WEST COAST OLEFINS LTD.

West Coast Olefins Project

Preliminary Project Description

September 12, 2019

Revision 1

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List of Acronyms and Abbreviations

Acronym / Abbreviation	Definition
AM	Accidents and Malfunctions, specific to Tables 2.7, 2.8 and 2.10
ALR	Agricultural Land Reserve
BC	British Columbia
BCEAA	BC Environmental Assessment Act
BC EAO	BC Environmental Assessment Office
BC OGC	British Columbia Oil and Gas Commission
BEP	Basic Engineering Package
C	construction phase, specific to Tables 2.7, 2.8 and 2.10
C2+	hydrocarbons with 2 or more carbon atoms in the carbon chain
C3	hydrocarbons with 3-carbon chains
C4	hydrocarbons with 4-carbon chains
C4+	hydrocarbons with 4 or more carbon atoms in the carbon chain
C5+	hydrocarbons with 5 or more carbon atoms in the carbon chain
Cdn	Canadian dollars
CEAA	Canadian Environmental Assessment Act
CNC	College of New Caledonia
CO_2	carbon dioxide
D	decommissioning phase, specific to Tables 2.7, 2.8 and 2.10
FID	Final Investment Decision
GHG	greenhouse gas
H_2S	hydrogen sulphide
IFD	Issued For Design
LHA	Local Health Area
NGL	natural gas liquid
NO_2	nitrogen dioxide
NOx	any of several possible nitrogen oxides
O	operation phase, specific to Tables 2.7, 2.8 and 2.10
PM	particulate matter
$PM_{2.5}$	particulate matter with particle diameters less than 2.5 micrometres
PM_{10}	particulate matter with particle diameters less than 10 micrometres

Acronym / Abbreviation	Definition
RAAD	Remote Access to Archaeological Data
RDFFG	Regional District of Fraser-Fort George
SBS	Sub-boreal Spruce
SOx	any of several possible sulphur oxides
UNBC	University of Northern British Columba
USGC	USA Gulf Coast
VHP	very high pressure
VOC	volatile organic compound(s)

List of Symbols and Units of Measure

Symbol / Unit of Measure	Definition
%	percent
<	less than
>	greater than
Btu	British thermal unit
°C	degrees Celsius
GJ/h	gigajoules per hour
km	kilometre
kPag	kiloPascals gauge pressure
kV	kilovolts
lb	pound
m	metre
mm	milimetre
m^3/d	cubic metres per day
m^3/h	cubic metres per hour
M	million
Mt/y	millions of tonnes per year
MW	megawatts
pH	a measure of acidity
Sm^3/d	standard cubic metres per day
t/d	tonnes per day
t/h	tonnes per hour

t/y	tonnes per year
µm	micrometre (one-millionth of one metre)

Defined Terms

Term	Description
Application	Application for an Environmental Assessment Certificate
Extraction Site	the location of the NGL Extraction Plant
Riparian	interface between land and body of water
NGL Recovery Plant	Separately owned WCOL subsidiary, comprised of two separately sited component Plants: The NGL Extraction Plant, and the NGL Separation Plant. The NGL Extraction Plant will be located at the Extraction Site. The NGL Separation Plant will be located in the Project Area.
NGL Extraction Plant	Individual Plant, but part of the NGL Recovery Plant. Located on the Extraction Site. Receives rich gas from the Westcoast Pipeline, removing a mixture of NGLs (ethane and heavier) and returning a leaner natural gas to the pipeline.
NGL Separation Plant	Individual Plant, but part of the NGL Recovery Plant. Located within the Project Area. Will receive C2+ NGL from the NGL Extraction Plant, and separate into 4 products: ethane, propane, butane and condensate.
Ethylene Project	Subject of this EA Project Description. Will receive ethane feedstock from NGL Separation Plant and convert it into ethylene product. Also referred to as "the Project". Consists of Ethylene Plant and all associated utilities and infrastructure.
Ethylene Derivative Plant	A separate plant owned by a third party partner. Receives ethylene product from the Ethylene Plant and converts it into polyethylene, and potentially mono-ethylene glycol, product.
Project Area	Site of the Ethylene Plant. Located within the BCR Industrial Area. NGL Separation Plant will also be located on this site.
Fired CO2	CO2 that results due to combustion
Unfired/Process CO2	CO2 that results due to chemical removal processes (amine treatment) and is removed from the Westcoast Pipeline natural gas.

1 Introduction

West Coast Olefins Ltd. (WCOL), through a wholly owned subsidiary, is proposing to develop the West Coast Olefins Ethylene Project (Ethylene Project, or Project) that will convert ethane to produce polymer-grade ethylene. The Ethylene Project will be located within existing industrial lands in the City of Prince George, British Columbia (BC). The Project will produce and sell approximately 1 million tonnes per year (Mt/y) of polymer-grade ethylene and will have an initial lifespan of approximately 25 years.

The ethane will be purchased from a Natural Gas Liquid (NGL) Recovery Plant owned by a separate subsidiary of WCOL, which will recover the ethane and other NGLs from the Enbridge Westcoast Pipeline that runs just east of Prince George. The ethane purchased from the NGL Recovery Plant will be used by the Ethylene Project as a feedstock to produce ethylene. The recovered ethylene will be sold to an Ethylene Derivative Plant, owned by a third-party company, that will produce derivative products such as polyethylene or mono-ethylene glycol. The relationship of the Ethylene Project and the NGL Recovery and Derivative Plants is represented in Figure 1.1.

The WCOL team anticipates the Project will be subject to review under the BC *Environmental Assessment Act* (BCEAA), SBC 2002, c. 43 (see Section 1.5 for details). The purpose of this Project Description is to:

- Provide an overview of Project information to enable the BC Environmental Assessment Office (BC EAO) to determine whether an Environmental Assessment (EA) is required under the enabling legislation.
- Provide other parties and stakeholders (e.g., provincial government agencies, Indigenous groups, local and regional governments, the public) with information about the Project so that they can determine whether they have an interest that would be affected by the Project.
- Provide an overview of other facilities related to the ethylene supply chain, which will be developed in parallel to the Project, but which are not part of this Project Description or the EA for the Project. This will provide stakeholders with additional context to be considered in evaluating cumulative impacts.

The Project Description has been prepared in accordance with *Preparing a Project Description for an Environmental Assessment in British Columbia* (BC Environmental Assessment Office , 2016).

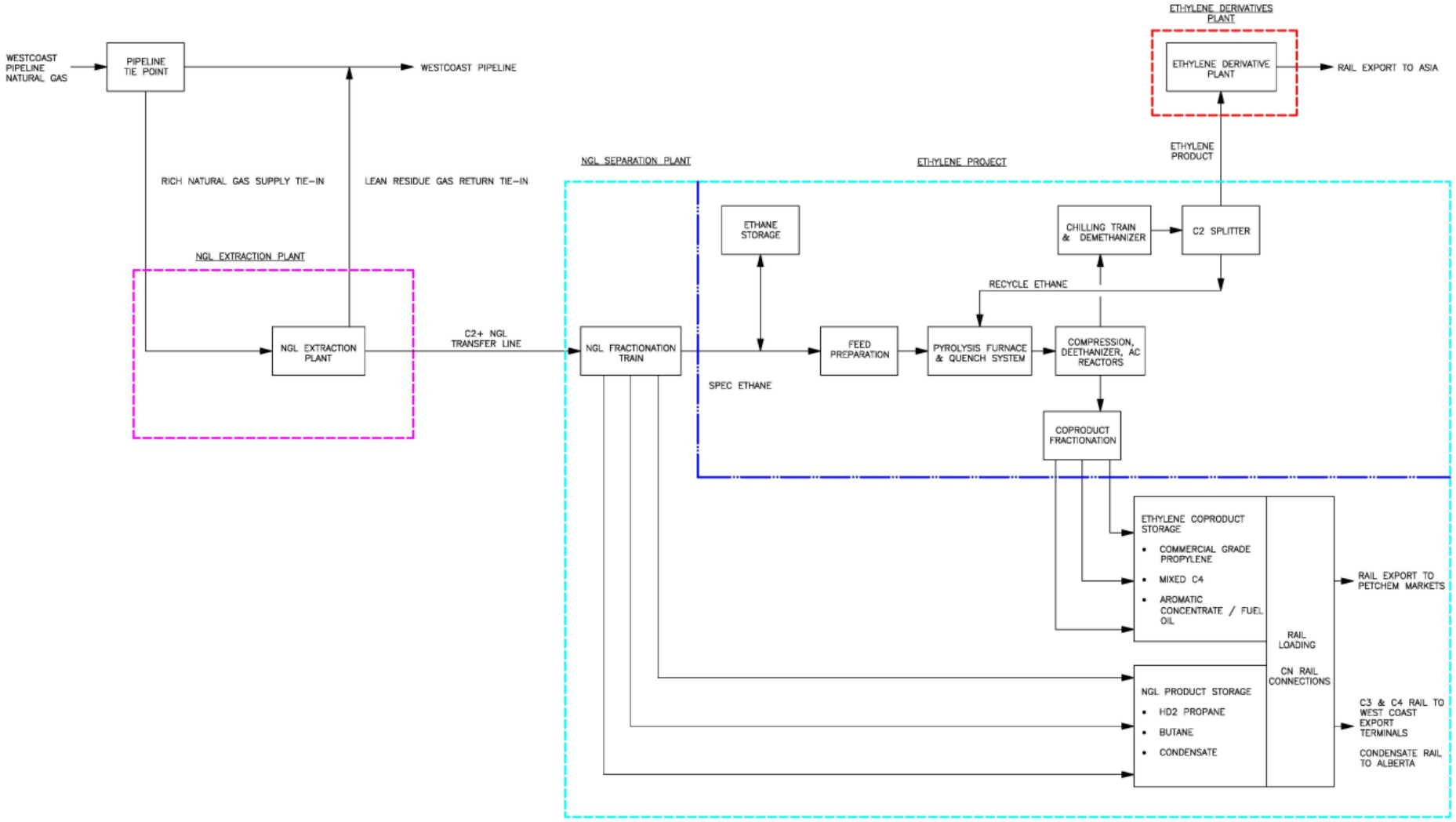

Figure 1.1: Ethylene Project's Relation to NGL Recovery Plant and Ethylene Derivative Plant

1.1 Project Overview

The Project will purchase ethane from the NGL Recovery Plant. The ethane feedstock will be processed to remove contaminants such as carbon dioxide (CO_2) and hydrogen sulphide (H_2S) and then converted to ethylene and a mixture of other products in Pyrolysis Furnaces. Undesirable contaminants will be removed, and the primary ethylene product will be separated from the other byproducts. The ethylene will be sold to the Ethylene Derivatives Plant and the other byproducts sent to the NGL Recovery Plant to be loaded onto rail cars for delivery to markets in Canada and the USA.

The Project is proposed to be located on over 120 hectares of previously developed, fee simple land located within an industrial zone in the City of Prince George. WCOL has selected Prince George as the location of the Project because of the superior combination of existing infrastructure and resources (e.g., rail, power infrastructure, existing pipeline access, Fraser River) and the stable and sizable population base. The site location has been selected to minimize the use of undisturbed land, thereby minimizing potential environmental impacts from the facility location. See Figure 1.2 and Section 3.

The Project development is currently in the conceptual stage and is proceeding to the Basic Engineering Package (BEP) phase through the remainder of 2019 and into early 2020. Design information from the BEP phase will be incorporated into the Application for an Environmental Assessment Certificate (Application) for the Project to BC EAO. Many options relative to the design and execution of the Project will be assessed and developed during the BEP phase. Current concepts are described in Section 2; as the details related to the Project are developed, the updated options and designs will be presented in the Application.

The Issued for Design (IFD) engineering stage is planned for completion in 2020, which supports a targeted final investment decision (FID) by the fourth quarter of 2020. Assuming regulatory approvals leading to a positive FID, fabrication and construction activities will start in early 2021, and plant start-up is planned to occur by the end of 2023.

1.1.1 Project Rationale

The Project is an Ethylene Plant, which will utilize low-cost, abundant ethane from natural gas production primarily in northeastern BC and generate ethylene that can be further manufactured into derivative products such as polyethylene and mono-ethylene glycol, for export to growing Asian markets. The Project will utilize ethane that is available from the existing Westcoast Pipeline, thereby adding value to a resource that has been under-utilized for decades, while avoiding the need for the construction of any new major pipelines. The Project is part of an ethylene value chain, and 2 other facilities will be developed outside the Project, but on roughly the same schedule: an NGL Recovery Plant and an Ethylene Derivative Plant. The NGL Recovery Plant will undergo a BC Oil and Gas Commission (OGC) application, and the Ethylene Derivative Plant will undergo a separate EA process. See Section 1.2.1 for further information on the ethylene value chain and facilities not covered by this Project Description.

1.1.2 Project Benefits

The Project will create tremendous value-added economic benefits from a natural gas resource that is otherwise destined to be burned as fuel by customers on the Westcoast Pipeline system. Close to a $1 million per day of value will be created through the conversion of ethane to ethylene in the ethylene value chain, and additional revenue of a similar magnitude will be realized from the other facilities in the extended ethylene value chain. The $2.0 billion to $2.8 billion Project will generate thousands of person-years of employment during the construction period and up to 230 permanent, direct and contract employment positions once the Project reaches commercial operation. Once the plants are in operation, approximately $20 million to $50 million will be needed per year of sustaining capital investment, which will in turn generate significant on-going economic benefits to the local community. Numerous other indirect benefits will accrue to the local community, such as training at local institutions (University of Northern British Columbia and College of New Caledonia (UNBC and CNC)), support services (i.e. transport, food, lodging, maintenance, professional services, etc.) and associated new business development opportunities.

Ethane, as a feedstock, is the most direct, lowest energy route to manufacturing ethylene, giving the Project an environmental edge over ethylene plants based on hydrocarbon liquids or coal as a feedstock. The Project will utilize latest technology in the design of the Ethylene Plant, such as highly energy efficient plant designs, the use of ultra-low NOx (nitrogen oxide) burners and the use of clean burning fuel to reduce greenhouse gas (GHG) emissions. The combination of feedstock and new plant design will make the Plant a low emissions facility from a local perspective and “best-in-class” relative to other facilities globally.

The Ethylene Plant will be designed and operated to minimize the impacts on water sources and aquatic life. The Project will be located on fee simple land in an existing and under-utilized industrial park within the city limits of Prince George to minimize land disturbance.

