow large trucks to pull off the highway and be clear of the intersection.

This area will also have a small security office or "gatehouse" which will contain a potable water supply and public washroom with holding tank. Other features include radio communications, electric heat, overhead exterior lighting, parking stalls and a turnout lane for large trucks. Electricity will be conveyed to the gatehouse by pole line by tapping into the existing WL-43 Transmission line located approximately 1.5 kilometres to the south.

There will be a bus stop/rest area with a small shelter located near the gatehouse. A shuttle van service will be established to transfer workers and mail to and from the main camp during the construction of the generating station. This service will be coordinated with the current Grey Goose bus service operating between Thompson and Lynn Lake.

4.6.3.4 Operation During Construction

During construction, special access arrangements for NCN resource users will be addressed through the NCN/Manitoba Hydro partnership and the Access Management Plan. This portion of the Access Management Plan (Appendix 3) will be prepared jointly by NCN and Manitoba Hydro before the construction of the generating station begins.

A review was conducted of the construction related ground transportation activities for the Wuskwatim Project (ND Lea 2000). Estimates of the potential distribution of traffic volume and vehicle classification using the access road are summarized in Table 4.6-3.

Traffic on the access road during construction of the generating station will typically be composed of workers, construction material deliveries, food, mail, office related deliveries, specialized maintenance vehicles and gravel trucks hauling granular material from deposits "G", "H" or "J" to the Project site. It is estimated that during the core construction period, there will be between 130 to 160 vehicles per day. Trucks will make up 40 to 50 percent of this volume

Table 4.6-3 Access Road - Forecasted Daily Traffic volume by Vehicle Classification						
Traffic	Project Start-up		Core Construction		Project Wrap-up	
	Winter	Summer	Winter	Summer	Winter	Summer
Large Trucks/Day	0	5	15	25	10	15
Gravel Trucks/Day	0	10-20	0	30-60	0	10-20
Passenger Vehicles/Day	0	40	35	75	30	35
Total Vehicles/day	0	55-65	50	130-160	40	60-70

It is estimated that Provincial Trunk Highway 6 (PTH 6) will experience between 5 and 20 additional trucks/day between Winnipeg and Thompson, depending on the time-of-day and season. There is sufficient capacity for the additional traffic on PTH 6 since, as a primary arterial, it is designed to accommodate up to 6,000 vehicles per day. In year 2000, the average annual traffic volume on the entire length of PTH 6 varied from 400 to 2,300 vehicles per day. During the summer months, that average increased to between 480 and 2,600 vehicles per day.

It is forecasted that during Project construction the traffic volumes on PR 391 between Thompson and the access road intersection will increase by between 30 to 75 vehicles per day. The peak volume of traffic is expected during the summer months of core generating station construction. In the summer of 2000, the average traffic volume on PR 391 ranged from 525 to 935 vehicles per day. In 2004, it is predicted that the average traffic volume will increase to between 580 and 1035 vehicles per day. This is well below the design volume of up to 6,000 vehicles per day for a secondary arterial.

The report concludes that based on forecasted volumes, traffic accidents on PR 391 are not expected to increase significantly with the addition of Wuskwatim Project construction related traffic. There are no modifications warranted to PR 391 at the Wuskwatim Project access road intersection, however the approach from the access road to PR 391 will be widened to safely accommodate the largest truck expected.

Wuskwatim Project construction traffic travelling through Thompson will have little effect on the overall traffic volumes at Thompson's four signalized intersections and any increase in volume is within the normal fluctuations of day-to-day traffic.

Maintenance

Surface grading, dust control, permafrost maintenance, and snow clearing measures will be implemented along the road route, as required. Dust control procedures will utilize conventionally acceptable methods and materials, which are currently utilized by Manitoba Transportation and Government Services on public roads.

4.6.4 Main Construction Camp

A temporary construction camp will be required at the Wuskwatim GS site to accommodate up to 625-person, single status, construction work force, as well as to provide other construction support facilities. The proposed location of the camp and its detailed layout have been shown previously in Figures 2.4-2 and 4.6-7. Separate accommodations will be provided for female residents.

The facilities at the Wuskwatim camp will be manufactured to meet the latest codes and standards. In addition to the living quarters, the camp facilities will include the following: a kitchen/diner complex; a chapel; a recreation complex including a gymnasium; a beverage hall/café; a garage and fire truck for the volunteer fire department; a first aid building and ambulance; an uncontrolled helicopter landing area; a communications system; a commissary; and recreation fields for baseball and soccer. The construction schedule for the construction camp is shown in Figure 4.6-8.

Camp residents will be subject to rules and regulations. Smoking will be allowed in designated areas.

At this time there are no plans to provide boat/watercraft access for recreation during the Project. Provision has been made for occasional boat access to Wuskwatim Lake for non-recreational purposes such as research, law enforcement or safety. Special arrangements will also be made for boat access to Wuskwatim Lake for NCN commercial fisherman. These details will be addressed by Manitoba Hydro and NCN, in consultation with the Nelson House Resource Management Board prior to construction.

Manitoba Hydro and NCN are presently discussing the potential to allow recreational fishing in designated areas.

For safety reasons, no snowmobiles or all-terrain vehicles will be allowed on the Project site or on the access road ROW without prior approval. Signage displaying "No Trespassing – Private Property" and "No firearms/hunting" will be posted at key access points to the road ROW i.e. transmission lines corridors, security gatehouse. Special access arrangements will be made for NCN resource users.

Recreational activities must comply with applicable provincial and federal regulations.

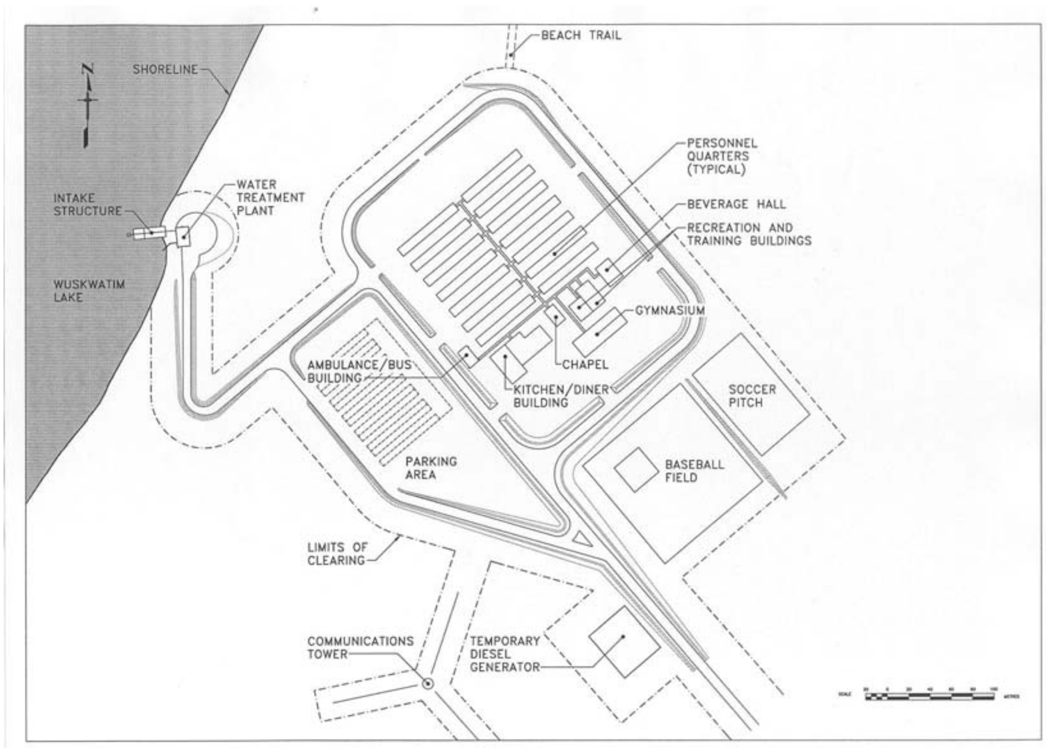


Figure 4.6-7 Construction Camp – Detailed Layout

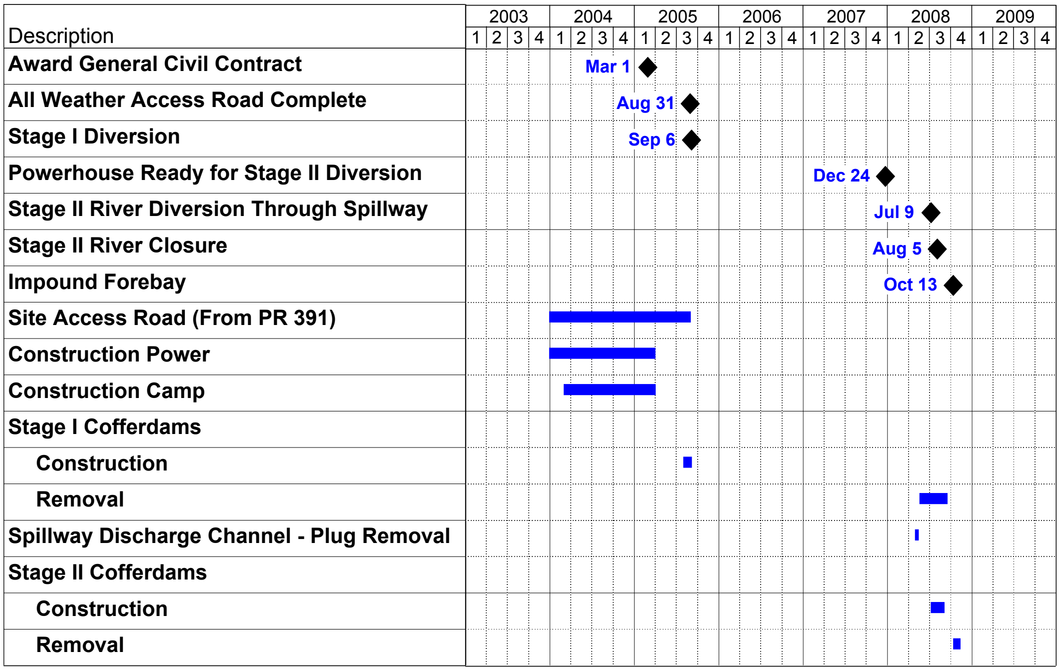


Figure 4.6-8 Construction Camp – Construction Schedule

4.6.4.1 Water Treatment and Distribution

The potable water system will be designed and constructed in accordance with all current standards and requirements. The potable water system will be constructed as part of the main camp work that will be undertaken between March 2004 and April 2005.

Potable water supply for the camp and work areas will be taken from Wuskwatim Lake at an intake located to the west of the camp area (Figure 4.6-7) and will be pumped to a treatment plant facility located south west of the camp. The raw water pumphouse will be located onshore near the Lake. The intake line will be buried on shore and run into the lake, with a riprapped, bermed area created in areas of wave action. The intake screen will be designed in accordance with the Department of Fisheries and Oceans Freshwater Intake End-of Pipe Fish Screen Guideline (i.e. approach velocity of 0.038 m/s). It is unknown whether the raw water intake pipe and screen will be installed in the summer or winter. Installation works will not be completed during the typical fish spawning period. The pipe will be sunk from a barge in the summer or from the ice in the winter. A diver will finalize the placement of the pipe on the lake bottom and install the intake screen. The 150 mm diameter intake pipe will extend approximately 115 m into the lake from shore. The estimated minimum water depth above the intake screen is approximately 5 m. Water will flow under vacuum (pump suction) from the intake to raw water centrifugal pumps. The water will then be pumped to the water treatment plant (WTP) via a buried raw water force main.

Water storage at the WTP will be in the form of an in-ground reinforced concrete chamber that will form the foundation of the water treatment plant building. The WTP building will house the water treatment equipment, chlorination equipment, etc. Total water storage will be approximately 630,000 litres (including 340,000 Litres for fire water storage). A distribution pump system consisting of three electric pumps and a fire pump system consisting of a diesel and an electric pump will be tied to a common distribution header. The WTP will contain an area for storage of chemicals used for treatment.

The WTP will be a tube settling packaged plant containing flocculation, coagulation, sedimentation, filtration and chlorination. The rated plant capacity is 378 L/min and the total retention time is 120 minutes. The configuration was selected based on the quality and temperature of the water to be treated, as well as water quality in the area.

The waste water (sludge and backwash) from the water treatment unit will be temporarily stored in a separate equalization chamber of the concrete reservoir and slowly released (by pumping) to the sewage collection system.

Based on an average consumption of 265 L/person/day, the camp requirements will be approximately 159,000 L/day. Adding an estimated 5,000L/day each for the Manitoba Hydro's and Contractor's work areas, the total daily consumption of treated water is estimated at 169,000 L/day. Water will be treated to a turbidity less than 0.3 NTU (Nephelometric Turbidity Unit), color less than 15 TCU (True Color Units) and THM's (Trihalomethanes) less than 80 ppb. All water used will be monitored by flow meters. Chlorination levels will be maintained between 0.4 - 0.6 mg/L free. The operator will have testing equipment to monitor chlorine and turbidity levels onsite.

Water lines will most likely be buried in a trench using a backhoe. The system is primarily bare pipe, but will use a recirculation system and heating at the WTP to prevent freezing. Service connections shall be buried and heat traced and insulated. The modular facilities in the camp will likely be serviced by the building supplier with a utilidor system.

Water for fire fighting will be drawn from the same source as the potable water supply and will be pumped through the same system. The camp and work area buildings will contain fire detection sensors, which will be continuously monitored by the site security forces.

The water system will be monitored and tested in accordance with government regulations.

4.6.4.2 Sewage Collection and Treatment

The sewage treatment facility (lagoon) was designed based on 625 person summer capacity (196.6 m^3/day) and 312 person winter capacity (105.6 m^3/day), creating a total annual hydraulic load of 55,160 m^3 (which includes per capita consumption, allowances for Manitoba Hydro and Contractor consumption at the construction site, backwash waste from the water treatment plant and sewer main infiltration).

Sewage will be conveyed by gravity to a main sewage lift station where it will be pumped via force main to the lagoon, which is to be constructed and lined from locally available clays. Sewage will be treated by a two-cell sewage lagoon (105 m x 105 m primary cell and 100 m x 200 m secondary cell), designed with a BOD5 (5 day Biochemical Oxygen Demand) loading rate of 77 grams BOD5/person/day. The lagoon will be operated in accordance with provincial regulations.

Final discharge will be through a gravity outfall ditch into the Burntwood River. Discharge will occur twice per year, once in the Spring (June) and once in the Fall (October). The lagoon will be fenced off, with a gate to be located on the access road approaching the sewage treatment facility.

4.6.4.3 Waste Collection and Disposal

During construction, both hazardous and non-hazardous wastes will be generated. Wastes will be managed, collected and disposed of in accordance with current provincial and/or federal regulations. Management procedures for specific hazardous materials are detailed in the Hazardous Material Management Handbook (Manitoba Hydro 2003). The Environmental Protection Plans will contain general guidelines for non-hazardous and hazardous waste management.

The following is a summary of Possible Wastes Generated during the Construction Phase of Wuskwatim GS:

Hazardous Wastes

- Aerosol Containers
- Antifreeze
- Batteries-Dry Cell, Wet Cell and Rechargeable
- Chemical Containers
- Surplus Chemicals
- Compressed Gas Cylinders
- Oil and Fuel Filters
- Fire Extinguishers
- Grease
- Light/lamp bulbs
- Oils
- Paint
- Solvents: halogenated/non-halogenated
- Tires

Other Waste Streams

- Aluminum Cans
- Cardboard
- Electronics
- Paper
- Packaging Materials
- Plastics
- Glass
- Building Materials
- Scrap Metals
- Street Light Heads
- Toner containers & Printer cartridges
- Wood Pallets
- Wood
- Surplus Equipment
- Cleaners

Opportunities to reduce, reuse, and recycle the wastes will be taken whenever possible. Wastes will be stored in designated areas (transfer station) and disposed of regularly to reduce potential for unsafe conditions and negative impacts. Non-hazardous waste would be diverted from landfills when possible for reuse and recycling.

It is likely that scrap wood and paper products will be disposed of by burning in a designated area at the construction site, under a permit from Manitoba Conservation. Other waste will be disposed of either by creating a new permanent waste disposal site or by haulage from a transfer station to an existing permitted waste disposal site in Thompson. The preferred option will be selected after discussion with the City of Thompson, Manitoba Conservation and in consultation with the Nelson House Resource Management Board prior to construction.

Food refuse which is not disposed of through the kitchen garberators and sewage system, as well as those other wastes destined for the waste disposal site, will be stored temporarily in approved containers maintained in a secure location to prevent intrusion by wildlife. The requirements for storage and haulage may be minimized through the use of garbage compactors.

4.6.5 Manitoba Hydro Work Area

The principal work areas for Manitoba Hydro and the contractors involved in the construction of Wuskwatim GS are shown in Figures 4.6-9 and 4.6-10, respectively. It is also anticipated that there will be small storage and field office facilities located directly at the site of the various work locations.

The Manitoba Hydro Work Area will contain an engineering office, a warehouse storage building and yard, a fuel storage and vehicle refueling facility, field offices, a soils and concrete laboratory, and maintenance building. A helicopter landing area will be located close to the access road near the site's main security gate and immediately opposite the Manitoba Hydro Work Area. The landing area will be available for all emergency medical evacuations and all authorized traffic as required. Work Area water and sewer services will be tied into the camp water and sewer systems.

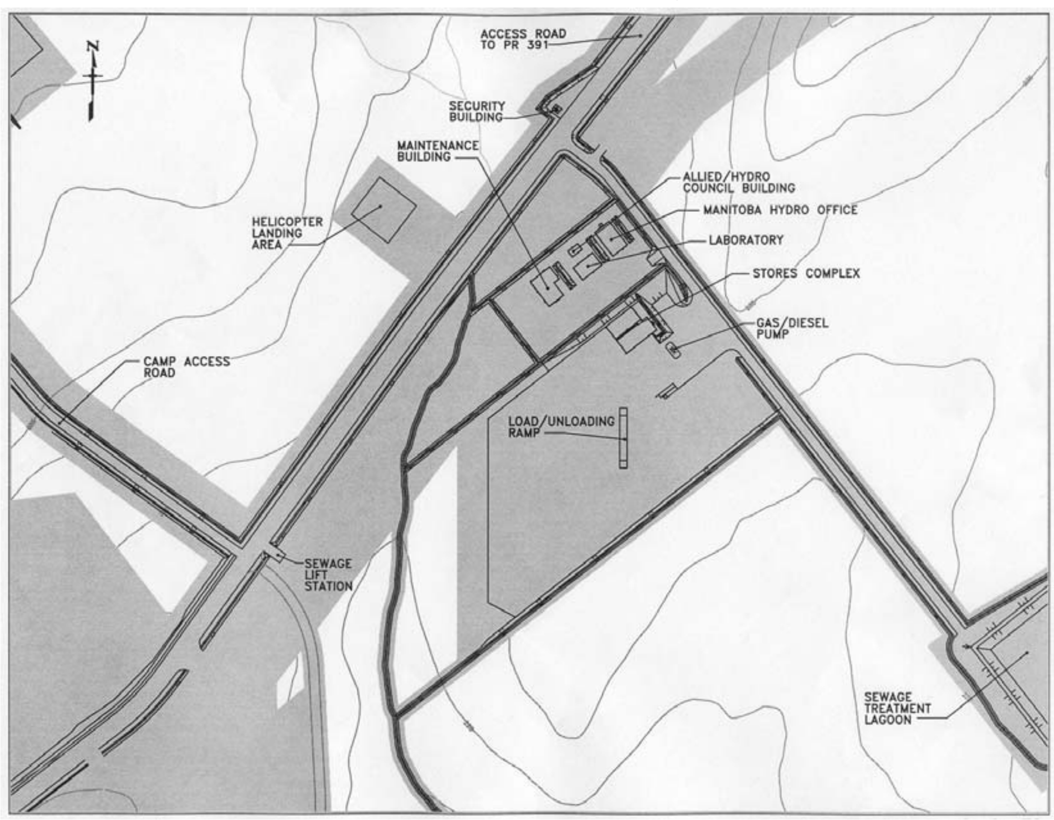


Figure 4.6-9 Manitoba Hydro Work Area

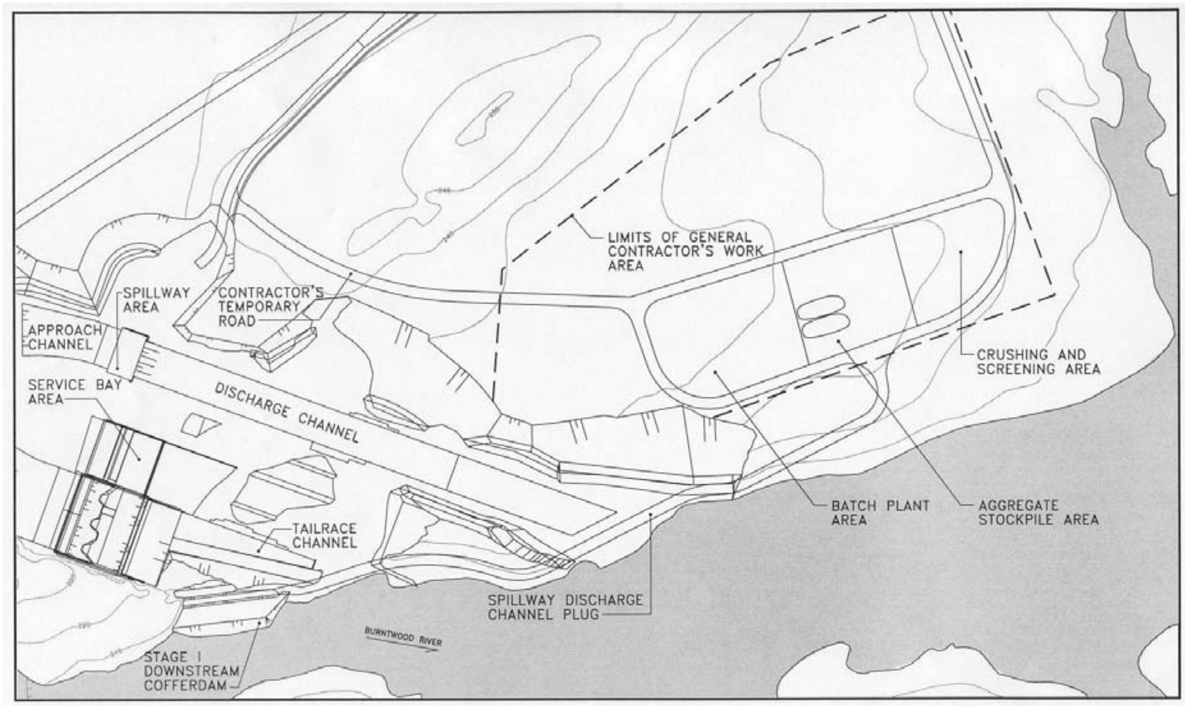


Figure 4.6-10 Contractors' Work Areas

4.6.6 Contractors' Work Areas

The Contractors' Work Area will generally contain relocatable modular buildings, storage facilities, maintenance shops, a fuel storage and vehicle refuelling facility, toilet facilities, a concrete batch plant, an aggregate processing area, a carpenters' shop, and a precast concrete yard. In addition, a magazine for storing explosives will be located away from the work and camp areas, in accordance with provincial blasting regulations. Its location, however, will be subject to all applicable legislation and regulation, as well as to the approval of Manitoba Hydro. Explosives will be required at the site only as needed to undertake the excavation of rock.

For the construction of Primary structures, the contractor will provide temporary portable toilet facilities with holding tanks. The waste will be regularly pumped out and taken to the sewage lagoon.

The Environmental Protection Plans will identify special precautions to be taken within the Work Areas in addition to the drainage management requirements described in Section 4.4.2. Provincial and federal regulations, guidelines and special conditions related to the storage of fuels, explosives, etc, and the handling and storage of other hazardous or dangerous goods will be strictly enforced.

The design and development of the construction access routes, water crossings, drainage, erosion control and sediment control methods will be developed by the contractor. All site drainage, erosion and sedimentation management will be in accordance with the Environmental Protection Plans and applicable provincial and federal regulations and guidelines.

4.6.6.1 Concrete Batch Plant

The construction of the generating station will require the manufacture and placement of approximately 118,000 m^3 of concrete as shown in the Summary Construction Schedule Figure 4.2-1. The concrete will be manufactured in a concrete batch plant. The contractor will be responsible for determining the layout and installation of the concrete production facilities. A typical batch plant is shown in Figure 4.6-11 and will be located in the contractor's work area as shown in Figure 4.6-10. The batch plant will be used to mix water, cement, aggregates and additives to produce concrete. Water for the operation will be obtained from the Burntwood River near the batch plant via small pumphouse complete with appropriate screens. It is difficult to determine the amount of water withdrawn from the river, since this will depend upon the specific equipment selected by the contractor. However, the amount of water used will be insignificant relative to the flow in the river. The cement will be delivered to site by truck throughout the duration of the Project and may be stored temporarily in silos located adjacent to the batch plant. The aggregates required for use in the concrete will be produced from local rock and gravel sources, as discussed in Section 4.5.

Figure 4.6-11 Typical Concrete Batch Plant and Cement Storage Silos

4.6.6.2 Aggregate Processing (Crushing, Screening, Washing, Stockpiling)

The production of aggregates for the concrete will involve the crushing, screening, washing and stockpiling of bedrock obtained from the Project's required excavations, as well as granular material obtained from one of the granular deposits. Typical crushing and stockpiling operations utilize a number of crushers and conveyor belt systems, similar to those pictured in Figure 4.6-12. In order to permit the production of concrete during the winter months, a heating system may be employed to maintain the concrete aggregate in an unfrozen state and at suitable temperatures. No heated water will be discharged directly into the river.

Wash water for the concrete aggregate and batch plant mixers will go into an adequately sized, two-cell settling pond. The larger particles will settle out in the primary cell and the finer ones in the secondary. The clarified effluent may be discharged into the river. The discharge will not be continuous. If effluent is discharged into the river, it will be in accordance with provincial and federal regulations and the Environmental Protection Plans.

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Figure 4.6-12 Typical Rock Crusher Operation

4.6.7 Service Roads

All-weather gravel service and haul roads will be developed to provide access for construction equipment between the construction areas, the borrow areas, and the Excavated Materials Placement Area. The precise layout and extent of these haul roads, other than the main access road, is unknown at this time and will be subject to the construction methodology developed by the Contractor. Particular care will be taken in areas of permafrost to prevent thawing. These will include preservation of organic cover, use of corduroy timber or placement of additional gravel. Service roads not required for operation will be closed and rehabilitated in accordance to the Environmental Protection Plans.

4.6.8 Stage I and II Cofferdams

4.6.8.1 General

In preparation for construction of the Generating Station's Primary Structures (Section 4.7), the river must be carefully managed to create a dry, safe working area. River management for this Project is divided into two stages: Stage I and Stage II Diversions. Each stage requires the construction of cofferdams across portions of the river.

A cofferdam is a temporary structure that is built to isolate and protect a construction area from flooding during the period of construction. The cofferdams that will be required at Wuskwatim GS will be constructed from a specific combination of rockfill, clay and granular materials. These structures will be constructed by progressively dumping rockfill or gravel from the shore along the alignment of the cofferdam, as shown in Figures 4.6- 13, 14 & 15. This is generally followed by the placement of granular filters and an impervious seal as shown in Figure 4.6-16. The latter materials are placed by dumping on the surface of the cofferdam, followed by forcing large un-consolidated masses of the materials to slip below the water, by exerting a downward force from the blade of a large dozer tractor.

Figure 4.6-13 Typical Rock Fill being end dumped to close a cofferdam across a river.

Figure 4.6-14 Typical cofferdam being pushed into the river channel.

Figure 4.6-15 Typical cofferdam advanced into the river channel

Figure 4.6-16 Typical Placement of sand filter on upstream face

After completion of the cofferdam's construction, the enclosed area will be dewatered by pumping the trapped water back into the flowing river and will be maintained in that condition, thereby allowing construction of the permanent works to proceed within the previously inundated areas. The enclosed area will provide opportunity for any suspended sediment to settle prior to completion of the dewatering activities. In the case of the Wuskwatim Project, excavation and construction of the permanent concrete structures can start in advance of the completion of the cofferdams and the dewatering of the area. Since much of the construction area for the concrete structures is located on the north bank of the river, only the approach and exit channels from the structures require excavation within areas that are presently under water.

In the discussions that follow, reference will be made to five different cofferdams:

- Stage Ia Upstream Cofferdam;
- Stage I Upstream Cofferdam;
- Stage I Downstream Cofferdam;
- Stage II Upstream Cofferdam; and
- Stage II Downstream Cofferdam.

4.6.8.2 Diversion Sequences

The above noted cofferdams play a key role in the Project's construction, by temporarily diverting the river's flow around or through the construction site during the construction period. Figure 4.6-17 illustrates the arrangement of the cofferdams during the two diversion phases of the Project, except for the relatively small Stage Ia Upstream Cofferdam, which becomes redundant once the Stage I Upstream Cofferdam is built.

The Stage I Cofferdams permit the construction of the Intake/Powerhouse complex and the Spillway to be undertaken in the dry. Once these structures are substantially completed, the Stage I Upstream Cofferdam and the Spillway Discharge Channel Plug (an unexcavated portion of bedrock and overburden) will be removed and the river will be partially diverted through the Spillway and its associated channels. The removal of the required portions of the structures will involve removal of as much of the fill as possible in-the-dry, followed by removal in-the-wet by equipment such as a backhoe and/or a dragline, as shown in Figures 4.6- 18 &19. The diversion will then be completed by constructing the Stage II Upstream Cofferdam across the location presently occupied by Taskinigup Falls. Construction of this cofferdam will dry up the area presently occupied by the falls, and thus permit the Main Dam to be constructed.

The arrangement of the Wuskwatim GS (Figure 4.6-17) as well as the management of the river during the construction take advantage of the natural configuration of the Taskinigup Falls. Key to these aspects is the existence of a narrow "chute" to the east of the main falls and a large island approximately at the centre of the falls.

The construction of the Stage I Cofferdams will allow the following structures and channels to be built in the dry:

- South Transition and Walls A and D;
- Intake/Powerhouse Complex, including the Service Bay;
- Non-Overflow Dam.

- Spillway.
- Walls B, C, F and G.
- North Dyke
- Intake Channel and the upstream section of the Tailrace Channel
- Spillway Approach and Discharge Channels.