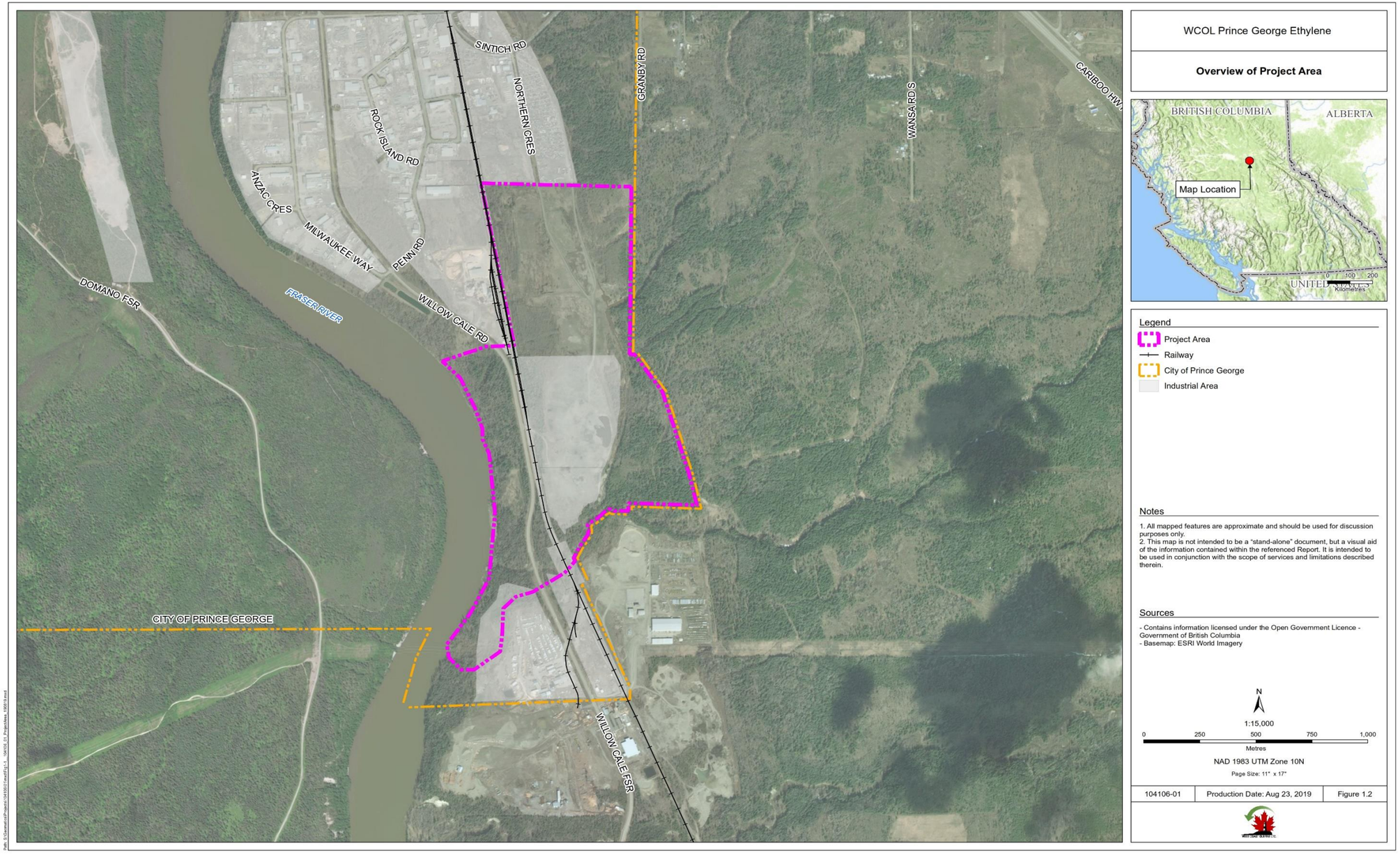

Figure 1.2: WCOL Project Area Location.

1.2 Scope of Related Ethylene Value Chain

As noted in Section 1, the Project will convert purchased ethane into ethylene, for sale to a third-party who will produce ethylene derivative products. The various facilities involved in this transformation, including the proposed Project, comprise the ethylene value chain and will include:

- An NGL Recovery Plant to recover ethane, propane, butane and natural gas condensate from Enbridge's Westcoast Pipeline.
- The Ethylene Plant Project, which will produce nominally 1 Mt/y of polymer-grade ethylene.
- A Polyethylene Plant developed by others to consume the majority (70% to100%) of ethylene produced and potential for a future Mono-ethylene Glycol Plant to be developed by others to utilize the balance of the ethylene produced. Collectively, these facilities will be referred to as the Ethylene Derivative Plant (or Derivative Plant). The ethylene derivative products are used in the manufacture of plastic products, fabrics, etc.

This Project Description specifically pertains to the EA process for the Ethylene Project, which consists of the Ethylene Plant and directly related utilities and infrastructure. Separate regulatory applications are being submitted for other facets of the ethylene supply chain. The purpose of Section 1.2 is to provide a clear explanation of the regulatory and business rationale for the separate applications as well as an explanation of how regulatory applications for all aspects of the development will be managed.

This is a new industry in BC, one that offers considerable value, both in generating revenue from otherwise under-utilized natural gas liquids and reducing the carbon footprint of Canada's natural gas industry by returning a leaner, clean burning natural gas to the Westcoast Pipeline. Unlike in other locations where a mature industry exists for ethylene recovery and use (such as the US Gulf Coast), established business interests do not yet exist in BC for each of the key components in the value chain. For instance, there are no consumers of ethane or ethylene within BC. A value chain is a series of related businesses which extract value from a particular commodity (in this case ethylene) by converting it into other value added products. Thus, at this early juncture, and to grow the industry, WCOL will be the catalyst for and partially involved in several components that in the future will be independently owned and operated businesses.

This development has been designed to accommodate the need for a separate regulatory review process for each of the 3 key components, which would result in a separate and individually transferable suite of approval conditions for each. This approach acknowledges that until a mature industry develops, the multitude of possible end uses resulting from ethylene production cannot be predicted, and the independence of each is critical, as described further in this section. Each component in the overall value chain will be subject to a regulatory approval process, either by the BC EAO or by the BC OGC, with the cumulative effect of the overall development being outlined in the EA Application for the Ethylene Project (see Section 1.2.3). This arrangement provides for a robust and

appropriate assessment for each component, and where applicable, acknowledges the need to address the combined or cumulative influence of the overall supply chain.

1.2.1 Business Structure

The WCOL Ethylene Plant will have a unique but not exclusive business relationship with the NGL Recovery Plant and the Ethylene Derivative Plant Each of these 3 facilities is expected to have separate ownership as the projects move forward and hence the need for each business to file separate regulatory applications (see Section 1.2.3) to construct new facilities in the Prince George region. During the regulatory and permitting process there is the need for separate permits for these facilities while ensuring that the aggregate environmental impacts are evaluated. WCOL's intent is to include a detailed evaluation of the social, economic and environmental impacts of the Ethylene Plant as well as an overview of the overall impacts for the combined project.

The NGL Recovery Plant will extract the ethane, propane, butane and natural gas condensate from Enbridge's Westcoast Pipeline that runs just east of Prince George. This facility will process natural gas as a service to upstream natural gas producers, who will sell these liquid products at much higher value in the market. The propane and butane will serve local markets and be exported into international markets via ports on the west coast of British Columbia. The condensate product would be an ideal local source of feed to be refined in the Prince George refinery or could be exported to Alberta.

Ethane is the one product that does not have a readily available market in BC, and this is the rationale for the WCOL Ethylene Plant, which will be the sole purchaser of ethane recovered from the NGL Recovery Plant on a long-term (25 year), take-or-pay basis. They will be 2 distinct and independent companies with different ownership and management. The source for ethane will likely change over time as more ethane becomes available from pipelines supplying various liquefied natural gas plants that are currently in various stages of development. This prediction is consistent with what happened in Joffre, Alberta, where the ethane supply was originally provided by the Alberta Ethane Gathering System but now includes ethane from North Dakota, oilsands off-gases and ethane extracted from the natural gas feed to the cogeneration system at the plant site.

WCOL plans to operate the Ethylene Plant as a midstream service between the seller of the ethane feedstock (the NGL Recovery Plant) and the buyer of the ethylene (the Derivative Plant) produced in the plant. Ethylene will be sold to the Derivative Plant on a cost-of-service basis via a long-term purchase agreement, and the owner of the Derivative Plant will then design, construct and operate the facilities that will convert the ethylene into polyethylene or other derivatives such as mono-ethylene glycol. The Ethylene Plant and Derivative Plant need to proceed on same construction schedule, as the only consumer of the ethylene product from the Ethylene Plant will be the Derivative Plant. The Derivative Plant proponent will seek separate EA approval for this project.

Once the plants reach full commercial operation, numerous scenarios could result in the 3 plants operating independently of each other. For example, if an event causes an outage or delay in the initial start-up in either the Ethylene Plant or Ethylene Derivative Plant, the NGL Recovery Plant would continue to operate in ethane rejection mode but would recover propane, butane and natural gas condensate.

In addition to the business rationale for separate permitting processes for each of the 3 projects, other issues need to be considered over the life of the operations:

- Proceeding with a single regulatory approval and permitting application for the 3 projects would require that all parties provide required information to prepare and respond to requests generated through the regulatory process. This would be particularly difficult where proprietary technology or market information is involved.
- Post start-up, operating the plants under a single permit would be difficult as it would require that all parties make the necessary information available to meet regulatory reporting requirements. This would become very complex when each company is required to consider the division of environmental liabilities should an incident occur.
- It is very likely that the future relationship between the NGL Recovery Plant, the Ethylene Plant and the Ethylene Derivative Plant will change at some point in the future, making a combined permit impractical. This has certainly proven to be the case for the Alberta ethylene plants, for which, as noted above, the source of feedstock has expanded dramatically The original ethylene buyers have also changed over time, for example, Dow started as the only buyer of the ethylene from the first ethylene plant, but no longer purchases ethylene from the original Nova Chemicals ethylene plant.

The three related projects have been defined to align with the different business ownership models and separate regulatory applications will be filed for each, as described in Section 1.2.3.

1.2.2 Elements in the Ethylene Supply Chain

Through discussions between WCOL, BC EAO, and BC OGC, a regulatory approval process has been designed to (i) ensure appropriate and rigorous evaluation of the impacts of the overall development **and** (ii) divide the overall development into 3 component pieces: the NGL Recovery Plant, the Ethylene Plant and the Ethylene Derivative Plant. Each of the components in the supply chain is a major processing facility with unique regulatory needs and business considerations.

Ethylene Project

The Ethylene Project is the subject of this EA Project Description, and the facilities and operation for this Project are described in detail in the balance of this document. The Ethylene Project will be located on a site in Prince George's industrial park, referred to as the Project Area (see Section 3). The Project will purchase ethane feedstock from the NGL Separation Plant and primarily convert it into ethylene product (roughly 80% of the total production from the facility), with the remainder being hydrogen-rich offgas and some mixed liquid coproducts. The ethylene product will be sold to the Ethylene Derivative Plant. Offgas will be recycled as fuel within the Ethylene Project; its hydrogen-rich nature will reduce GHG emissions that might otherwise be associated with the facility if other fuels were used instead. Liquid coproducts, consisting of mixed C3, mixed C4, aromatic concentrate and pyrolysis fuel oil, will be sent to the storage and rail loading facilities owned and operated by the NGL Separation Plant proponent, then loaded onto rail cars and likely sent to Alberta or the USA Gulf Coast (USGC) where they typically become feed streams for other petrochemical or refinery facilities.

NGL Recovery Plant

The purpose of the NGL Recovery Plant is to recover an NGL mixture of ethane, propane, butane and condensate (C2+) from the Westcoast Pipeline and then separate this mixture of NGL into separate product streams (e.g. ethane, propane, etc.). There are 2 separately sited component facilities in the NGL Recovery Plant:

1. The NGL Extraction Plant will process rich natural gas from Enbridge's Westcoast Pipeline, removing a mixture of otherwise under-utilized NGLs (ethane, propane, butane and condensates) and returning a leaner and cleaner-burning natural gas to the pipeline for export or domestic use. The NGL mixture will be sent from the NGL Extraction Plant via an underground Transfer Line to the NGL Separation Plant. The NGL Extraction Plant will be located at a site adjacent to the Westcoast Pipeline, less than 10 km from Prince George.
2. The NGL Separation Plant will separate the 4 mixed NGL products received from the Extraction Plant: ethane, propane, butane and condensate. The ethane will be sent to the Ethylene Plant Project as feedstock. The propane and butane will be loaded on rail cars and likely sent to third-party Liquefied Petroleum Gas (LPG) marine export terminals in Prince Rupert or Kitimat for export to Asia. Expected product volumes will result in the movement of a full Unit Train of rail cars roughly every other day. The condensate will be loaded onto rail cars and sent to Alberta for sale into the condensate pool, or it could be sold as feedstock to the Husky refinery in Prince George. The NGL Separation Plant will be

located adjacent to, but separate from, the Ethylene Plant in the Project Area site.

Additional detail related to the scope of the NGL Recovery Plant and its component facilities is contained in Appendix B.

Ethylene Derivative Plant

The Ethylene Derivative Plant will purchase ethylene product from the Ethylene Project and convert it into polyethylene product, most likely in the form of polyethylene pellets, for shipment to the growing Asian market. The capacity of this facility is nominally 1 Mt/y of polyethylene product, with no coproducts produced. Facilities associated with the Derivative Plant are expected to be located within the Prince George industrial corridor and could be co-located at the Ethylene Project Area. Polyethylene product will be loaded into rail cars at the Ethylene Derivative Plant, resulting in the movement of a full Unit Train of rail cars roughly every 2 or 3 days.

This part of the Project will likely be developed by an international partner with a global share of the polyethylene market. They will select the technology and process design of the facility to meet future demands of the polyethylene market. Until this partner is selected, the scope and design of the Ethylene Derivative Plant cannot be defined as the equipment can vary substantially depending on the slate of products and the fundamental technology choices of the future developer.

Some of the derivatives partner(s) currently being considered by WCOL would potentially divide the derivatives production and build a Mono-ethylene Glycol Plant to consume some of the ethylene. This product would also be destined for export to the Asian market.

1.2.3 Regulatory Strategy

WCOL and the Ethylene Project are the catalyst for the overall ethylene supply chain development. Each of the components of the initiative will submit separate regulatory applications as follows:

- The EA covered within this Project Description is being submitted for the Ethylene Project, which includes the Ethylene Plant and all associated utilities, infrastructure and off-sites scope, with assets located at the Project Area site.
- An OGC application will be submitted for the NGL Recovery Plant, covering the NGL Extraction and NGL Separation plants and all associated utilities, infrastructure and off-site scope, with assets located both at and between the NGL Extraction Site at the Westcoast Pipeline and the Project Area site.
- A future and separate EA Application will be submitted for the Ethylene Derivatives Plant, which may include a Ethylene Derivative Plant or other

ethylene derivatives, and all associated utilities, infrastructure and off-sites scope. The site location and the proponent have not yet been selected.

WCOL has developed a regulatory strategy that will consider cumulative impacts of the total development, while filing the 3 separate applications. The proposed regulatory application approach is discussed in the following sub-sections and depicted in Figure 1.3.

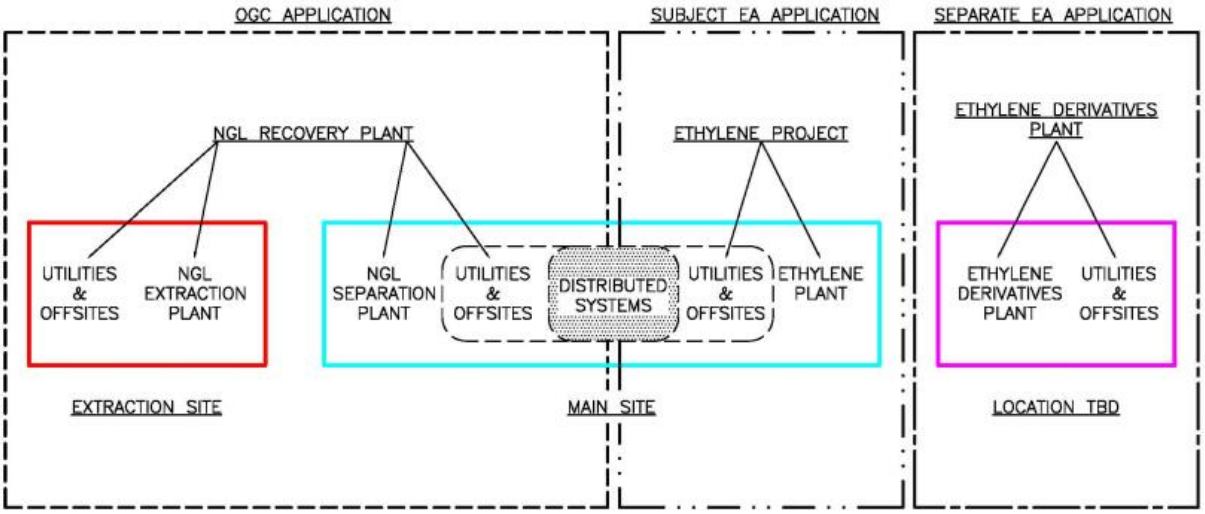

Figure 1.3: Depiction of WCOL Development Application Approach.

Ethylene Project

WCOL will submit an EA Application for the Ethylene Project, as described in this Project Description. As required by the BC OGC, WCOL will also initiate an application process for the separate approval requirements required of the Ethylene Project.

NGL Recovery Plant

The NGL Recovery Plant will be the subject of a BC OGC application, with an expected filing date during the first half of 2020.

This BC OGC application will cover:

- All impacts associated with the NGL Extraction Plant, mixed NGL storage and utilities or infrastructure at the pipeline Extraction Site
- The NGL Transfer Line from the Extraction Site to the Ethylene Plant Project Area at the Prince George Industrial Park
- All impacts associated with the NGL Separation Plant, liquid hydrocarbon storage, rail loading facilities and dedicated utilities at the Prince George Industrial Park

Water usage or disposal requirements for this plant are minor, and the intention is to provide water requirements on a fee-for-service basis from the Ethylene Project. Consequently, the NGL Recovery Plant is not expected to require its own water withdrawal or water discharge licence. Stormwater management at the Prince George Industrial Park site will be required, but the management strategy will be dependent on the site layout: the NGL Separation Plant might have an independent stormwater collection and management system, or there might be a single system for the site, which would be included in the design and Application for the Ethylene Project.

WCOL will perform cumulative effects assessments on applicable past, present and reasonably foreseeable projects and related Plant components within the agreed study area boundaries (NGL Recovery Plant, Ethylene Plant, and Ethylene Derivitives Plant, as appropriate).

Ethylene Derivative Plant

The Ethylene Derivative Plant is an component of the overall supply chain that will complete a separate EA Application. The development and submission of this EA Application will be the responsibility of the third-party ethylene derivative partner. This EA Application is expected to lag behind the Ethylene Project EA Application by 6 to 9 months.

See Section above for how cumulative effects assessments will be carried out.

Following early discussions with regulators, the Ethylene Derivative Plant may not fall under the mandate of the BC OGC, and any required water or air emissions permits might be issued by the BC Ministry of Environment and Climate Change Strategy. These details will need to be resolved once the ethylene derivatives owner engages with regulator(s).

1.3 Proponent Information

The Project will be developed by a subsidiary of WCOL, a private Canadian company that is developing value-added petrochemical projects to access abundant feedstocks available in western Canada.

WCOL and the Project will proceed/operate under the following corporate policies:

- **Provision of environmental benefits**: WCOL is taking measures to reduce our carbon footprint during the operation phase of the Project. Some of the environmental benefits include the use of the latest technologies for an energy-efficient design of the Ethylene Plant process, use of low emission fuel gas for the Pyrolysis Furnaces, use of ultra-low NOx burners and maximization of water re-use and recycling.
- **Provision of long-term local benefits**: The Project is anticipated to foster diversification of the local economy; generation of long-term, highly skilled job

positions during the construction and operation phase of the plant; indirect economic benefits to the local community; training and skills upgrading at local institutions; opportunities to provide support services; and new associated business development opportunities.

- **Best-in-class technology and operating standards**: The Ethylene Plant will be operated with processes and procedures that ensure reliable and optimized plant operation (high thermal efficiencies, high product yield), reduce safety incidents, and meet regulatory targets.
- **Consultation with Indigenous People, stakeholders and regulatory agencies**: WCOL recognizes that the Project has the potential to directly interact with the rights, interests, uses and activities of the community and understands that open dialogue and community engagement will be important throughout the Project's development.
- **Competitive access to markets**: Due to the location of the Ethylene Project, this Project has structural advantages over key competitors, and this positions the proposed facilities to be a low-cost global producer.
- **Health and safety**: WCOL understands the crucial need for safe practices and procedures. Precautions such as rigorous training programs and access to medical and emergency systems will be employed.

WCOL information and key contacts are listed in Table 1.1.

Table 1.1: Proponent Information and Key Contacts.

Project Name	West Coast Olefins Ethylene Project
Proponent Name	West Coast Olefins Limited
Proponent Corporate Address	555 - 4 Ave. SW, Suite 1700 Calgary, AB, Canada T2P 3E7
Proponent Contact Information	Email: info@westcoastolefins.com Phone: 403-350-8434
Company Website	https://www.westcoastolefins.com/
Company President	Ken James
Principal Contact Person for West Coast Olefins Ethylene Project	Ron Just Chief Operating Officer rjust@westcoastolefins.com 403-350-8434

1.4 Consultation with Indigenous Groups, Stakeholders and Regulatory Agencies

WCOL values the importance of engagement with Indigenous groups, community stakeholders, and regulatory bodies potentially affected by the Project. WCOL views the support of these groups as fundamental to the long-term success of the Project and will continue to place a priority on identifying affected groups and working collaboratively with them to manage concerns throughout the lifecycle of the Project.

WCOL is in discussions with the Lheidli T'enneh First Nation with the intent to develop agreements that would define the terms of a meaningful and beneficial relationship between the parties related to the Project and other facilities and activities that would comprise the overall ethylene supply chain.

WCOL believes strongly in the need to engage often and early with the local community and various stakeholders to clearly explain the scope of the Project and then obtain feedback about the benefits and potential concerns related to the Project. WCOL will work with stakeholders to address concerns in a timely and responsive manner.

Further information regarding the previous activities, activities to date and on-going and proposed consultation activities is provided in Section 5.

1.5 Regulatory Context

WCOL has reviewed the *Regulations Designating Physical Activities* (Government of Canada, 2012) under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012), SC 2012, c. 19, s. 52, as well as the draft *Physical Activities Regulations* (Government of Canada, 2019) under the *Impact Assessment Act*, pending this new legislation coming into force on August 28, 2019, and has determined that the Ethylene Project does not meet the criteria for a designated project. WCOL therefore anticipates that the Ethylene Project will not be subject to a federal review.

Further, WCOL has completed an assessment of the Project scope against the thresholds identified in the BC regulations, and as a result it is anticipated that the Project will require a review under *Reviewable Projects Regulation* of BCEAA. (Government of BC, 2002).

Comparison of the Project scope against the relevant provincial threshold is provided in Table 1.2.

Table 1.2: Comparison of Project Scope Against BCEAA Threshold.

Category	BC *Environmental Assessment Act* Criteria/Threshold	Relevant Project Component/Capacity
Organic and Inorganic Chemical Industry (Table 1 in *Reviewable Projects Regulation*)	A new manufacturing facility that has the production capacity of ≥ 100,000 t/y.	The Project has an ethylene production capacity of 1 Mt/y, which is above the guideline of 100,000 t/y. This category is the reason that the Ethylene Project is moving forward with a BC EA

The Project is not located in an area that has been the subject of a federal regional environmental study as defined in CEAA 2012.

WCOL will submit an EA Application for the Ethylene Project, as scoped out in this Project Description. As required by the BC Oil and Gas Commission (BC OGC), WCOL will also initiate an application with the BC OGC for the separate approval of this Project.

It is not anticipated that an EA will be required under a First Nations treaty or agreement.

Municipal rezoning of the proposed Project Area to heavy industrial designation is required with the City of Prince George.

Based on the Project's current design state, it is anticipated that the following Federal and Provincial permits and authorizations will be required. It is important to note that this list is preliminary and subject to change as the Project progresses.

Table 1.3: Expected Regulatory Requirements.

Permit/Authorization	Relevant Project Activity	Applicable Legislation/ Regulation	Responsible Agency
Federal			
Fisheries Act Self-Assessment or Authorization	Required if Project activities will likely result in serious harm to fish that are part of a commercial, recreational, or Indigenous fishery, or to fish that support such a fishery. May be required for water withdrawal from the Fraser River.	*Fisheries Act*, RSC 1985, c. F-14	Fisheries and Oceans Canada
Navigable Waters Notice of Works	Required for the construction of a work in a scheduled navigable waterway unless classified as a designated work under the Minor Works Order. May be required for water withdrawal from the Fraser River.	*Navigation Protection Act*, RSC 1985, c. N-22	Transport Canada
Aeronautical Obstruction Clearance	Required for tall structures that may interfere with air navigation, which may include buildings and Flare Stacks.	*Aeronautics Act*, RSC 1985, c. A-2*; Canadian Aviation Regulations*, SOR/96-433	Transport Canada
Non-objection to land use and construction proposals	Required for tall structures that may interfere with air navigation, which may include buildings and Flare Stacks.	*Aeronautics Act, Canadian Aviation Regulations*, and various zoning regulations and orders	NAV CANADA

Permit/Authorization	Relevant Project Activity	Applicable Legislation/ Regulation	Responsible Agency
Species at Risk Act Permit	May be required if any Project activities or components affect a Schedule 1 (*Species at Risk Act*) listed species or any part of its critical habitat or the residences of its individuals.	*Species at Risk Act*, SC 2002, c. 29	Environment Canada, Fisheries and Oceans Canada and Parks Canada
Provincial			
Environmental Assessment Certificate	Required prior to obtaining other Provincial permits or constructing the Project.	BCEAA	BC EAO
Facility Permit, including Leave to Construct and Leave to Operate	Required prior to any construction activities for the Project and for operation of the facility.	*Oil and Gas Activities Act*, SBC 2008, c. 36	BC OGC
Decision for an Exclusion of land from the Agricultural Land Reserve (ALR)	May be required to remove land from the ALR to allow for industrial activities.	*Agricultural Land Commission Act,* S.B.C. 2002, c. 36 *Agricultural Land Reserve Use Regulation,* B.C. Reg. 30/2019 *Agricultural Land Reserve General Regulation,* B.C. Reg. 171/2002	BC (supported by the Agricultural Land Commission)
Heritage Site Alteration Permit	May be required during the construction phase to alter an archaeological site within the Project footprint, if any archaeological site(s) is confirmed to exist during an archaeological overview or impact assessment.	*Heritage Conservation Act*, RSBC 1996, c. 187	BC OGC (supported by Archaeology Branch, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development)

Permit/Authorization	Relevant Project Activity	Applicable Legislation/ Regulation	Responsible Agency
Wildlife Salvage Permit	May be required for site preparation during pre-construction, construction and operation phases if wildlife salvages and bird nest removal or relocation are necessary.	*Wildlife Act*, RSBC 1996, c. 488	BC OGC (supported by BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development)
Waste Discharge Permit(s)	Required prior to discharge of effluent (e.g., water from process operation) to the environment; release of air emissions; and management of solid waste.	*Environmental Management Act*, SBC 2003, c. 53; *Waste Discharge Regulation*, BC Reg. 320/2004; *Oil and Gas Waste Regulation*, BC Reg. 254/2005; *Petroleum Storage and Distribution Facilities Storm Water Regulation*, BC Reg. 168/94; *Hazardous Waste Regulation*, BC Reg. 63/88	BC OGC (may be supported by BC Ministry of Environment and Climate Change Strategy)
Registration under the Code of Practice for the Concrete and Concrete Products Industry	May be required if a concrete batch plant is used on-site during construction.	*Environmental Management Act; Waste Discharge Regulation*	BC OGC (may be supported by BC Ministry of Environment and Climate Change Strategy)
Water Licence	Required prior to withdrawal of surface water or groundwater.	*Oil and Gas Activities Act; Water Sustainability Act*, SBC 2014, c. 15	BC OGC (may be supported by BC Ministry of Forests, Lands, Natural Resource Operations and Rural

Permit/Authorization	Relevant Project Activity	Applicable Legislation/ Regulation	Responsible Agency
Notification(s) or Change Approvals for Changes in and about a Stream	Notification is required prior to undertaking an authorized change in and about a stream as defined in section 39 of the *Water Sustainability Regulation*. A change approval is required prior to undertaking any other type of change.	*Water Sustainability Act; Water Sustainability Regulation*, BC Reg. 36/2016	BC OGC (supported by BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development)

In addition, WCOL anticipates the following Municiple permits/authorizations. This list is preliminary, and will be updated and refined as the Project progresses:

- A Servicing Study will be required for the Project, that would discuss the services needed for Project on the site to meet the City of Prince George Subdivision and Development Servicing Bylaw No. 8618, 2014. The Serving Study will include water modelling, need for main extensions, fire flows, and review of City Master plans for water and sewer Development Permit(s) (Servicing Brief required to address technical issues related to water supply, sanitary sewer collection and storm drainage system designs, with consideration the City's Municipal Master Plans).
- Building Permit(s).
- Plumbing Permit(s).
- Permit to Construct in City roadway (for any work proposed within the City road right of way i.e. sewer and water main extensions).
- Works and Services Agreements for work completed by WCOL within the City road right of way.

Additional provincial and municipal authorizations may be required if a temporary camp is required to house a portion of the construction workforce required to support the combined construction of the Project, the NGL Recovery Plant and the Derivatives Plant.

1.6 List of Contributors to Project Description

Table 1.4: Document Contributor Information.