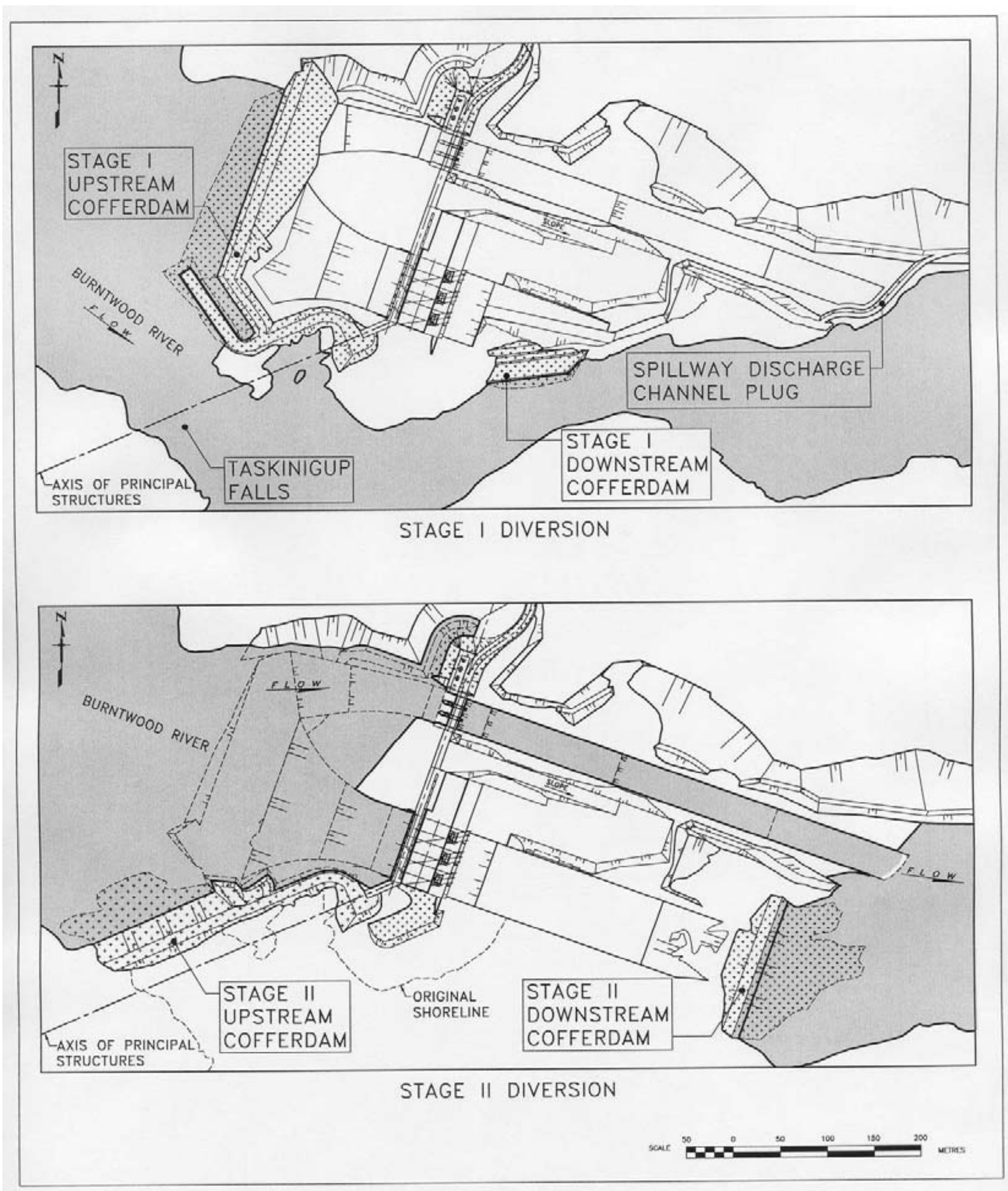

Figure 4.6-17 Stage I and II Diversion Layouts

During the course of the Stage I Diversion period, the north-eastern portion of the Stage II Upstream Cofferdam will be prebuilt, in the dry, up to the central island, together with an initial portion of the Main Dam, in the area located immediately adjacent to the South Transition Structure. Combined, this will serve to close off the Stage II Upstream Cofferdam to the concrete South Transition structure of the Powerhouse, as shown in Figure 4.6-17.

Stage II Diversion will require the removal of almost all of the Stage I Upstream Cofferdam, i.e., that portion above el 224.0 m, and the entire Spillway Discharge Channel plug. This will be followed by the construction of the Stage II Upstream Cofferdam from the central island, above Taskinigup Falls, to the south shore. This action will divert the Burntwood River's flow through the open Spillway and into the Discharge Channel. For this to be possible, the Intake portion of the Powerhouse complex needs to be completed to the extent that the Intake service gates, bulkhead gates and trashracks are installed and commissioned.

Figure 4.6-18 Typical cofferdam removal with backhoe

Figure 4.6-19 Typical cofferdam removal with backhoe

The precise timing for the initiation of Stage II Diversion within the summer construction season is not particularly critical from a construction perspective, given that the flow into the Wuskwatim Lake basin is governed, in the main, by the Notigi Control Structure.

The schedule for the construction of the cofferdams is summarized in Figure 4.6-20.

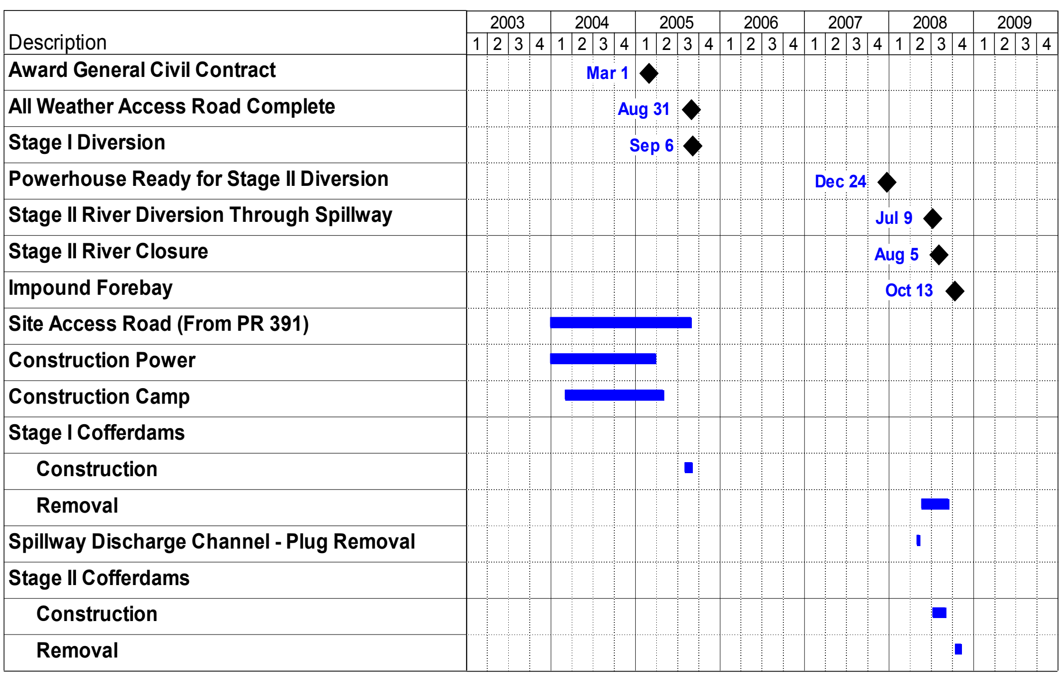

Figure 4.6-20 Construction Schedule for cofferdams

4.6.8.3 Stage I Cofferdams

As shown in Figure 4.6-21, the start of work on Stage I Cofferdams involves the construction of the Stage Ia Upstream Cofferdam at the head of the chute which separates the main island from the North Abutment. This small cofferdam will permit the start of the excavations for the primary concrete structures to commence in an area where the bedrock surface is close to the ground surface. The bedrock which is obtained from the excavations, along with the impervious overburden layer, will provide the majority of the materials required to construct the Stage I Upstream Cofferdam.

The Stage I Upstream Cofferdam will be constructed between the north abutment, above Taskinigup Falls, and the central island. This cofferdam, on an approximate north-south axis, will close off the entrance areas to the Powerhouse, Intake and Spillway Approach Channels and will provide the principal protection for the channel excavation works and permit significant work to proceed on the Powerhouse and Spillway excavations. In order to reduce the potential for erosion of the cofferdam's fill during construction, a rockfill deflector groin will be constructed adjacent to the main flow channel at Taskinigup Falls, as shown in sequence steps 2 and 3 of Figure 4.6-22. This deflector groin will create a tranquil water area within the bay where the Stage I Cofferdam is to be constructed. Once the deflector groin is in place, the balance of the Stage I Upstream Cofferdam will be constructed as shown in sequence steps 4 through 6. The Stage I Upstream Cofferdam will consist of a dumped rockfill groin faced with dumped granular transition and impervious zones, as shown in Figure 4.6-23. Over most of the length of the cofferdam crest, the upstream slope of the impervious zone will be protected against erosion from wave action by means of a layer of riprap. Closer to the main falls, however, where flows accelerate past the central island, and space will be limited, the impervious zone will be contained and protected by the short upstream deflector groin of dumped rockfill, which will be placed along an axis parallel to the direction of the water flow.

Early access to the Powerhouse excavation and the Tailrace area, as well as to the Spillway's Discharge Channel, will be provided by the construction of the Stage I Downstream Cofferdam, as illustrated in Figure 4.6-23 and by sequence step 7 in Figure 4.6-22, as well as by the maintenance of a temporary plug (an unexcavated portion of bedrock and overburden, as shown in Figure 4.6-23 located immediately to the downstream of the Powerhouse and Spillway).

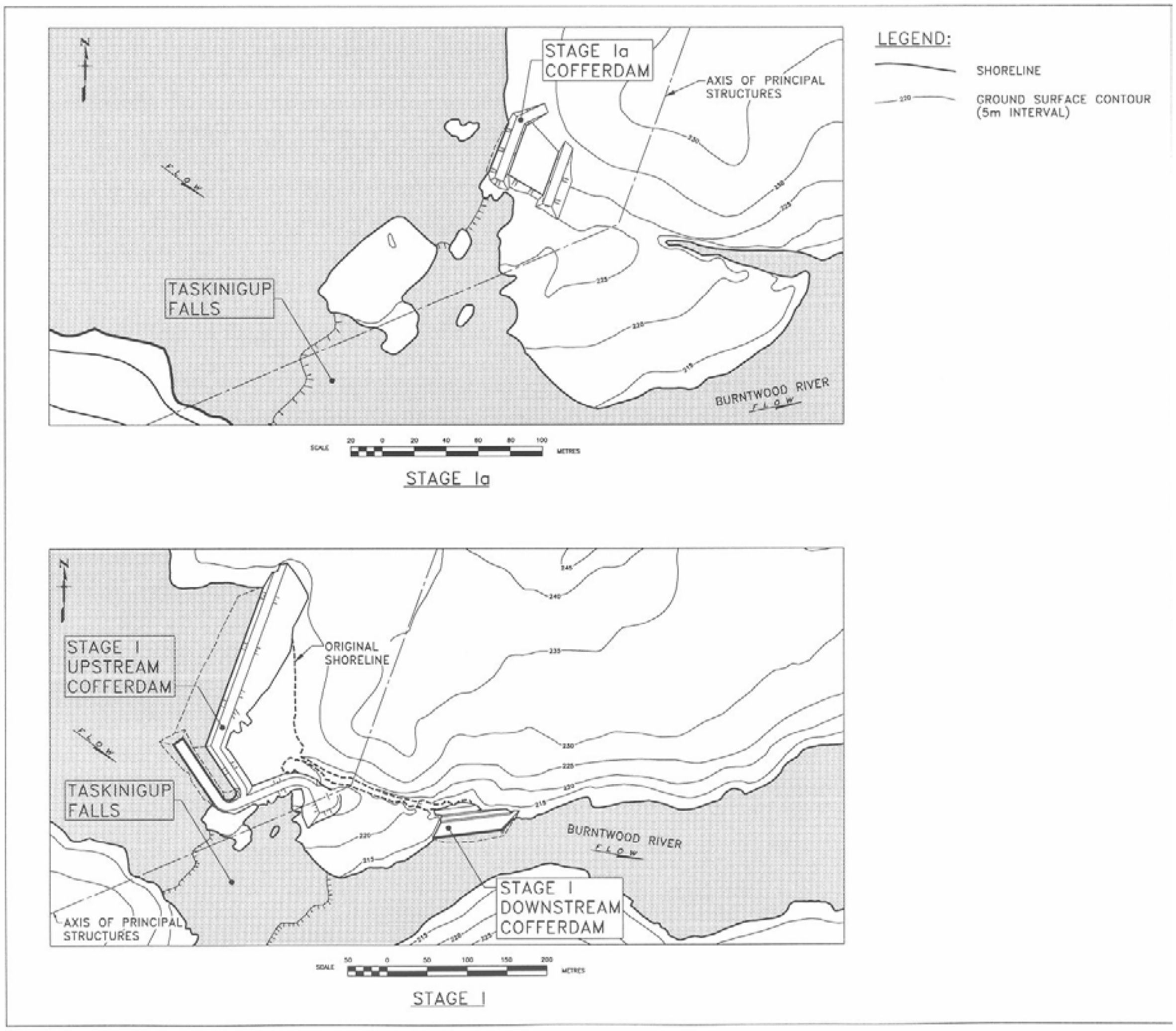

Figure 4.6-21 Stage I Cofferdams – Plan Views

Both the Stage Ia Upstream Cofferdam, at the head of the chute, and the Stage I Downstream Cofferdam (Figure 4.6-23, as well as the portion of the Stage I Upstream Cofferdam located closest to Taskinigup Falls, will be double rockfill groin sections, with the impervious fill located between, to confine and protect the impervious zone from cross flow erosion. The Stage Ia Upstream Cofferdam becomes redundant subsequent to the completion of the Stage I Upstream Cofferdam, and will be removed, in-the-dry, during the excavation of the Intake Channel.

The upstream and downstream cofferdams, as well as the Spillway Channel plug, will be constructed to ensure that their crest elevations are compatible with the 1:20 year return period construction design flood, plus an allowance of 1-m freeboard.

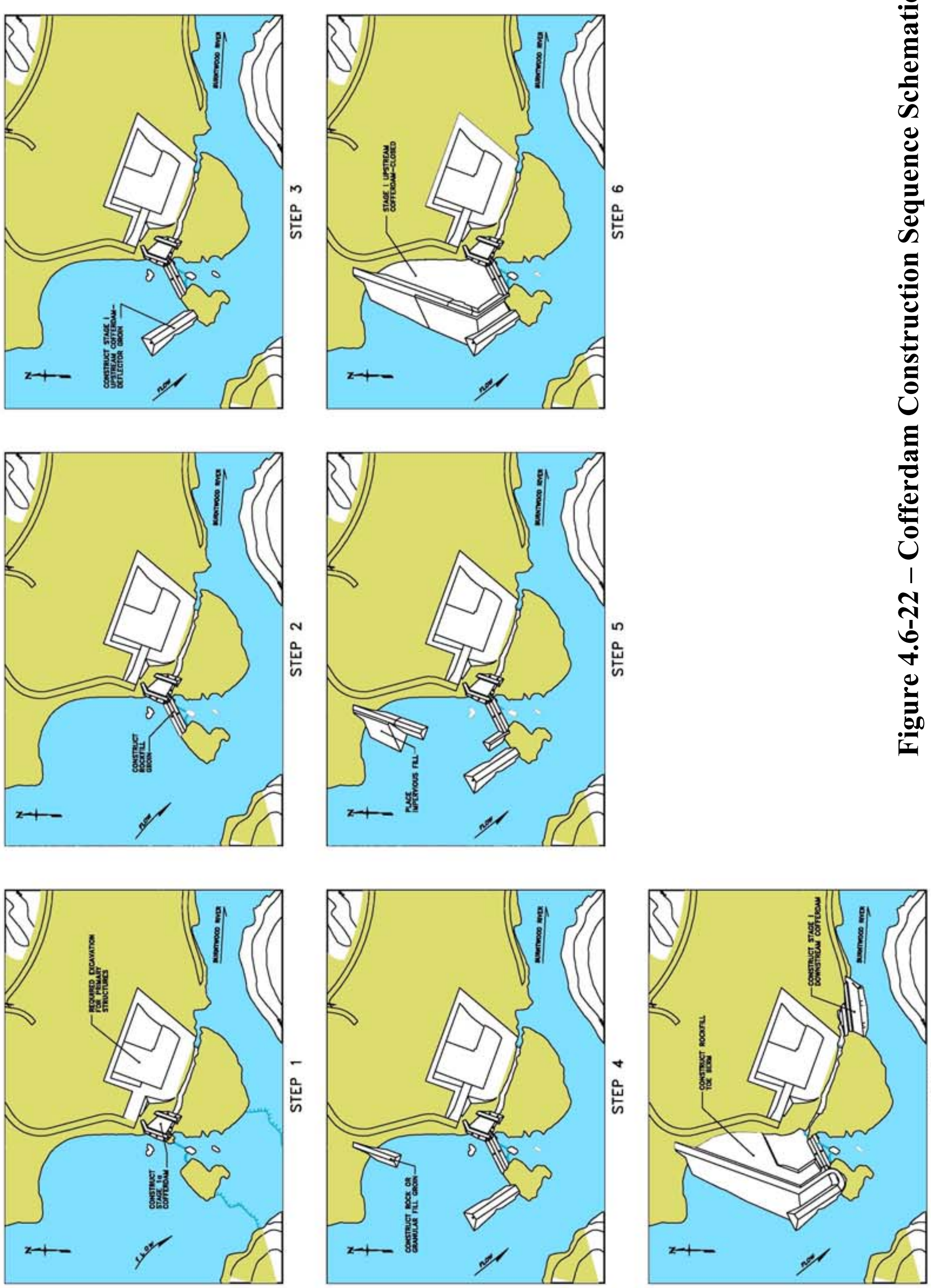

Figure 4.6-22 – Cofferdam Construction Sequence Schematics

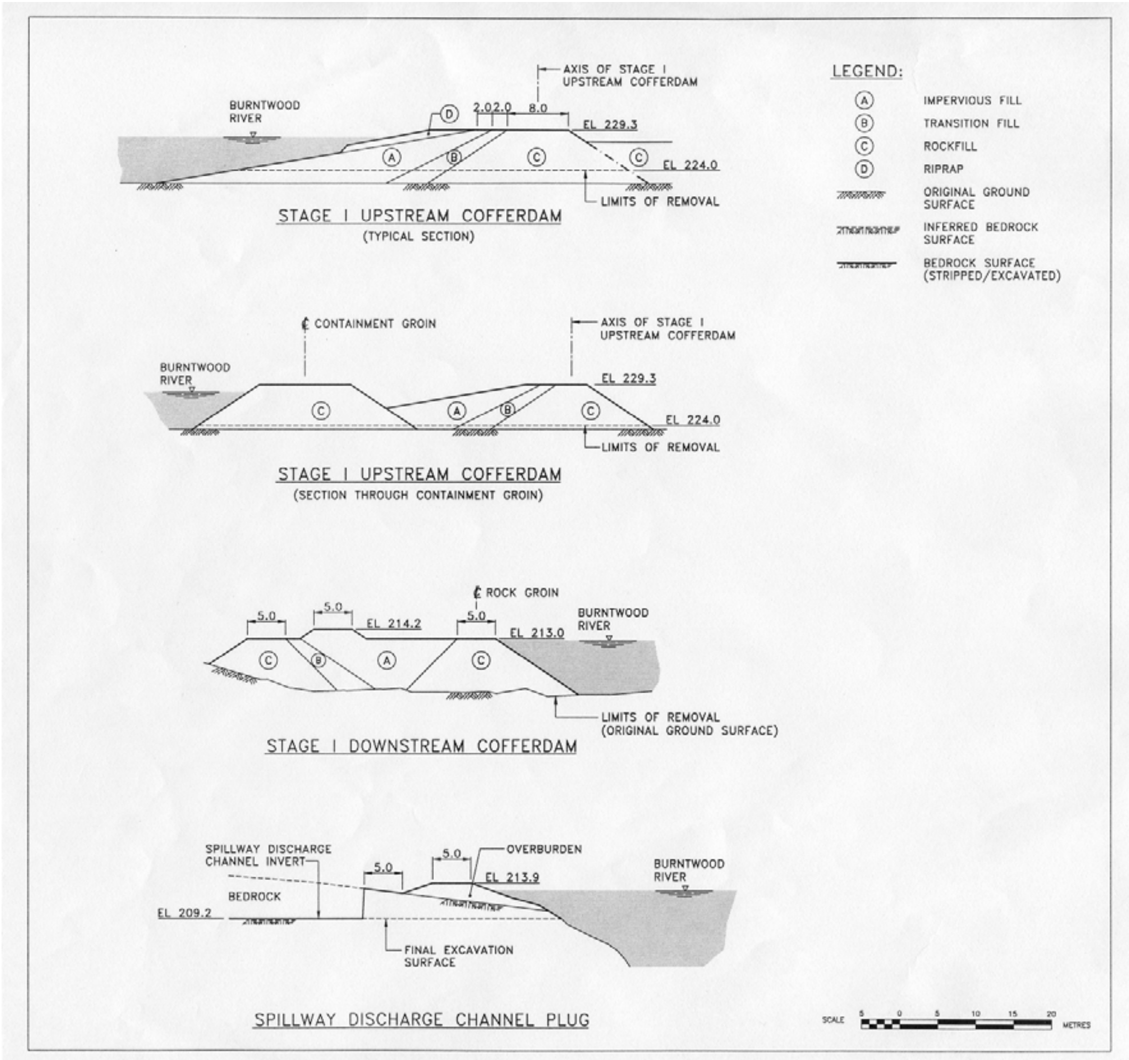

Figure 4.6-23 Stage I Cofferdams and Control Plug – Cross-Sectional Views

The temporary plug, which permits the excavation of the Spillway Discharge Channel, will be removed immediately prior to Stage II Diversion (see Schedule Figure 4.2-1). During removal, its cross section will be narrowed to the minimum safe dimension, through excavation in-the-dry. Following this, the area within the Discharge Channel will be flooded to the same level as the Burntwood River, on the opposite side of the plug, and the balance of the plug will then be demolished by a specifically designed and controlled explosive charge. The balance of the material from this small remaining area will then be removed in-the-wet, by a backhoe, and hauled to the Excavated Materials. Placement Area.

The removal of the Stage I Upstream Cofferdam will be undertaken in a controlled fashion by the use of backhoes and a dragline. As much material as possible will be removed in-the-dry, prior to flooding the area between the cofferdam and the primary structures. It is estimated that less than 5% of the fine material will remain in the water course following cofferdam removal. The Intake and Spillway gates will be in the closed position during this operation. The balance of the cofferdam material to be removed will then be excavated in-the-wet, down to elevation 224.0 m (as shown in cross-sectional view in Figure 4.6-23. The excavated materials will either be reused for construction of the Stage II Upstream Cofferdam or hauled to the Excavated Materials Placement Area.

Due to the configuration of the Stage I Upstream Cofferdam's layout, especially the position of the rockfill deflector groin located adjacent to Taskinigup Falls, the river's velocities in the vicinity of the Stage I Upstream Cofferdam will be relatively low. This layout, and the subsequent low velocity, will help to minimize the dispersion of any fine material that is disturbed by the backhoe and dragline buckets during the cofferdam removal process. Only a minor increase in the total suspended solids concentration of the Burntwood River's flows is anticipated during the removal process (Volume 4, Section 7.5.1).

The Stage I Downstream Cofferdam will be left in place until construction of the Stage II Downstream Cofferdam has been completed and the area between the Stage II Upstream and Downstream Cofferdams has been dewatered. Thus, this cofferdam will be completely removed in-the-dry and the materials will either be used in the construction of the Main Dam or disposed of in the Excavated Materials Placement Area.

4.6.8.4 Stage II Cofferdams

The portion of the Stage II Upstream Cofferdam to be built in-the-wet, as shown in Figures 4.6-24 and 25, will consist of a single dumped rockfill groin, faced with dumped granular transition and impervious zones. During the placement of the rockfill section, the volume of flow through Taskinigup Falls will have been reduced by the diversion of a portion of the river's flow through the completed Spillway. As the rockfill groin is advanced across the head of the falls, more and more flow will be diverted through the Spillway and less and less over the falls, until final closure of the rockfill against the south bank of the river. To minimize the potential for erosion of overburden materials on the south river bank, a rockfill spur will be built on the south shore, during the winter before diversion closure.

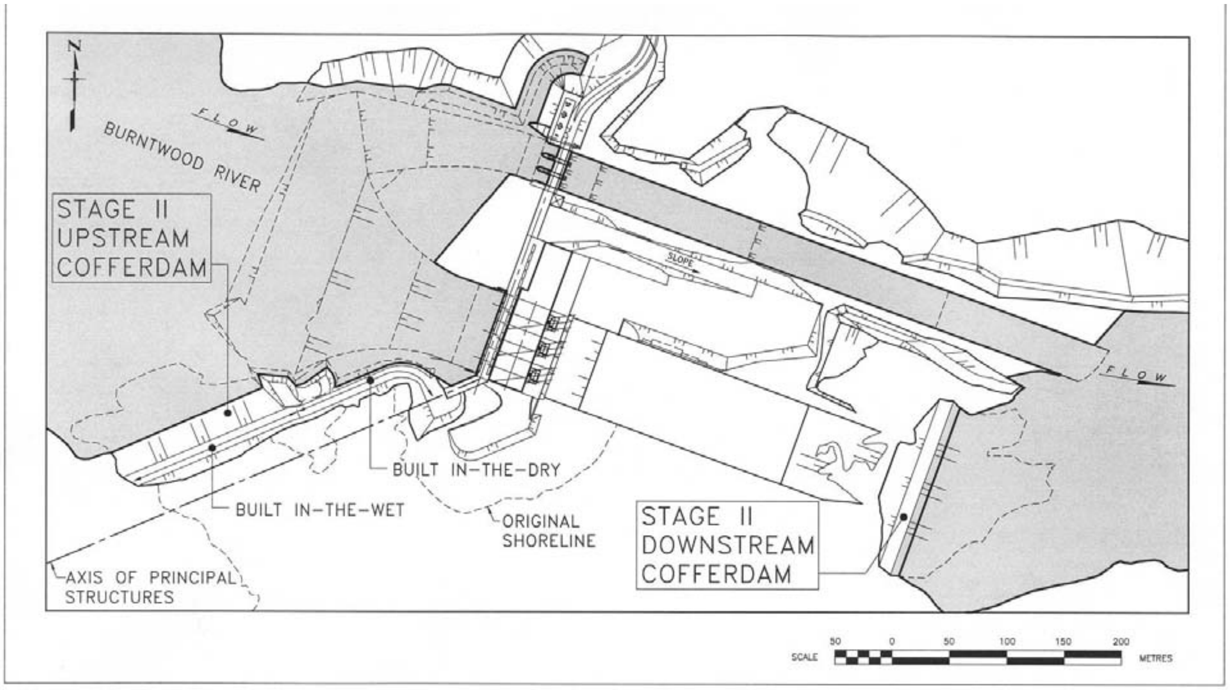

Figure 4.6-24 Stage II Cofferdams – Plan View

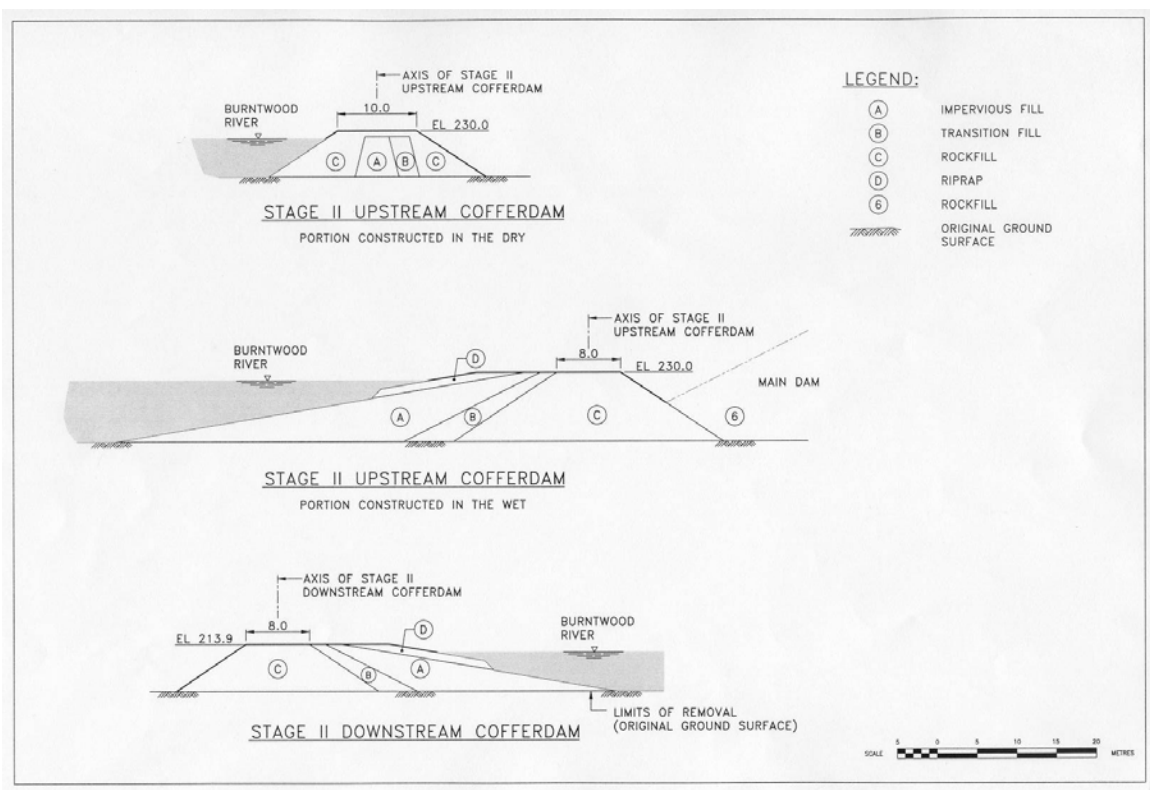

Figure 4.6-25 Stage II Cofferdams - Cross-Sectional Views

A layer of rip rap will be used protect the upstream slope of the impervious fill from erosion. This cofferdam will remain in place and form a permanent part of the upstream shell of the Main Dam.

The final cofferdam to be constructed in the diversion sequence will be the Stage II Downstream Cofferdam (Figures 4.6-24 and 25), which will be a single groin, dumped fill structure, built in relatively calm water just to the south of the Spillway Discharge Channel's outlet. Its construction is required to allow the completion of the Powerhouse Tailrace Channel excavation to be undertaken in the dry. This embankment, as well as the Stage II Upstream Cofferdam, will have crest elevations compatible with the 1:20 year return period construction design flood, plus an allowance of 1-m freeboard. Following completion of the Tailrace Channel excavation, the Stage II Downstream Cofferdam will be removed by means of a backhoe and/or a dragline, and the materials deposited in the Excavated Materials Placement Area. It is estimated that less than 5% of the fine material will remain in the water course following cofferdam removal.