Contributor	Credentials	Section(s)	Relevant Experience
Kevin C. Dorma	PhD, P.Eng. (Alberta)	3 – Project Overview	Professional engineer with over 20 years' experience across the oil, gas and petrochemical industry. Specific ethylene experience at Alberta ethylene plants specializing in quench water management, amine treating, GHG emission quantification and GHG reduction initiatives.
Laura Byrne	B.A.Sc.	1 – Introduction 3 – Project Overview 4 – Project Location, Land and Water Use	Graduate chemical engineer from Queen's University in April 2019.
Ronald Just	B.A.Sc, P.Eng. (APEGA, PEGBC)	Contribution to and review of all sections	Professional engineer with over 30 years' experience in oil, gas, and petrochemical facility design, construction and operation. 15 years' specific ethylene experience in engineering and business development roles with Nova Chemicals; lead engineer for major portions of ethylene 3 facility design and operation (2000 start-up).
Kenneth G. James	B.A.Sc, P.Eng. (APEGA)	2 – Ethylene Supply Chain 6 – Engagement and Consultation	Professional engineer with over 30 years' experience in oil, gas, and petrochemical facility design, construction and operation. Specializing in business development, plant design and operations optimization, Ken has direct experience in over 10 ethylene / polyethylene complexes worldwide.

Contributor	Credentials	Section(s)	Relevant Experience
Glenn Isaac	B.Sc. EP QAES	5.1.2- Freshwater Environment 5.3 – Potential Environmental Effects	Senior Aquatic Scientist with approximately 25 years of experience providing technical expertise related to data collection and impact assessment analysis with a focus on aquatic resources for projects and activities of varying scope and complexity at locations across western Canada including British Columbia, Alberta and the Northwest Territories.
Ruth Hardy	M.Sc., P.Ag.	4.2 -Land Ownership and Legal Description; 4.5 - Land Use Plans	Senior environmental impact assessment practitioner with over 15 years of experience that includes land and water use assessment, community and land use planning, land suitability analysis and soil and terrain survey and analysis.
Jay Brogan	M.Sc., R.P.Bio.	5.1.3 - Terrestrial Environment	Wildlife biologist with over 10 years of experience in western Canada including impact study design and assessments, and wildlife feature evaluations for major energy projects.
Mark Milner	B.A.Sc., M.Eng., P.Eng.	5.1.1 - Atmospheric Environment	Senior atmospheric environment specialist with 20 years of experience in air quality, noise, greenhouse gas, odour, and light assessments within the mining, transportation, oil and gas, industrial and forestry sectors.

Contributor	Credentials	Section(s)	Relevant Experience
Nina Barton	B.Sc., MRM	5.2 – Social, Economic, Health and Heritage Setting	Senior researcher with over 15 years of diverse interdisciplinary experience, including environmental and socio-economic assessment, environmental planning and Indigenous land use for major resource projects.

2 Project Overview

This section provides an overview of the Project, describes the Project-related components and activities, summarizes the emissions, discharges and wastes associated with the Project and provides a summary of the Project schedule.

2.1 General Project Description

This Project Description pertains to the Ethylene Project, which includes the Ethylene Plant, and all directly associated utilities and infrastructure. Located within the Project Area in Prince George's industrial park, the Ethylene Plant will purchase ethane feedstock from the NGL Recovery Plant and convert it primarily into ethylene product (roughly 80% of the total production from the facility), hydrogen-rich offgas and some mixed liquid coproducts. The ethylene product will be sold to a third-party Ethylene Derivative Plant as feedstock to manufacture products such as polyethylene or mono-ethylene glycol. Offgas will be used as fuel within the Ethylene Plant; its hydrogen-rich composition will reduce GHG emissions associated with the facility. The liquid coproducts consist of 4 products:

- A mixture of propylene, propane and other compounds containing 3 carbons (mixed C3)
- A mixture of butadienes, butene, butane and other compounds containing 4 carbons (mixed C4)
- Aromatic Concentrate
- Pyrolysis Fuel Oil

These coproducts will be loaded onto rail cars by facilities owned and operated by the NGL Recovery Plant and likely sent to petrochemical hubs in Alberta or the USGC.

2.2 Project Environmental and Socioeconomic Benefits

2.2.1 Socioeconomic Benefits and Competitive Advantage

The $2.0 billion to $2.8 billion Project will generate thousands of person-years of employment during the construction period and up to 230 permanent direct plus contract employee positions once the Project reaches commercial operation. Once the plants are in operation, there will be a need for approximately $20 million to $50 million per year of sustaining capital investment that will generate significant on-going economic benefits to the local community.

The numerous other indirect benefits to the local community will include training at local institutions (UNBC and CNC), opportunities to provide support services (transport, food, lodging, maintenance, professional services, etc.), and new associated business development opportunities.

One important aspect of the WCOL Project is the inclusion of the ethylene and polyethylene plants that create a new demand market for ethane in BC. Ethane

is the most abundant natural gas liquid product that is present in natural gas but the only current market in Western Canada is the Alberta petrochemical hubs at Joffre and Fort Saskatchewan. The WCOL Project is an important first step to add value to BC's natural gas industry and to provide economic diversification into a new industry segment.

Low-cost feedstock and efficient access to Asian markets are the key competitive advantages of the WCOL Project over similar plants in Alberta or on the USGC.

The shale gas revolution that has occurred over the past ten years has changed the global natural gas supply and pricing structure and this is likely to prevail for the foreseeable future. Historically, Western Canadian gas production has largely been exported to Eastern Canadian and US markets. Shale gas production from formations such as the Marcellus in the US Northeast has grown to a scale that now surpasses total Western Canadian production and is eroding Canada's historic export markets. Consequently, Western Canada has some of the lowest natural gas prices in the world as Western Canadian production is being delivered into an over-supplied US market with few other options.

Domestic North American production capacity of polyethylene and mono ethylene glycol now exceeds North American demand and substantially all new production will be destined for large and growing Asian markets. BC has a significant advantage for export of products into the growing Asian market, when compared to the USGC or Alberta (see Figure 2.1). Product shipped from BC's west coast will have less than half the travel time of USGC shipments, and unlike the USGC cargoes, will avoid the added cost of toll payments through the Panama Canal.

For polyethylene produced from ethane feedstock, the combination of feedstock, fuel and product logistics movements can comprise over 85% of the variable costs of the product manufacture. The WCOL project has structural advantages over key competitors and this positions our facilities to be a low-cost global producer.

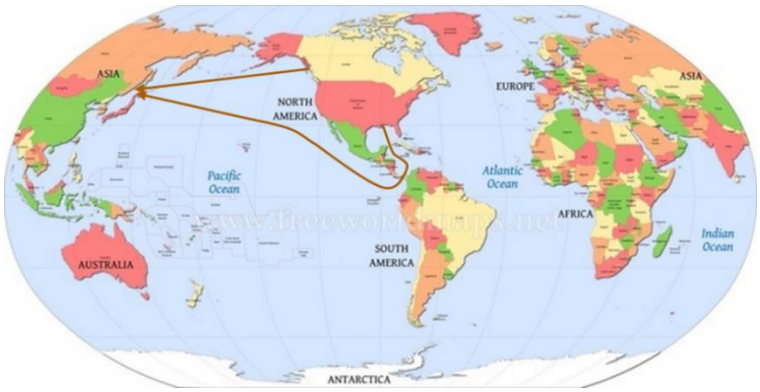

Figure 2.1: Delivery pathways to Asian markets between USGC and WCOL Shipments.

2.2.2 Environmental Benefits

In addition to delivering tremendous economic benefits to the communities within which we work, WCOL is committed to best-in-class environmental performance. The Project scope has been developed to minimize local environmental impact and achieve carbon footprint reductions. The following lists some of the large-scale environmental benefits or opportunities associated with the Project:

- Using ethane as the feed to an ethylene plant results in the simplest chemistry and lowest energy consumption process for manufacturing ethylene, creating an energy and emissions advantage against other feedstocks used globally.
- The WCOL Project will utilize the latest technology in the design of the Ethylene Plant, resulting in directionally lower emissions than older facilities operating globally today. Ethylene technology licensors claim a 30% reduction over the past 20 years in energy consumption and emissions from ethane-based ethylene plants.
- Due to on-going airshed issues within Prince George, odour and levels of atmospheric particulate matter with a diameter of less than 2.5 micrometres ($PM_{2.5}$) are of great concern for the Prince George population. The primary fuels for the Project will be Ethylene Plant offgas, that consists of mostly hydrogen and methane, and lean natural gas. These are very clean-burning fuels that emit no odour and negligible particulate matter. The Project will be designed with vapour recovery systems and fugitive emission monitoring systems to minimize fugitive emissions and odours.
- The Project proponent will minimize land disturbance by locating the Project Area on fee simple land in an under-utilized, existing industrial park within the Prince George city limits. Required amenities and utilities for the plant, including power supply, rail and access routes exist close to the site, and thus limited additional construction or tie-ins will be required.
- WCOL will design and operate its facilities to minimize impacts on the important fisheries of the Fraser and Nechako Rivers. The majority of the water used by the Project will be for non-contact cooling water in a circulated cooling water system to minimize the volumes required and minimize the risk of contamination by the petrochemical process. The plant will be designed to treat and recycle process water streams wherever practical. Any water that is released into the river will be cooled in the cooling water circuit, treated and tested to ensure that it exceeds all regulatory standards.
- As noted above, the combination of using ethane as a feedstock, combined with a new plant utilizing the latest technology, results in a facility which will have very high energy efficiency and low GHG emissions per tonne of ethylene produced. An ethane cracker with low input gas pricing will compete favourably against Asian facilities operating on

higher-cost, higher-emissions feedstocks. So the WCOL Project is well positioned to displace these high-cost facilities and reduce carbon footprint on a global basis.

- A large amount of low-grade waste heat is available from an ethylene facility; this waste heat will be rejected to the atmosphere via the Cooling Tower. However, this heat could instead be used for low-grade heating, such as a greenhouse operation. WCOL is working to identify interested third parties who will own and operate a greenhouse to grow tree seedlings for reforestation, utilizing the waste heat from the Ethylene Plant.

2.3 Project Components and Activities

2.3.1 Project Components

The WCOL Ethylene Plant will convert approximately 4,000 tonne per day (t/d) (approximately 11,000 cubic metres per day (m^3/d)) of high-purity ethane feedstock, purchased from the NGL Separation Plant into approximately 3,000 t/d of high-purity ethylene, which will be sold to a third-party Ethylene Derivative Plant to produce various grades of polyethylene for the expanding Asian market. The conversion process will also produce byproduct offgas (hydrogen and methane mixture) and small amounts of a mixed C3 stream, a mixed C4 stream, Aromatic Concentrate and Pyrolysis Fuel Oil.

The process will consume fuel (lean natural gas and byproduct hydrogen) to provide the heat needed for the conversion of the ethane. The products and coproducts will be separated and purified through distillation, which requires various heating and cooling utilities.

The Ethylene Plant process will require the following main process units:

- Feed preparation
- Pyrolysis Furnaces
- Quench water and dilution steam system
- Pyrolysis gas compression, Deethanizers, and Acetylene Reactors
- Chilling Train and Demethanizer
- C2 Splitter
- Coproduct Fractionation
- Refrigeration
- Ethane Feed and Ethylene Product Storage

Figure 2.2 provides an overview of the relationships between the facilities.

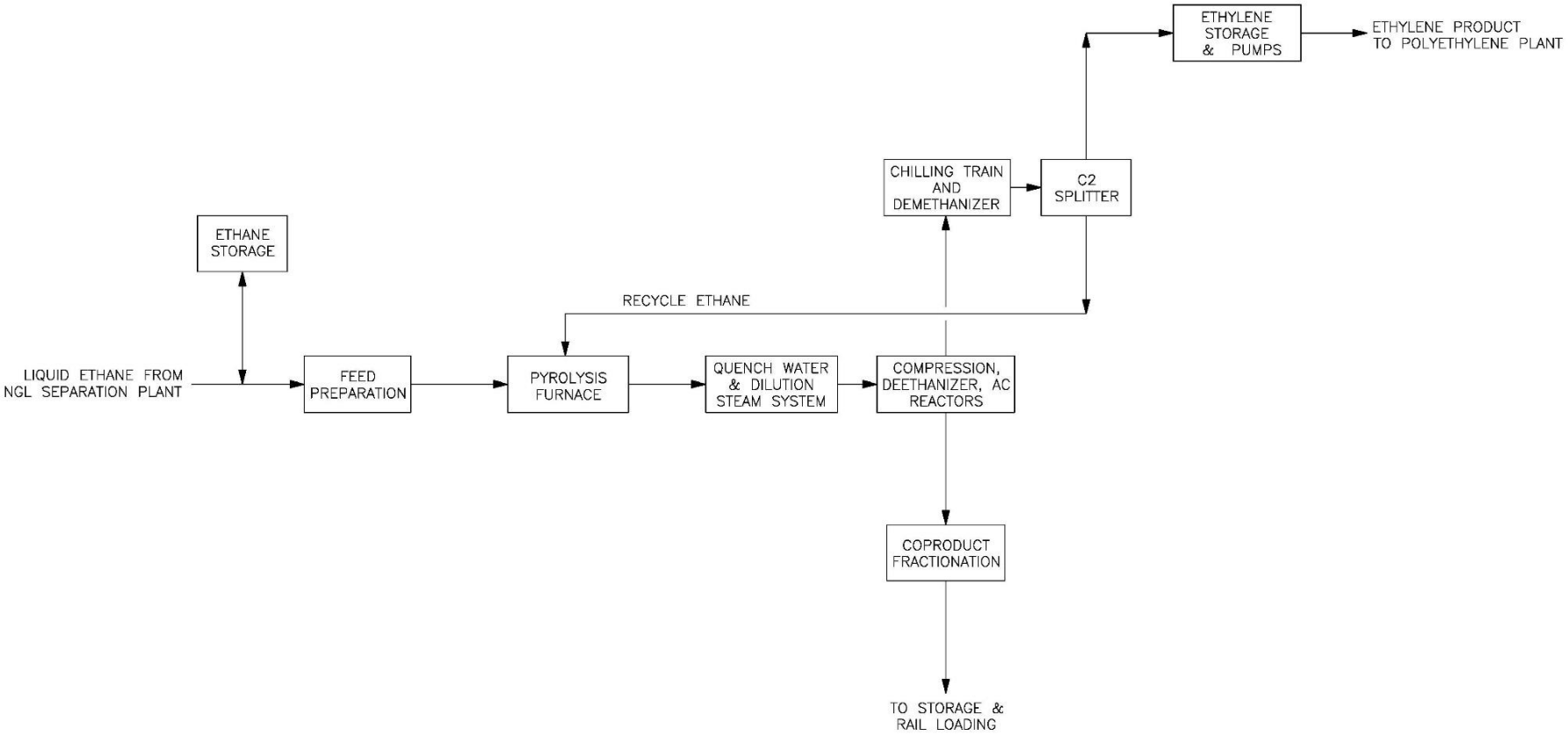

Figure 2.2: Relationships Among Key Components of the Ethylene Plant.

Individual units associated with the key components of the Ethylene Project are summarized in Table 2.1. Key components are described in further detail in the following sub-sections. At this stage, WCOL has completed preliminary engineering; thus, capacities are subject to change as engineering design progresses.

Table 2.1: Summary of the Ethylene Project's Major Components.

Key Components, Capacities and Purposes	Individual Units
Feed Preparation Plant Approximately 4,000 t/d (approx. 11,000 m^3/d) of fresh ethane will be used as feedstock for the Ethylene Plant Approximately 1,300 m^3 of ethane storage will be provided. A sulphur-based chemical (such as dimethyl sulphide or dimethyl disulphide) will be added to control coking rates in Pyrolysis Furnaces.	• Heat exchangers and process vessels • Amine treatment system, including Amine Contactor and Regenerator towers, filters, pumps, heat exchangers, storage tanks, and chemical injection • Horizontal storage vessels • Chemical storage and injection system

Pyrolysis Furnaces
Approximately 6,000 t/d of fresh and recycled ethane will be consumed by the Furnace, which will convert nominally 65% of the feed to ethylene and coproducts. Note: unconverted ethane will be recycled back as furnace feed.
The fired duty of each furnace will range between 375 and 425 gigajoules per hour on a lower heating value (LHV) basis. (GJ_{LHV} /h)
	• Up to 6 Pyrolysis Furnaces to convert ethane to ethylene
	  ○ Between 30 and 50 m in height plus a stack between 8 and 15 m tall, for a cumulative total of up to 65 m tall
	• Each furnace will include:
	  ○ Refractory-lined radiant box
	  ○ Refractory-lined convection section and furnace stack
	  ○ Convection section exchanger banks
	  ○ Induced draft fan
	  ○ Forced draft fan, combustion air preheat system and ducting (likely)
	  ○ Heat exchangers
	  ○ Steam drum
	  ○ Ultra-low NOx burners and burner management system

Key Components, Capacities and Purposes	Individual Units
Quench Water and Dilution Steam System Approximately 8,000 t/d of furnace output (charge gas) will be quenched (cooled), and process water will be recovered for use as dilution steam.	• Quench Tower ○ Up to 7 m in diameter x up to 70 m high • Process vessels • Process equipment (such as filters) • Process water stripping tower(s) • Vaporizers • Heat exchangers

Pyrolysis Gas Compression, Deethanizers and Acetylene Reactors
 	
The cooled charge gas will undergo compression, as well as water and CO_2 removal. Approximately 6,000 t/d of treated charge gas will be fed to the Deethanizer system, where heavy coproducts will be separated from the ethane and lighter hydrocarbons in the charge gas stream, and acetylene (a byproduct of pyrolysis) will be converted to ethylene.
	• Centrifugal compressors driven by steam turbines
	  ○ Total power input required of 45 to 60 MW
	• Compressor intercoolers
	• Treatment system including Caustic Tower
	• Dehydration system
	• One or 2 Deethanizer distillation towers
	  ○ Up to 5 m diameter x up to 30 m high
	• Acetylene Reactor system
	• Miscellaneous heat exchangers, vessels and pumps

Chilling Train and Demethanizer Charge gas from the Acetylene Reactors will be processed in the Chilling Train to separate ethylene and unreacted ethane from the offgas byproduct (methane, hydrogen and CO) Approximately 500 to 700 t/d of offgas will be produced and used as fuel in Pyrolysis Furnaces.	• Brazed aluminum heat exchangers • Separation vessels • High-speed vapour Expanders and Compressors • Demethanizer distillation tower • Multiple diameters ranging up to 6 m x 45 to 55 m high

Key Components, Capacities and Purposes	Individual Units

C2 Splitter
The C2 splitter will separate the ethylene product from unreacted ethane. Approximately 3,000 t/d of ethylene product will be produced.
1,300 m^3 of ethylene storage will be provided
	• C2 Splitter distillation tower
	  ○ 5 to 6 m diameter x 55 to 65 m high
	• Heat pump compressor, with steam turbine driver
	  ○ <20 MW power input required
	• Brazed aluminum and shell and tube heat exchangers
	• Centrifugal pumps
	• Horizontal storage vessels

Coproduct Fractionation
Separate the coproducts into 4 product streams:
• Mixed C3 (approx. 100 t/d to 125 t/d)
• Mixed C4 (approx. 100 t/d to 125 t/d)
• Aromatic concentrate (approx. 150 t/d to 200 t/d)
• Heavy pyrolysis fuel oil (approx. 25 t/d to 50 t/d)
	• Up to 4 distillation towers to separate components
	  ○ Depropanizer
	  ○ Debutanizer
	  ○ Potentially two Aromatic Concentrate towers
	• Heat exchangers, such as reboilers, condensers and product coolers
	• Storage vessels and tanks
	• Centrifugal pumps

Refrigeration Provide refrigerants at temperatures ranging from -100 degrees Celsius (°C) and 0°C for removing heat from the process.	• Centrifugal compressor systems with steam turbine drivers ○ 5 MW to 15 MW power input required • Heat exchangers and process vessels

Feed Preparation

The Ethylene Plant will receive approximately 4,000 t/d (11,000 m^3/d) of ethane as a pressurized liquid from the NGL Separation Plant via the Transfer Line. Ethane feed storage will be provided to maintain steady operation of the NGL Recovery Plant and the Ethylene Plant.

The ethane liquid will be vapourized and preheated and then passed through an amine system to remove both CO_2 and traces of H_2S from the ethane. CO_2 and H_2S will then be sent to the Pyrolysis Furnace firebox to ensure complete destruction of H_2S and trace hydrocarbons.

Treated ethane will be mixed with recycled ethane and dilution steam before entering the Pyrolysis Furnaces. A low-dose sulphur agent will be added to the heated mixture to control coke formation in the Pyrolysis Furnaces.

Pyrolysis Furnaces and Quench System

Approximately 6,000 t/d of fresh and recycled ethane will be fed to the Pyrolysis Furnaces. The ethane feed will be mixed with approximately 2,000 t/d of dilution steam. The dilution steam will be added to reduce coking (build-up of carbon deposits on furnace coils).

The Pyrolysis Furnaces will heat the feed to convert roughly 65% of the ethane, primarily into ethylene. Several byproducts are also produced by the furnaces, including hydrogen, methane, acetylene, propylene and heavier hydrocarbons.

The hot reaction products, known as charge gas, will leave the furnace after which they will be cooled (quenched) to prevent further unwanted side reactions. Heat is recovered during the cooling of the charge gas by generating VHP steam. This generated steam will be used at different pressure levels to drive various steam turbines and provide heat to the process, resulting in a very energy efficient design.

The furnace fuel will be a mixture of hydrogen and methane recovered from the charge gas, plus supplemental lean natural gas. Usable heat will be removed from the hot combustion gases to heat the ethane feed, boiler feed water and very high pressure (VHP) steam, before the combustion gases are sent to atmosphere through the furnace stack. The overall thermal efficiency of the Pyrolysis Furnaces will range from 90 to 94%.

The Pyrolysis Furnaces will also require periodic decoke cycles to remove coke from the inside surface of the tubes. The effluent resulting from this process will be sent back to the firebox of the furnace to be combusted to CO_2 before being discharged to the atmosphere from the furnace stack.

Quench Water and Dilution Steam System

Final cooling of the charge gas will be completed in the Quench Tower, where cool water (quench water) will directly contact the hot charge gas.

Water present within the charge gas (added as dilution steam to the furnace feed) and heavy C5+ hydrocarbons (oil) will condense within the Quench Tower. The quench water will go through the following processes, which are intended to clean the water to allow maximum recycle and reuse:

- Bulk separation of free oil
- Removal of coke fines and heavy hydrocarbons through a combination of coalescing, gravity settling or flotation
- Removal of dissolved light hydrocarbons by steam stripping

The clean quench water will then be vapourized to generate dilution steam, which will be mixed with the ethane feed to the furnaces.

The condensed oil will be delivered to the Aromatic Concentrate Recovery Unit.

Charge Gas Compression, Deethanizers and Acetylene Reactors

The charge gas must be compressed to separate the ethylene product and unreacted ethane from other byproducts. This compression will be carried out with a multi-stage, intercooled compressor, driven by steam turbines.

Water and hydrocarbons are condensed throughout the compression system. The water is recycled to the Quench Tower and the hydrocarbons are delivered to the Aromatic Concentrate Recovery Unit.

Compressed charge gas will undergo treatment within the Caustic Tower where most of the remaining CO_2 will be removed (less than 5 parts per million will remain in the ethylene produced by the plant).

After the final compression stage, the gas will be cooled and water will be removed in driers.

Compressed charge gas will be fed to the Deethanizer system, where the heavy byproducts (C3 and heavier) will be separated from the lighter product (ethylene), unreacted feed (ethane), acetylene and lighter hydrocarbons (hydrogen, methane, carbon monoxide, etc.).

As the acetylene in the charge gas can deactivate catalysts in downstream derivative processes, the acetylene will be converted to ethylene within the Acetylene Reactor, prior to the separation of ethane and ethylene.

It should be noted that there are multiple ethylene technologies available and the detail of how the processes in this section are integrated together will be developed and design of this system will be finalized as engineering progresses.

Chilling Train and Demethanizer

Charge gas from the Acetylene Reactor will be sent to the Chilling Train, a series of heat exchangers, Turbo Expanders and a “cold box” (a brazed aluminum heat exchanger) where the gas will be cooled to roughly -150°C.

Cold liquids condensed and recovered at various points in the Chilling Train will be fed to the Demethanizer to separate the ethane and ethylene from the light gases (hydrogen, methane and carbon monoxide (CO)). Hydrogen-rich gas from the Demethanizer overhead will be cooled via the Turbo Expanders to provide refrigeration and then compressed, producing approximately 600 t/d of offgas (hydrogen, methane and CO). The offgas will be sent to the plant fuel gas system to be used as low-emissions fuel gas. The stream which exits the bottom of the Demethanizer (bottoms stream) will be fed to the C2 Splitter.

C2 Splitter

The C2 Splitter will receive approximately 5,000 t/d of bottoms product from the Demethanizer and will separate the ethylene product from the unconverted ethane. The overhead ethylene vapour from the C2 Splitter is the primary product from the Ethylene Plant. Unreacted ethane will be recovered from the bottom of the distillation tower and recycled back to the Pyrolysis Furnaces.

The design of this system varies between ethylene licensors. The ethylene from the overhead of the C2 splitter is often incorporated into a refrigeration system to provide heating and cooling for the distillation process, often in a process referred to as a heat pump. The design, operating conditions and power requirements will be finalized during future engineering.

A small amount of working storage will be provided for the liquid ethylene product. Approximately 3,000 t/d of ethylene product will be produced and pumped to derivative customers.

Coproduct Fractionation

Separation of the heavier byproducts will be achieved by feeding the C3+ hydrocarbons from the Deethanizer system to a series of distillation towers, with the light product stream being recovered from the overhead of the tower and the heavier bottom stream being sent to the next tower. These towers are the Depropanizer and the Debutanizer:

- The Depropanizer will take the C3+ stream from the Deethanizer, produce the mixed C3 product as the overhead, and deliver the bottom C4+ stream to the Debutanizer. The C3 product will primarily consist of propylene and propane. Approximately 100 t/d to 125 t/d of mixed C3 product will be produced.
- The Debutanizer will take the C4+ stream from the Depropanizer, produce the mixed C4 product as the overhead, and produce an Aromatic

Concentrate stream from the bottom. The C4 product will primarily consist of butadienes and butenes. Approximately 100 t/d to 125 t/d of mixed C4 product will be produced.

Aromatic coproduct resulting from the Quench Tower and charge gas compression will be fed to the Aromatic Concentrate Recovery Unit (ACRU). The Aromatic Concentrate generated from this unit will be combined with those recovered from the Debutanizer bottoms. Approximately 150 t/d to 200 t/d of this Aromatic Concentrate will be produced. Approximately 25 t/d to 50 t/d of the heavier Pyrolysis Fuel Oil will be produced.

These products will be stored on-site, and subsequently transported via rail to either US or Alberta petrochemical markets. The assets related to the storage and loading of these liquid coproducts are expected to be owned and operated by the NGL Separation Plant.

Refrigeration

The ethylene production process will require refrigeration at very low temperatures. Two refrigeration systems are typically used to meet the cooling requirements for the process: a mixed propylene refrigerant and an ethylene refrigerant. Design is dependent on final design by the ethylene licensor and concepts will be completed as engineering progresses.

Storage

Ethylene Plant product storage volumes are described in Table 2.2. It is important to note that ethylene coproducts (mixed C3, mixed C4, Aromatic Concentrate coproduct, and Pyrolysis Fuel Oil coproduct) will be stored within the General Hydrocarbon storage farm owned by the NGL Separation Plant. Storage requirements will be sold as a service to the Ethylene Plant by the Separation Plant. Thus, this storage is outside the level of detail required for description of the key components of this Project's EA. Storage requirements for the ethylene coproducts are presented within Appendix C.

Table 2.2: Product Storage in the Ethylene Plant.

Product	Storage Type	Purpose of Storage	Total Working Volume	Shipping Strategy
Ethane Feed	Bullet (x3)	To permit steady operation of the Ethylene Plant, specifically the Pyrolysis Furnaces. Will ensure ethane feed rate remains steady against any changes in the upstream facilities and will ensure sufficient ethane volume to allow proper shutdown of Pyrolysis Furnaces in the event of total ethane loss from the Separation Plant. The storage will also allow the NGL Recovery Plant to transition to only recover C3+ when the Ethylene Plant shuts down.	Approximately 1,300 m^3 (approximately 430 m^3 per bullet) pressurized liquid (horizontal vessels). Volume and number of bullets to be finalized.	Pump to Feed Preparation portion of Ethylene Plant as pressurized fluid
Ethylene Product	Bullet (x3)	To provide storage capacity of 4 hours so as to provide ethylene to the downstream Derivatives Plant should there be a process upset in the Ethylene Plant. This will allow the Derivative Plant to continue to operate and begin a controlled shutdown of facilities, depending on the length and severity of the upset. Or in event of a Derivative Plant shutdown, the storage can be used to effect a controlled shutdown of the Ethylene Plant.	Approximately 1,300 m^3 (approximately 430 m^3 per bullet) pressurized liquid (horizontal vessels). Volume and number of bullets to be finalized.	Pump to adjacent Ethylene Derivative Plant as pressurized fluid

2.3.2 On-site Utilities

The Ethylene Plant will be the predominant consumer of the utility and infrastructure requirements in the Project Area. Some of the equipment will be constructed and operated as part of the Ethylene Plant and will be physically located within the plant boundaries and adjacent to process equipment, because of how closely it is integrated to the design of the Ethylene Plant. Other utility systems, such as tie-ins to power supply, will be physically located in a general utility area and could be expanded in the future to provide utilities to multiple plants if there is a capacity expansion at the site. At the present stage of the Project, all utilities related to the Ethylene Project are described in this section without discussion of specific locations; additional detail will be provided with the Application.