4.6.8.5 Cofferdam Construction Materials

Construction of the Stage Ia and I Cofferdams will involve the placement of approximately 123,600 m^3 of rockfill, granular and impervious materials, 107,000 m^3 of which will be contained within the Stage I Upstream Cofferdam. The Stage II Cofferdams will require the placement of 130,700 m^3 of rockfill, granular and impervious fill materials, the largest proportion of which will be in the downstream cofferdam (81,200 m^3). Table 4.6-4 contains a breakdown of these quantities by material type and structure.

As stated earlier, the Stage II Upstream Cofferdam will remain in place as the toe of the Main Dam. The majority of the balance of the cofferdam fill materials will be removed and used in the subsequent construction of other structures, or be disposed of in the Excavated Materials Placement Area.

Both the rockfill and the impervious (clay) materials will be obtained locally on site, from the excavations which are necessary for the construction of the Project. The granular sources, however, are anticipated to be imported from one of the Deposit J granular sources, located between 18 km and 23 km to the northeast of the site, in close proximity to the route of the site access road.

Cofferdam	Fill Volume Requirement (m^3)		
	Impervious	Granular	Rockfill
Stage Ia	1,100	300	2,800
Stage I Upstream	22,000	6,000	79,000
Stage I Downstream	4,900	700	7,900
Stage II Upstream	22,000	6,000	21,500
Stage II Downstream	32,000	7,200	42,000

Table 4.6-4 Cofferdam Construction Material Quantities

4.7 PRIMARY STRUCTURES

The primary structures composing the Wuskwatim GS are the Spillway, Powerhouse/Service Bay Complex, Non-overflow Gravity Dam, Main Dam and Transition Structures. The general arrangement of these major components is shown below in Figure 4.7-1.

4.7.1 Spillway

4.7.1.1 Spillway Design

The Spillway will be a three bay concrete structure equipped with vertical lift fixed wheel steel gates. The Spillway structure will be 43 m in length along the axis of the primary structures, 27.5 m wide and 43 m high. The Spillway will be built within a channel which will be approximately 500 m long and 34 m wide. The downstream portion of the channel floor will be horizontal, allowing this reach of the channel to act as a stilling basin, dissipating the energy of the water as it re-enters the river. For the most part, the flow of water in the channel will be contained within the bedrock except for two locations where concrete walls, Wall F and G, will be required to contain other fills and/or reinforce areas of potentially poorer rock quality, to prevent erosion.

The Spillway will be located to the north of the Powerhouse and linked to it by a fixed concrete Non-Overflow Dam. Figure 4.7-2 illustrates a side view of the Spillway and Figure 4.7-3 and 4 shows what the Spillway will look like when it is completed (with the water removed in the upstream view, for clarity).

The design function of the Spillway is two-fold. It provides a diversion channel during the construction period and an overflow for the reservoir during the operation period. The Spillway has been designed to protect the plant from flows up to the Inflow Design Flood (IDF) which is equal to the Probable Maximum Flood (PMF) event (see Section 2.5). The PMF event will result in a peak discharge of 2650 m^3/s and in this extreme circumstance, the upstream water level will rise to 235.5 m which is the basis for selecting the elevation for the crest of the concrete structures.

The Spillway will contain various mechanical and electrical systems needed to operate and control the Spillway, including safety, security and monitoring systems.

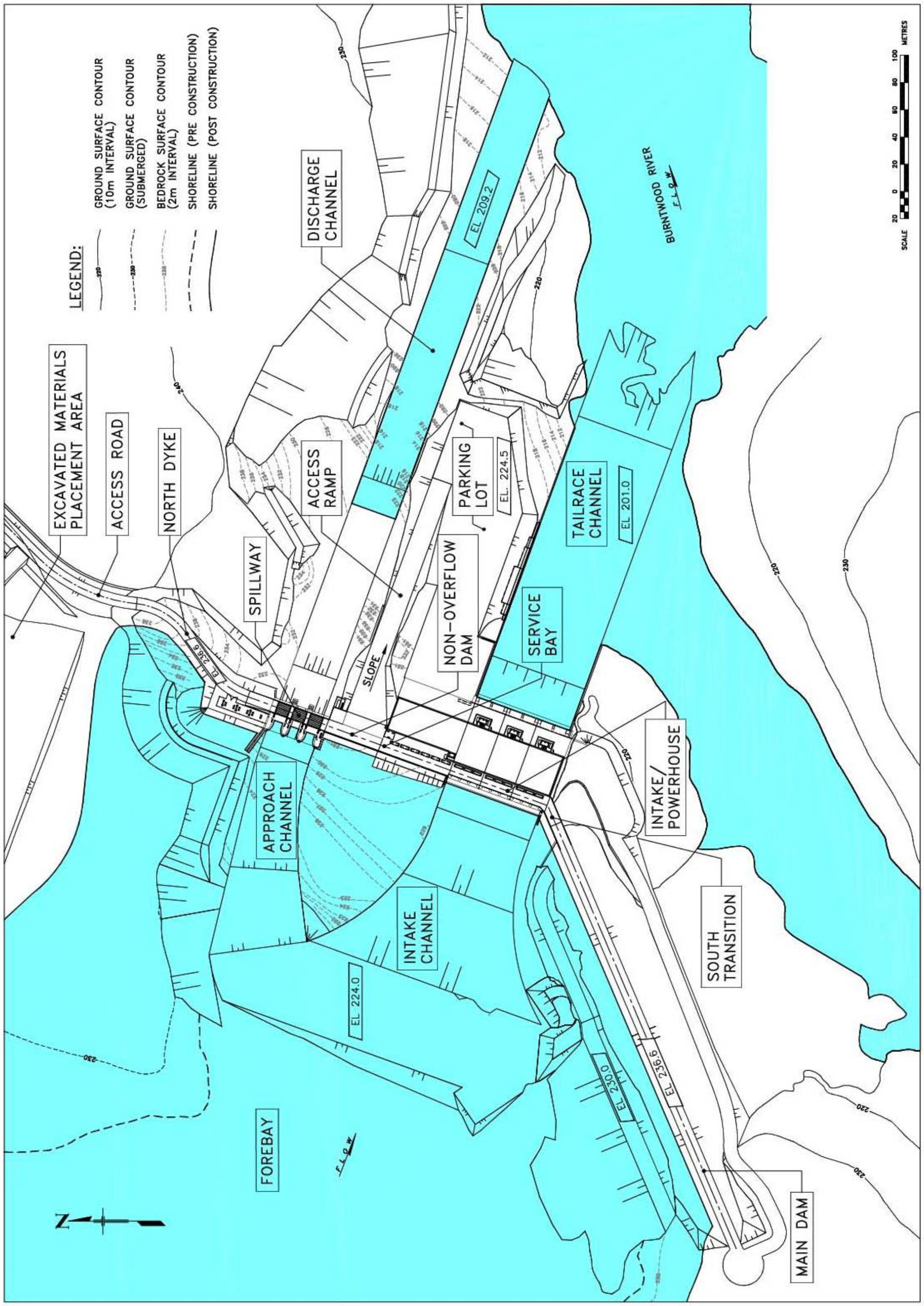

Figure 4.7-1 Primary Structures – General Arrangement

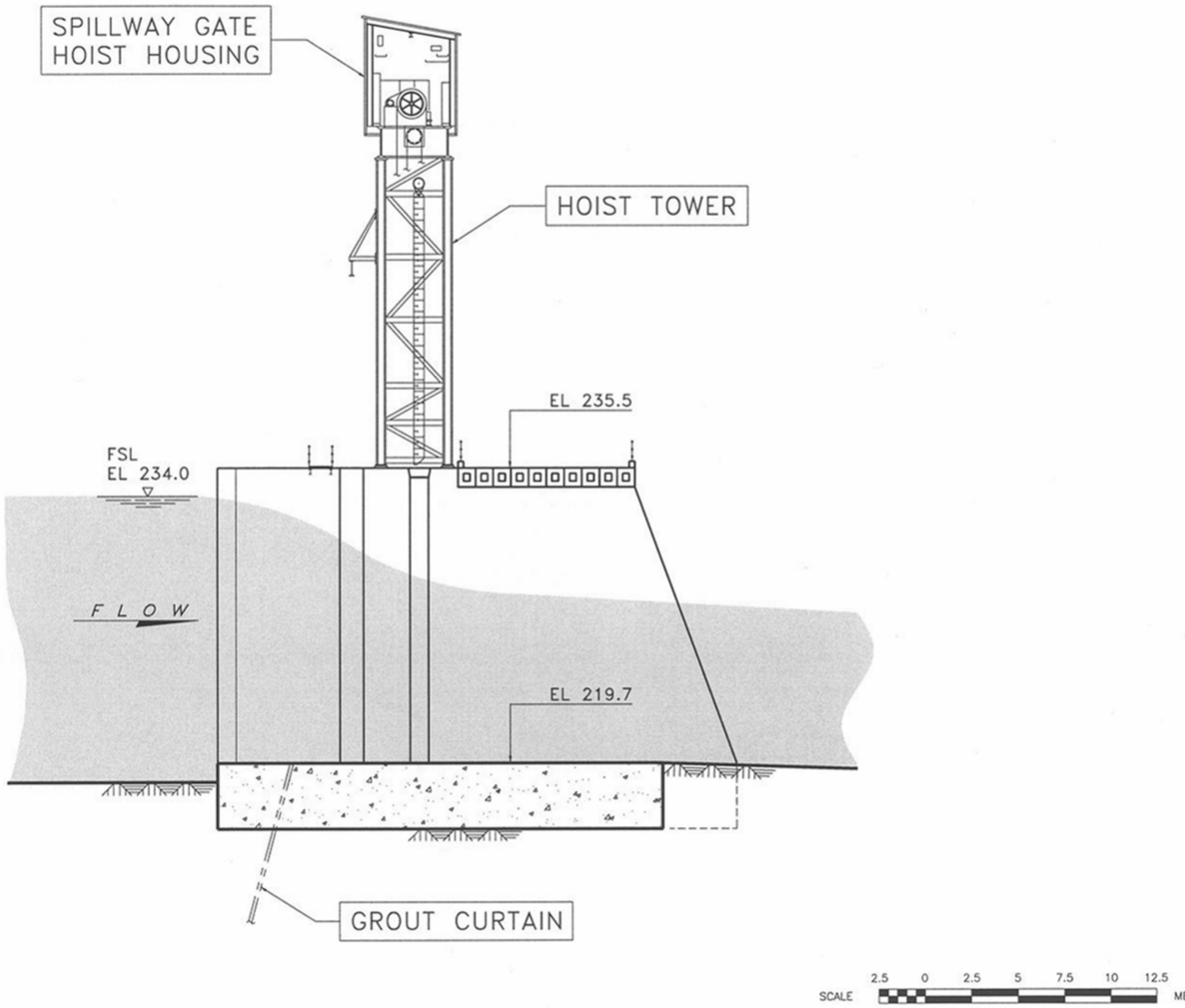

Figure 4.7-2 Spillway – Sectional View

Figure 4.7-3 - Spillway Upstream Elevation Intake

Figure 4.7-4 -Spillway Downstream Elevation Discharge

4.7.1.2 Spillway Construction

For the purposes of this document, Spillway construction will refer to the concrete Primary Structure, and not the excavations. The excavations have been grouped with the Secondary Structures, and as such are discussed later, in Section 4.8.

Construction of the Spillway concrete structure is anticipated to be undertaken through the use of a mobile crane for the placement of formwork and reinforcing steel, as well as for the concrete placement itself. It is further anticipated that some of the concrete may be placed by means of concrete pumps. It is estimated that 9,000 m^3 of concrete will be placed between July and the end of September 2006

Once the Spillway's base slab is in place, small holes will be drilled into the bedrock foundation below the structure to permit sealing of the foundation, by means of the injection of cement grout into the holes. Following completion of the concrete structure, steel towers and bridgework will be erected above the structure to support the hoist equipment for the structure's vertical lift steel gates, which will also be installed following the completion of the concrete works.

4.7.2 Intake/Powerhouse/Service Bay Complex

4.7.2.1 Intake/Powerhouse/Service Bay Complex Design

The Intake/Powerhouse Complex will be 72.4 m in length along the axis of the primary structures, 62.7 m wide and 56.0 m high. The selected arrangement is shown in Figure 4.7-5 in plan view and Figure 4.7-6 & 7 in rendered form, with a cross-sectional view shown in Figure 4.7-8.

The structures will be located on bedrock, close to the north bank of the original river channel. The Powerhouse units will have a layout similar to Manitoba Hydro's developments on the Nelson River. A Service Bay (turbine and generator assembly and erection area) will be provided at the north side of the Powerhouse. The road to the main Service Bay entrance door will be reached from the North Dyke, the Spillway Bridge, the crest of the Non-Overflow Dam and a descending ramp to a large parking area at Service Bay floor level.

A concrete Non-Overflow Dam will link the Powerhouse and the Spillway and provide continuous access from the North Dyke to the crest of the Main Dam.

The concrete Intake structure will allow water to flow through the scroll case to each of the three turbine units where the hydraulic energy will be converted into electrical energy by means of a vertical shaft connected to generators, located above. The Intake for each turbine unit will have three openings, each of which will contain an Intake service gate. The Intake service gates, operated by hoists mounted on top of the Intake structure, will be designed so as to shut off the flow to each of the individual units for purposes of maintenance as well as in the event of an emergency. Maintenance of individual service gates will be carried out behind temporary bulkhead gates, which will be placed in slots just to the upstream of the service gate which is being serviced. To keep the openings free of debris, trashracks (a grid of steel bars and support beams, with a clear space of 165 mm between each bar and a clear space of over 500 mm between each horizontal support beam) will be placed across all the water passages to the upstream of the bulkhead gate slots.

The Powerhouse will contain the turbines and the generators as well as the various mechanical and electrical systems needed to operate and control the units. These systems also provide the safety, security and monitoring devices for plant operation, fire safety and oil spill prevention.

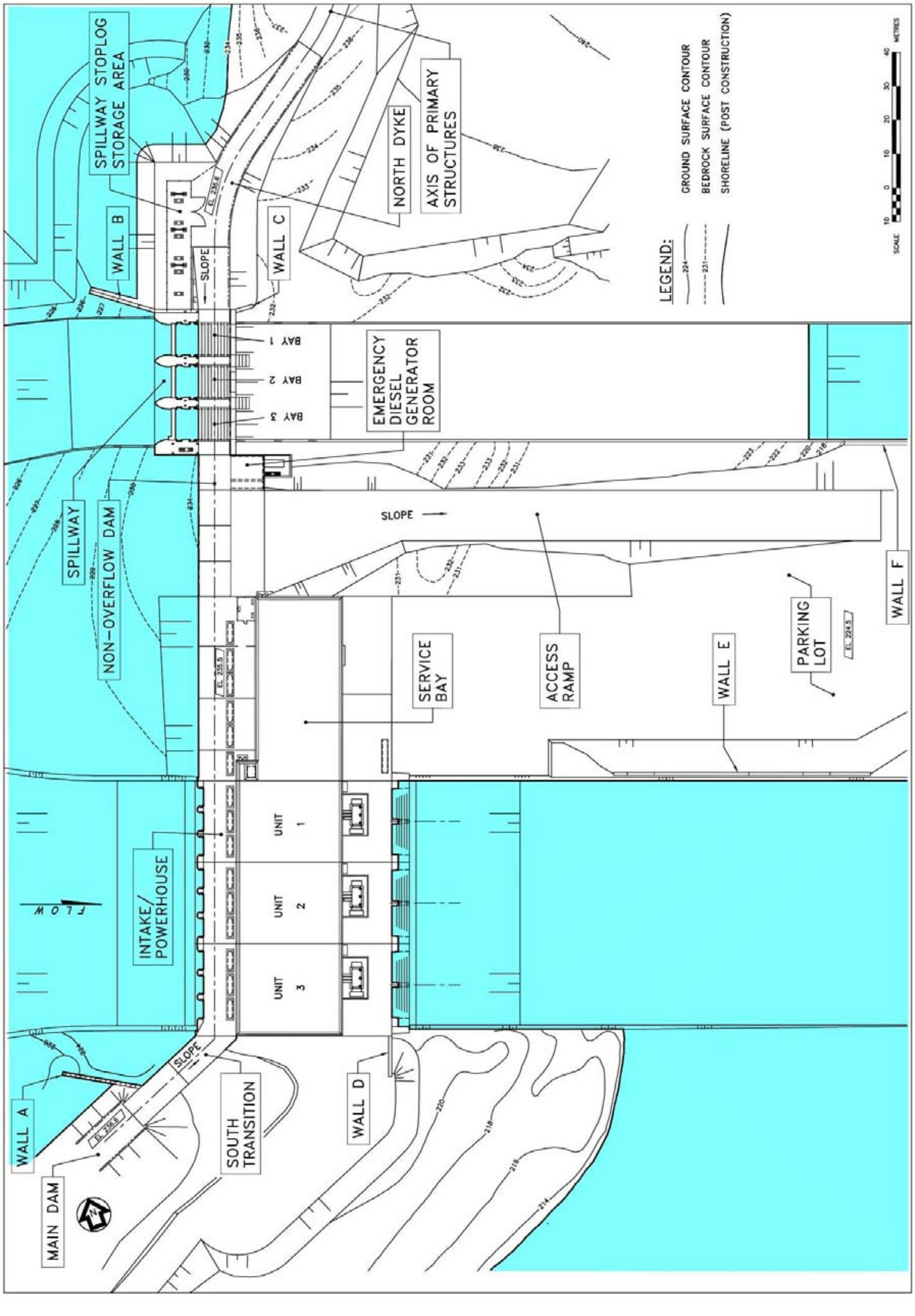

Figure 4.7-5 Powerhouse/Service Bay Complex – Plan View

Figure 4.7-6
Powerhouse/Service Bay Complex
Upstream Elevation

Figure 4.7-7
Powerhouse/Service Bay Complex
Downstream Elevation

After leaving the turbine scroll cases and passing over the turbine runner, the water will pass through the draft tubes, enter the tailrace channel and then be returned to the natural watercourse. Sectional gates will be provided to permit isolation of the draft tubes from the tailrace, thus allowing maintenance of the draft tubes & turbines to be undertaken as required.

At the north end of the Powerhouse, the Service Bay will provide the space required for the erection of the large pieces of equipment during the construction stage of the station. It will also provide the necessary space for maintenance during the operation of the station and include temporary accommodation quarters for the maintenance staff.

As briefly noted above, there will be numerous mechanical and electrical systems within the Powerhouse and the Service Bay. They will be principally divided into two groups: unit control and station services. The latter group will include heating and ventilating systems, domestic and fire water systems, cranes, sewage treatment, drainage, compressed air and oil storage facilities. These systems will be designed to ensure full containment of contaminants in the event of spillage.

South of the Powerhouse, a concrete gravity structure called the South Transition will connect the Intake structure to the Main Dam. The South Transition will articulate through 47 degrees at the junction with the Intake and will carry the major access capability from the Intake deck to the Main Dam crest. Concrete wing walls will be used to retain fills and prevent their interference with flow in the channel.

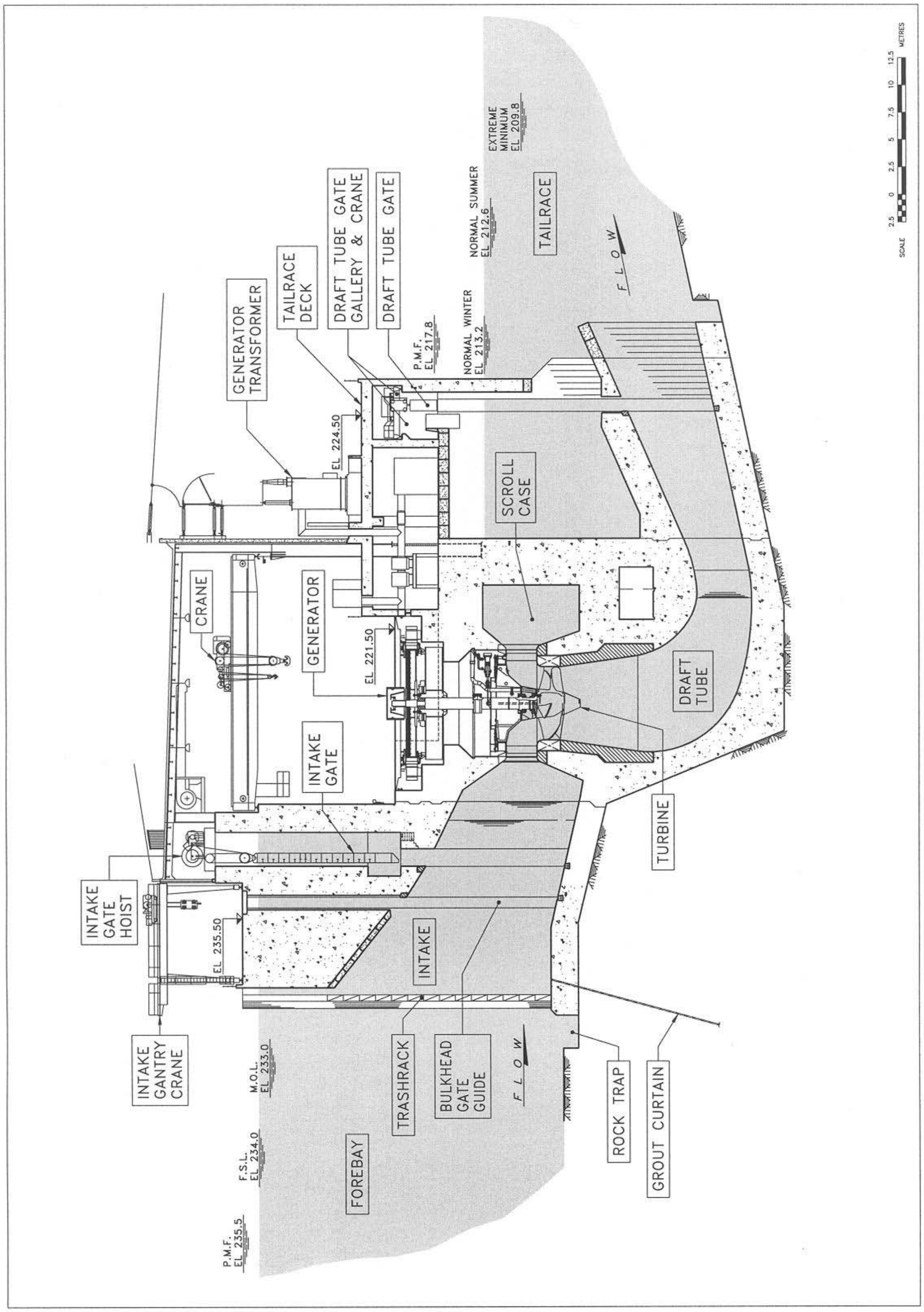

Figure 4.7-8 Powerhouse/Service Bay Complex – Cross-Sectional View

4.7.2.2 Intake/Powerhouse/Service Bay Complex Construction

The construction of the Intake/Powerhouse complex, the Non-Overflow Dam and the South Transition, the Intake Channel, and the Tailrace Channel, will require the excavation of approximately 330,000 m^3 of overburden, 500,000 m^3 of rock, and the placement of 80,000 m^3 of concrete and 8,000 m^3 of granular fill.

The schedule for the construction of the Powerhouse and the Intake and Tailrace Channels will be tightly interrelated with the schedule for the management of the river, as described in Section 4.6.8.2, after the Stage I Cofferdams have been installed (Scheduled for September, 2005). Excavations are scheduled to occur from August through November 2005.

As with the Spillway, discussed in Section 4.7.1.2, the construction of the Intake/Powerhouse/Service Bay Complex will require the use of heavy construction equipment. The excavations will be undertaken in a similar manner to that of the Spillway, with the excavated materials either being used as fill within the required structures or hauled to the Excavated Materials Placement Area for permanent disposal. It will be necessary to keep the channel's excavation faces as smooth as possible to limit the energy losses which would be associated with a rough surface. This will be achieved through the use of controlled perimeter blasting and techniques such as line drilling and pre-splitting, all conducted in the dry, behind the Stage I Cofferdams.

To seal the bedrock foundation against possible reservoir leakage, a grout curtain will be installed from the foundation interface below the base of all the primary structures.

The construction of the concrete structures and their associated structural steel enclosures may involve traveling tower cranes, mobile cranes and concrete pumps. The concrete work will be largely undertaken during the summer construction seasons of 2006, 2007 and 2008. Once the structural steel enclosure is erected and the structure can be heated, the work involved in the installation of the generating equipment, as well as the associated control equipment and basic building services, will be carried out year round.

4.7.3 Non-Overflow Gravity Dam

4.7.3.1 Non-Overflow Gravity Dam Design

A concrete Non-Overflow Dam will link the Powerhouse and the Spillway and provide continuous access from the North Dyke to the crest of the Main Dam. An enclosed gallery in the Non-Overflow Dam will allow weather-protected access for personnel between the Service Bay and the Spillway. This structure will also house a standby diesel generator and fuel storage tanks complete with secondary spill containment which will be capable of supplying the essential loads to operate gates, etc., in an emergency. The standby diesel generator will also provide the station with **black-start** capability, should the station shut down and be disconnected from the grid.

4.7.3.2 Non-Overflow Gravity Dam Construction

The construction of this structure will employ the same equipment and techniques as described in Section 4.7.2.2 for the balance of the concrete structures. It will involve approximately 1,480 m^3 of material and is scheduled for construction in October 2007.

4.7.4 Main Dam and North Dyke

4.7.4.1 Main Dam and North Dyke Design

The locations of the Main Dam and the North Dyke are shown in Figure 4.7-9. These structures are earthfill structures, which will be constructed to complete the containment of the immediate forebay

The Main Dam will be approximately 14 m high and 300 m long and will reach from the south bank of the river above Taskinigup Falls to the South Transition Structure and the Intake/Powerhouse Complex. The North Dyke will be approximately 7 m high and 100 m long and will reach from the north bank of the river to Wall C and Wall B on the north end of the Spillway.

The Main Dam will be a zoned earth and rockfill embankment consisting of a central impervious core with rockfill shells and erosion protection, as shown in Figure 4.7-10. Filter/transition zones will be located on both the upstream and downstream sides of the core. For the most part, the Main Dam will be founded on prepared bedrock. The exception will be the south (right) abutment, which will rest partially on a foundation of native lacustrine silty clay. The foundation will be sealed to minimize seepage by the installation of a grout curtain

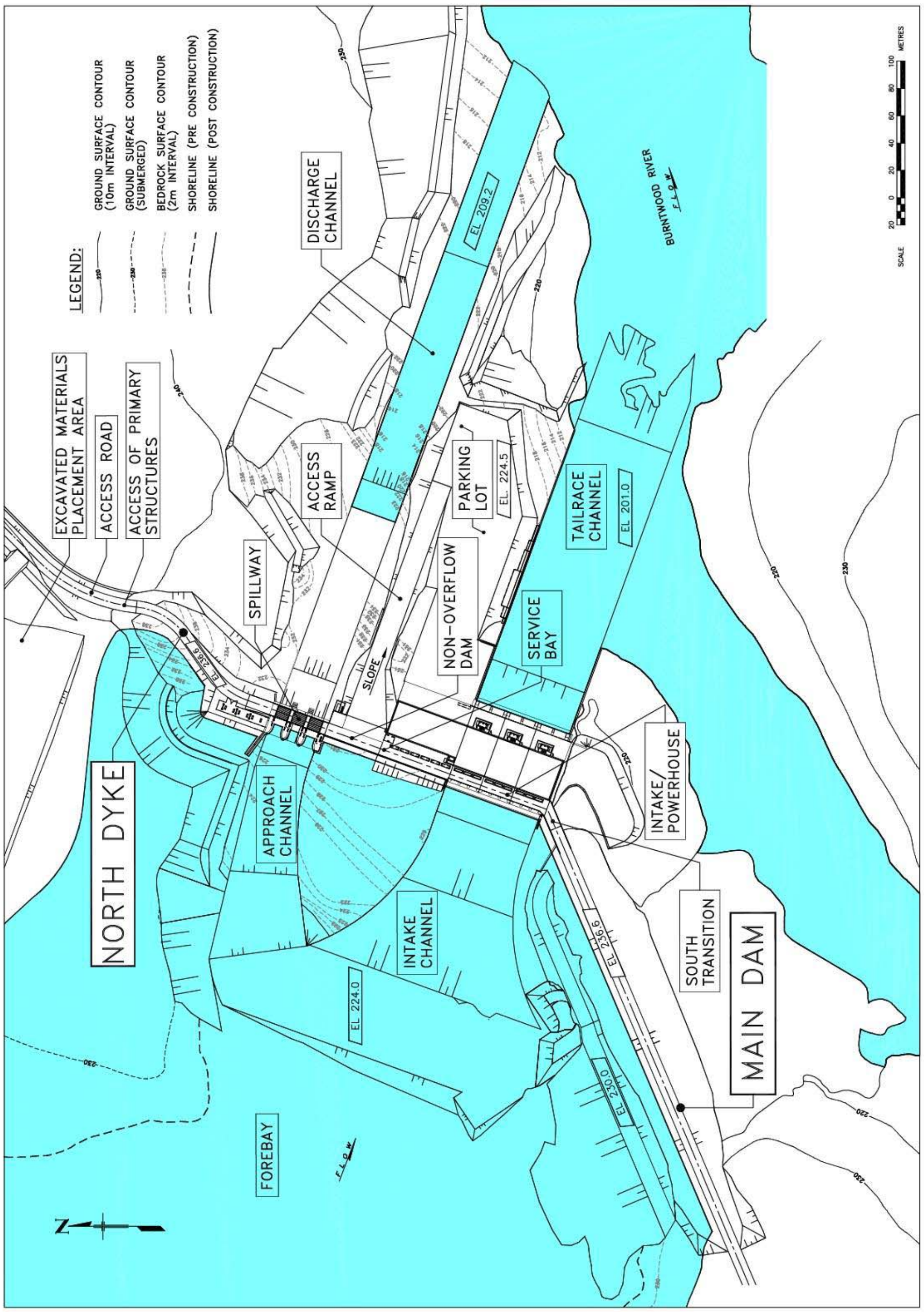

Figure 4.7-9 Main Dam and North Dyke – Plan View

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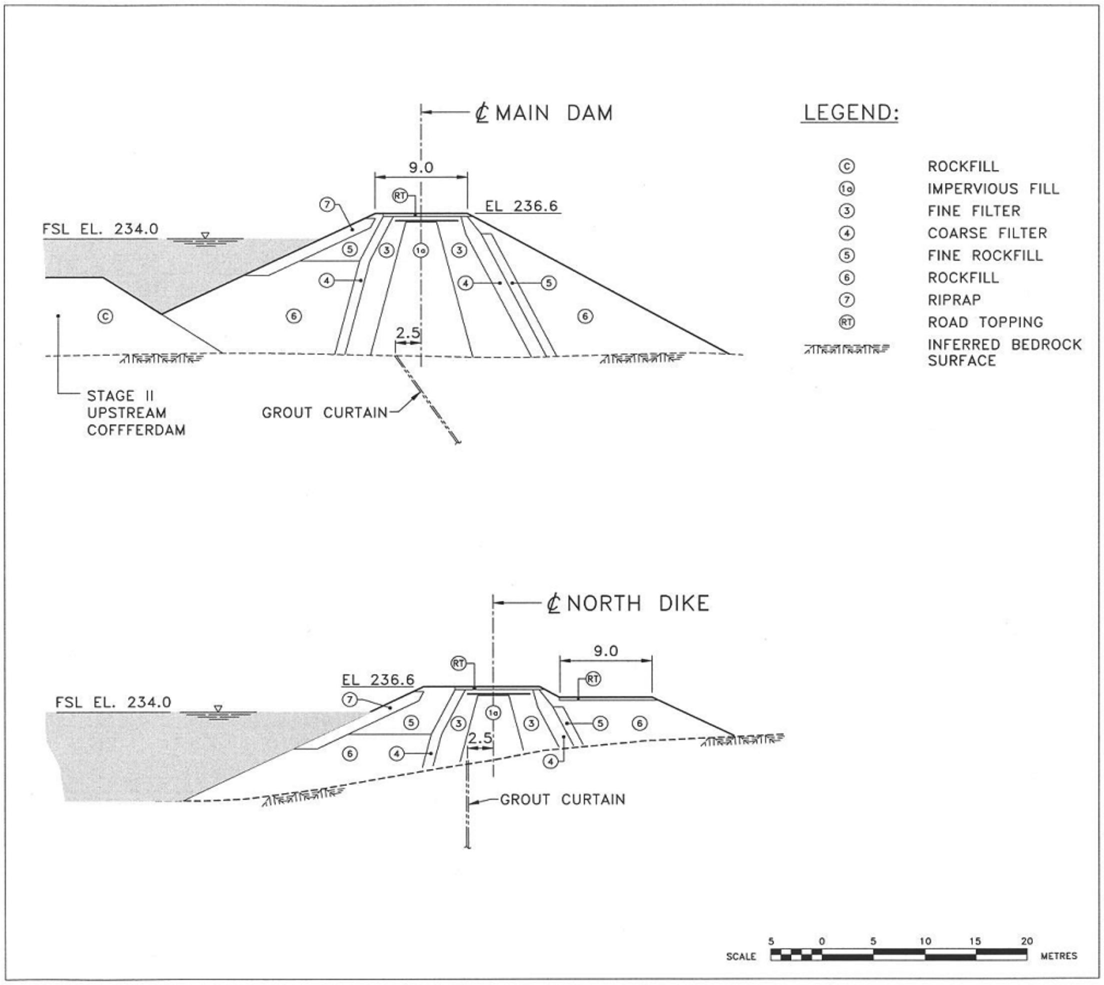

Figure 4.7-10 Main Dam and North Dyke – Cross-Sectional Views

The North Dyke will close the area from the north wall of the Spillway to the north bank. It will consist of an earth and rockfill embankment with the same basic cross section as the Main Dam and will also be founded on a prepared and grouted bedrock surface. The crest width will be enlarged to create an area for storage of the Spillway stoplogs. Road access to the Spillway deck and therefore to the Powerhouse, will be obtained by way of a compacted rockfill extension to the downstream side of the North Dyke, ramped down to meet the Spillway deck.