Certain infrastructure and utilities will be provided as a service and sold to the NGL Separation Plant by the Ethylene Project. This distribution of utilities is represented in Appendix D.

Individual units of the key components of the Ethylene Project are summarized in Table 2.3. Key components are described in detail in the following sub-sections.

Table 2.3: Summary of On-site Utilities for the Ethylene Project.

Key Component, Capacity and Objective	Individual Components
Raw Water System Designed to withdraw and treat a raw water supply of approximately 600 to 650 m^3/h.	• Water inlet, fitted with adequate screening or raw water supply wells • Treatment system • Pumps • Raw water storage
Cooling System Circulate between 25,000 and 35,000 m^3/h of cooling water Reject up to 1,500 GJ/h of heat via evaporation	• Cooling Tower basin, pumps, fans and circulating underground pipe system • Cooling water chemical treatment system • Blowdown treatment and river water return
Steam System Capacity to produce up to 450 t/h of VHP steam, to recover useful heat from the Pyrolysis Furnaces and ensure steam supply matches the demand from the large turbine drivers	• Demineralized water treatment system • Deaerator, water storage, pumps • Pressure letdown and desuperheater control stations • Piping distribution headers for boiler feed water and multiple steam pressure levels • Condensate collection and treatment system • Blowdown treatment system • Utility boiler
Effluent System	• Adequate pH adjusting and treatment systems • Discharge pumps
Supporting Systems	• Fire water system • Stormwater containment and treatment system • Wastewater collection system • Flare system • Instrument and utility air • Utility nitrogen • Potable and utility water • Project infrastructure • Methanol Circulation System • Utility Glycol Heat Medium System • Fuel Gas System • Utility boiler system

Water and Wastewater Treatment

For a more detailed description of water usage and distribution within the Ethylene Plant, refer to Section 3.

Raw Water System

Raw water will be diverted from either the Fraser River or from groundwater well sources, or a combination of the two, at approximately 600 to 650 m^3/h to meet the water make-up requirements of the Ethylene Plant. The raw water system will differ slightly depending on the raw water sources, but will likely include a water inlet, fitted with adequate screening, or raw water supply wells, followed by appropriate treatment to remove solids, organics and hardness as required. It is important to note that due to the high solids loading in the Fraser River, WCOL is evaluating the option of well water to supply raw water to provide Ethylene Plant water requirements. Raw water design will be developed prior to application.

The majority of the treated water will be sent to the Cooling Tower as make-up and the remainder will be sent to the Demineralized Water System for further treatment.

Circulating Cooling Water System

Cool supply water from the Cooling Tower is pumped and distributed through a network of underground piping and used to provide cooling requirements to numerous heat exchangers in the Ethylene Plant. As heat is removed from the process in the heat exchangers, it will heat up the cooling water. Warm cooling water will be returned to the Cooling Tower and cooled against ambient air. The cooled water will collect in a concrete basin in the bottom of the tower to be pumped again as cool supply water. The cooling water circulation rate will be between 25,000 and 35,000 m^3/h in the summer. Water loss will occur from the tower via evaporation and a minor amount of drift (entrained water droplets). A small blowdown stream, between 50 and 100 m^3/h, will be withdrawn from the tower to reduce the concentration of dissolved minerals, such as calcium, present in high amounts in the circulating water due to the evaporation. Suspended solids (dust and other particles scrubbed out of ambient air by the water) will also accumulate in the cooling water, and a small portion of the circulating water will be processed through sidestream filters to control solids content. Backwash effluent from the filters will join the blowdown from the system. Treated cooling water make-up will continuously be added to the tower to replace losses from evaporation, drift, blowdown and backwash. Chemicals will be injected to the cooling water system to control microbiological growth, prevent dissolved solids deposition and control pH.

Demineralized Water Treatment

A portion of the treated raw water from the Fraser River (or potentially well sources) will undergo ionic exchange treatment to remove minerals, which cause fouling in boilers. The resulting demineralized water will be very pure, containing low solid content. From 50 to 60 m^3/h of demineralized water will be provided to the Ethylene Plant, where it will be used as boiler feed water make-up, and to provide make-up water requirements where water has been lost (such as within amine treatment towers and caustic towers). The stream (approximately 20 to 30 m^3/day) that results from the regeneration of the ion exchange system will contain the dissolved salts that were captured in the ion exchange resin and the medium that is needed for regeneration. This demineralized regeneration residue stream will be combined with the treated blowdown stream from the Cooling Tower.

Effluent Treatment

The treated blowdown stream from the Cooling Tower will be combined with the demineralized regeneration stream. Approximately 70 to 120 m^3/h of combined blowdown will undergo pH adjustment and treatment to meet all effluent water quality requirements as required by operating permits before being discharged into the Fraser River.

Steam System

Very high-pressure steam (at roughly 10,500 kiloPascals gauge (kPag)) will be generated from waste heat in the Ethylene Plant and used at several different pressure levels to power steam turbine drivers and provide process heat to heat exchangers throughout the process. The majority of the steam will be condensed and recycled (minimal losses), but a small blowdown stream (1 to 2% of total steam production) will continuously be removed from the steam system to prevent hardness concentrations from cycling up and causing damaging deposits from occurring in the boiler tubes or heat exchange equipment. This blowdown will likely be recycled and used as make-up to the quench water system. Make-up water will continuously be added to the steam system to replace the blowdown and losses.

Dilution Steam System

Water that is present within the Pyrolysis Furnace effluent will condense within the upper portion of the Quench Tower. This water will contain small amounts of heavy C5+ hydrocarbons and will be treated through use of coalescing filters and steam stripping. This treatment removes most of the hydrocarbons so that the water can be recycled and reused to generate dilution steam. Trace amounts of dissolved hydrocarbons will exist within the treated quench water and a blowdown stream will be needed to reduce the possibility of build-up in downstream process units. This blowdown will likely be recycled and used as cooling water make-up.

Stormwater Containment

Stormwater falling on the developed portion of the site will be captured in a retention pond, pumped to a treatment system and recycled as cooling water make-up, to minimize the river or well water make-up required. As the layout of the NGL Separation Plant and Ethylene Project equipment is laid out on the site, there is potential that a single, integrated stormwater management system will be designed for the entire site. If so, this is expected to be an Ethylene Project asset.

Wastewater Collection

The facility will not have any waste collection systems open to the atmosphere. Any equipment with the potential to contain a mixture of water and hydrocarbons will have its normally operated vents and drains tied into either the flare or a closed hydrocarbon drain system, which will collect the streams, separate the oil and water and recycle the streams to the process where possible. Systems containing chemicals (e.g., the amine system, caustic system) will have local drain collection systems, which will be periodically recycled to the process when possible, or otherwise shipped off site for appropriate disposal.

Equipment that is located outdoors and has the potential for spills of liquid hydrocarbons or chemicals will be segregated from the general stormwater collection system with a dyke, berm or curb and a local collection sump. When rainwater collects in one of the segregated sump areas, it will be visually checked or tested released to the site stormwater collection system only if it is deemed clean. If contaminated, the water will be collected by vacuum truck and sent for safe disposal.

Fire Water System

The fire water system is a safety system that will be on standby at all times to provide water in the event of a fire. Hydrants and deluge systems, as required, will be tied into an integrated sitewide system, which will include an underground firewater distribution network. The system will consist of tanks, pumps and controls designed to meet National Fire Protection Association and other applicable codes and standards. This system will be designed to supply firewater needs for the NGL Separation Plant on a cost-of-service basis.

Miscellaneous Utilities

Flare System

The flare system will be a key safety system designed for the safe release of hydrocarbon during a serious plant upset or emergency. It will be comprised of a standard collection headers and Flare Stack(s). Vents and drains on hydrocarbon-containing equipment will not be released to atmosphere as part of normal operation or maintenance but will be piped directly into one of the flare

headers to be captured. Temporary tubing will be used as an operating practice to tie abnormal vents and drains into the flare for unusual maintenance events.

Instrument and Utility Air

The purpose of the instrument and utility air system will be to deliver clean, dry air to control valves and other equipment in the plant. This system will consist of two 100% packaged units and an Instrument Air Receiver (sized for 30 minutes' supply of instrument air) to provide reliable backup supply. The moisture that is removed from the air will be directly disposed of to the sanitary sewer system because it will not contain contaminants.

Utility Nitrogen

A utility nitrogen package, including liquid nitrogen storage and an ambient temperature vaporizer, will be provided. A backup heater will also be provided to supply supplemental heat if necessary. Utility nitrogen will be used as an inert gas within storage tanks and to provide a seal on rotating equipment to reduce the discharge of volatile organic compounds (VOC).

Methanol

Methanol barrel storage will be provided for manual injection at process tie-in points to address any formation of hydrates in the process.

A circulating hot methanol system may also be provided for the Ethylene Plant, to provide a heat medium for specific services, namely emergency vapourization of the liquid ethane and vapourization coils in the cold flare drum(s). Methanol is considered for these services because it will not freeze when in contact with very cold process streams. The system will consist of a heat exchanger (steam heated), storage vessel and circulation pumps.

Glycol Tracing System

A circulating hot glycol system will be provided. The hot glycol will be used to provide anti-freeze protection for piping and equipment, such as glycol tracing of piping, heating coils in tanks. Detailed engineering will evaluate options such as electrical tracing, but the availability of excess low-pressure steam typically makes glycol tracing an attractive option in cold climate ethylene plants. The system will consist of a heat exchanger (steam heated), storage vessel, filters and circulation pumps.

Utility Boiler

A total of 2 boilers will be used to ensure that sufficient backup steam is available for specific process units within the Ethylene Plant, such as steam-driven turbines. These boilers will normally operate at minimum turndown to be ready to supply steam during plant upset conditions. The boilers will produce high-pressure steam at roughly 4,200 kPag.

Potable and Utility Water

Potable water will be used within various operations of the plant, including but not limited to eye washing stations, emergency showers, and kitchen and lavatory uses. Utility water will be provided at utility stations throughout the plant and will provide clean water for various maintenance operations such as the equipment and pad cleaning. Potable and utility water will be supplied from the Prince George Municipal water supply. Sanitary sewer collection will be included in all occupied buildings with standard washroom or kitchen facilities. Sanitary sewage and grey water will be collected and sent to the Prince George sewage collection system; no process water will be tied into the City sewage system.

Fuel Gas System

Fuel gas will be supplied to the Ethylene Plant from offgas produced within the Demethanizer and Chilling Train System. Make-up natural gas will be provided to the fuel gas system to ensure that the fuel demands of the Pyrolysis Furnaces are met. Because the offgas contains over 80% hydrogen (by volume) with most of the remainder being methane, the fuel has a very low GHG footprint.

Lean natural gas will be used for the utility boilers and the flare pilot.

Miscellaneous

A number of auxiliary systems are associated with some of the rotating equipment in the facility, which are not normally considered as independent utilities, but are listed here for completeness: compressor and pump lube oil systems, compressor seal gas systems, steam turbine sealing steam systems and pump seal systems.

Project Infrastructure

WCOL will develop all necessary infrastructure at the Project Area to accommodate the needs of on-site personnel. This infrastructure will include maintenance and support buildings, warehouses for equipment, site security infrastructure and laboratory services. Project infrastructure will include:

- Buildings

  Following is a list of buildings potentially required for the Ethylene Plant operation, but many of these buildings could be located in the City of Prince George or at other locations in the BCR industrial area. WCOL's operating strategy will be to minimize the number of personnel at the site by locating non-essential personnel to other locations. This strategy will reduce risk to personnel in the case of an event such as fire or evacuation at the site.

  - Control Room
  - Administration and engineering
  - Maintenance
  - Warehouse
  - Process equipment buildings (multiple)
  - Water treatment
  - Motor Control Centers (MCC)
  - Emergency response/medical
- Site Security
  - Fencing and controlled access gate
  - Closed circuit cameras and monitoring
  - Communications
- Emergency Response

  A mutual assistance arrangement will be discussed with City emergency response services. Initial emergency response will be by trained WCOL personnel, but secondary response could be provided by the City. WCOL equipment:

  - Fire truck
  - Ambulance
- Laboratory
- Control system and information systems

2.3.3 Project Activities

The following section outlines the general activities that will occur within the 3 main phases of the Project's lifetime: construction, operation and decommissioning.

Construction

- Potential clearing of areas to accommodate any required infrastructure.
- Levelling and contouring of areas within the site to accommodate transport and construction and to direct stormwater from developed areas to the retention pond.
- Construction of water supply and return systems, including Fraser River intake and return, storage, treatment and distribution or raw water supply wells.
- On-site construction and erection of Ethylene Plant equipment and modules (e.g., pipe racks).
- Transportation of construction materials into Prince George and between shops and the construction site within Prince George:
    - Use of CN rail lines and major highways (16 and 97) for transport of materials and infrastructure to the site, as well as transport of equipment and subcomponents to local module fabrication shops within Prince George. The vast majority of shipments will be bulk construction materials and transportable equipment, but some movement of over-sized equipment and modules on rail or highways into Prince George will be required.
    - Delivery of completed modules from fabrication shops and module assembly yards in Prince George to the construction site. This will include a large number of over-sized loads, most of which are expected to originate within the BCR Industrial Site, but some modules may be transported from fabrication shops on the Hart Highway to the site.
    - Additional detail will be provided as the project execution plan is developed further.
- Installation of tie-ins to pre-existing natural gas supply lines, power supply lines (Fortis, BC Hydro), and potable water and sewage systems (City of Prince George).
- Construction of on-site components such as administration buildings, a laboratory, the Ethylene Plant and wastewater and stormwater collection systems.
- Renovation or construction of off-site buildings such as office space (in Prince George) or maintenance shop space.

- WCOL will embark on a strategy to maximize the amount of fabrication that will be completed in and around Prince George. The scale of the Project far exceeds the capacity of local fabrication contractors (by roughly a factor of 10). WCOL plans to maximize the assembly of modules in Prince George, for easier delivery of complete modules to the site. Large numbers of vessels, heat exchangers, pumps, pipe spools, structural steel elements and other components will be manufactured outside Prince George and delivered to the city for assembly. Large, fully assembled modules and equipment will be delivered from fabrication shops within and around Prince George to the site.
- Lodging for construction workers will be assessed. The combined workforce of the Ethylene Project and related ethylene supply chain projects may require a temporary camp to supplement local housing. WCOL will engage in conversations with the Prince George community to determine if the City has the capacity to accommodate personnel housing requirements. Additional detail will be provided as the project execution plan is developed and regional workforce assessments are completed.

Table 2.4: General Outline of Proposed WCOL Construction Activities.