The crest elevations of the dam and dyke have been set to accommodate the more severe of the following conditions; the FSL of 234.0 m, or the forebay level which would occur during passage of the IDF (PMF), which corresponds to a level of 235.5 m. The required crest elevations take into account the appropriate combined affects of the wind-generated waves and post-construction embankment settlements, which are associated with each of these two design conditions.

Materials for the construction of the Main Dam and the North Dyke will be largely derived from the necessary excavations. Rockfill for the outer shells and for the processed rockfill zones will be stockpiled from the excavations for the Primary Concrete Structures and the channels. Impervious core material will be selected from the unclassified excavations and placed directly into the structures or stockpiled prior to its placement. Filters, granular fills and transitions will be obtained from borrow sources, likely from one of the Deposit J areas.

4.7.4.2 Main Dam and North Dyke Construction

To construct the Main Dam and the North Dyke will require the excavation of approximately 60,000 m^3 of overburden materials and the placement of 13,000 m^3 of fill in the North Dyke and 120,000 m^3 of fill in the Main Dam.

The construction of the earthfill dam and dyke will involve equipment like bull-dozers, scrapers, compaction equipment, front end loaders, rock wagons, gravel trucks and backhoes. Activities will include placement of the fill materials in specified lift thicknesses, the addition of water, if necessary, and the compaction of the fills to ensure achievement of suitable long-term performance characteristics. Prior to the start of the fill placement, the bedrock surface will be thoroughly cleaned and any joints and fissures sealed with grout, so as to establish a suitable surface on which to seal the dam to its foundation.

These activities will be conducted inside the Stage II Cofferdams, as described in Section 4.6. The North Dyke is scheduled for construction from mid May to mid June 2007, with initial work on the Main Dam scheduled to occur in early May 2007, and final work phase scheduled from August through September 2008.

4.8 SECONDARY STRUCTURES

The Secondary Structures include the channels for the Spillway, Powerhouse and the Upstream Channel Excavations. The channels will be cut through overburden and bedrock in the dry. The overburden is mainly composed of soft lacustrine clays. Within the bedrock, the channel sides will be almost vertical, whereas in the overburden, the side slopes will be quite flat. The overburden slopes will be protected with rockfill to prevent erosion.

The schedule for the construction of the Spillway and the Approach and Discharge Channels will be tightly interrelated with the schedule for the management of the river and the diversion sequencing. The majority of the excavation for these structures and channels is scheduled to occur between August and the end of November 2005. These activities will be conducted inside the Stage I Cofferdams, as described in Section 4.6.8.

Drilling and blasting will be used as the method of excavation of bedrock. In addition to drilling and blasting, a bulldozer equipped with a hydraulically operated ripper tooth may be used to dislodge material. The removal of the bedrock will involve controlled perimeter blasting techniques to ensure that the final faces of the excavation conform to the design requirements. This technique will also minimize disturbance to the rock located beyond the excavation faces. The blasted/loose rock will be removed by dump trucks, using equipment such as a front-end loader, backhoe or dragline. The overburden and bedrock will either be hauled to a temporary stockpile for future use as impervious or rock fill in the dams or dyke, or hauled for final disposal in the Excavated Materials Placement Area.

The construction of the Spillway and its associated Approach and Discharge Channels will require the excavation of approximately 365,000 m^3 of overburden and 215,000 m^3 of rock and the placement 8,000 m^3 of granular and rockfills.

The Intake Channel entrance will share a deep section of the Forebay with the Spillway Approach Channel. The reach of the Intake Channel immediately upstream of the Intakes will be a blasted rock channel with the balance being an excavation through clay and till. It has been designed to carry water to the Intakes with the smallest possible head loss and thus the velocity of the water through the channel will be low and not pose a threat to causing erosion along the channel's slopes or floor. From its entrance, the channel floor will gently fall through 18 m towards the Intake. Over the same distance, the channel's walls will converge in a bell-mouth shape to a width of 72 m.

Having passed through the Powerhouse, the flow will emerge from the draft tube into the 72 m wide Tailrace Channel, which has been designed to conduct flow back to the river with minimal head loss and to maximize the efficiency of the plant. The floor of the channel will first slope upwards at the draft tube exit and then remain horizontal to a location approximately 240 m downstream from the Powerhouse. The channel will then be feathered in to match the natural riverbed levels.

4.8.1 Upstream Channel Excavation Area – Location Plan

The immediate forebay will be physically separated from the main reservoir (Wuskwatim Lake) by Wuskwatim Falls. These falls are located at the outlet of Wuskwatim Lake, approximately 1.5 km upstream of the proposed site of the Wuskwatim GS. Under pre-development conditions, Wuskwatim Falls are a natural control for Wuskwatim Lake outflows.

To regulate the lake within the prescribed limits of 234.0 m to 233.0 m and to minimize the loss of head in the flow towards the Powerhouse through the area, it will be necessary to construct a channel through the bedrock peninsula to the left of the falls. The dimensions of this channel were determined to be 125 m wide with a floor level of el 229.0 m and are shown in plan view in Figure 4.8-1.

This configuration, to be confirmed during detailed design, will require the excavation of approximately 60,000 m^3 of overburden and 95,000 m^3 of rock.

Most of the excavation will be carried out behind the protection of an upstream rock plug. The removal of this plug will be carried out after the balance of the channel excavation has been completed and the forebay has been impounded to the level of Wuskwatim Lake, for the following reasons:

(a) If the rock plug were to be removed during one of the diversion stages, a rapid drawdown of Wuskwatim Lake by about 2.0 m would occur, resulting in large uncontrollable flows downstream, as well as other undesirable environmental consequences, both of which are unacceptable.

(b) This will provide water on both sides of the rock plug, minimizing the head differential through the channel and hence facilitating the rock plug removal.

The excavation of the overburden and bedrock, other than the rock plug, will be undertaken in the dry and will employ the same techniques as previously described for the channel excavations of the Primary Structures. A construction access road will be constructed as shown on Figure 4.8-1 to allow access to the channel improvement area. The access road will be constructed within a buffer area that will be cleared to account for wave uprush and wind set up within the immediate forebay area. Blasting will be used during excavation of bedrock to loosen or break up rocks for removal. Drilling and/or boring will be used to position charges for blasting and to facilitate grouting of rock. In addition to drilling and blasting, a crawler tractor equipped with a hydraulically operated ripper tooth may be used to dislodge material. Loose rock is removed by dump trucks, using equipment such as a front-end loader, backhoe, crawler tractor or dragline.

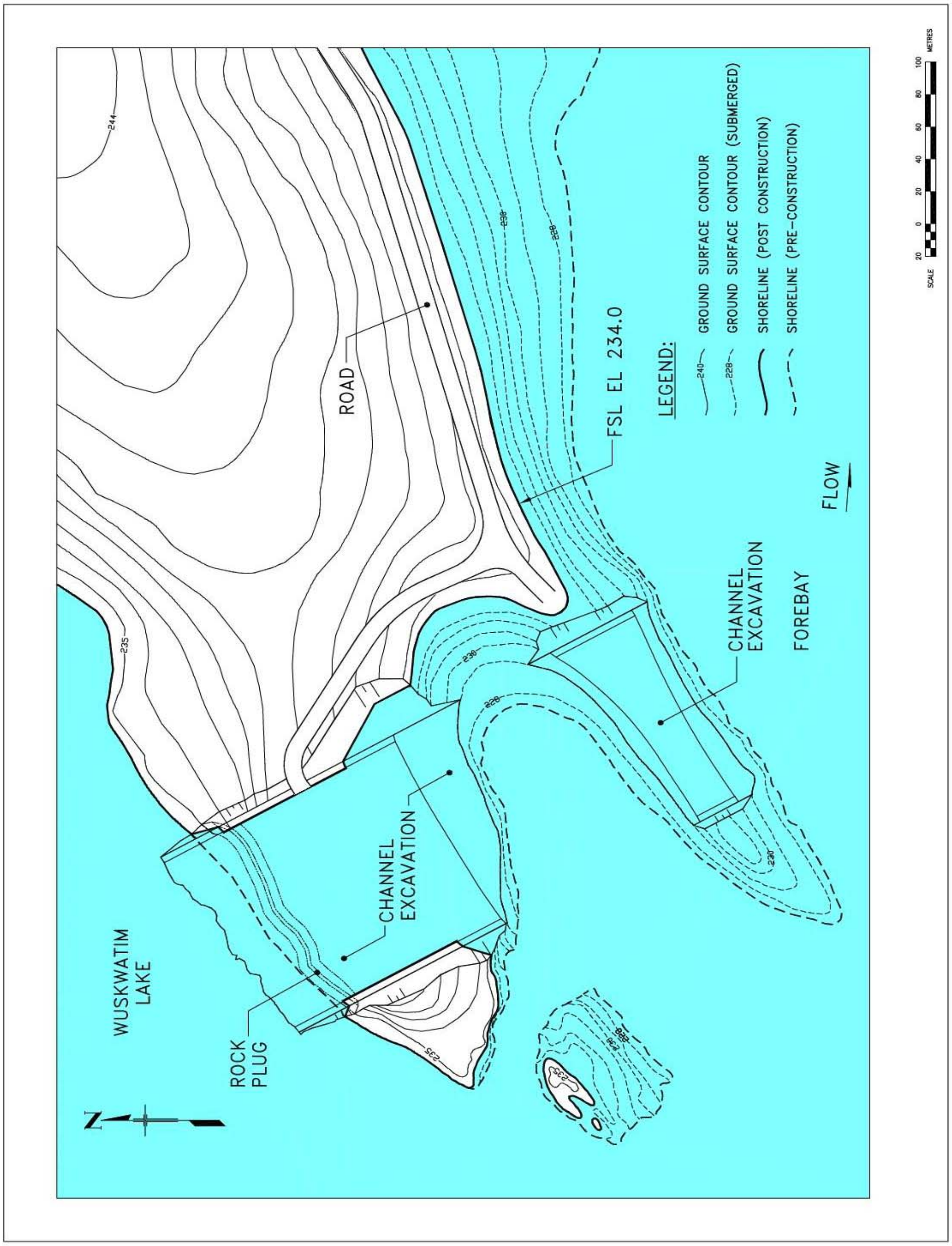

Figure 4.8-1 Upstream Channel Excavation Area – Location Plan

The new channel is scheduled to be constructed from May through July 2008. The rock plug will be left in place to control natural flows until after the forebay is impounded and will be removed October 2008. The removal of the rock plug will be undertaken in compliance with the requirements of the Environmental Protection Plans (Section 4.11).

4.9 PREPARATION OF SWITCHING STATION FOUNDATION

The location of the permanent Switching Station will be directly south of the construction power sub-station, as shown in Figure 4.6-1. A L-shaped building consisting of two floors and an exterior 'line termination area are the main components of the Wuskwatim Stage 2 – 230 kV Gas Insulated Switching Station. The foundation preparation details are summarized below and the remaining components of the Switching Station are described in the Wuskwatim Transmission Project EIS.

The area for the Switching Station will be cleared and grubbed to facilitate placement of granular fill materials on which the foundations of the various structures will be built. The granular materials are placed after the organic material has been stripped and stockpiled for use in rehabilitation activities.

The Switching Station will require the placement of approximately 12,500 cubic metres of granular fill as part of foundation preparation and final grading around the site. The foundation preparation will be undertaken using equipment similar to that used in the construction of the camp. All site drainage, erosion and sedimentation management will be in accordance with the Environmental Protection Plans (Section 4.11) and applicable provincial and federal regulations and guidelines.

A fence will be erected around the perimeter of the line termination area on the north side of the building.

4.10 CONSTRUCTION CLEAN UP, DECOMMISSIONING & REHABILITATION

The decommissioning and clean-up of the Wuskwatim construction camp will occur after the construction of the generating station is completed, the Units have been placed into commercial service and the camp is no longer needed. Decommissioning will involve removal of supporting infrastructure including specific roads and buildings; collection and disposal of wastes, recyclables and hazardous materials; and removal of water intake and sewage treatment facilities. The construction power sub-substation and the local distribution system will be decommissioned and salvaged. The conductors will be removed from the poles and the poles will be pulled from the ground. All electrical distribution equipment will be returned to the supplier (Manitoba Hydro) for salvage.

Some lands will be fully rehabilitated and others will be partially rehabilitated depending on the final land use. Lands under the transmission line corridors will be rehabilitated to an extent that ensures line maintenance remains possible. The areas to be rehabilitated and a general description of the degree of rehabilitation are shown in the Camp and Work Area Rehabilitation Plan Figure 4.10-1. An estimated 117.5 ha will be required for the long term operation and maintenance of the Project, shown on Figure 4.10-1. An estimated 62.9 ha will be fully rehabilitated and 3.7 ha will be partially rehabilitated.

Reclamation and re-vegetation programs will be initiated for the vacated sites and borrow areas to control/prevent erosion, re-establish wildlife habitat, or create buffer zones. Reclamation measures and vegetation species selection will be undertaken as determined by regulatory requirements, site conditions and management objectives. Consideration will be given to feasibility, practicality, effectiveness and management requirements. Manitoba Hydro or their consultants will monitor site reclamation/re-vegetation programs, in consultation with the appropriate authorities. The general description of the rehabilitation approach during decommissioning will be described in the Environmental Protection Plans (Section 4.11). A detailed reclamation plan will be developed during the decommissioning phases of the Project.

The remaining lands are part of the Lands Required (Section 5.1).for the long term operation and maintenance of the Project and are summarized in Table 5.1-1.

Borrow pits will be rehabilitated in accordance with the Environmental Protection Plans (Section 4.11).

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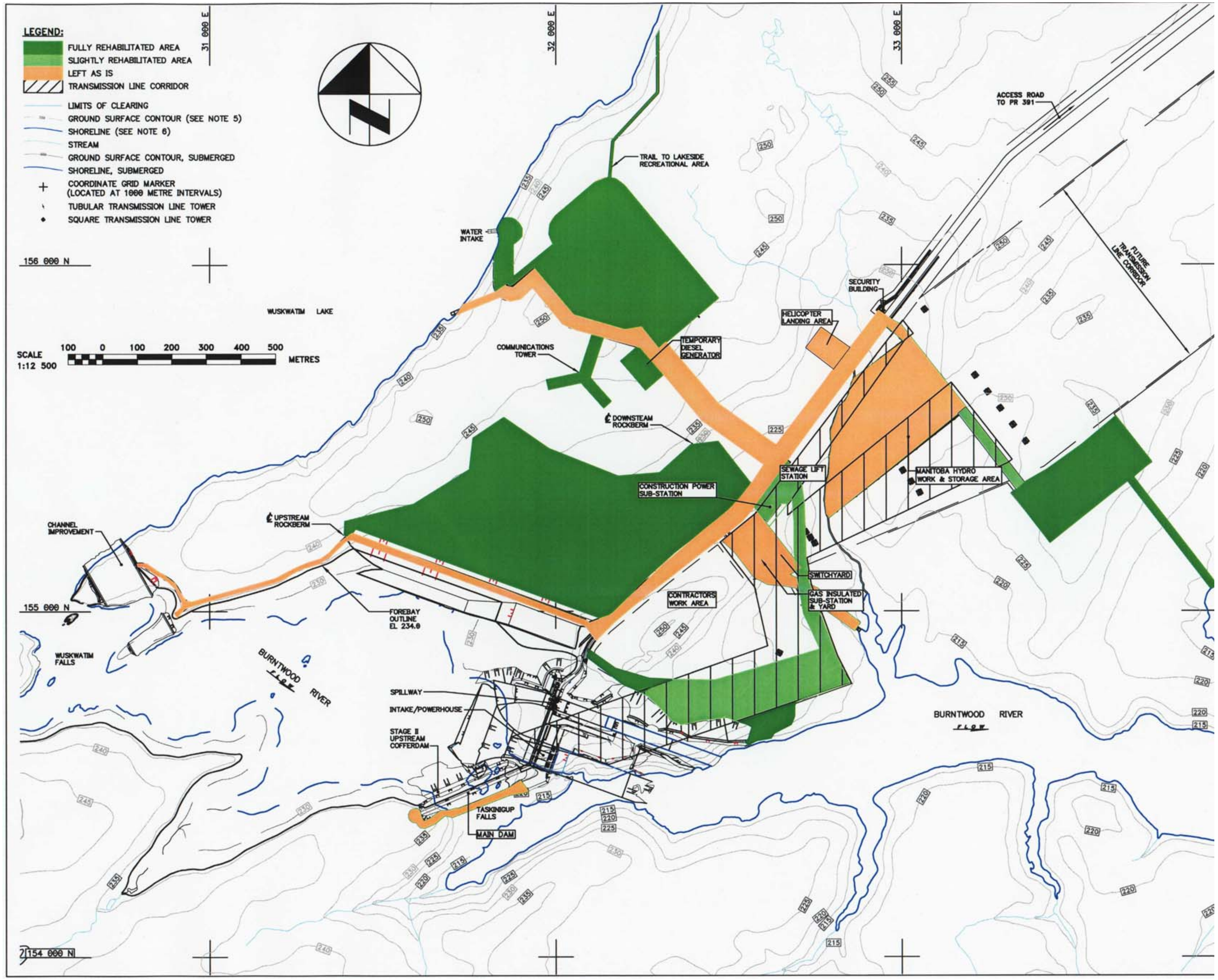


Figure 4.10-1 - Camp and Work Area Rehabilitation Plan

4.11 ENVIRONMENTAL PROTECTION PLANS

As stated in Section 1.3, Manitoba Hydro has made a Corporate Commitment to Environmental Protection. Manitoba Hydro supports the need to protect and preserve the environment affected by its projects and facilities. This goal can only be achieved with the full commitment of staff and contractors at all stages of projects from planning and design through implementation. The preparation and use of Environmental Protection Plans (EnvPP) are a practical and direct implementation of the Corporation's Commitment to responsible environmental stewardship.

EnvPPs are environmental protection guidelines that supplement project design, construction and operating specifications to prevent or minimize adverse environmental effects arising from the construction and operation of the Project. EnvPPs are "user friendly" instructional documents prepared for use as a reference document by field construction and operating personnel.

EnvPPs prescribe practical responses to legislation, regulations, licenses, permits, standards, contracts, agreements, designs and specifications for specific situations at specific locations. They also identify and describe protection measures for sites or features of importance to local communities and individuals.

The EnvPP will be presented in a format that provides the user with quick reference and instruction regarding anticipated environmental concerns. It also describes procedures for dealing with unanticipated situations. The document will be presented in 10 sections:

- Section 1 - States the Corporate commitment to environmental protection and provides directions on how to use the EnvPP.
- Section 2 - Gives the description of work to be completed.
- Section 3 - Describes features of local importance.
- Section 4 - Describes general practices that are used to prevent and minimize environmental impacts.
- Section 5 - Provides site specific environmental protection measures, detailed description of impacted sites which include present land use, terrain sensitivity to activities and mitigative measures
- Section 6 - Provides a description of project environmental and engineering monitoring programs

- Section 7 - Outlines the Project management system including the responsibilities for environmental inspection and enforcement.
- Section 8 - References and Glossary
- Section 9 - Copies of available licenses, permits and special approvals.
- Section 10 - Key Maps

The EnvPP will be subdivided into sections that are applicable to project construction, operation and decommissioning. If the information is not designated as a specific project phase, it applies to all phases. It is intended that all Project staff will be familiar with the contents of the EnvPP. The document will be available at the Project work site. The EnvPP will be attached to tender documents and thoroughly reviewed with Contractors at pre-job meetings. Copies of the EnvPP will be made available for the Contractor's staff. Questions regarding the implementation of environmental protection measures by the Contractor's staff will be directed to the Field Supervisor. Further discussion items regarding the EnvPP will be included on the agendas of regular safety meetings scheduled for the duration of the Project.

The following EnvPPs have been designed for the Wuskwatim Generation Project:

- Wuskwatim Generating Station Access Road Environmental Protection Plan & Monitoring Program.
- Wuskwatim Generating Station Construction Camp Environmental Protection Plan & Monitoring Program.
- Wuskwatim Generating Station Environmental Protection Plan & Monitoring Program.

The EnvPPs have been prepared in draft form and will be finalized after the Environmental Impact Assessment has received regulatory and public review. Draft copies do not include site specific environmental protection measures. These measures will be incorporated into the engineering design and construction practices as specified in regulatory work permits.

5.0 STATION OPERATION

5.1 LANDS REQUIRED

The amounts of land required for the construction, operation and maintenance of Wuskwatim GS excluding the permanent transmission lines and associated works are summarized in Table 2.3-1. The total amount of land to be cleared for construction at site was estimated to be 184.1 ha. Following construction, approximately 120 ha of land will be required for the ongoing operations and maintenance of the Project at site while the remaining land required for construction will be rehabilitated to varying degrees as discussed in Section 4.10. Table 5.1-1 summarizes the Lands Required status following construction. Note that there is no estimated change in the areas for the Access Road and Construction Power Transmission Line.

5.2 GENERATING STATION DESIGN PARAMETERS & OPERATING REGIME

5.2.1 Introduction

The Wuskwatim GS has been planned and will be operated to be respectful of the environment. The key plant parameters of full supply level (FSL) and the **plant outflow capability** have been selected to fit within the boundaries of the current physical environment (Sections 2.6). These plant parameters form the basis of the mode of operation and have been selected from the many potential options available (Section 3). In combination, these plant parameters are expected to result in a project that will cause less environmental damage than the various other options considered.

This section will describe the following:

- the existing CRD operations, licenses and constraints;
- the physical inputs – project inflow;
- the key plant parameters;
- the proposed mode of operation under normal and abnormal conditions;
- special operating conditions;
- the expected Hydraulic Zone of Influence; and
- the expected water levels and flows.

Table 5.1-1 – Summary of Lands Required for Operation of Wuskwatim GS		
Description	Reference Figure	Amount of Land (ha)
Access Road 48 km long road with a 100 metre ROW, between GS site and PR 391.	2.3-1	479
Construction Power Transmission Line 46 km transmission line with a 60 metre ROW, between GS site and Thompson.	2.3-1	272
Granular Borrow Areas *Borrow areas G,H & J – A small portion of the main granular borrow areas will be left accessible with a supply of materials for future maintenance of the GS and the access road.	2.3-1	654*
Impervious Borrow Areas *The main impervious borrow area becomes the areas where the Spillway and Powerhouse channels now exist. There will be no rehabilitation of these areas. If any of borrow area SA-A were required the main portion of that borrow area is within the flooded area of the immediate forebay and within the cleared area.	2.3-2	26*
Permanent Facilities at Wuskwatim GS Table 4.4.1 summarized the clearing areas for the construction of the GS and supporting infrastructure. A number of the areas will be rehabilitated as summarized in the Section 4.10. The remaining areas are required for the permanent operation of the GS and will not be rehabilitated including; 18 ha for the Primary Structures, 21.4 ha for Transmission Corridor Right of Way, 8.5 ha for the Manitoba Hydro work area and storage area, and a portion of the local roads as much as 23.1 ha, 37 ha for the flooded area and 9.5 ha for the high rock area which should not have been touched.	4.10-1	117.5
Flooded Area Land area between Wuskwatim Falls and Taskinigup Falls that will be inundated as a result of construction of the generating station.	2.3-2	37
Rehabilitated Area -Fully Rehabilitated Area (42.8 ha for the Excavated Materials Placement Area, 12.9 ha for the camp area, 7.2 ha for the Sewage Lagoon and Outfall area) -Partially Rehabilitated Area (3.7 ha for Construction power right of way and substation)	4.10-1	62.9 3.7
Water Storage Area A setback line will be established around the reservoir in accordance with accepted procedures to define a safe and practical distance beyond which development could proceed. The setback line forms the upper limits of an easement area which is referred to as the Lands Required for Water Storage Purposes. The lower level of the easement area is based on the reservoir Full Supply Level of 234.0 m	2.3-3	2750

5.2.2 Existing Operations, Licenses & Constraints

The primary purpose of the CRD is to divert water from the Churchill River to the Nelson River to supply the generating stations on the lower Nelson River. Natural inflows to the Rat, Footprint and Burntwood River system combine with the CRD regulated outflows and flow downstream along the Burntwood River through Wuskwatim Lake and on downstream to Split Lake. The existing licenses governing the operation of the CRD are described in Section 4.2 (Volume 4).

The seasonal and monthly regulation pattern of outflows from Notigi Control Structure (CS) that has been experienced since the CRD was fully commissioned in September of 1977 (referred to as post CRD) will remain unaltered as a result of the development of the proposed Wuskwatim GS. The primary purpose of the CRD will also not change as a result of the development of the proposed Wuskwatim GS.

The design and planning for Wuskwatim GS assumes that the CRD will continue to operate as it has been operated to date and that the CRD operation will not be changed as a result of Wuskwatim GS (Section 2.5). The following sections describe how the Wuskwatim GS will affect water levels and flows in the area.

5.2.3 Project Inflows

Inflow to the Project is one of the key inputs considered in the planning, design and operation of a hydro development site.

Manitoba Hydro has developed an estimate of the long-term monthly average inflows or **project inflows** to Wuskwatim Lake, to assess the operation of the Wuskwatim GS under a much longer time period of flow conditions than is available using the 25-year post-CRD (existing) record. See Section 4.3 (Volume 4), for an explanation of the development of the project inflow record. The long-term project inflows are judged to be the best representation of future inflows for assessing the impacts associated with operation of the Project. Manitoba Hydro has also developed an estimate of potential flood flows that are used as input in the design of the various structures (Section 2.5). The operation of Wuskwatim GS under flood flows is briefly described in Section 5.2.5.4. The normal and abnormal operation of Wuskwatim GS is described in Sections 5.2.5.2 and 5.2.5.3 respectively using the project inflows.

Duration curves of the project inflows are shown in Figure 5.2-1. Three groupings are illustrated, a composite set of all monthly inflows, as well as open-water (summer) and ice cover (winter) time periods. The median flow expected over the long term is 980

m^3/s, and varies between a low of 435 m^3/s and a high of 1126 m^3/s. There tends to be more variation in the open-water inflows than the ice-covered inflows. The low inflows (less than 550 m^3/s) tend to be clustered in the summer months of two extended low periods that last approximately five years each.

5.2.4 Key Plant Parameters

The following key plant parameters are essential components of the mode of operation:

- forebay level;
- rated plant discharge/best gate discharge; and
- number and type of units.

The plant parameters are described briefly to provide an understanding of how they affect the mode of operation.

5.2.4.1 Forebay Level

The reservoir (also referred to as the forebay) for the Project comprises two areas, the impounded immediate forebay area and Wuskwatim Lake. The immediate forebay area will be formed between Wuskwatim Falls, the natural outlet of Wuskwatim Lake, and the proposed structures located at the head of Taskinigup Falls. The normal Full Supply Level (FSL) for the reservoir was selected to be elevation 234.0 m ASL. With the Project, Wuskwatim Lake water levels will be stabilized within the **existing water regime** at or very near the FSL most of the time (Sections 2.6 and 3.3).

The area of the forebay at 234.0 m provides a very large body of water covering over 88 square kilometres that can support changes in outflow from Wuskwatim GS within a day without significant changes in the water level. There is a slight elevation change (gradient) between Wuskwatim Lake and the immediate forebay. This gradient varies under different flow conditions, but is typically less than 0.1 metres. As the immediate forebay is just upstream of the generating station and is a smaller surface area, the water levels in the immediate forebay area react over a slightly larger range than Wuskwatim Lake. For the purposes of assessing the Project , the water level range established in the immediate forebay area has been referred to as what could be expected on Wuskwatim Lake. The actual range of Wuskwatim Lake will be less than that presented for the immediate forebay (Volume 4, Section 4.3.3).

Up to one metre of storage has been designated for utilization under abnormal conditions when power demand is high in either the Manitoba Hydro system or that of its neighbours and when inflows are very low. During these infrequent times there will be

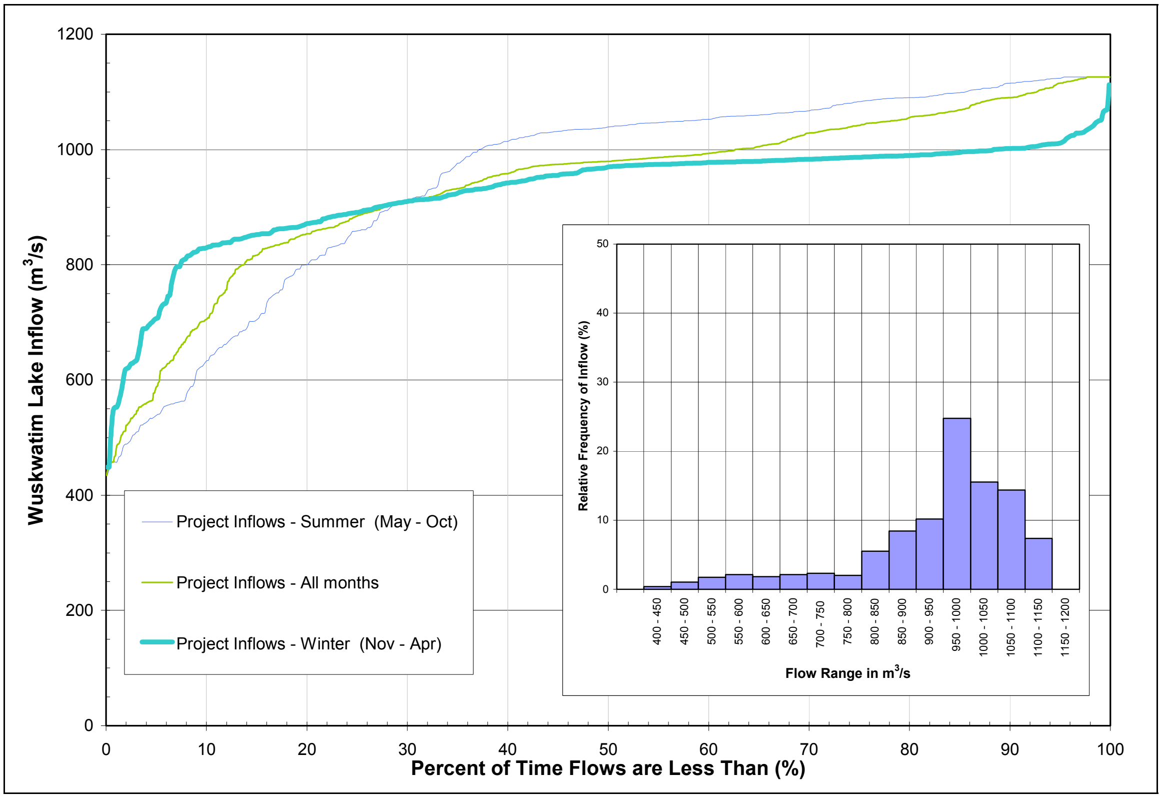


Figure 5.2-1 –Duration Curve of monthly project inflows for all months, summer months and winter months with relative frequency curve of project inflows.

increased usage of the storage to supplement inflows, drawing Wuskwatim Lake as low as 233.0 m (Section 5.2.5.3) The one-metre of storage is also within the existing water regime of Wuskwatim Lake.

The elevation difference between the immediate forebay and the tailrace defines the amount of gross hydraulic head available for power production purposes. The hydraulic head available at Wuskwatim GS will be 21 to 22 m, and range as high as 24.4 m which would occur with one unit operating during the summer or as low as 20.8 m which would occur with three units operating at full gate during the winter.

5.2.4.2 Rated Plant Discharge and Best Gate Discharge

The **rated plant discharge** for the generating station was selected to be 1,100 m^3/s. The rated plant discharge is the maximum outflow that can be used to produce power through the turbines. Most of the plant operation occurs at what is referred to as **best gate,** which is the operating condition corresponding to the most efficient operation of the turbine (Section 5.2.4.3). Generally, for a fixed-blade turbine design, the best gate discharge is selected to be somewhere between 90 and 95 percent of the rated discharge. The selection of best gate follows from a further review of the project inflow frequencies, shown as insert in Figure 5.2-1. Nearly 25 percent of the inflows expected into Wuskwatim Lake occur in the 950 to 1,000 m^3/s range with the most frequent occurring inflow equal to 990 m^3/s. A best gate discharge of approximately 90 percent of the rated plant discharge was selected which establishes the best gate discharge to be coincident with the most frequently occurring inflow. This, coupled with the mode of operation selection as discussed in Section 2.6, reduces the amount of time that the plant will have to vary the outflows to maximize efficient operation. For nearly 50 percent of the time, there will be enough inflow to simply pass it as outflow and maximize efficient operation (Section 5.2.5.2) and also eliminate downstream water level fluctuations due to the operation of the plant (Section 5.2.5.6).

5.2.4.3 Number and Type of Turbine Units

Three vertical shaft, fixed blade propeller type units were selected for Wuskwatim GS. A cross-section view of one of the units is shown in Figure 4.7-8. 'Fixed blade' refers to the fact that the blades are connected to the vertical shaft in a fixed position and the pitch cannot be adjusted. The number and type of units were selected together, with an effort to minimizing environmental effects. The fixed-blade vertical shaft units are considered relatively "fish-tolerant" (Volume 5) and the selection balanced the economics of construction and maintenance against increased generation, as briefly discussed in Section 3.4. The expected efficiency characteristics are described here to assist in the explanation of why most of the operation will be near the 'best gate' discharge.

The three-vertical shaft, fixed blade propeller units each have a narrow range of flows at which they should be operated to maximize efficiency. The efficiency drops off quite quickly, as shown in Figure 5.2-2. The best gate is the most efficient setting and is the target operating condition for most operations, with either one, two or three units operating. The plant will also operate at its full gate operating point at various times as is discussed in Section 5.2.5.1.

5.2.5 Wuskwatim Operation

The EIS Guidelines require that the proponent provide a discussion of river flows and levels, with and without the Project, specifically (Volume 1, Appendix 2):

- "planned, average hourly discharges at the plant"; and

- "under a range of flow and station operating conditions discuss average hourly forebay elevations, tailrace water elevations and water elevations at several downstream locations."

The following section describes how the Project will modify river flows and levels and expands upon the information contained in Section 4.5 (Volume 1). A full discussion on existing conditions (i.e., flows and levels) can be found in Section 4 (Volume 4).

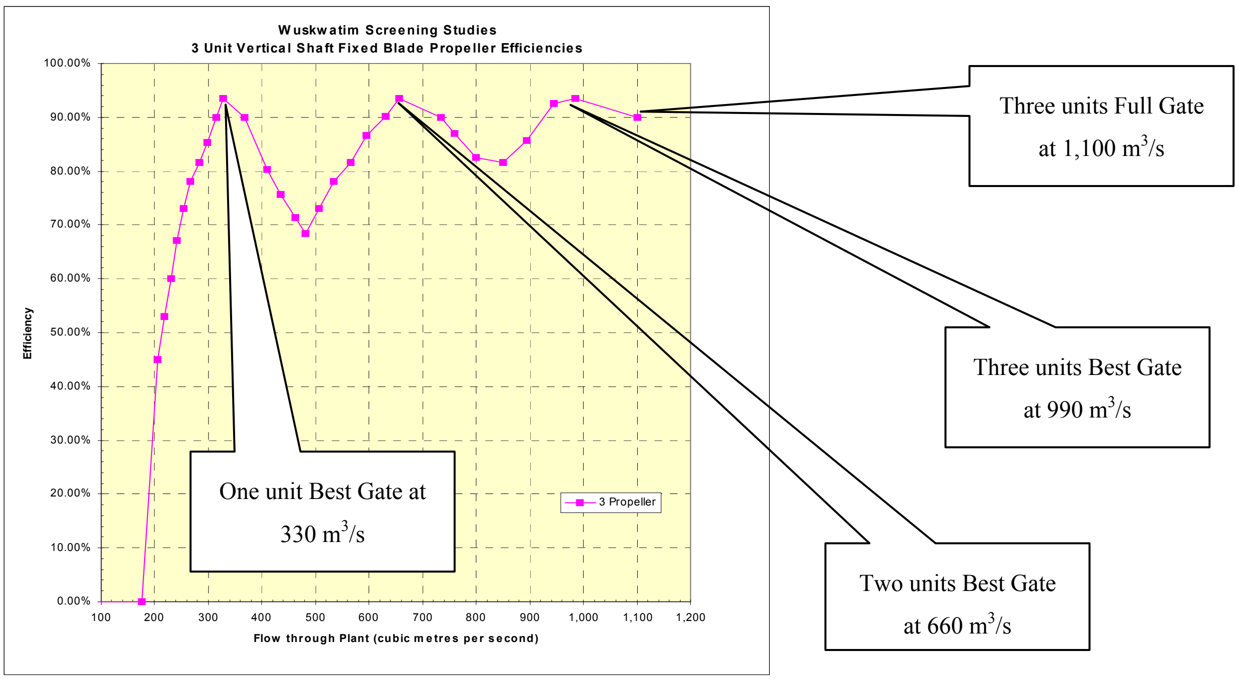


Figure 5.2-2 Key Operating Points illustrated on the Turbine Efficiency Curve for three-fixed blade vertical shaft turbine units.

The purpose of the Main Dam and associated structures is to direct the river flow into the Powerhouse, through the intakes into the scroll case, past control mechanisms called wicket gates, onto the propeller turbine, and then out through the draft tube back into the river. The force of the water turns the propeller, which is connected to a vertical shaft, which rotates a generator producing electricity. Operation and hence the amount of power produced is determined by the wicket gate setting, which regulates the flow through the unit. The wicket gates are controlled by a sophisticated series of governing controls and monitoring systems that are installed in the Wuskwatim GS control room. The plant can be operated on-site or remotely. The pattern of outflows from the plant is dependent on the mode of operation as discussed below.

5.2.5.1 Modified Run-of-River Mode of Operation

The background to the selection of the **Modified Run-of-River Mode of Operation** is described in Section 3.4. Briefly, the mode of operation for Wuskwatim GS was derived by integrating all the relevant physical inputs and constraints with the key plant parameters described above to establish a mode of operation that reduces environmental impacts while providing the flexibility and economic benefits necessary to make the Project viable. The resulting mode of operation has been referred to as a **modified run-of-river** or 'shaping' mode of operation. Simplistically, the Wuskwatim GS outflows will be 'shaped' as a practical measure in such a way as to generally maximize efficient operation. The mode of operation can also be described as a "daily balance cycle" where the project inflows (CRD flows) on any given day will be routed through Wuskwatim Lake in such a way that Wuskwatim GS will be generally operating at or near its most efficient settings (operating points), and pass the same daily average flow downstream. The resulting flow changes are moderated by generally limiting the typical flow change to be the flow from one unit, which is about 330 m^3/s.

The big advantage from a power economics perspective is that the **modified run-of-river** mode of operation provides higher energy production during peak periods as a result of higher outflows during the day and lower outflows during the off-peak periods.

The Modified Run-of-River mode of operation is a modest cycling pattern with smaller daily water level fluctuations than would occur under a peaking mode of operation, and larger daily water level fluctuations than would occur under a rigorous run-of-river mode of operation. The monthly and seasonal water level fluctuations presently experienced as a result of CRD will be virtually eliminated on Wuskwatim Lake and on the Burntwood River up-to and including the downstream portion of Early Morning Rapids. The Modified Run-of-River mode of operation will result in relatively stable water levels on both the immediate forebay and reservoir, as well as moderate daily water level fluctuations downstream.

The Wuskwatim GS turbines can operate over a wide range of flow settings, however, there is only a narrow range of settings at which the turbine unit will operate most efficiently, called the "best gate" setting. Wuskwatim GS outflows will be adjusted to obtain "near" best gate settings as much as possible, alternating between efficient unit settings to balance outflows with inflows on a daily basis. There are therefore three target outflow settings for inflows at or below 990 m^3/s. The following best gate setting discharges are proxies for the three narrow target ranges that were developed for use in the computer models that have been developed for the purpose of simulating the plant operation. These proxies are assumed to represent how the plant equipment will ultimately be manufactured and installed and ultimately operated:

- 330 m^3/s, 1 unit operating at "best gate";
- 660 m^3/s, 2 units operating at "best gate"; and
- 990 m^3/s, all 3 units operating at "best gate".

For inflows greater than 990 m^3/s and less than 1,100 m^3/s there are a number of options. In the shaping mode, the plant outflow can be modified by either alternating between best gate outflow of 990 m^3/s and full gate outflow of 1,100 m^3/s or by alternating between best gate outflow of 990 m^3/s and something less than full gate outflow of 1,100 m^3/s. Alternatively, under these inflow conditions, the plant can be operated by simply passing the inflow unmodified. For assessment purposes, the option of alternating between best gate outflow of 990 m^3/s and a full gate outflow of 1,100 m^3/s was chosen. This is a conservative approach to the assessment, since it would result in more and larger fluctuations of outflows than are likely to occur.

5.2.5.2 Operations under Normal Conditions

It is estimated that Wuskwatim GS will normally operate in the modified run-of-river mode for about 97.5% of the time with the plant shaping outflows to balance daily inflows. This will be accomplished by turning one unit on and off during the day or by adjusting the turbine flow when all units are on. For the remaining 2.5% of the time, a combination of low-inflow conditions and high or unusual power demands may require deviations from the above normal operation, as discussed in Section 5.2.5.3.

Upstream

Wuskwatim Lake water levels will be stabilized within the **existing water regime** at or very near the FSL (234.0 m ASL, wind and wave eliminated) most of the time.

The typical daily water level fluctuations (difference between high for the day and low for the day) of Wuskwatim Lake are estimated to be about 0.06 m excluding the effects from wind and waves. The normal maximum daily water level fluctuation of Wuskwatim Lake is estimated to be about 0.13 m excluding the effects from wind and waves (Figure 5.2-8). Normally the reservoir will be in the top 0.25 m below the FSL, drawn and reponded over short periods (three to five days).

The one metre storage range on Wuskwatim Lake has been divided into five zones (Figure 5.2-3) to assist in estimating expected frequencies. The top two zones would be used under normal conditions. The lower three zones would be used under abnormal conditions (described in Section 5.2.5.3).

The top zone (Zone 1) is 0.13 m, ranging from elevation 234.0 m to elevation 233.87 m, and will be used regularly as part of the modified run-of-river mode of operation. The reservoir will be in this zone most (approximately 85%) of the time. In fact more than 50% of the time the forebay is not expected to vary from the FSL.

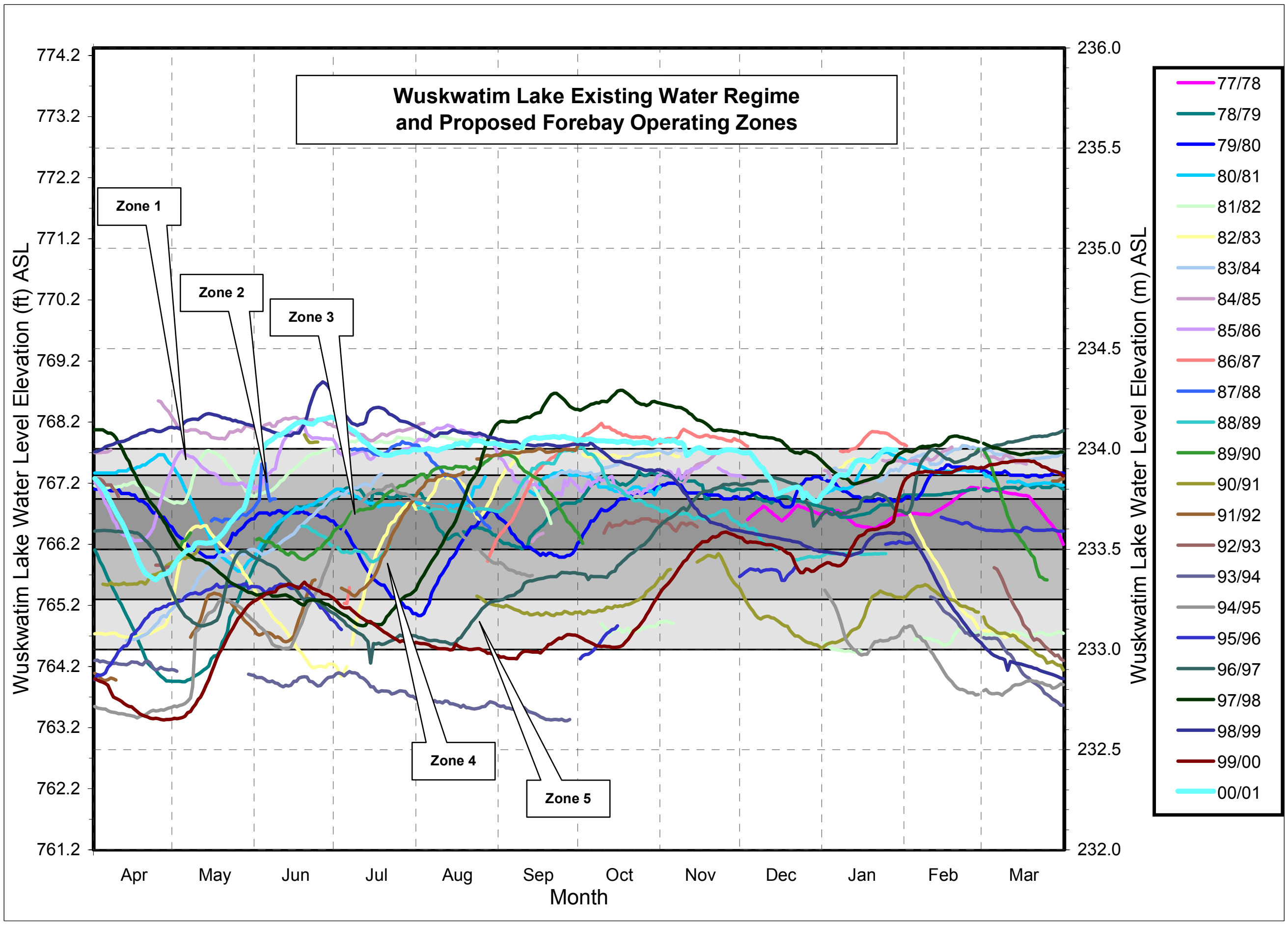


Figure 5.2-3 Wuskwatim Lake – Existing Water Regime with proposed Forebay Operating Zones.

The second zone (Zone 2) is 0.12 m, ranging from elevation 233.87 m to elevation 233.75 m, and may be used regularly when the inflows drop below about 880 m^3/s. The reservoir will be at or above 233.75 m about 97.5% of the time. The reservoir may be drawn into this zone for brief periods (three to five days) multiple times a year. This may either occur in the open water or ice cover periods. Zone 2 operation would be infrequent, but not abnormal.

Downstream

The outflow pattern resulting from the Modified Run-of-River mode of operation will be constrained to moderate the downstream water level fluctuations. This will be accomplished by limiting daily water level fluctuation due to the operation of Wuskwatim GS on Birch Tree Lake to less than 0.10 m during the open water period (not including wind and wave effects) and 0.15 m during ice cover period (herein referred to as the Birch Tree Lake Stability Guideline). Generally this will be accomplished by avoiding large, sustained (greater than 4 hours) flow changes. There may be other smaller flow changes sustained for longer periods (i.e. a one unit flow change of 330 m^3/s for durations of up to 12 hours) but this will not result in a daily water level fluctuation through Birch Tree Lake of more than 0.10 m (0.15 m winter). For example, for a daily inflow of 825 m^3/s, the plant would operate at a 3 unit 'best gate' outflow of 990 m^3/s for 12 hours and then at a 2 unit 'best gate' outflow of 660 m^3/s for the remaining 12 hours (Figure 5.2-4). Table 5.2-1 summarizes the normal operation for various inflow conditions. At times there may be uncontrollable events, such as local rainstorms or abnormal ice phenomena, which may not allow adherence to this guideline.

5.2.5.3 Operations Under Abnormal Conditions

There will be times when additional power or energy would be required above and beyond what the station would normally be producing. Such conditions could occur at any time and may last for varying durations. Up to one metre of Wuskwatim Lake storage has been designated for utilization under abnormal conditions when power demand is high in the Manitoba Hydro system or that of its neighbours and inflows are very low. The storage can only practically be utilized under low flows, and increased drawdown would be used under progressively lower flows and more prolonged energy requirements to supplement the existing inflows. The degree that the forebay may be used depends on how low the flows are, and on the nature of the unusual loading conditions. The storage would most likely only be required during the summer, as that is when most of the very low flows are expected to occur and (use of the storage) will be limited by the Birch Tree Lake Stability Guideline discussed in Section 5.2.5.2.

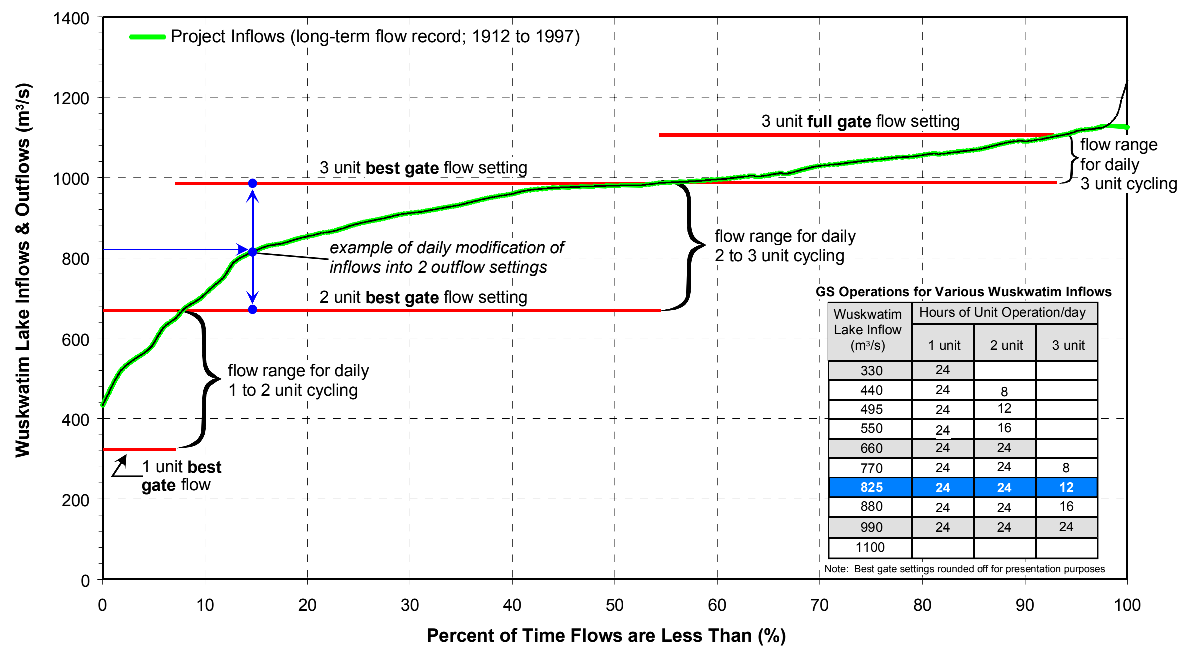
TABLE 5.2-1
NORMAL OPERATION
DISTRIBUTION OF NUMBER OF TURBINE UNITS OPERATING FOR VARIOUS INFLOW CONDITIONS

River Inflow Range (m^3/s)	Duration	First Unit*	Second Unit*	Third Unit*	Spillway
1100 plus	7 %	Continuous	Continuous	Continuous	As required
990 – 1100	39 %	Continuous	Continuous	Continuous	Not normally required
875 – 990	30 %	Continuous	Continuous	16 to 24 hours ** (during on-peak)	Not normally required
660 – 875	17 %	Continuous	Continuous	0 to 15.9 hours **	Not normally required
550 – 660	4 %	Continuous	16 to 24 hours ** (during on-peak)	Not normally in operation	Not normally required
434 – 550	3 %	Continuous	8 to 15.9 hours **	Not in operation	Not normally required
Total	100 %				

* Any individual unit may be selected to be first on at any particular time depending on unit choice and availability. Units will usually be operated at **best-gate** setting; except for flows greater than 990 m^3/s. For flows greater than 990 m^3/s, the outflows will EITHER be uniformly distributed among the three units or the plant full gate outflow will be utilized as required. Maintenance and inspections will be scheduled to cause minimal disruption to the normal operations.

** Partial daily operation is expected to occur during "on peak" hours.

Manitoba Hydro, as part of regional power grid (Figure 1.4-2), has been typically called upon in the past to provide Manitoba Hydro's portion of the regional reserve of electricity, either in spinning (meaning the turbines are rotating but not producing power) or ready form (on-line producing power but can increase the amount of power produced), at least once almost every day. The average time between calls from neighbouring electricity suppliers for reserve is 1.75 days. Most of the calls are of very short duration, usually less than 30 minutes. Operation at Wuskwatim GS to accommodate an abnormal request for power would not be distinguishable from normal operations, because of the very short time frame involved. However, there are situations when the forebay storage could be used to provide additional energy over a longer time period, during very low flows requiring additional draw down. A big advantage of Wuskwatim storage is that it is available immediately to serve any unusual power demand.



Wuskwatim Lake Inflow (m³/s)	Hours of Unit Operation/day		
	1 unit	2 unit	3 unit
330	24		
440	24	8	
495	24	12	
550	24	16	
660	24	24	
770	24	24	8
825	24	24	12
880	24	24	16
990	24	24	24
1100			

*Example of GS flow modification. For a daily inflow of 825m³/s, the plant would operate at a 3 units "**best gate**" flow of 990m³/s for 12 hours and then at a 2 units "**best gate**" flow of 660 m³/s for the remaining 12 hours (see insert table).*

Figure 5.2-4– Example Operation for an inflow of 825 m³/s.

Upstream

The forebay range has been divided into five zones (Figure 5.2-3). The upper two zones are described in Section 5.3.5.2 Operations under Normal Conditions. The lower three zones reflect abnormal conditions.

The reservoir cannot normally be drawn down below Zone 1 when inflows are above average conditions. The reservoir will not normally be drawn below Zone 2 unless flows are in the lower decile. Therefore, it is only under low inflow conditions that the forebay may be drawn below Zone 2. Abnormal operation will become more extreme as inflow and loading conditions become more problematic or extreme. An estimate of degree of reservoir usage and duration of abnormal operation (based on project inflows) is illustrated in Figure 5.2-5, and discussed below.

The third zone (Zone 3) is 0.25 m, ranging from elevation 233.75 m to elevation 233.50 m, and may be used during periods when the inflows are below about 660 m^3/s (7 percentile). On average, the low summer inflows occur about one month per year. However, the project inflow record suggests that low inflow periods tend to "cluster" where there are about five consecutive low flow years, followed by ten to fifteen years of more normal flows (Volume 4, Section 4-3.1). It is expected that during a summer with such low inflows, the reservoir may be drawn into this zone about three times. For example, this may result in drawing down into this zone (and responding back to Zone 1 or 2) for four to seven days, three times a summer for five consecutive summers, and then not entering this zone for some ten years. The extent of the excursions into Zone 3 would look similar to the existing monthly and seasonal water level variations that are observed on Wuskwatim Lake, although they would occur with significantly less frequency than they do now.

The fourth zone (Zone 4) is 0.25 m, ranging from elevation 233.50 m to elevation 233.25 m, and may be used under low summer inflows and unusual prolonged loading conditions. It is expected that once in a low flow year (inflows less than 660 m^3/s) the reservoir may be drawn into this range during the open water period. For example, this may result in drawing down into this zone (and responding back to Zone 1 or 2) for a period of seven to ten days, once a year for five consecutive summers, and then not entering this zone for some ten years.

The fifth zone (Zone 5) is 0.25 m, ranging from elevation 233.25 m to elevation 233.0 m , and may be used under extreme low flows and unusual prolonged loading conditions. It is expected that such low summer inflows will occur in only one of seven years, and such extreme loading conditions will occur only once in three years. Thus, drawing into this low range will only occur about one in twenty years. For example, this may result in drawing down into this zone (and responding back to Zone 1 or 2) for a period of four to seven weeks, once a low-flow “cluster”, and then not entering this zone for some twenty years.

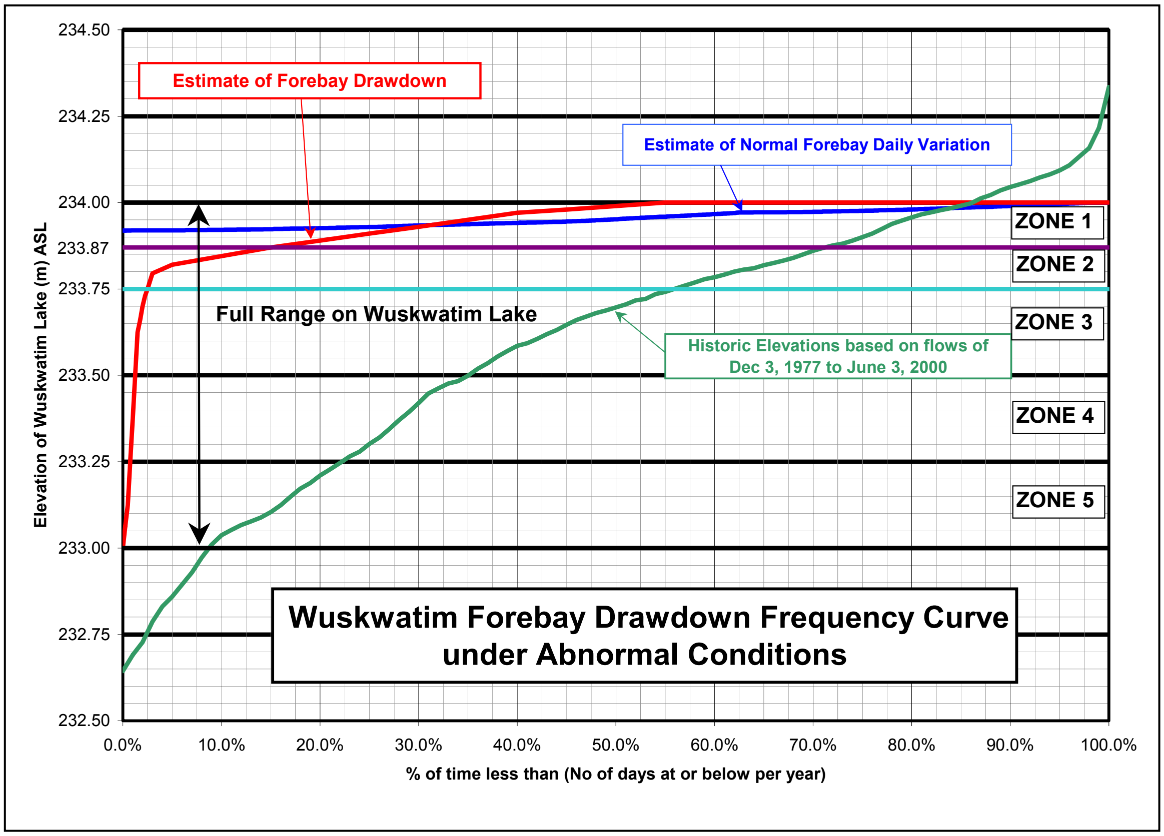


Figure 5.2-5 – Wuskwatim Forebay Drawdown Duration Curve under Abnormal Conditions

Downstream

The outflow pattern from Wuskwatim GS will follow the normal pattern as described in Section 5.3.5.2. The difference will be that the average daily outflow will be slightly greater than the average inflow during periods of drawdown of the forebay, and slightly less than average inflow during periods of re-ponding. All operation will be constrained by the Birch Tree Lake Stability Guideline which limits the daily water level fluctuation on Birch Tree Lake to less than 0.10 m in the summer and 0.15 m in the winter.