Construction Activity	Timeline
Site Clearing and Site Preparation	Spring 2021 to Fall 2021
Underground Work, Pilings and /Foundations	Spring 2022 to Fall 2022
Module Installation in Field	Fall 2022 to Summer 2023
Mechanical Completion	July 2023

Operation

- Pre-operation commissioning activities, including:
  - Chemical washing of equipment and safe disposal of used chemicals
  - Air blows and steam blows to remove debris from piping
  - Testing of Process Safety Valves (PSV)
  - Inventorying of all systems with hydrocarbon and initial charges of chemicals
  - Additional flaring during the commissioning and operational testing phase of the equipment
- Delivery of liquid ethane from the NGL Separation Plant via the Transfer Line
- Storage of liquid ethane within bullets

- Treatment and processing of ethane within amine treatment system
- Production and refining of ethylene via Pyrolysis Furnace and processing/separation
- Production of ethylene coproducts via coproduct fractionation
- Production of lean fuel gas from Demethanizer overhead
- Distribution of products into respective storage units
- A continuous flame will be present at the flare tip to maintain pilots and incinerate the natural gas purge of the flare system; the pilot and purge are mandatory features for safe operation of a flare. Intermittent flaring events during plant upsets, plant shutdowns, start-ups, and to ensure protection and safe operation of equipment
- Raw water withdrawal from the Fraser River or raw water wells, treatment, and distribution for use in the plant
- Return of treated water to Fraser River
- General treatment and collection of all other water sources on the Project Area (wastewater, stormwater, etc.)
- Delivery of chemicals and consumables to the site by road. Delivery of these materials and other equipment to the Prince George region may be by truck or rail
- Maintenance when and where needed
- Periodic planned plant turnarounds (every 3 to 5 years). A turnaround is a planned regular plant outage (4 to 5 week duration) to allow for regular inspection and maintenance of equipment to ensure continued safe and reliable operation.

Decommissioning

- Removal of differing units/infrastructure within the plant site (re-use and recycling where possible)
- Will go through proper steps and measurements to ensure that the land is usable following the decommissioning of the WCOL Project
- Expected Project lifespan is at least 25 years

2.3.4 Off-site Utilities and Infrastructure Requirements

Table 2.5 summarizes the key Off-site Utilities and the individual components of each. The following sub-sections provide more detail about the key components. Figure 2.3 gives the general location of some of the Off-site Utilities relative to the Project Area.

The site layout is still under development, so Figure 2.3 provides a preliminary layout only. We note particularly the following:

- The distance and routing of the Transfer Line will be determined with stakeholders and once the site for the NGL Extraction Plant is finalized. The distance and routing of the Transfer Line will be a part of the NGL Recovery OGC submission.
- The location of river intake and/or water wells is under development and will be determined following an assessment of the proposed area shown.
- WCOL has obtained an option to purchase the land shown within the pink outline on Figure 2.3
- Alternative land options were considered. See Section 3.1 for details.

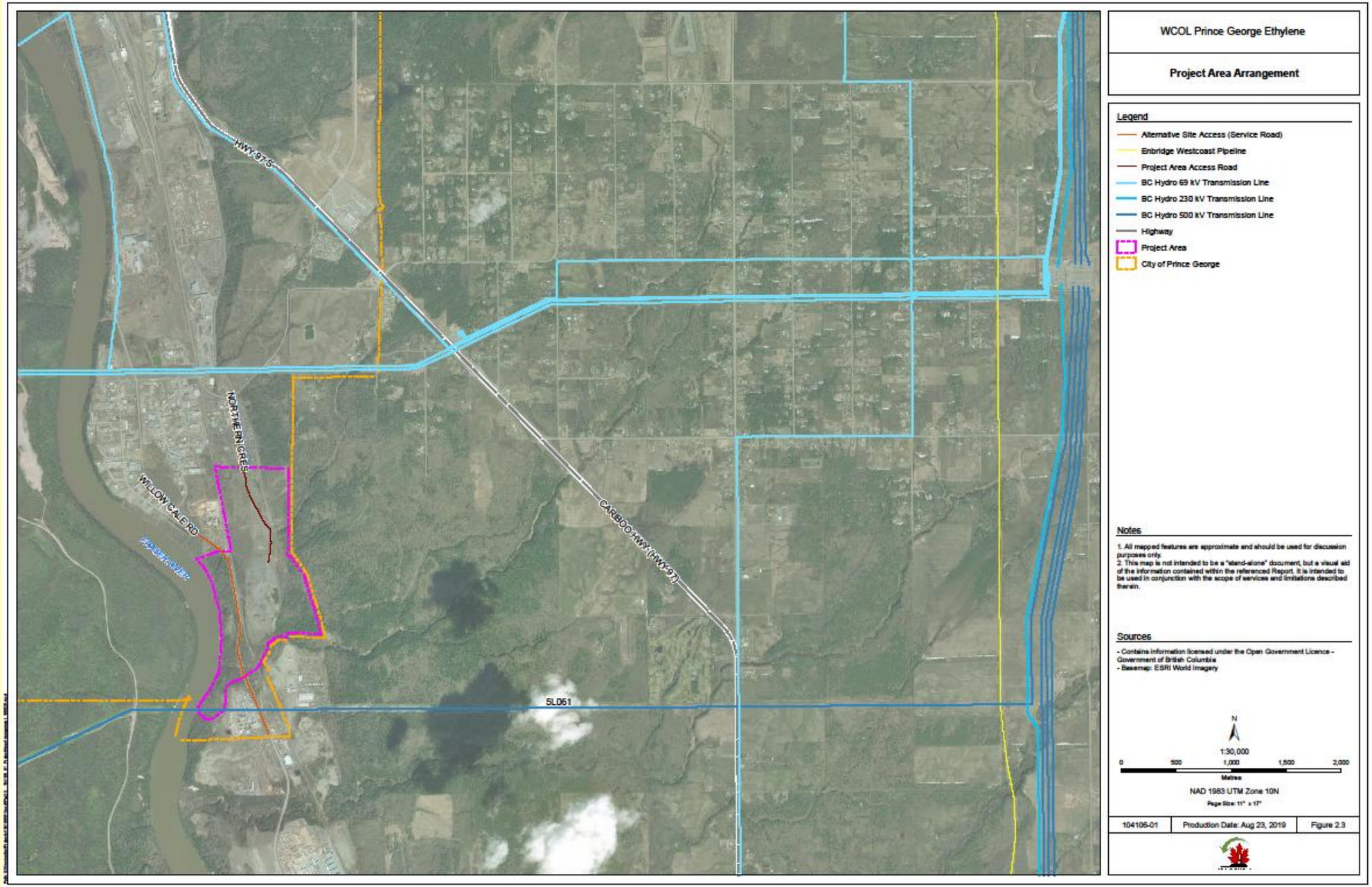

Figure 2.3: Project Area Arrangement.

Table 2.5: Summary of Ethylene Plant Off-site Utilities and Infrastructure.

Key component and Capacity	Individual Components
Electrical Transmission Lines Electricity will be provided to the Ethylene Plant via pre-existing BC Hydro 500 kV transmission lines (BC Hydro, 2017/2018) Additional line could range in length from a minimal tie-in of less than 5 km up to 40 km (iMapBC, 2019)	• Electric Transmission Lines • Transformer • All associated auxiliary equipment
Supporting Infrastructure	• Ethylene Product transfer line • Fuel gas supply line • Access Roads

Electrical Transmission Lines

Electrical power for the Project will be provided via the BC Hydro provincial grid.

Tie-ins to pre-existing 5L061 transmission lines will provide electrical power to the Ethylene Project. These 500 kV lines run adjacent to the WCOL Project Area, approximately 3 km away. A range of less than 5 km up to 40 km of new transmission lines will be completed to allow for tie-in to BC Hydro Power Supply.

Ethylene Project power supply requirement is roughly 12 to 17 MW. Potential to integrate the electrical supply system with the NGL Separation Plant will be considered during detailed design (estimated incremental load of 12 to 16 MW).

Product Transfer Lines

Ethylene product from the Ethylene Plant will be sent via a Transfer Line as feedstock to a third-party Ethylene Derivative Plant and possibly a Mono-ethylene Glycol Plant. The distance and routing of this Transfer Line will depend on the final location of the Derivatives Facility, and its location will be developed jointly between the third-party partner and local stakeholders. The Transfer Line will be sized for anticipated expansion of the WCOL facility and will probably have a capacity of 2 Mt/y.

Access Roads

Willow Cale Road, a forestry service road, runs adjacent to the WCOL Project Area. This gravel road will be used for the transportation of subcomponents and equipment during the construction phases and requires no upgrades to facilitate transportation requirements. There are various access points to the site from Willow Cale Road via the Cariboo Highway, an important factor for minimizing

traffic disruptions that may occur during shipping and transportation. Access to the Project Area via Willow Cale is shown in Figure 2.3, which depicts 2 alternative access points.

The main access road for site personnel will be Northern Crescent. No upgrades to Northern Crescent or construction at the access points are anticipated to facilitate transportation needs.

At this time, no new roads are proposed for construction to access the WCOL Project Area for construction or operational use. A logistics study will be performed to identify any upgrades required to the infrastructure (e.g., permanently elevating power lines along the Willow Cale Road).

Rail Loading Facilities

The tank farm (storage area), rail loading area and rail facilities will be owned by the NGL Recovery Project and will be included in the OGC application for that project. Use of the storage area as well as the rail facilities will be provided to the Ethylene Plant as a cost of service from the NGL Separation Plant. Approximately 40 rail cars per week will be loaded with ethylene coproducts. This coproduct will not significantly contribute to the rail traffic that is expected to be produced by the NGL Recovery Project. More information regarding rail loading facilities and relevant statistics is presented in Appendix E.

2.4 Schedules

Table 2.6 presents an estimated schedule of WCOL Project activities. Dates are subject to change, and the duration of each phase will depend on factors such as weather conditions and human resource availability.

Table 2.6: Estimated Timeline for Anticipated Project Milestones.

Project Phase	Project Activity	Timeline
Project Studies	Existing conditions studies	Q3 2019 to Q4 2020
Financial Decision	Final investment decision	End of 2020
Construction	Construction start date	Spring 2021
	Commissioning and start-up	Q2 / Q3 2023
Operations	Facility in-service date	Late 2023
	First shipment of ethylene coproducts from the Ethylene Plant	September 2023
	First shipment of ethylene from Ethylene Plant to Derivative Plant	September 2023
Decommissioning and Abandonment	Decommissioning and reclamation	Upon completion of operation
	Abandonment	Upon completion of reclamation

2.5 Emissions, Discharges and Wastes

As discussed in Section 1, this Project Description specifically pertains to the Environmental Assessment process for the Ethylene Project. Therefore, the following information regarding individual emission points and overall estimated emission values relate to the Ethylene Project only. WCOL will perform cumulative effects assessments on applicable past, present and reasonably foreseeable projects and related Plant components within the agreed study area boundaries (NGL Recovery Plant, Ethylene Plant, and Ethylene Derivitives Plant, as appropriate).

WCOL will report on the Project's emissions in accordance with the *Greenhouse Gas Industrial Reporting and Control Act*, SBC 2014, c. 29, and associated regulations.

2.5.1 Atmospheric Emissions

Operational techniques and modern technology will be implemented within the Ethylene Plant to mitigate air emissions, including but not limited to:

- The use of lean natural gas and Ethylene Plant offgas that consists of mostly hydrogen and methane. These are very clean-burning fuels that emit no odour and minimal particulate matter. They will provide a majority of the fuel requirements within the Ethylene Plant.

- Vapour recovery systems, fugitive emission monitoring systems, and closed sewer systems to minimize fugitive emissions and odours.
- Use of ultra-low NOx burners.

Ethylene Plant Emissions

Anticipated emissions from the Ethylene Plant will arise from various point sources and will comprise carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbons, particulates, sulphur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOC), and water vapour (Table 2.7):

Table 2.7: Ethylene Plant Emission Sources and Types.

Ethylene Plant Emission Point Source	Description	Emission Type	Project Phase
Flare Stack	• The primary purpose of the flare system is to safely deal with emergency releases or abnormal operation (e.g., facility start-up or shutdown). • The emission values calculated are based on the pilot(s) and flare purge gas, which for safety purposes must be in continuous operation to ensure flare safety and readiness.	CO_2 (fired) CO SOx (trace) NOx Hydrocarbons Particulate	O, AM
Pyrolysis Furnace Stacks	• These units mainly utilize hydrogen-rich offgas as the primary fuel source; thus, the amount of natural gas required—and in turn the greenhouse gas emissions—for these furnaces are minimized. • Up to 6 furnaces operate continuously. • Also used to incinerate furnace decoke effluent and CO_2/H_2S vent stream from amine system.	CO_2 (fired) CO SOx (trace) NOx Particulates	O, AM

Ethylene Plant Emission Point Source	Description	Emission Type	Project Phase
Utility Boiler Stacks	• 2 units are used to ensure there is sufficient backup steam available for the Ethylene Plant. • These boilers normally operate at minimum turndown to be ready to supply steam during changing operating conditions.	CO_2 (fired) CO SOx (trace) NOx	O, AM
Vapour Combustion Units	• Present for the incineration of vapour recovered from storage tanks and miscellaneous process vents.	CO_2 (fired) CO (trace) SOx (trace) NOx	O, AM
Amine System (Non-combustion emission source)	• Emissions from this source comprise CO_2 removed from the rich pipeline gas, which is currently being emitted at the point of end users; the WCOL Project does not change the quantity of these emissions. • This stream also contains H_2S and will be sent to the firebox within the Pyrolysis Furnaces for destruction of H_2S and trace hydrocarbons.	CO_2 (unfired) SOx	O, AM

Ethylene Plant Emission Point Source	Description	Emission Type	Project Phase
Pipe Connections and Rotating Equipment Seals	• Small leaks that occur at pipe connections (flanges) and small leaks from pump and compressor seals are the main potential sources of VOC emissions. • The risk of piping leaks will be minimized through the use of welded connections on many hydrocarbon-containing piping in the Ethylene Plant. • Seal systems for the large compressors will be tied into the flare so that hydrocarbon leaks from the seals will be combusted. • The operating facility will have a rigorous VOC monitoring and repair program, which will meet regulatory requirements and industry best practices.	VOC	O, AM
Cooling Tower	• Water loss from the Cooling Tower will be in the form of evaporation and drift (small entrained water droplets).	Water vapour VOC	O

Note:

C – construction; O – operation; D - decommissioning; AM – Accidents and Malfunctions

Additional potential atmospheric emissions from the Ethylene Plant are listed in Table 2.8.

Table 2.8: Potential Project Emissions.

Emission Type	Project Phase
Particulate matter with a diameter of <10 µm (PM_{10})	C, O, D, AM
Particulate matter with a diameter of <2.5 µm ($PM_{2.5}$)	C, O, D, AM
Dust	C, O, D, AM
Carbon monoxide (CO)	C, O, D, AM

Note:

C – construction; O – operation; D – decommissioning; AM – Accidents and Malfunctions

Emissions from the Ethylene Plant are predicted to be up to 0.5 Mt/y for CO_2 (fired) and up to 0.2 Mt/y for CO_2 (unfired), as shown in Table 2.9.