5.2.5.4 Wuskwatim GS and Spillway Operations during Special Operating Conditions

Over the life of the Project there may be several situations where Wuskwatim GS and Spillway will not be operated in the normal or abnormal modes as described in Sections 5.3.5.2 and 5.3.5.3. Situations would include one-time conditions like Stage II cofferdam construction and forebay impoundment, assuming the Project does not require any re-construction within the 100 year design life. After the initial completion of the Project, situations like unit commissioning (a series of tests associated with new equipment) will only occur once per unit, approximately every 25 years during major unit overhauls.

Scheduled maintenance can be expected to occur at least once every year for each unit. Situations that give rise to management of flood flows and emergency operation are impossible to predict, but operations for these conditions are described none-the-less.

Stage II Cofferdam Construction

The Burntwood River's flow will be diverted through the open Spillway as part of the Stage II Diversion (Section 4.6.8). Closure of the Stage II upstream cofferdam will be accomplished under normal CRD operation. CRD operation will not be modified to assist in the closure activities.

Forebay Impoundment

The flow through the Spillway will be regulated to raise (impound) the water in the immediate forebay, and if required, in the Reservoir (Wuskwatim Lake) to the Full Supply Level of 234.0 m in a controlled manner at the time specified in the construction schedule (October, 2008, Figure 4.2-1). There will not be any flow through the turbines during this event as the turbine installation will be incomplete at that time. The rate of impoundment will be limited by the CRD inflow conditions that occur at that time. The rate of water level increase in the immediate forebay area will be limited to approximately 0.5 to 1.0 m per day, which will result in impoundment being complete in about 7 to 14 days.

Unit Commissioning

The Spillway will be utilized in conjunction with the turbine flow control systems during the unit commissioning period, as required, to maintain a stable forebay and to maintain the scheduled CRD flows. The turbine unit commissioning period will begin with the first unit scheduled to be on line in May, 2009 and will take approximately 6 months with the final unit to be on line by the end of September, 2009. As each unit is commissioned and put on-line, it will most likely be operated at Full Gate until all units are available. Once all the units are fully commissioned, the plant will follow the modified run-of-river mode of operation as the routine operating mode.

Scheduled Maintenance

Each turbine-generator assembly generally requires an annual outage to allow plant maintenance staff to complete a full inspection and perform any necessary maintenance. The outage will be scheduled to minimize disruption to the normal operations. During the maintenance period, the other two units will generally be operated at full gate settings and run continuously 24 hours a day at those settings, with any excess water being spilled. Generally, the maintenance will be undertaken when the CRD flows are scheduled to be lowest during the open water season. Each unit could normally be out of service for up to two weeks to allow a complete inspection of all components.

Trashracks will be cleaned routinely (about every other month) or as required throughout the open water time-period without impacting normal operations. Plant maintenance staff typically perform trashrack cleaning using the site mobile crane with a clam bucket attached to the cable. The clam bucket is dropped into the water immediately upstream of each intake gate (there are three intake openings for each turbine-unit) and the debris is grappled and hauled to the surface and deposited into a maintenance truck which hauls the debris to a storage area for drying and final disposal.

Management of Flood Flows

The Spillway is operated to manage flow conditions that may exist and cannot be controlled satisfactorily by regulation of the flow through the turbine units. The turbines can generally handle all flow conditions up to and including the plant outflow capability of 1,100 m^3/s. The only exception to this is when one or more units are down for maintenance and then the Spillway may be required to assist in passing the desired outflow. A defined set of procedures will be developed to ensure safe passage of flood flows and that all regulations and License constraints are maintained to the extent practicable.

Spillway gates regulate the amount of flow passing through the Spillway. The Spillway gates are controlled through a hoist mechanism which must be operated by qualified plant personnel. The decision regarding how much water must be diverted through the Spillway is determined by the System Operations Centre. Once the desired amount of spill has been determined, the gates are adjusted as required. Most of the time the Spillway will not be used.

During the passage of the **IDF**, Wuskwatim GS is assumed to be incapable of passing any water through the turbines and all flow will have to pass through the Spillway. For example, for inflows greater than the 1:1,000 year flood, with no generating capacity, Wuskwatim Lake will rise above the normal maximum FSL of elevation 234.0 m. During the passage of the **IDF,** Wuskwatim Lake is expected to rise to 235.6 m ASL, and the immediate forebay area is expected to rise to 235.5 m ASL, as discussed in Section 2.5.

Emergency Mode of Operation

The mode of operation could be deviated from the modified run-of-river mode (i.e., typically consisting of flow changes corresponding to one generating unit, Section 5.2.5.2) under highly unusual conditions which could result in a flow change corresponding to two generating units. This type of operation would be considered an emergency mode of operation. The necessity to operate in this fashion could come about under very infrequent low outflow conditions when only one unit is operating (about 3% of the time) and coincident failure of Manitoba Hydro's HVDC transmission system (removing a significant amount of Manitoba Hydro's generation capability). The combination of very low flows and loss of the HVDC transmission system is estimated to have very low likelihood of occurring (less than once in about 90 years). If such an emergency situation did occur, Manitoba Hydro would take extraordinary measures to keep the electrical system functioning, such as maximizing imports, maximizing thermal generation, cutting curtailable loads and other emergency management options. Such circumstances could result in a change from 1 unit best gate to 3 units full gate operation at Wuskwatim GS which would cause an outflow increase of 770 m^3/s resulting in a tailwater level increase of 2.75 m. The use of the Wuskwatim GS under such emergency conditions is likely to be of short duration, i.e., 10 minutes to 1 hour. The short-term increase in tailwater water levels will be largely dampened out by Opegano Lake. If the Wuskwatim GS full gate operation was required for longer periods, the water levels at Birch Tree Lake could be affected. Manitoba Hydro would take all practicable measures to keep within the Birch Tree Lake Stability Guideline.

5.2.5.5 Hydraulic Zone of Influence on the Burntwood Waterway

The Hydraulic Zone of Influence along the Burntwood River was determined by studying the water levels and flows that will result along the waterway both during construction of the Project and after the Project is commissioned and in commercial operation (Volume 4, Section 4.3). The upstream and downstream daily water-level and flow changes resulting from Wuskwatim GS normal operation are used as input into the various environmental studies. The areas studied include:

- Burntwood River from Early Morning Rapids to Wuskwatim Lake;
- Wuskwatim Lake;
- immediate Wuskwatim GS forebay;
- tailrace area;
- Opegano Lake;
- Birch Tree Lake;

- Burntwood River in the Thompson area;
- Apussigamasi Lake inlet; and
- upstream area of First Rapids.

Upstream

The construction of the Wuskwatim GS will result in higher water levels at the site. The water levels will rise approximately 7 metres in the immediate forebay area and cause a backwater effect through the immediate forebay area to Wuskwatim Lake. The backwater effect extends upstream to the foot of the next set of rapids on the Burntwood River called Early Morning Rapids. The forebay elevation of 234.0 m ASL combined with the normal mode of operation will stabilize the upstream water levels near 234.0m. The backwater effect does not flood out the rapids at Early Morning nor does the backwater progress through the rapids because of hydraulic conditions. Hence, the water levels upstream of that point will not be affected by Wuskwatim GS. Water levels upstream of Early Morning Rapids are only affected by Churchill River Diversion (CRD) flows.

Downstream

The downstream limit of the 'Hydraulic Zone of Influence' was determined by assessing how far downstream the water levels and flows will no longer be significantly affected by the Wuskwatim GS mode of operation. A wide range of project inflow conditions, both open water and ice cover seasons were studied to determine how far downstream the effects were noticeable.

5.2.5.6 Results under Normal Mode of Operations

The mode of operation estimates of the water regime characteristics were developed by first determining the sub-hourly (10 minute intervals [timesteps]) outflow patterns that could result from the normal operation (Section 5.2.5.2) of Wuskwatim GS for each month of the 86 year project inflow record. The plant outflows for all the months (over 1,000 scenarios) were then routed through the waterway using two different hydraulic models. The HecRas hydraulic model was utilized for open water conditions and the IceDyne hydraulic model was utilized for ice cover conditions (Volume 4, Appendix 4A-5). The resulting plant sub-hourly plant outflows, the sub-hourly water levels and flows, and associated maximum daily water level fluctuations at all the locations described in Section 5.2.5.5 for each day of operation have been summarized and compiled into **duration curves.** The duration curves provide inferences about the frequency of occurrence for each of the various water regime characteristics in addition to the normal maxima and minima. It should be noted that in producing the estimates, only one day for each month was modelled during the open water period as each day of the month was assumed to have the same inflow and the operating pattern would be repeated for each day that the inflow was constant. Because of the way ice processes evolve through the winter, each day of the month was modeled during the ice covered period.

The 50 percentile and maximum daily water level fluctuations for open water and ice covered periods from the normal mode of operation simulations are shown in Figure 5.2-6 and Table 5.2-2. The figure indicates that the daily water level fluctuations decrease with distance downstream from Wuskwatim GS.

The largest fluctuations in downstream water levels will occur in the 9 km river reach from the tailrace to the set of rapids 4 km upstream of Opegano Lake. Review of the typical daily water level fluctuations in Table 5.2-2 indicates that the typical daily water level fluctuation in Opegano Lake is around 0.1 m and that by Birch Tree Lake, the typical daily water level change is in the 2 to 3 cm range. The typical daily water level fluctuations in the lakes further downstream from Birch Tree Lake are even less. The typical daily water level fluctuation on Birch Tree Lake is deemed to be negligible and would be difficult to distinguish from wind-generated waves. Birch Tree Lake was therefore judged to be the downstream boundary location of the physical effects from the operation of Wuskwatim GS and was used as input into the environmental studies.

Duration curves of all the plant outflows resulting from normal operation and all project inflows considered are shown Figure 5.2-7. This figure clearly shows the target outflows described in Section 5.2.5.1 and also shows the amount of time over the life of the Project that the plant is estimated to be operating at the various target outflows. The estimates of time are summarized below:

- 330 m^3/s - 3% of the time;
- 660 m^3/s - 18%;
- 990 m^3/s - 52%;
- 990 to 1,100 m^3/s - 20%; and,
- over 1,100 m^3/s - 7%.

The water levels (duration curves of the results from all the project inflows) resulting from the computer simulations of normal operation at Wuskwatim GS for Wuskwatim Lake (using the immediate forebay as a proxy for the whole lake), Wuskwatim Tailrace, Opegano Lake and Birch Tree Lake are shown in Figures 5.2-8, 5.2-9, 5.2-10 and 5.2.11, respectively. The distinctive shape of the water level duration curve for the tailrace under open-water conditions in Figure 5.2-9 is associated with the typical plant outflows shown in Figure 5.2-7. The other downstream locations do not exhibit the same distinctive shape because the river channel and lakes downstream of the Wuskwatim GS dampen the flow changes that are made at Wuskwatim GS. At the Wuskwatim tailrace, the ice-covered period does not illustrate the same distinctive shape because the winter ice processes evolve as the winter progresses resulting in slightly different water levels even though the outflow pattern does not necessarily change.

The water level duration curves for Opegano Lake and Birch Tree Lake illustrate the distinctive shape of the project inflow duration curves shown in Figure 5.2-1. This is expected, especially when looking at a summary of all the results and not a sequential flow or water level hydrograph, because after the inflows are modified by Wuskwatim GS operations, the outflow pattern becomes dampened as the flows move downstream. The further downstream, the more dampened the flows become. The modifications of the outflows resulting from Wuskwatim GS operation, diminish to such an extent that, when all the flows are summarized in a duration curve, the distribution of the downstream Project outflows , and hence the distribution of the downstream water levels do not look much different than the shape exhibited by the inflows into Wuskwatim Lake.

Water level changes on Opegano Lake are a function of daily outflow change (i.e. ranging from 0 m^3/s to 330 m^3/s) and the number of hours per day of operation at each outflow setting. Figure 5.2-12 shows the maximum daily water level fluctuation of Opegano Lake for a variety of Wuskwatim Lake inflows. For inflows near 660 m^3/s and 990 m^3/s there will be minimal daily moderation of plant outflows and therefore no daily water-level fluctuations will occur in Opegano Lake. For inflows greater than 1100 m^3/s, there will be no changes in plant outflows and therefore no water-level fluctuations. The largest daily water-level fluctuations will occur for inflows that are in the mid-range between these flows. For example, for an inflow condition of 825 m^3/s, as previously described in Section 5.2.5.2, the plant will operate for 12 hours above and then 12 hours below the inflow.

The predicted water regime has also been characterized in more detailed forms including; estimates of the velocity distribution along the river for various inflow conditions, estimates of the amount of shoreline that will be wetted and un-wetted during the various operations for use in specific environmental assessment studies and comparison of the future water levels with and without the Project. All the results are documented in the Section 4 of Volume 4

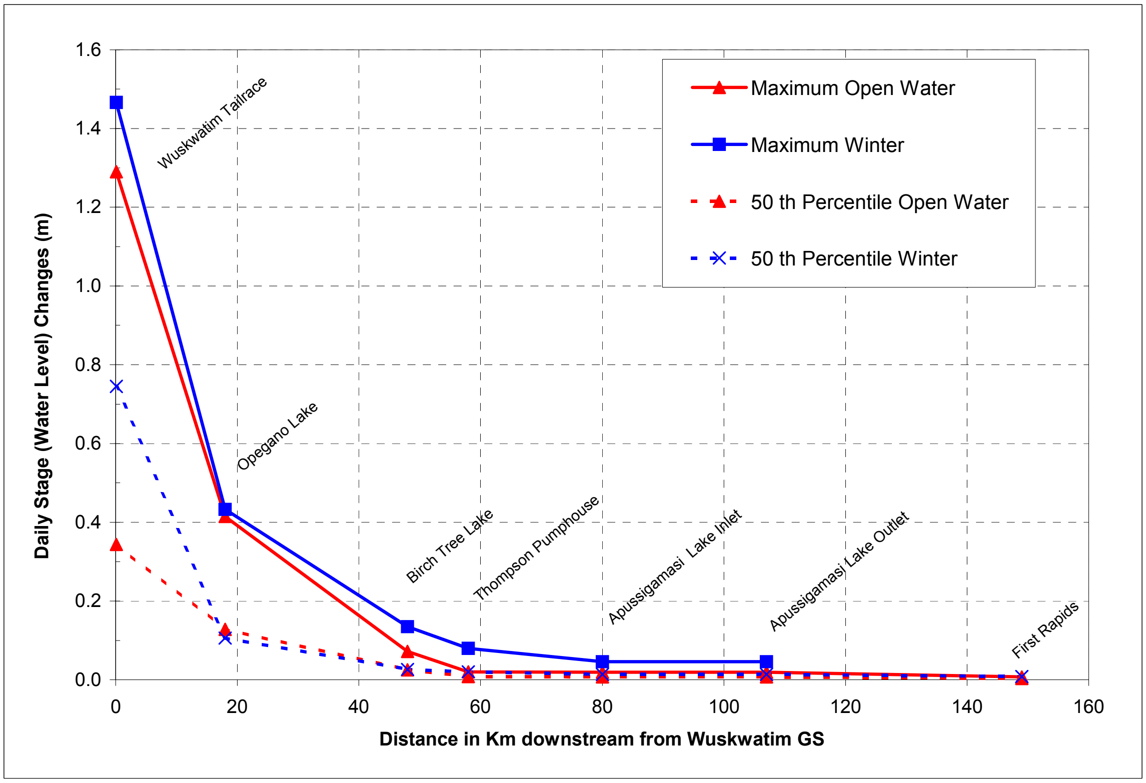


Figure 5.2-6. – Spatial Distribution of Downstream Daily Water Level Fluctuations

Table 5.2-2
Summary of Daily Water Level Fluctuations in metres
for Normal Operation

Location	Maximum Daily Water Level Fluctuations in metres					
	Maximum of all events		50 th Percentile of all events		Average of all events	50 th Percentile of all events
	Open Water Time period	Ice Cover Time Period	Open Water Time period	Ice Cover Time period	Composite (Open Water and Ice Cover events combined)	
Wuskwatim Lake	0.130*	N/A	0.063	N/A		0.063
Wuskwatim Tailrace	1.293	1.466	0.344	0.745	0.595	0.418
Opegano Lake	0.415	0.433	0.128	0.106	0.158	0.125
Birch Tree Lake	0.072	0.135	0.025	0.026	0.038	0.025

* Note preliminary calculations indicated that the maximum was 0.13 m. A review of the calculations determined that the duration curve in Figure 5.2-8 better represents the distribution for Wuskwatim Lake.

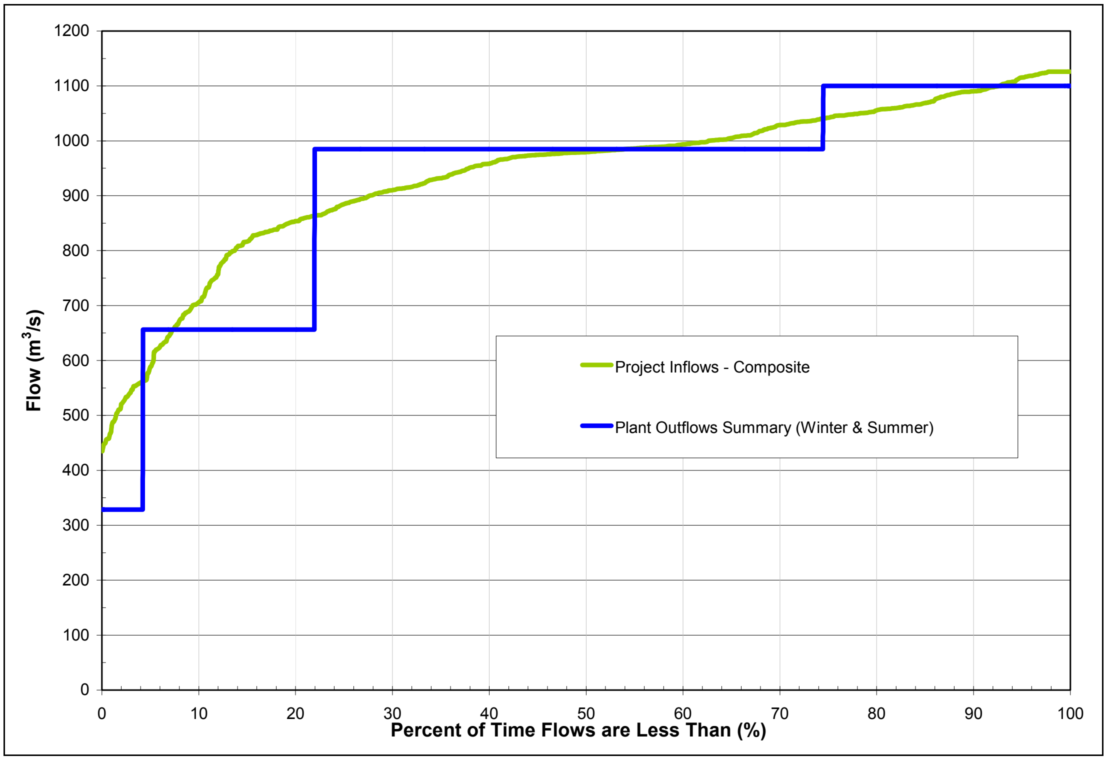


Figure 5.2-7 – Duration curves of summer and winter project inflows and projected Wuskwatim GS outflow summary.

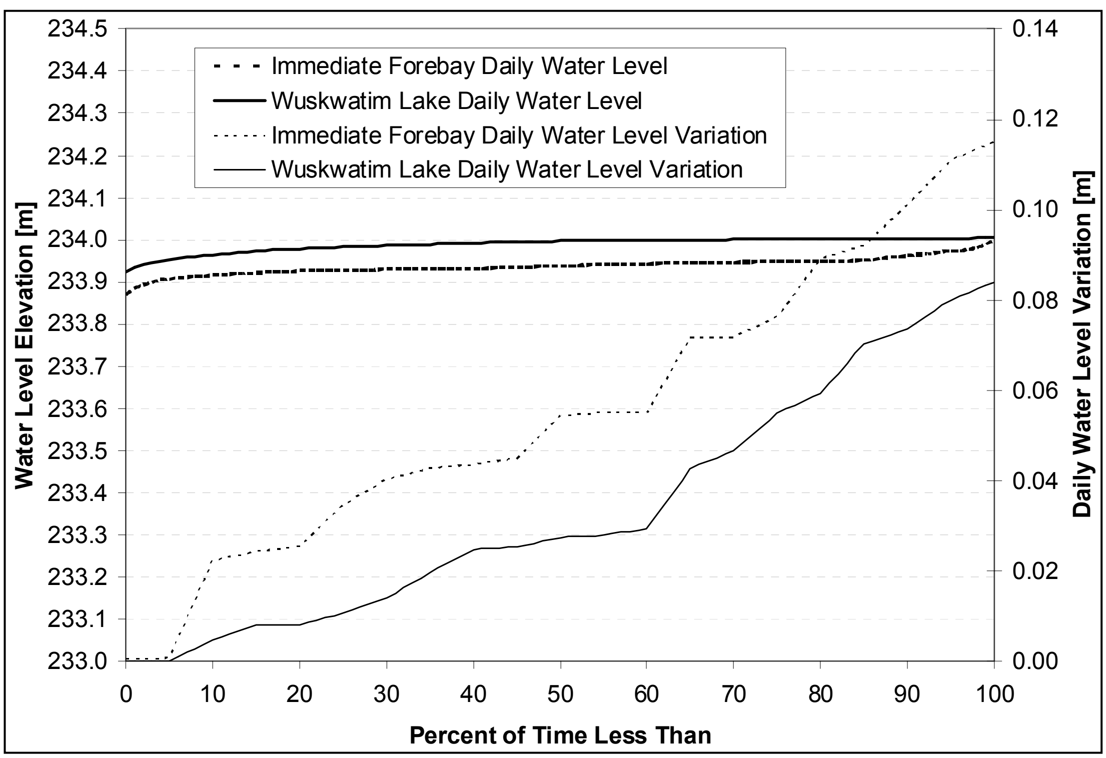


Figure 5.2-8 – Duration Curves of Future Immediate Forebay and Wuskwatim Lake Water Levels and Maximum Daily Water Level Fluctuations

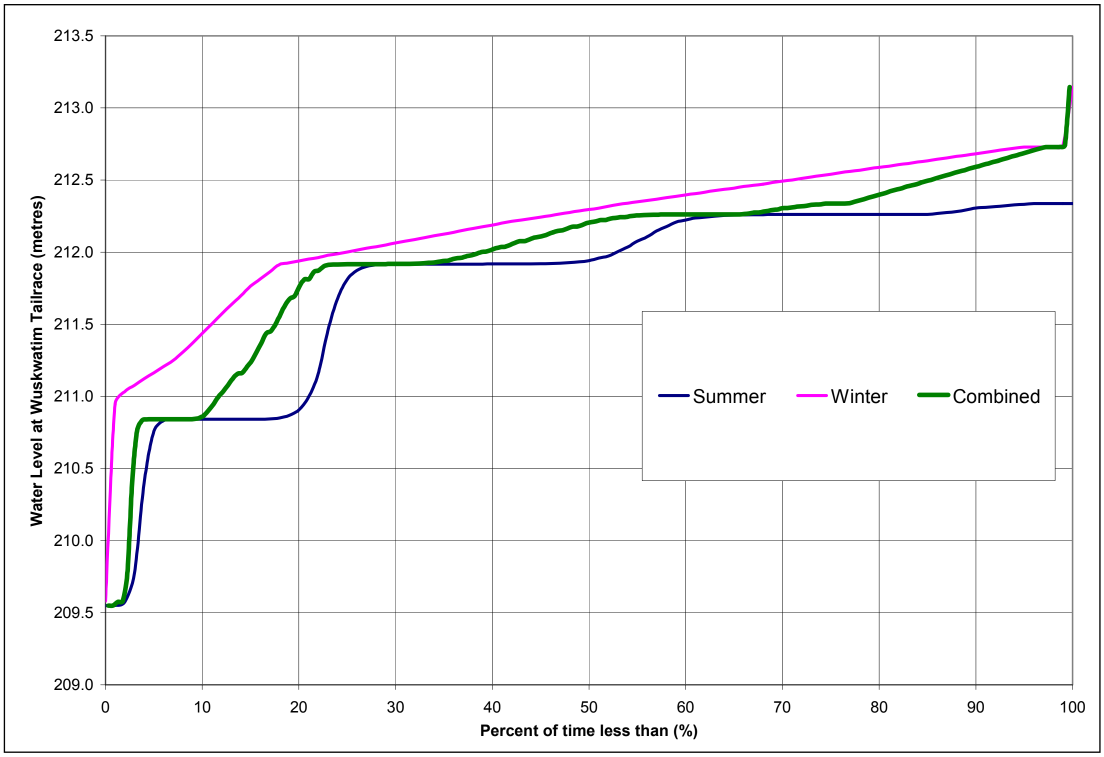


Figure 5.2-9 – Duration Curve of Future Wuskwatim Tailrace Water Levels

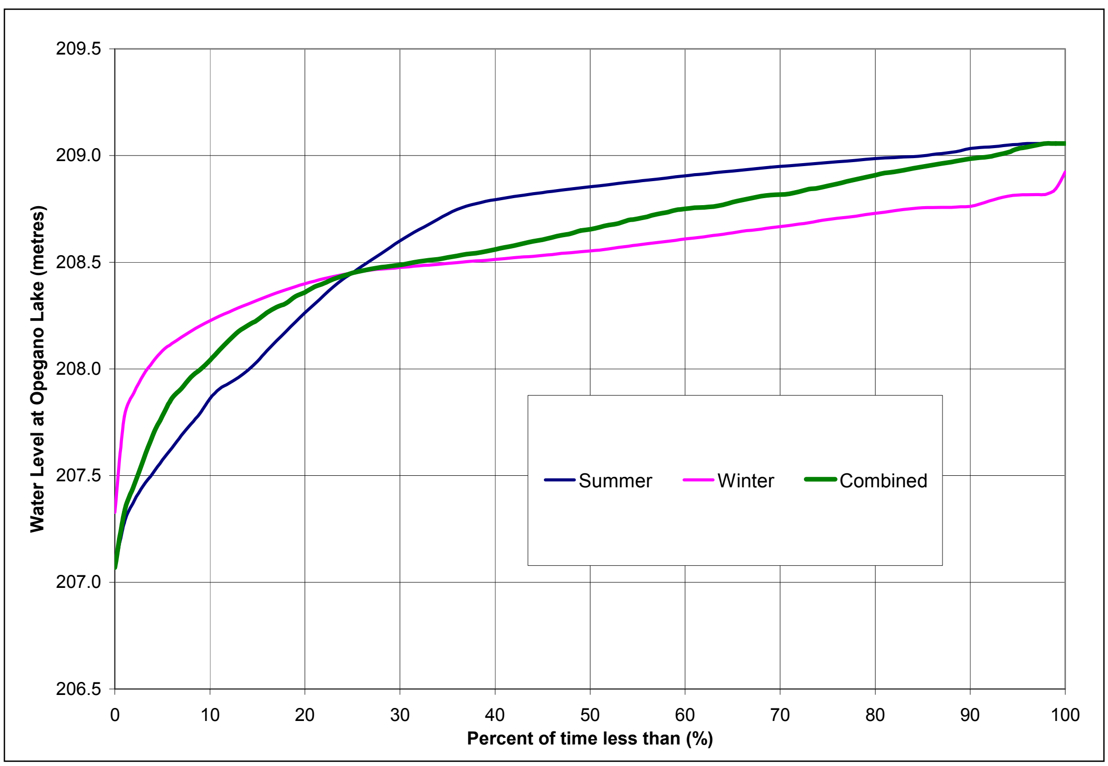


Figure 5.2-10 – Duration Curve of Future Opegano Lake Water Levels

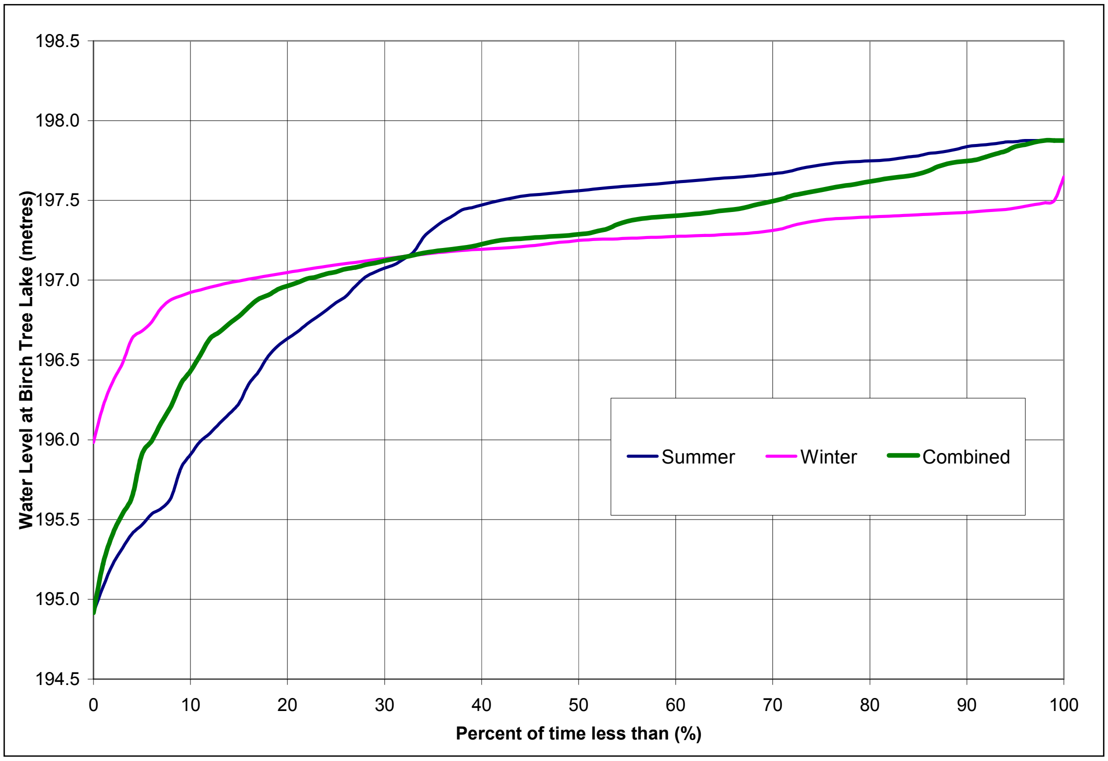


Figure 5.2-11 – Duration Curve of Future Birch Tree Lake Water Levels

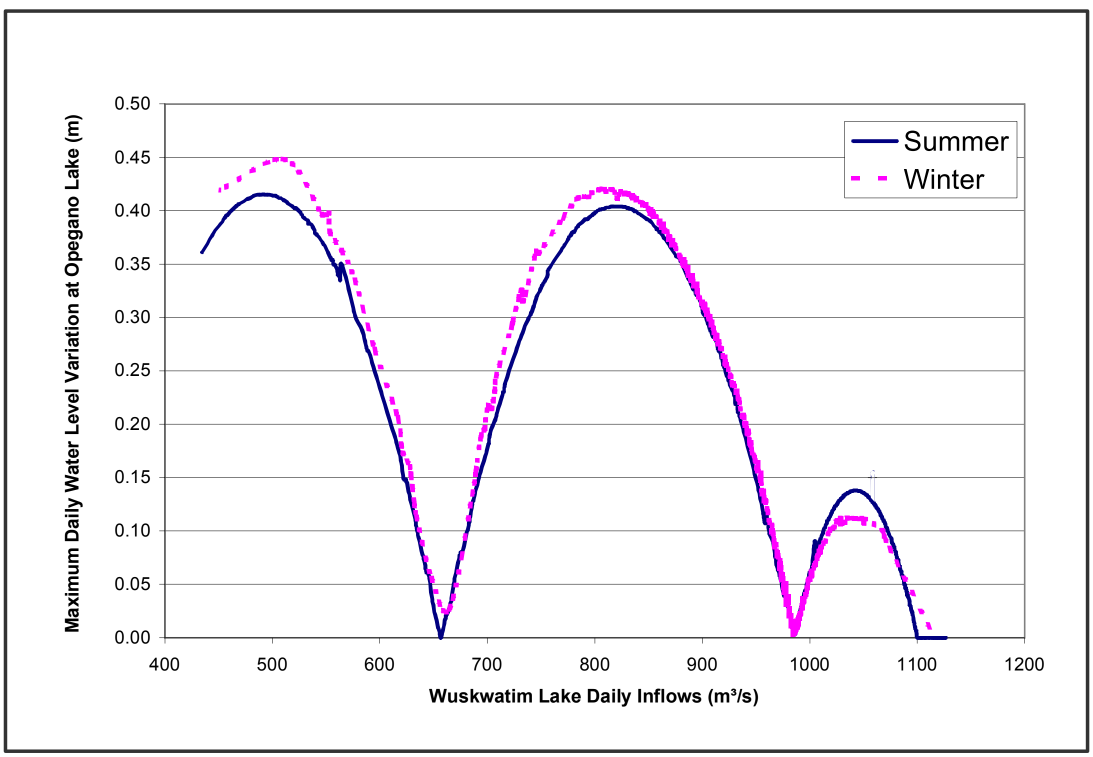


Figure 5.2-12 – Maximum daily water level fluctuation at Opegano Lake from Wuskwatim GS operation.

5.2.5.7 Power & Energy

Wuskwatim GS will be capable of producing as much as 200 MW of power at any time. The average gross plant energy production is approximately 1,570 gigawatt-hours of energy per year. The expected annual energy production after consideration of maintenance outages is 1,550 gigawatt-hours. The distributions of power and energy capability for the modified run-of-river mode of operation are summarized in Figures 5.2-13 & 14 respectively. The average power potential is about 180 MW resulting in a plant capacity factor over 85 percent.

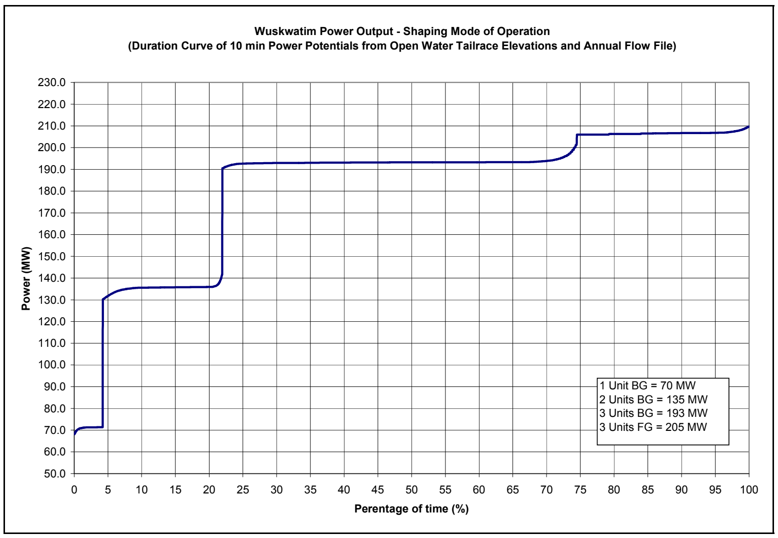


Figure 5.2-13 – Distribution of long-term annual power potential

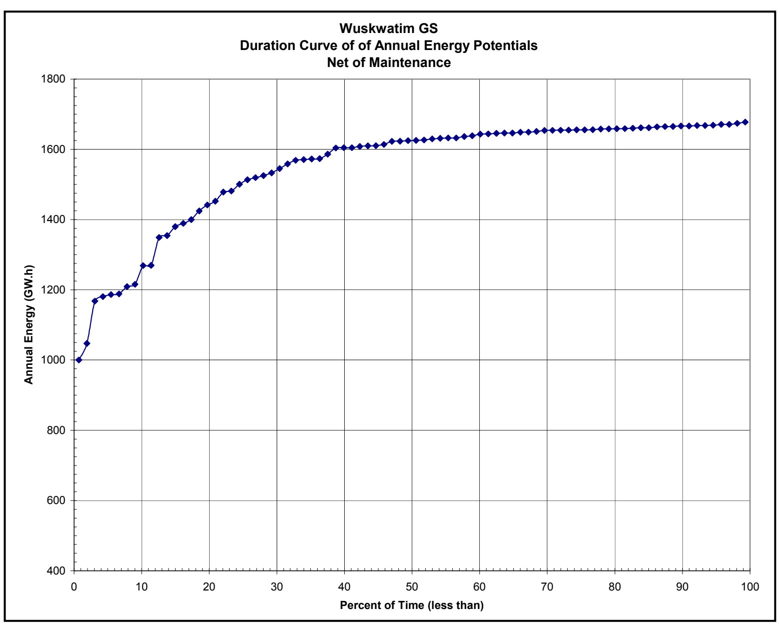


Figure 5.2-14 – Distribution of long-term annual energy potential

5.3 PERMANENT FACILITY OPERATION

5.3.1 Operational Workforce

The overall operation and administration of the proposed generating station will be the responsibility of the Generation North Division of Manitoba Hydro's Power Supply Business Unit located in Gillam.

The Wuskwatim GS is being designed to operate remotely (i.e., unmanned) through the use of state-of-the-art electronic control systems linked to various telecommunication systems. A workforce of 3 to 4 technicians and 2 utility workers will be required for routine operation and maintenance at the plant. Generally there will be two workers travelling to Wuskwatim GS every day during the week.

Additional staff may be required from time to time, during inspection and maintenance programs (Section 5.3.5). These additional staff will be supplied from other work sites and facilities (usually located throughout northern Manitoba) and accommodated for these short-term assignments in Thompson (commuting to Wuskwatim GS daily). Accommodations have been incorporated into the generating station for short-term stays, when required by operation and maintenance staff.

5.3.2 Operating and Maintenance Procedures and Compliance

Manitoba Hydro will operate the generating station in accordance with the terms and conditions of the Water Power License, Manitoba Environment Act License and any other regulatory requirements and Licenses.

Manitoba Hydro is committed to the practice of environmental stewardship and will ensure that employees operating the station will continue to integrate environmental practices and enhancement measures into their daily operations in accordance with the Environmental Management Systems (EMS). The operating procedures will be contained in a series of manuals specifically prepared for the station and will be revised, as required, on an ongoing basis.

In addition to the Wuskwatim GS permanent facilities such as the Powerhouse, Spillway, and related concrete and earth structures there will be a permanent electrical Switching Station located at the site. Also forming an integral part of the permanent works will be the former construction camp stores buildings which will be used as cold storage facilities where mechanical and other miscellaneous spare parts will be stored and protected from the elements. The former stores buildings will also be used during major equipment overhauls, and for regular maintenance of equipment. Within the fenced stores yard, the Spillway and Powerhouse intake stop logs will be stored outside on their respective pads. All cold storage facilities and yards will be fenced, secured and alarmed.

Manitoba Hydro's existing facilities have received ISO 14001 registration and it is expected that Wuskwatim GS will be included once it is commissioned. Manitoba Hydro will incorporate existing documented procedures and codes of practice and train its employees in the management systems so that the employees can perform the operation and maintenance tasks safely, efficiently and effectively and meet all regulatory requirements while fulfilling their duties. To meet rigorous review requirements all employee training is monitored in an in-house system called the "On-Track" management system. The following is a summary of the Environmental Management Systems that will be in place.

(a) Spill containment & response;
(b) Transportation of Dangerous Goods Regulation (TDGR);
(c) Pertinent Legislation Changes (Manitoba Hydro's Thermal technical services department provides a service which reviews and keeps all field staff updated on legislation changes);
(d) Asbestos use and removal practices (Manitoba Hydro has a code of practice for dealing with asbestos and staff are trained in the handling and removal as required);
(e) WHMIS (Workplace Hazardous Materials Information Sheets);
(f) Waste water treatment, testing, and monitoring;
(g) Drinking water quality and testing and monitoring;
(h) Storage and Handling of Petroleum Products;
(i) Dam Safety reviews and Emergency Preparedness Plans;
(j) River Water quality;
(k) Debris Management programs and their implementation;
(l) PCB handling and storage code of practice; and
(m) Erosion monitoring of the immediate areas upstream and downstream of the station.

5.3.2.1 Safety Management Systems

In addition to the Environmental Management Systems described previously, documentation and training are provided in the following areas related to occupational workplace safety:

- Safety rule book;
- Equipment Clearance procedures/lock out tag out;
- Confined space procedures;
- Working along procedure;
- Accident and incident investigation procedures;
- Forced outage or equipment failure reporting and monitoring;
- Public access;
- Security;
- Fire procedure manuals; and
- Emergency Response Crews (ERC).

5.3.3 Activities During Operations and Maintenance

To ensure safe and efficient operation of the Wuskwatim GS, a variety of management and maintenance activities will be undertaken in the following specific areas:

5.3.3.1 Vegetation Management/Landscaping

For the safe and efficient operation of the Wuskwatim GS, vegetation management will be undertaken for right-of ways, fire breaks (fire guards), station yards and earth-fill dams. Landscaping, erosion controls, pest control and drainage management will all be components of a vegetation management program.

Activities would include the removal of new growth, cutting grass and spraying for disease and insect control. Equipment used would include sprayers, water trucks, tractors and mowers. Mechanical means of vegetation control would be the preferred method and chemicals would only be used if mechanical methods were unsuccessful and only when authorized by the appropriate authorities.

5.3.3.2 Water and Ice Management

Operation of a hydraulic GS requires monitoring of water availability and other relevant components such as water levels and ice thickness information. This activity is performed to ensure that water is available for downstream users as well as for power generation and to ensure that impacts from ice processes and extreme flow conditions (high or low) can be managed.

Ice management is a complex problem. Public safety, efficient flows and effects on shorelines and permanent structures all need to be considered in ice management. Ice is generated in reaches of open water and can be carried downstream by the river. This ice usually bridges in early winter and accumulations can approach facilities and cause problems in maintaining water level control. Station operators have documented procedures to precipitate the formation of a stable ice cover on the forebay. The procedures include maintaining a stable forebay level during freeze-up, monitoring ice thickness, and recording accumulation and ambient temperatures.

Regular inspections of the shoreline in the immediate forebay and in the downstream areas will be undertaken. Vegetative control, rip rap or shoreline stabilization may need to be required in some locations. Debris management will be carried out through the Corporate Debris Management Program.

5.3.3.3 Plant Equipment Rehabilitation

Plant equipment used for the operation of a hydraulic generating station, for example include turbines, generators, transformers and various electrical and mechanical systems controlling heating and ventilation, domestic and filtered water systems, cranes, sewage treatment facilities, drainage systems, compressed air systems and oil storage. During the life of a hydraulic generating station, various equipment will need to be replaced or rehabilitated due to wear, upgrades, or structural improvements. Equipment is monitored and maintained to operate in compliance with manufacturers and corporation standards. Leaks, mechanical failures and reduced performance are recorded and remedial actions initiated as required.

Specialized heavy equipment such as a mobile crane required for maintenance would be shared amongst several plants and would be brought to site and possibly stored at the site if not required at the other plants.

About every 25 years, exterior structures exposed to the elements will require stripping and resurfacing and in some instances sandblasting or dry ice will be used to prepare surfaces. Where work is being undertaken adjacent or near to water, appropriate precautions will be undertaken to ensure that the by-products of surface preparation and resurfacing do not enter the aquatic environment.

5.3.3.4 Hazardous Materials/Petroleum Handling and Storage

During normal operations about 5,000 gallons of petroleum materials will be stored in a dedicated area within the powerhouse complete with appropriate spill proof equipment and documentation. A spill response plan for all operating and maintenance activities will be kept at Wuskwatim GS, specifically in the Control Room, Engineering Office, and with the Emergency Response crews.

5.3.3.5 Sewage Treatment, Potable Water and Water Quality Management

Sewage generated by staff at Wuskwatim GS will be treated to meet all provincial and federal regulatory requirements. Outflows will be monitored by station staff.

Potable water for use at the Wuskwatim GS will be drawn from the immediate forebay and will be treated to meet all provincial and federal regulatory requirements. Potable water quality will be monitored by station staff in accordance with Provincial Legislation.

5.3.3.6 Access Roads Maintenance

During the operation of the Wuskwatim GS, access roads and trails will require regular maintenance year round to ensure access to the Wuskwatim GS and associated sites. Activities will include road inspection, repair, erosion control, dust control, snow removal, and maintenance of ditches and culverts.

5.3.3.7 Stream Crossings Maintenance

Regular inspection and maintenance of the stream crossings along the access road will be required during the operation of the Wuskwatim GS. This will ensure proper water flow, fish passage, and reduce the chance of erosion and sedimentation.

5.3.3.8 Work Yards – Post Construction

Contractors' construction equipment, machinery and parts, and any other equipment required for major maintenance programs will be marshalled and stored at designated sites. These sites will comply with all regulatory requirements. The sites will be kept tidy, organized and a current inventory and materials management program will be maintained.

5.3.3.9 Materials Stockpiles

Maintenance of Wuskwatim GS and infrastructure will require gravel, sand, rockfill, road repair, and road surface material stockpiles. Stockpiles will be located within Manitoba Hydro's work area and within the parking turn-around area on the south side main dam. (Figure 4.10-1).

Maintenance stockpiles for the access road (Figure 2.3-1) will be established within and/or adjacent to the road right-of-way. The details of which borrow areas will be required after construction have not been finalized. It is expected that after the road is constructed, between three and five of these borrow pit areas would be used to stockpile granular material for road maintenance.

Any borrow pits needed for maintenance will comply with the Corporation's EMS protection measures and all applicable regulatory requirements.

5.3.3.10 Spillway and Powerhouse Structures

Concrete structures will infrequently need maintenance to ensure safety and effective operations. Examples of this maintenance could include: piezometer replacements, grouting and exterior concrete repair work.

Activities associated with these repairs could include drilling, changes in forebay water levels, and working in the water. All activities will be conducted as required by regulatory requirements at the time the work is conducted.

5.3.3.11 Earth Dams

Earth dams are transition structures between the concrete powerhouse and Spillway structures and the banks of the river. Maintenance of earthfill structures would include vegetation management (so that the impervious core is not damaged by the roots of trees and shrubs). Also general repairs will occasionally need to be done to earthfill dam crests due to settlement or to the protective riprap due to erosion.

5.3.3.12 Distribution Lines

During operations of the Wuskwatim GS, distribution lines will be needed for onsite storage buildings. Maintenance of these distribution lines could include change over of poles, insulators, pole mounted transformer and other hardware. Only PCB-free oil will be used in distribution line infrastructure.

5.3.3.13 Waste Management

During operation of the Wuskwatim GS, wastes will be generated from domestic sources, wood, scrap metal, tires, surplus equipment, packaging materials, office paper, light bulbs and solvents and other cleaners. Station recycling programs provide opportunities to reduce, reuse and recycle the wastes whenever possible. Wastes will be stored in protected areas and disposed of regularly to reduce potential for unsafe conditions and negative aesthetic impacts.

Non-hazardous waste would be diverted from landfills when possible for reuse and recycling. Where landfill disposal is used disposal methods must comply with local and provincial regulatory requirements.

Hazardous Wastes will be stored in approved bins, handled, transported and disposed of in compliance with regulatory requirements.

5.3.3.14 Emergencies, Accidents and Malfunctions

An Emergency Preparedness Plan will be prepared for the Wuskwatim GS to deal with potential major emergency scenarios, which may occur during the life of the plant. Manitoba Hydro will also prepare response plans to deal with the potentially more frequent emergencies such as oil spills. Manitoba Hydro will also ensure that staff is trained in the implementation of the procedures.

The systems and equipment necessary to protect the integrity and safety of the facilities in these emergency situations are incorporated in the final design. For example, in the event of loss of generation at the station, provision has been made to open the Spillway gates either locally or remotely using a standby diesel generator to provide power to the electric hoists.

Under a scenario where neither the Spillway nor the intake gates could be opened remotely and under average flow conditions (940 m^3/s), it would be approximately 39 hours before water would start flowing over the concrete structures; for PMF (2700 m^3/s) conditions, the duration would be reduced to approximately 12 hours. For both of these conditions, men and equipment would be mobilized in time to avert a disaster.

5.3.4 Environmental Monitoring

Once the construction of the Wuskwatim GS has been completed and the Units placed into commercial service Manitoba Hydro will implement additional and/or carry on with existing monitoring programs for the purposes of:

(a) verifying the scope of the impacts forecast by the impact study
(b) assessing the effectiveness of remedial measures
(c) improving the techniques for forecasting impacts for future projects and
(d) if required compliance with the terms and conditions of the License.

A summary of the various environmental monitoring requirements is found in Volume 1. The details are provided in the various supporting documents.

5.3.5 Public Access

Access to the generating station site and use of the access road will be restricted and controlled through the use of various measures, including; secure fencing, signage and monitoring systems (Section 2.6). An Access Management Plan will be developed by the Limited Partnership in consultation with the Nelson House Resource Management Board (Section 4.3.3).

Potentially hazardous areas at the Project site (e.g. slopes leading to the spillway discharge and tailrace channels) will be fenced off as a safety precaution. Safety railings will be installed on the spillway deck, powerhouse forebay deck, the main dam and tailrace deck.

Signs will be posted on both sides of the shoreline on the upstream and downstream side of the generating station facilities warning of the potentially dangerous boating and swimming conditions. A siren system will be installed to provide advance warnings of the movement of the spillway gates.

A boat landing dock and launch area would be located approximately 1.8 km from the generating station facilities on Wuskwatim Lake. A similar landing area would be located on the first creek downstream of the generating station on the north side of the river.

5.3.6 Plant & Site Security

Wuskwatim GS and adjacent areas will be secured in accordance with Manitoba Hydro's standards and procedures; however for security reasons, this information will not be made available to the public.

6.0 DECOMMISSIONING

The plant has been designed for a 100 year life. However, at any time in the future, if Manitoba Hydro concludes that the Wuskwatim GS is no longer required for the production of hydroelectric power, Manitoba Hydro is obligated to maintain the overall water regime range established as a result of the Wuskwatim GS. This requirement is consistent with the obligations under Section 2.9.1 - Maintenance of the Water Regime of the 1996 NFA Implementation Agreement (NFA Implementation Agreement 1996). The plan for the eventual disposition of the facilities and its execution could only be made by the signatories to the 1996 NFA Implementation Agreement and jointly submitted for regulatory review and approval prior to its implementation.

7.0 REFERENCES

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NORTHERN FLOOD AGREEMENT. 1977 Agreement among Government of Canada, Province of Manitoba, Manitoba Hydro-Electric Board and the Northern Flood Committee, Inc.

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BURNTWOOD RIVER STUDY 1978 APPENDIX 4. Hydro Development Department, System Planning Division, Report No. SPD – 78-14, Manitoba Hydro, dated May 1978, (Blue 30f - HPP Report File).

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HAZARDOUS MATERIAL MANAGEMENT HANDBOOK 2003 Manitoba Hydro, January. 2003.

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MANUAL OF THE DESIGN AND IMPLEMENTATION OF EROSION AND SEDIMENT CONTROL 2000 Manitoba Department of Transportation and Government Service 62 pp.

8.0 GLOSSARY

AC Alternating Current - is the oscillating (back and forth) flow of electrical current, whereas the DC (Direct Current) is the unidirectional continuous flow of electrical. The AC current form of electricity is the common household form. DC current form of electricity is the form provided by a battery.

ASL Elevation Above Sea Level, elevations are referenced to Geodetic Survey of Canada, Canadian Geodetic Vertical Datum 1928, 1971 Local Adjustment

Augmented Flow Program An annual amendment to the Churchill River Diversion 1973 Interim Water License which provides additional flexibility in the operation of the CRD

backflooding intentionally flooding the work area behind a cofferdam to minimize erosion during cofferdam removal.

bedrock the solid rock that underlies soil and the regolith or that is exposed at the surface

best gate The wicket gate setting at which a hydraulic turbine operates most efficiently. The wicket gates are the main flow control to the turbine.

black-start a source of electricity is required to enable a hydroelectric generator to produce electricity (excitation power). When a generating station has a stand-by diesel generator to excite it's generators, then the generating station can feed power into the transmission system to start other generating stations.

borrow areas or borrow 'sites' or 'pits'; areas were materials (e.g. gravel, sand, silt, clay) are excavated for use.

buffer an area of land separating two distinct land uses that acts to reduce or mitigate the effects of one land use on the other

capacity factor the ratio of average load of a plant or machine, to its maximum capacity rating.

CRD Churchill River Diversion; involved constructing a control structure at the outlet of Southern Indian Lake to divert a large portion of the Churchill River down the Rat/Burntwood Rivers into the lower Nelson River at Split Lake to enhance power production at the Kettle, Long Spruce and Limestone operating stations.

channel forming flow the dominant river flow in river that has an erodible bed. This flow determines the channel width and occurs at a frequency of every two years.

cofferdam A temporary barrier, usually an earthen dyke, constructed around a work site in a river, so the work site can be de-watered or the water level controlled. See dam.

commissioned with reference to a hydro generating station: testing of generating equipment and upon satisfactory completion, releasing for commercial service.

concrete aggregate crushed rock or gravel of varying size used in the production of concrete. Aggregate is mixed with sand, cement, and water and other additives to produce concrete.

Control Structure a type of structure designed to control the outflow from a waterbody (e.g. Missi Falls control structure, Notigi control structure).

dam A barrier built across a river that obstructs the flow of water.

decommission to take out of active use (typically involves the dismantling and removal of the original structure(s) and associated facilities)

duration curve a cumulative distribution function based on a sample of data, to indicate frequency of exceedance. A curve that shows how often an event is expected to be exceeded.

dyke: an embankment, usually constructed to prevent flooding of low lying areas and thus limit the extent of flooding.

EIS Environmental Impact Statement; an assessment designed to identify, predict, interpret and communicate information about the impact of a proposed action on the natural and human environment

EnvPP Environmental Protection Plan; a "user-friendly" guide for the contractor that includes: information such as a brief project description; updated construction schedule; summary identifying environmental sensitivities and mitigative actions; listing of all federal, provincial or municipal approvals, licenses, or permits that are required for the project; a description of general corporate practices and specific mitigating actions for the various construction activities; emergency response plans, training and information; and environmental / engineering monitoring plans and reporting protocols.

erosion the wearing away of the earth's surface by the action of water, wind, current, etc.

existing flows refers to flows (or water levels) that have occurred since the final commissioning of the Churchill River Diversion (CRD), see **post-CRD.** Flow record used in study goes from Sept. 1977 to June 2001.

fill natural soils that are manually or mechanically placed. Soil or loose rock used to raise a grade.

flow motion characteristic of fluids (liquids or gases); any uninterrupted stream or discharge

footprint the surface area occupied by a structure or activity

forebay impoundment area immediately upstream from a dam or hydroelectric plant intake structure.

FSL Full Supply Level – refers to the maximum level of normally controllable water levels on a forebay above sea level.

full gate	the wicket gate setting at which the hydraulic turbine produces maximum power. The fully open wicket gate position.
generating station	a complex of structures used in the production of electricity. A hydroelectric generating station would include the powerhouse, spillway, dam(s) and transitions structures.
granular fill	fill material including sand and gravel.
groin	a rock fill structure extending out into a river or lake from the bank or shore. Used to protect the bank from erosion.
GW (Gigawatt)	one billion watts (1,000,000,000 watts) of electricity.
groundwater	the portion of sub-surface water that is below the water table, in the zone of saturation
ha	hectares; a metric unit of square measure equal to 10,000 square metres or 2.471 acres
high-head	A generating station design that has a high forebay elevation compared to other options.
hydroelectric	electricity produced by converting the energy of falling water into electrical energy (i.e. at a hydro generating station)
impervious fill	fill that has low permeability (usually clay) and used in an embankment structure to reduce leakage through the dam. It can also be used as a liner of a pond or lagoon to prevent leakage into the surrounding area.
impoundment	a body of water confined by a dam or other structure. See forebay.
infrastructure	the basic features needed for the operation or construction of a system (e.g. access road, construction camp, construction power, batch plant, etc)
in situ	in place; undisturbed

km kilometres

lacustrine of, pertaining to, or inhabiting lakes

low-head a generating station design that has a low forebay elevation compared to other options.

LWR Lake Winnipeg Regulation

m metres

mitigation actions taken during the planning, design, construction and operation of works to reduce or avoid potential adverse effects

mode of operation the method of operating a generating station for meeting electrical demands. The operation method, or mode, will determine the pattern of the outflows from the powerhouse.

modified run-of-river A **mode of operation** that is based on modest flow changes that allows efficient generation, but is restricted so that the outflow pattern does not cause excessive downstream water level fluctuations. Generally the daily average outflow will be equal to the daily average inflow, therefore also limiting the forebay water level changes.

model a tool used to help visualize something that cannot be directly observed

monitoring any on-going process or program for measuring the actual effects of constructing or operating a development

MW (Megawatts) a unit of power equal to one million watts. One megawatt is enough to power 50 average homes.

NFA Northern Flood Agreement; an agreement signed in 1977 by Manitoba Hydro, the governments of Canada and Manitoba, and five affected Cree Nations regarding the effects of the Churchill River Diversion and Lake Winnipeg Regulation

overburden the soil (including organic material) or loose material that overlies bedrock

Organic soils of the Organic order are composed largely of organic materials. They include most of the soils commonly known as peat, muck, or bog and fen soils. Most organic soils are saturated with water for prolonged periods. These soils occur widely in poorly and very poorly drained depressions and level areas in regions of subhumid to perhumid climate and are derived from vegetation that grows in such sites

peaking a mode of operation that is based on large flow changes that maximize on-peak generation, unrestricted outflow pattern may cause large downstream water level fluctuations.

permafrost permanently frozen ground

planform shape of plan view

ponding formation of a reservoir due to the damming of a river or creek; retention of water to replenish an existing reservoir

post-CRD see **existing flows**

potable water which meets drinking quality standards.

powerhouse the building that encloses the generating equipment at a generating station

Precambrian bedrock ***bedrock formed in the Precambrian era, which began with the consolidation of the earth's crust and ended approximately 4,000 million years ago***

Primary Structures ***the main structures of a hydroelectric development that when combined, work together to contain the water on the upstream side of the structures so that the flow can be directed through the intake gates towards the turbines which turn the generator.***

project inflows a synthetic record of Wuskwatim Lake monthly inflows created from historical monthly system inflows (1912 to 1997) and current system operating rules. Assumed to represent future inflows for the Project.

project manager Person who oversees the construction and all related aspects of the project.

Plant outflow Capability the total flow through the turbines associated with rated capacity, with wicket gates in fully open position. The plant outflow or discharge is the sum of the maximum outflow through all three turbines and is also referred to as the Plant Full Gate Flow.

rated capacity the maximum power that a generator is designed to deliver without exceeding mechanical safety factors or allowable temperatures.

reach term used to describe sections of a river

rehabilitate to carry on or cause a process of rehabilitation

rehabilitation restoring to a more normal state

riprap A layer of large stones, broken rock, boulders, or other suitable material generally placed in random fashion on the upstream and downstream faces of embankments, or other land surfaces to protect them from erosion or scour caused by current, waves, and/or ice action.

rock fill fill material typically consisting of excavated and crushed rock or blast rock that is used to provide mass to a structure while protecting it from erosion.

RoW (**Right-of-Way**); area or strip of land cleared to accommodate a road or transmission line

Secondary Structures those structures that are not directly required to contain the water as part of the primary structures. These structures typically perform other tasks, like serve as a location of excavated material or improve the outflow from a lake i.e. channel excavation.

service bay An open area of the powerhouse where turbine and generator components are assembled during construction, and later, where maintenance and repairs are performed to major generating equipment.

shaping see **modified run-of-river.**

shore the narrow strip of land in immediate contact with the sea, lake or river

spillway a structure that allows normal and/or flood flows to bypass the powerhouse in a manner that protects the structural integrity of the dam.

switching station an area that typically contains electrical equipment that is used in the transmission of electricity.

tailrace a channel or raceway that directs the water away from a turbine into the river channel

tailwater the water in the tailrace, or the level of this water.

thermal plant a generating station that uses coal or natural gas to create steam to drive a generator. Thermal plants are used at both Brandon and Selkirk, as well as a natural gas-fired simple-cycle combustion turbine at Brandon.

Total Suspended Solids (TSS) the portion of the total solids remaining in suspension (undissolved)

Transmission the electrical system used to transmit power from the generating station to customers.

turbine A machine in a hydroelectric generating station which converts the energy of flowing water into rotary mechanical energy. This rotational energy is then transferred to the generator for conversion to electrical energy.

turbulence disturbed or agitated flow

water regime a description of water body (i.e., lake or river) with respect to water levels, flow rate, velocity, daily fluctuations, seasonal variations, etc.

APPENDIX 1.0

Manitoba Hydro's Sustainable Development Policy Principles

1. Stewardship of the Economy and the Environment

- Recognize its responsibility as a caretaker of the economy and the environment for the benefit of present and future generations of Manitobans.

- Meet the electricity needs of present and future Manitobans in a manner that ensures the long-term integrity and productivity of our economy, our environment, our natural resources and safeguards our human health.

2. Shared Responsibility

- Ensure that Manitoba Hydro's employees, contractors, and agents are aware of our sustainable development policies and guiding principles and encourage them to act accordingly.

- Encourage the Corporation's employees to share their knowledge of the concepts and practical application of sustainable development.

3. Integration of Environmental & Economic Decisions

- Treat technical, economic and environmental factors on the same basis in all corporate decisions, from initial planning to construction to operations to decommissioning and disposal.

- To the extent practical, include environmental costs in economic and financial analysis.

4. Economic Enhancement

- Enhance the productive capability and quality of Manitoba's economy and the well-being of Manitobans by providing reliable electrical services at competitive rates.

5. Efficient Use of Resources

- Encourage the development and application of programs and pricing mechanisms for efficient and economic use of electricity by our customers.

- As well, efficient and economic use of energy and materials will be encouraged throughout all our operations.

6. Prevention and Remedy

- To the extent practical, anticipate and prevent adverse environmental and economic effects that may be caused by Corporate policies, programs, projects and decisions rather than reacting to and remedying such effects after they have occurred.

- Purchase, where practical, environmentally sound products taking into account the lifecycle of the products.

- Address adverse environmental effects of Corporate activities that cannot be prevented by:
  - first, endeavouring, wherever feasible, to restore the environment to pre-development conditions or developing other beneficial uses through rehabilitation and reclamation
  - second, striving to replace the loss with substitutes that would enhance the environment and/or associated resource uses while offsetting the type of damage experienced
  - third, making monetary payments for compensable damages on a fair, equitable and timely basis.

7. Conservation

- To the extent practical, plan, design, build, operate, maintain and decommission Corporate facilities in a manner that protects essential ecological processes and biological diversity.

- Give preference, where practical, to projects and operating decisions that use renewable resources or that extend the life of supplies of nonrenewable resources.

8. Waste Minimization

- Manage all wastes arising from Corporate activities by:
  - first, endeavouring to eliminate or reduce the amount generated
  - second, striving to fully utilize reuse and recycling opportunities
  - third, disposing of remaining waste in an environmentally sound manner.

9. Access to Adequate Information

- Share relevant information on a timely basis with employees, interested people and governments to promote a greater understanding of Manitoba Hydro's current and planned business activities and to identify impacts associated with the Corporation's plans and operations.

10. Public Participation

- Provide opportunities for input by potentially affected and interested parties when evaluating development and program alternatives and before deciding on a final course of action.

11. Understanding and Respect

- Strive to understand and respect differing social and economic views, values, traditions and aspirations when deciding upon or taking action

- Give preference to those alternatives which best fulfil Corporate objectives while minimizing infringement on the ability, rights, and interests of others to pursue their aspirations.

12. Scientific and Technological Innovation

- Research, develop, test and implement technologies, practices and institutions that will make electrical supply and services more efficient, economic and environmentally sound.

13. Global Responsibility

- Recognize that there are no political and jurisdictional boundaries to our environment, and that there is ecological interdependence among provinces and nations.

- Consider environmental effects that occur outside of Manitoba when planning and deciding on new developments and major modifications to facilities and to methods of operation.

APPENDIX 2.0

RECOMMENDATION TO CHIEF AND COUNCIL
REGARDING PREFERRED ACCESS ROAD
FOR THE PROPOSED WUSKWATIM GENERATING STATION

(Note: also used by Manitoba Hydro as summary of results from Alternatives Committee)

Prepared by the Alternatives Committee @ November 21, 2001

BACKGROUND

- To build and operate the Wuskwatim Generating Station, an access road is required between PR 391 and the Wuskwatim site.
- No optional routes are possible between the Wuskwatim site and the location of gravel deposits about 30 km northeast of the site; alternative routes are possible between that point and PR 391.
- Since May 2000, Manitoba Hydro and NCN have together examined a range of alternative routes for the access road – some routes proposed by Manitoba Hydro and others proposed by NCN.
- Between June and November 2000, an Alternatives Committee (with representatives from NCN, Manitoba Hydro and the Environmental Study Team) screened a broad array of alternative routes – Taylor River, Mile 5, Mile 20, Nelson House, Nelson House with Spur. Analysis focused on three main areas – impact on NCN, impact on the environment, and impact on the project. Results of initial work were presented to NCN members in an open house on August 2nd, 2000.
- Results of the work, including what was heard from members at the open house, was presented to Chief and Council and Manitoba Hydro in October/November 2000.
- Over the course of the winter, Chief and Council requested that additional variations be examined (i.e., RC Point access, South Route from 170B, Mile 33, and Mile 37); summary information was prepared on these other alternatives. NCN advisors recommended that, considering all criteria, Mile 5 and Mile 20 should be considered viable alternatives.
- Chief and Council presented this recommendation to NCN members in a meeting on August 1st, 2001. Results of the subsequent vote by Chief and Council were communicated in a letter to Manitoba Hydro on August 28th, 2001. That letter stated that Chief and Council were prepared to accept the Mile5/Mile 20 road option (clarified as the geographic area of Mile 5/20), subject to regulatory approval and pending Chief and Council's meaningful consultation with NCN members.

The following activities were undertaken to ensure information was available to support NCN member consultations and regulatory approval applications.

- Biologists examined Mile 5 and Mile 20, and subsequently the area between these points, during September and October. Their work on environmental constraints for Mile 5 and Mile 20, as well as the cultural sensitivity of the Eagle Hill site and the desire to protect the BOREAS site, were provided to engineers who took account of these constraints as they identified five detailed centrelines in the area between Mile 5 and Mile 20.
- At the same time, Elder Community Consultants undertook TEK interviews with elders/resource harvesters knowledgeable about the area between Mile 5 and Mile 20.
- The Alternatives Committee met on November 6th and 7th to review gathered information, survey the alternatives via helicopter, compare alternatives, and draw conclusions about the best centreline alternative. A subsequent meeting was held November 15th. This report summarizes results of that work.

SUMMARY OF ANALYSIS

The Alternatives Committee compared the five possible centreline right-of-way (ROW) routes for the access road in the area between Mile 5 and Mile 20 (see attached map). Conclusions are shown below under three headings – impact on NCN, impact on the environment and impact on the project. Details are provided in the attached tables.

IMPACT ON NCN

- eight evaluation criteria were examined to compare the impact of centreline ROW alternatives on NCN; of these, impacts on important cultural sites, particularly Eagle Hill and a nearby artesian water source, were considered to be most important.
- Mile 17 appeared to offer the least adverse impacts and most benefits to NCN of the alternatives considered; in particular:
    - it is the furthest away from Eagle Hill and the water source;
    - it provides more convenient access than Mile 5 for NCN members from Nelson House wishing to access the Wuskwatim Lake area;
    - it provides a safer intersection (based on site lines) than at Mile 20a and Mile 20 but is less safe than Mile 19.25 (note that safety may be improved with Mile 17 centreline adjustment at the intersection); and
    - it is likely to result in less adverse impacts on NCN resource uses (hunting, fishing, trapping and gathering of medicinal plants) than Mile 5 which has more abundant resources and more tendency for non-members from Thompson and elsewhere to access the area.

IMPACT ON THE ENVIRONMENT

- nine evaluation criteria were examined to compare the impact of centreline ROW alternatives on the Environment; of these, impacts on woodland caribou and moose were considered the most important.
- the Mile 17 option appeared to offer the least adverse impacts on the Environment; in particular:
    - it is far enough away from critical caribou calving habitat lying to the west of the esker (Mile 20 was considered too close to the critical caribou calving habitat);
    - it minimizes disturbance of the jack pine ecosystem associated with the glacial outwash feature;
    - it does not impact the high quality moose and other wildlife habitat along Birch Tree Creek (Mile 5);
    - caribou are expected to move through this area during spring and fall migration, but potential adverse effects are thought to be mitigable (caribou would also pass through the Mile 20, Mile 20a, and Mile 19.25 routes); and,
    - it avoids impact to the BOREAS site.

IMPACT ON THE PROJECT

- twelve evaluation criteria were examined to compare the impact of centreline ROW alternatives on the Project; of these, safety and the effect of terrain type on construction and maintenance costs were found to be the most important factors.
- Mile 20a is the least potential cost to the project ($63.4M), followed by Mile 20 ($63.5M), Mile 19.25 ($64.0M), Mile 17 ($65.2M) and Mile 5 ($67.1M).

- Mile 19.25 provides the safest intersection (based on sight lines) followed by Mile 17 & Mile 5. Mile 20 and Mile 20a provide poorest sight lines.
- Mile 5 provides a negative construction schedule risk due to the nature of the terrain type along the first part of the road.
- Mile 17 provides less construction risk due to better chance of acceptance by regulators and by NCN members.
- Mile 19.25 is the easiest intersection to construct due to the level terrain at PR 391, followed by Mile 5, Mile 17, Mile 20, Mile 20a.

RECOMMENDATIONS

That the Mile 17 alternative route be selected as the centreline ROW route for the Wuskwatim access road for the next phase of road activities.

That Mile 20, Mile 20a and Mile 5 be not considered as viable centreline ROW routes for the Wuskwatim access road for the next phase of road activities.

That Mile 19.25 be considered as the alternative that is the next best option to Mile 17.

ACTION

Following is a proposed schedule of activities to move to the next step in planning for a centerline ROW route for the Wuskwatim access road:

November 26, 2001 - results of access road evaluation and selection process presented to Chief and Council.

December 3, 2001 - A presentation would be made to NCN members showing results of access road evaluation and selection process, and inviting comment.

December 4, 2001 – Chief and Council consider and select their preferred centreline ROW for the next phase of road activities. Manitoba Hydro considers their preferred centerline ROW during this same period. Chief and Council and Manitoba Hydro will meet shortly thereafter to discuss the joint selection of the partners.

December 5, 2001 – application for a work permit for the exploration program is made to Manitoba Conservation

December 15, 2001 – if approval received from Manitoba Conservation, survey work and exploration program plans would be finalized and implemented as soon as possible.

IMPACT ON NCN

COMPARISON OF ACCESS ROAD ALTERNATIVES IN THE AREA BETWEEN MILE 5 AND MILE 20

Draft @ November 15, 2001

Evaluation Criteria	Explanation	Mile 5	Mile 17	Mile 19.25	Mile 20a (Env.)	Mile 20 (Eng.)
Important cultural sites (Eagle Hill, water source, any other)	• No known cultural sites along Mile 5 • Mile 19.25 considered too close to Eagle Hill; water source nearby • Mile 17 far enough away	1?	1	5	5	5
Access by non-members	• Access an issue with all options • Probably greater tendency by non-members to use Mile 5	5	3	3	3	3
Benefits of access for NCN members	• Least benefit shown by larger # • More convenient access via Miles 17-20	4	2	2	2	2
Safety (construction traffic and quality of intersection)	• Mile 5 – shortest distance that construction traffic on PR 391 is mixed with public traffic • Mile 20, Mile 20a, Mile 19.25, and Mile 17 – construction traffic on PR 391 for greater distance than Mile 5 • Mile 20 and 20a – poor intersections	1	2	2	4	4
Impact on Resource Use:						
• Hunting	• Most access by non-members and productive moose area	5	2	2	2	2
• Fishing	• More water features on Mile 5; greater access by non-members • All options get non-members to Wuskwatim Lake	4	1	1	1	1
• Trapping	• Mile 5 more productive area; greater access by non-members	5	2	2	2	2
• Gathering o Berries o Medicinal plants	• Berry picking area identified at Mile 20/20a on land use maps • Probably greater productivity for medicinal plants along Mile 5; greater access by non-members	2 5	2 2	2 2	5 2	5 2

Notes:
Sources: NCN Land Use Maps, TEK interviews, knowledge of Committee members
Smaller # = least adverse effect on NCN or most benefit for NCN
Shading = criteria considered by Committee to be most important

IMPACT ON ENVIRONMENT
COMPARISON OF ACCESS ROAD ALTERNATIVES IN THE AREA BETWEEN MILE 5 AND MILE 20B
Draft @ November 15, 2001

Evaluation Criteria	Explanation	Mile 5	Mile 17	Mile 19.25	Mile 20A (Env.)	Mile 20 (Eng.)
Woodland caribou	• protected by legislation • of particular interest to NCN • important part of natural ecosystem	1?	2	2.5	2.5	4
Moose	• valued resource • important part of natural ecosystem	3	1	1	1	1
Aquatic furbearer	• valued resource • important part of natural ecosystem	4	1	1	1	1
Jack pine-on-dry-sites ecosystem	• an enduring landscape feature • regionally uncommon ecosystem type	1	2	3	3	4
Terrestrial furbearers	• valued resource • important part of natural ecosystem	3	1	1	2	2
Waterfowl	• valued resource • important part of natural ecosystem	3	1	1	1	1
Forest birds	• indicator of terrestrial habitat quality • important part of natural ecosystem	3	2	1	1	1
Fish/water quality	• valued resource • important regulatory consideration • important part of natural ecosystem	2	1	1	1	1
BOREAS Site	• important research site	0	0	0	1	3

Notes: 1. Shaded areas represent the more important criteria for selection purposes.
2. Scorings indicate potential for adverse effect. A low number indicates least potential for adverse effect.

IMPACT ON PROJECT

COMPARISON OF ACCESS ROAD ALTERNATIVES IN THE AREA BETWEEN MILE 5 AND MILE 20B

Draft @ November 14, 2001

(costs removed from table)

Evaluation Criteria	Explanation	Mile 5	Mile 17	Mile 19.25	Mile 20a (Env.)	Mile 20 (Eng.)
Construction Length (Kilometres) by terrain type	• Granular Plateau	1.66	11.35	15.35	16.29	16.59
	• Uplands complex	0.00	4.27	4.27	4.27	4.27
	• Flank of East Esker	8.53	8.59	8.59	8.59	8.59
	• Hummocky thin silt/clay over till	14.67	3.48	3.48	3.48	3.48
	• Thin veneer over silt/clay, undulating	16.61	13.85	11.32	10.68	10.68
	• Swamps and fens	0.95	1.28	1.16	1.16	1.16
	• Patterned peatland	4.97	6.03	5.96	5.66	5.66
	• Floodplain	0.23	0.47	0.47	0.47	0.47
	• Bedrock	1.15	1.15	1.15	1.15	1.15
	• **Total Length**	**48.77**	**50.47**	**51.75**	**51.75**	**52.05**
Stream Crossings	• Metres of culvert	1950	2050	2050	2050	2050
Construction Costs	• Least benefit shown by larger # • More convenient access via Miles 17-20					
Contingency Costs	• Risks and uncertainties					
Miscellaneous Costs	• Related to road length					
Project Construction Schedule	• Construction cost carrying charges					
Transportation of Workers and Materials	• Mobilization, transportation and stores costs for materials from Thompson, travel for labour on rotational leave					
Effect on PR391	• Costs to maintain PR391 during construction					
Safety	• Optional paving cost					
	• PR 391 intersection line-of-sight	Good	Good	Good	Poor	Poor
O&M costs of Road during construction	• Depends on road length and quality of base and sub-base material					
O&M costs after construction	• Depends on road length and quality of base and sub-base material					
Materials and staff transportation costs after construction	• Based on 67 year plant life (present value)					
Total Cost	• Sum of item costs					
Cost Penalty	• Difference between least and most expensive					

Source: Manitoba Hydro Shading = criteria considered by Committee to be most important

APPENDIX 3.0

RECOMMENDATIONS TO NCN CHIEF AND COUNCIL AND MANITOBA HYDRO RE: MANAGEMENT OF ACCESS ON THE WUSKWATIM ACCESS ROAD

SUBMITTED BY THE ACCESS MANAGEMENT COMMITTEE

Aug 2, 2002

BACKGROUND:

- The Access Management Committee was formed to address issues and concerns raised about new access created by the Wuskwatim Access Road. These issues were brought up during the course of reviewing alternative road locations for the Wuskwatim Access Road. Manitoba Hydro and NCN together considered, evaluated and selected a preferred route for the proposed Wuskwatim Access Road. A summary of the alternatives considered and recommendations are found at Attachment 1.

- It was also important to examine these issues since new access is a source of change from the Wuskwatim generating station project that needs to be addressed in the Environmental Impact Assessment; mitigation of concerns about new access should be included in the Environmental Impact Statement.

- These concerns and issues are (but not limited to): over-harvesting of wildlife (especially caribou and moose) and fish (especially on Wuskwatim Lake); vandalism to cabins and traplines; disturbance of traditional cultural sites important to NCN; theft; environmental pollution/damage; wildfire ignition; unpermitted cabins; the need for unrestricted access by station operators; and need to manage access by others in this part of the Nelson House RMA.

- The Access Management Committee (many of whom had been part of the Alternatives Committee) included members from NCN and Manitoba Hydro, supported by NCN Advisors and representatives of the Environmental Study Team. Committee membership is found at Attachment 2. The Nelson House Resource Management Board was invited to attend two meetings.

The Access Management Committee undertook the following (meeting notes are found at Attachment 3):

- Undertook legal and other research to examine possible approaches to access management.
- Looked at experience in Manitoba and elsewhere with access management methods.
- Held four meetings:
    - defined the issues of concern
    - identified objectives for access management
    - reviewed legal and other research brought to the Committee regarding potential approaches to access management and their effectiveness
    - discussed the role of NCN and Manitoba Hydro and the Nelson House Resource Management Board in access management
    - considered approaches to access management appropriate for the Wuskwatim Access Road.

CONCLUSIONS:

- An **Access Management Plan** is an important tool for setting out: the objectives of NCN and Manitoba Hydro (on behalf of the potential Partnership) for access management; the approach to access management during the construction phase; the approach to access management during the operations phase; the approach to communicating the Plan to all parties, including the NCN membership, residents of Thompson and other communities who may potentially be interested in making use of the new access road; and, a monitoring program.

Objectives

- The Access Management Committee established **three objectives** for the **Wuskwatim Road Access Management Plan (the Plan)**:

    1. The Wuskwatim Access Road must provide unrestricted (i.e., all season, anytime) safe access for the operators to the generating station site and associated transmission facilities.

    2. Access to the Resource Management Area should be managed to provide protection to natural resources of the area, and safety of people and property. (Cultural, heritage and wilderness values are included in the "protection to the natural resources of the area").

    3. Access should, to the extent possible, be managed to the benefit of Nisichawayasihk Cree Nation (NCN) as a whole.

Who Prepares the Plan

- The Plan should be **prepared by NCN and Manitoba Hydro** and, ultimately, be implemented by the NCN/Manitoba Hydro Partnership (if the Partnership is created). It is expected that this responsibility will be set out in the licence under *The Environment Act*. The Committee recognizes that the Access Management Plan would require review and comment by the NHRMB prior to implementation.

- In view of the foregoing, the Plan should be **prepared in consultation with the Nelson House Resource Management Board (NHRMB)**, who are preparing resource management and land use plans for the Nelson House Resource Management Area (RMA). The NHRMB includes representation from NCN and the Province.

Construction Phase

- During the Construction Phase of the generating station project, the Wuskwatim access road will be **closed to the general public**. There will be a security gate and gatehouse (location to be determined); it will be manned 24 hours per day, seven days per week.

- **Access by anyone not associated with the construction project** (e.g., NCN trappers, commercial fishermen and those wishing to use traditional cultural sites for ceremonies)
- should be addressed through the NCN/Manitoba Hydro Partnership. A mechanism, such as a permitting process, may be feasible to address access by others.

- **Early restriction of access** to the public-at-large and **communication of same** to the public are essential to managing access effectively (e.g., to avoid claims of traditional use and to help people understand why access is being restricted). Information should be provided, as early as the announcement of the project, that road access will be restricted, at least during the construction phase.

Operations Phase

- During the six-year construction phase, the Partnership should **consult with the NHRMB to finalize plans for access management** for the period after construction (2009 onward), when full access control will no longer be in place.

- **Pursuing ownership, or the equivalent**, of the access road would provide the maximum degree of flexibility in implementing the selected approach to access management for the Wuskwatim Road. That is not to say that full control will necessarily be the only option pursued, but ownership will make possible the broadest array of options. Options to achieve this include:
    - Fee simple ownership
    - Treaty Land Entitlement land, with assurances from NCN of uninterrupted access
    - Long term lease under *The Crown Land Act*
    - Reservation under *The Water Power Act*

  The Committee did not reach consensus on the best approach of those listed and further discussion would be required between NCN and Manitoba Hydro as to how best to proceed, after examining the benefits and drawbacks of each approach. Liability was not considered to be an issue constraining the choice among alternatives.

- **Other options** were identified to address the objectives of the Plan, particularly if ownership or the equivalent is not possible. For example:
    - establishment of a Wildlife Road Refuge under *The Wildlife Act*
    - general area closure under *The Wildlife Act*
    - protection of the caribou range under *The Crown Land Act*
    - possible actions under *The Fisheries Act* regulations
    - Educational programming

- **Monitoring** will be an essential part of the Plan, particularly during the operations phase, to identify issues as they arise so that action can be taken in a timely way to address them.

RECOMMENDATIONS:

The Access Management Committee makes the following recommendations to NCN Chief and Council and to Manitoba Hydro:

1. **Prepare an Access Management Plan**
   That an Access Management Plan be prepared for the Wuskwatim Access Road, with the elements set out in the conclusions of this report and in the following recommendations. The interim product (focused on the overall outline, Construction Phase portion and process for completing the Operations Phase portion) is an important input to the EIA conclusions and should be completed as soon as possible (no later than mid-September). The full Plan should be completed as soon as possible during the Construction Phase and no later than the end of the Construction Phase.

2. **Pursue Private Ownership or the Equivalent for the Access Road**
   That private ownership or the equivalent be pursued and that Manitoba Hydro and NCN discuss a preferred option, after considering the benefits and drawbacks of the options identified. Consensus could not be reached at the Access Management Committee.

3. **Construction Phase Portion of the Plan**
   That the construction phase portion of the Plan include, as is understood to be in place, a security gate and gatehouse (location to be determined) with manned access control 24 hours per day and seven days per week.
   That a mechanism be put in place, developed by the Partnership, for permitting of access for non-construction activities to the Wuskwatim Road (e.g., by NCN resource harvesters).
   That this mechanism be put in place as soon as possible, once access is established via the access road.

4. **Process to Complete the Operations Phase Portion of the Plan**
   That the operations phase portion of the Plan be prepared by the Partnership, in consultation with the NHRMB.
   That the Partnership, in consultation with the NHRMB, consider the range of land management tools available under various Acts and Regulations of the Province of Manitoba and discussed by the Access Management Committee (*The Wildlife Act*, Manitoba Fisheries Regulations, *The Crown Lands Act*, *The Parkland and Protected Area Act*, *The Environment Act*, *The Trespass Act*).

5. **Implement Education and Communication Strategy for the Plan**
   That NCN and Manitoba Hydro prepare an Education and Communication Strategy to complement the Plan and that access restrictions during the Construction Phase be communicated as early as possible, even as early as the announcement of the Project.

6. **Implement Monitoring Program for the Plan**
   That monitoring of access (levels of use, issues) begin during the construction phase and continue, as needed, during the operations phase.

ACTIONS:

- NCN Chief and Council and Manitoba Hydro review the above recommendations and give further direction.

- That the Access Management Plan, as developed in the near term (overall outline, construction phase portion, process for completing operations phase portion), be available for inclusion in the EIS with respect to mitigation of access issues and be available for reference in the Project Development Agreement.

Attachment 1

BACKGROUND: SELECTION OF AN ACCESS ROAD LOCATION FOR THE PROPOSED WUSKWATIM GENERATING STATION

- To build and operate the Wuskwatim Generating Station, an access road is required between PR 391 and the Wuskwatim site. Between May 2000 and December 2001, Manitoba Hydro and NCN worked together via the Alternatives Committee to examine a range of alternative routes for the access road – some routes proposed by Manitoba Hydro and others proposed by NCN.
- The Alternatives Committee (with representatives from NCN, Manitoba Hydro and the Environmental Study Team) screened a broad array of alternative routes – Taylor River, Mile 5, Mile 20, Nelson House, Nelson House with Spur. Additional variations were also examined (i.e., RC Point access, South Route from 170B, Mile 33, and Mile 37).
- Of these alternatives, the Mile 5/20 area was selected for more detailed analysis, where 5 specific routing options were examined (Manitoba Hydro and NCN Chief and Council concurred with this recommendation).
- Comparison of the alternative routes focused on three main areas – impact on NCN, impact on the environment, and impact on the project. The Alternatives Committee identified criteria with which to examine each of these topics and undertook research in each area. This included TK interviews with elders and resource harvesters, looking at available mapped information, examining experience elsewhere, over flights of the routes and other sources.
- Results were presented to NCN members at various stages (an open house in August 2000, community meeting in August 2001 and workshop in December 2001 looking at the more detailed centreline options).

CONCLUSIONS SUPPORTING MILE 17 ROUTE

The Alternatives Committee compared the five possible centreline right-of-way (ROW) routes for the access road in the area between Mile 5 and Mile 20 and concluded that the Mile 17 route offered the most benefits and least problems when considering impact on NCN, impact on the environment and impact on the project.

IMPACT ON NCN

- eight evaluation criteria were examined to compare the impact of centreline ROW alternatives on NCN; of these, impacts on important cultural sites, particularly Eagle Hill and a nearby artesian water source, were considered to be most important.
- Mile 17 appeared to offer the least adverse impacts and most benefits to NCN of the alternatives considered; in particular:
    - it is the furthest away from Eagle Hill and the water source;
    - it provides more convenient access than Mile 5 for NCN members from Nelson House wishing to access the Wuskwatim Lake area;
    - it provides a safer intersection (based on site lines) than at Mile 20a and Mile 20 but is less safe than Mile 19.25 (note that safety may be improved with Mile 17 centreline adjustment at the intersection); and
    - it is likely to result in less adverse impacts on NCN resource uses (hunting, fishing, trapping and gathering of medicinal plants) than Mile 5 which has more abundant resources and more tendency for non-members from Thompson and elsewhere to access the area.

IMPACT ON THE ENVIRONMENT

- nine evaluation criteria were examined to compare the impact of centreline ROW alternatives on the Environment; of these, impacts on woodland caribou and moose were considered the most important.
- the Mile 17 option appeared to offer the least adverse impacts on the Environment; in particular:
    - it is far enough away from critical caribou calving habitat lying to the west of the esker (Mile 20 was considered too close to the critical caribou calving habitat);
    - it minimizes disturbance of the jack pine ecosystem associated with the glacial outwash feature;
    - it does not impact the high quality moose and other wildlife habitat along Birch Tree Creek (Mile 5);
    - caribou are expected to move through this area during spring and fall migration, but potential adverse effects are thought to be mitigable (caribou would also pass through the Mile 20, Mile 20a, and Mile 19.25 routes); and,
    - it avoids impact to the BOREAS site.

IMPACT ON THE PROJECT

- twelve evaluation criteria were examined to compare the impact of centreline ROW alternatives on the Project; of these, safety and the effect of terrain type on construction and maintenance costs were found to be the most important factors.
- Mile 20a is the least potential cost to the project ($63.4M), followed by Mile 20 ($63.5M), Mile 19.25 ($64.0M), Mile 17 ($65.2M) and Mile 5 ($67.1M).
- Mile 19.25 provides the safest intersection (based on sight lines) followed by Mile 17 & Mile 5. Mile 20 and Mile 20a provide poorest sight lines.
- Mile 5 provides a negative construction schedule risk due to the nature of the terrain type along the first part of the road.
- Mile 17 provides less construction risk due to better chance of acceptance by regulators and by NCN members.
- Mile 19.25 is the easiest intersection to construct due to the level terrain at PR 391, followed by Mile 5, Mile 17, Mile 20, Mile 20a.

RECOMMENDATION AND DECISIONS

The Alternatives Committee recommended that the Mile 17 alternative route be selected as the centreline ROW route for the Wuskwatim access road for the next phase of road activities. This decision was approved by NCN Chief and Council and Manitoba Hydro. In January 2002, the Nelson House Resource Management Board approved the work permit to allow the exploration program for the Mile 17 centreline to commence. The exploration program was undertaken and completed during the late winter/spring 2002.

Throughout the course of the alternatives process, management of new access into the Nelson House RMA was raised many times as a key concern. As a result, the subsequent Access Management Committee work was initiated.

Attachment 2
Access Management Committee

Attendees at one or more meetings of the Access Management Committee have included:

Councillor D'Arcy Linklater	NCN and NHRMB
Councillor Agnes Spence	NCN
Ron Spence	NCN
Mike Dumas	NCN (SIL)
Val Dysart	NCN (SIL)
Ed Vystrcil	NCN
Terry Linklater	NCN
Charlie Joe Hart	NCN and NHRMB, Co-Chair
Bill Yetman	NCN and NHRMB
Norman Linklater	NCN
Violet Turner	NCN
Brian Shortt	Manitoba Hydro
Wally Muzyczka	Manitoba Hydro
Roy Bukowsky	Manitoba Hydro
Ron Rawluk	Manitoba Hydro (transmission)
Tim Nykoluk	Footprint Engineering, NCN advisor
Don Cook	Footprint Engineering, NCN advisor
Elliot Leven	Myers Weinberg, NCN advisor
Trevor Ray	Myers Weinberg, NCN advisor
Cam MacInnes	Unies, NCN advisor
Michael Lawrence	Environmental Study Team, Chair
Janet Kinley	Environmental Study Team
Gordon McColm	Environmental Study Team
Elisabeth Hicks	Environmental Study Team (transmission)

Guests at one or more meeting:

Steve Kearney	Manitoba Conservation and NHRMB
Steve Danyluk	Manitoba Conservation and NHRMB
Harold Smith	Manitoba Aboriginal and Northern Affairs and NHRMB, Co-Chair
Darryl Headman	Manitoba Conservation

Attachment 3

Access Management Committee

Meeting Notes

Following are meeting notes from the Access Management Committee:

- February 14th, 2002 Thompson, Manitoba
- March 8th, 2002 Thompson, Manitoba
- April 12th, 2002 Winnipeg, Manitoba
- May 7th, 2002 Thompson, Manitoba (notes pending from V. Turner)