Table 2.9: Estimated Annual Greenhouse Gas Emissions from Ethylene Plant.

Emission Type	Emission Amount
CO_2 (fired)	0.4–0.5 Mt/y
CO_2 (unfired)	0.1–0.2 Mt/y

2.5.2 Wastes, Discharges and Waste Management

Table 2.10 summarizes the potential liquid, solid and hazardous wastes and discharges that may result from the Ethylene Project, together with the sources of these wastes and discharges and potential waste management strategies.

With the implementation of waste management strategies and the utilization of appropriate treatment and disposal facilities, WCOL will reduce both the amount and potential impacts of waste.

Table 2.10: Potential Wastes and Discharges from the Ethylene Project.

Potential Waste or Discharge and Source	Proposed Management or Mitigation	Project Phase
Liquids		
Discharges from process operation (Cooling Tower blowdown, and demineralization regeneration stream)	• Cooling tower blowdown will be combined with the demineralized water regeneration stream. • Regeneration of the demineralized water treatment process (ionic exchange) will result in a regeneration stream containing a high mineral content. • The combined stream will be cooled and returned to the Fraser River. The volume will be much less than the original raw water make-up, but it will contain most of the dissolved salts and minerals that were in the original water intake. The amount of blowdown and the mineral content of the blowdown will be dependent on the quality of the raw water make-up (river water and well water quality varies). • The stream will be treated and pH adjusted as required, and water quality will comply with permit conditions when discharged.	O
Stormwater	• Stormwater will be collected on site in a retention pond, treated (if required) and used as a cooling water make-up for the Cooling Tower. Recycling of the stormwater will reduce the amount of raw water make-up required. • Any stormwater not used as cooling water will be tested, and water quality will comply with permit conditions before the water is discharged.	C, O, D
Segregated collection system wastes	• Liquids from any of the segregated collection systems (amine sump, caustic sump, closed hydrocarbon drain, chemical collection sumps) may not be suitable for recycling, in which case they will be trucked off site for appropriate disposal.	O
Spent liquids from lab (e.g., used solvents)	• Follow proper Workplace Hazardous Materials Information System procedures and Material Safety Data Sheet procedures for disposal methods.	O

Potential Waste or Discharge and Source	Proposed Management or Mitigation	Project Phase
Used potable or utility water	• Potable or uncontaminated utility water wastes will be directed into a sewer system that connects with the City of Prince George water treatment facilities and discharge routes. This sewer line will be completely segregated to ensure no water from the processing facility can become mixed with this stream.	C, O, D
Spent hydrostatic water from testing procedures	• Used water will be collected onsite and will be treated and pH adjusted as required. Water quality will comply with permit conditions when discharged.	O
Waste caustic	• Will be transported from site and disposed of at appropriate facility.	O
Spent chemicals such as glycol or amine	• Chemicals that need to be replaced will be trucked offsite to be disposed of at suitable facilities.	O
Discharge that results from maintenance of Quench Tower (coke, tar, oil)	• Materials will be shipped offsite for disposal at suitable facilities. Can be a combination of liquids and solids.	O
Non-recyclable streams resulting from waste water treatment, such as non-separable oil/water streams	• Wastes will be shipped offsite for disposal at suitable facilities.	O, AM
Chemical spills on site	• Collect spill and dispose of chemical suitably.	AM
Liquid hydrocarbon spill or leak within secondary containment	• Recover hydrocarbon and reprocess or suitably dispose if contaminated.	AM
Liquid hydrocarbon spill outside of secondary containment	• Outside of secondary containment, liquid hydrocarbon will flow to stormwater retention pond. Will recover hydrocarbon and treat contaminated water within pond.	AM
Pressurized hydrocarbon leak at flanges, pump seals or instrument connections	• Will be recovered within containment, reprocessed or suitably disposed of if contaminated.	AM
Release of glycol as a result of break in glycol tracing system	• Use of absorbent to collect spilled materials, and suitable disposal of contaminated materials.	AM

Potential Waste or Discharge and Source	Proposed Management or Mitigation	Project Phase
Gases		
Pressurized hydrocarbon leak at flanges, compressor seals or instrument connections	• Major leaks will result in a hydrocarbon release to atmosphere. Gas leak detection systems will be installed throughout the facility with alarms to alert operators to isolate leaking equipment and shutdown the plant if necessary.	AM
Flaring of residual hydrocarbons to de-inventory equipment for preparation of equipment maintenance and inspection during turnaround	• Operating procedures will be developed to recover as much hydrocarbon inventory as possible prior to starting the de-inventory process.	O
Solids		
Solid residue resulting from the raw water treatment process	• The disposal method for this waste is still being determined. It may be sent to landfill.	O
Wastes that may result from on-site construction of equipment or modules and future in-plant projects (metal scraps, piping, packaging, etc.), and waste safety consumables, such as gloves or disposable coveralls	• Segregate and recycle if possible and dispose of remaining material at proper facility.	C, O, D
Vegetation and biomass resulting from any levelling or clearing of land that needs to occur during construction	• Will be stockpiled on site and re-used or sold as fibre to local wood processing facilities where possible. Excess vegetation will be disposed of per City of Prince George requirements and facilities. Any contaminated material will be removed and disposed of offsite in an approved facility.	C, D
Domestic wastes (food wrappers, cardboard, plastics, etc.)	• Recycle if possible and dispose of remaining material at a proper facility.	C, O, D
Materials that cannot be re-used or recycled following decommissioning of the Project	• Dispose of at a designated landfill or other facility.	D

Potential Waste or Discharge and Source	Proposed Management or Mitigation	Project Phase
Used solid filter media (e.g., water treatment sand / anthracite, quench water walnut shells, activated carbon from amine filters)	• Recycle or dispose at a designated landfill or other facility, as appropriate.	O, D
Used filter cartridges	• Dispose of at proper facility.	O, D
Used drier molecular sieve	• Recycle or disposal methods to be confirmed.	O, D
Spent Acetylene Reactor catalyst	• Typically sent to original catalyst vendor for recycling of precious metals in the catalyst.	O, D
Used tubes/coils from the Pyrolysis Furnace	• Furnace tubes have high nickel and chrome content, so materials are typically sold to metal dealers to recover and recycle the valuable metals.	O
Hazardous Wastes		
Used furnace refractory	• Requires special handling and disposal to contain fibres that can be released from brittle refractory after it has been in service.	O, D
NORM (naturally occurring radioactive materials) contaminated wastes	• Requires special testing, handling and disposal, following published guidelines and standards for NORM materials.	O, D
Accidental release of motor oils or hydraulic oils from construction equipment	• Disposal of contaminated materials (e.g., cleaning supplies) at designated facilities.	C, D, AM

Note: C – construction; O – operation; D – decommissioning; AM – Accidents and Malfunctions

2.6 Ethylene Plant Design and Operations Features for Environmental Performance

Ethylene manufacturing is a very mature industry and designs have evolved to continuously improve the utilization of feedstock, the consumption of fuel and the environmental performance of ethylene plants. Ethylene can be manufactured from a range of feedstocks and ethane is the most direct and energy efficient feed to use to deliver ethylene as the primary product. The Ethylene Plant design will benefit from the constant technological evolution of plant and equipment design improvements within the industry and consequently the WCOL Ethylene Plant will have best in class energy and environmental performance. This section outlines the multitude of heat integration and recycling design features and equipment and process operations advances that will result in improved efficiencies environmental performance within the Ethylene Plant.

2.6.1 Energy Efficiency within the Ethylene Plant

High energy efficiency within the Ethylene Plant is a function of two primary aspects in the design: pyrolysis furnace design features and overall plant energy integration.

The heart of the proprietary technology associated with an ethylene plant design is the pyrolysis furnaces. The reaction from ethane to ethylene takes place in the radiant coils and the furnaces are the single largest energy consumer within the ethylene manufacturing process. The Pyrolysis Furnaces will be designed with short residence time coils (typically <0.6 seconds) and a proprietary effluent quench exchanger design, which combine to deliver an ethylene yield of approximately 80%. A higher yield reduces the amount of energy required to separate and recycle undesired byproducts, and therefore results in higher energy efficiency.

Further, the Pyrolysis Furnaces will have a high degree of energy efficiency, with an expected thermal efficiency of 90% to 94%. This is accomplished by investing capital cost in the furnaces and related equipment to maximize energy efficiency:

- Heat is recovered from the hot furnace effluent by generating very high pressure (VHP) steam in the effluent quench exchangers and then also to preheat boiler feed water.
- Heat from the combustion flue gas in the furnaces will act as a heating medium to preheat ethane and dilution steam feed as well as the boiler feed water and also to superheat VHP steam.
- Combustion air will be preheated with available waste heat, reducing the heat input required to the furnaces.

Ethylene manufacturing processes are highly energy integrated and have evolved significantly in the last 20 to 30 years, with technology licensors reporting reductions in energy consumption in the range of 30%. In addition to the furnace design features listed above, this has been largely achieved through optimization of the ethylene separation and recovery equipment to reduce the compression

horsepower required. The Ethylene Plant will also produce and use VHP steam, which results in greater efficiency in the generation and utilization of steam throughout the plant.

2.6.2 Low Carbon Footprint and Atmospheric Emissions

The Ethylene Plant will produce over 200 t/d of hydrogen as a byproduct, which has many potentially advantageous uses environmentally. The WCOL Ethylene Plant will use this produced hydrogen (part of the offgas produced by the plant) as the primary fuel source for the Pyrolysis Furnaces. When this fuel (offgas) is burned, emissions will be mainly water vapour and CO_2, resulting in a small GHG footprint for the facility.

Furthermore, the furnaces will be equipped with ultra-low nitrogen oxide (NOx) burners that are expected to emit less than 0.065 pounds of NOx per million Btus of heat produced (<0.065 lb/MBtu of NOx).

Finally, radiant coil technology improvements, specifically surface technology, reduce the amount of coke that forms within the furnace coils. As a result, the decoking process will be less frequent, thus reducing the associated emissions. This also translates into longer furnace run times which results in more efficient use of resources.

2.6.3 Technical and Environmental Advances Inherent within Ethylene Plants

There are numerous other plant design and specific equipment advances which reduce energy consumption and emissions and improve overall environmental performance:

- Acetylene Reactor technology, specifically catalyst surface technology, has been improved to increase selectivity, thus preventing over-conversion of ethylene to ethane and optimizing the use of ethane feedstock.
- The use of steam for all major compressor drivers will eliminate the need for electric or gas-based drivers, and will thus reduce the amount of atmospheric emissions.
- Use of steam to supply process heat will eliminate the need for a separate fired process heat medium system.
- The Ethylene Plant will have low-flaring start-up procedures and the plant will be designed with the necessary recycle streams required to accommodate these procedures. Low-flaring startup procedures will lead to minimized flaring requirements during abnormal operation, and thus the reduction of potential atmospheric emissions.
- Ethylene plants are inherently very reliable, with typical onstream time of >98%. Longer onstream times will reduce plant upsets, flaring time, the potential for safety incidents and lost productivity.

- Major compressors within the facility are expected to have efficiencies of between 81 and 87%, reducing the energy required.
- Advanced process control systems will be installed by the Project and will be developed over the life of the plant to optimize plant productivity and minimize the energy requirements within the plant. They will be automated systems that operate 24 hours per day, 7 days per week.

2.6.4 Minimization of Water Use

The Project will integrate various strategies to minimize water withdrawal from raw water sources.

Firstly, the Cooling Tower is a circulating system, providing non-contact cooling of the process. Treatment of the make-up to the cooling water system combined with a chemical treatment program allows the system to be operated at typically 8 to 12 cycles of concentration, to significantly reduce the raw water make-up requirements for the Project. Additional improvements, such as the drift eliminator systems, will reduce the amount of water losses from the system.

Internal water recycling strategies have been identified for the Ethylene Plant and will minimize the volume of water make-up required. Quench water treatment systems will separate hydrocarbons (often referred to as oils) from water that has condensed from pyrolysis gas effluent. The reclaimed water will be re-used as dilution steam make-up. Blowdown streams from the dilution steam system and steam system will be also recycled as make-up to various processes within the Ethylene Plant.

Miscellaneous process wastewater streams within the Ethylene Plant will also undergo internal treatment and be recycled where possible. Further, the proposed recycling and re-use of captured stormwater will further reduce raw water make-up requirements.

2.7 Project Capital Costs and Employment

All estimates in this section related to capital and operating costs and employment opportunities (both construction and long-term operations) are based on preliminary estimates and will be refined as the design of the Project is advanced and detailed project execution plans and operations establishment plans are developed. Updated information will be provided in the Application.

The capital cost of the Ethylene Plant and associated utilities and infrastructure, as described in this Project Description, is estimated at $2 billion to $2.8 billion. WCOL is developing a project execution strategy that focuses on maximum modular construction in fabrication shops and modularization yards in order to minimize the size of the site construction force and to control Project capital costs. This approach will shift some construction personnel from the on-site field construction force to larger numbers of construction workers located in fabrication and module assembly shops. WCOL is also working with local Prince George contractors to maximize the use of local fabrication and construction companies. This strategy will result in a large construction workforce to support

the Project, located in the Prince George region, but will distribute the workforce between the facility construction site and local fabrication facilities, making the estimate of peak construction personnel loading difficult to determine until a detailed execution plan is finalized. WCOL expects local site construction and fabrication activities to span from the spring of 2021 through the summer of 2023. During this period, the workforce dedicated to Project fabrication and construction activities is expected to peak at between 2,000 and 3,000 workers.

Annual operating costs for the facility are estimated to be roughly Cdn $60 million, including salaries, chemicals, insurance, maintenance materials, utility costs, and other costs, but excluding the cost of ethane feed sold to the Ethylene Plant. Long-term employment numbers associated with operation of the Ethylene Plant are expected to be between 140 and 180 permanent, direct employees. The facility will also engage approximately 25 to 50 contract employees to support operations and maintenance activities. Permanent positions required for the long-term operation of the facility are expected to have annual salaries ranging from $60,000 to $150,000, with an average salary of around $100,000. Many of these positions are highly skilled and require specialized training. The facility will also have annual sustaining capital expenditures to cover required regular maintenance, inspections and periodic upgrades to ensure the on-going safe and reliable operation of the equipment. This sustaining capital typically requires annual spending in the range of 1 to 2% of the original capital cost of the facility and is expected to vary between Cdn $20 million and Cdn $50 million each year.

3 Project Location and Land and Water Use

This section describes the proposed location of the WCOL Project Area, as well as land use designation, water use and zoning on and around the Project Area. Indigenous communities affected by the Project are also considered and discussed. For further information regarding land and water use in a socioeconomic setting, refer to Section 4.2.2.

3.1 Overview

The Project location has been selected to be on previously developed, fee simple land within the Prince George BCR Industrial Area. This location has been selected to minimize impacts on Indigenous groups and the broader community.

WCOL has selected the region of Prince George as the optimum location for the Project because this region offers the following advantages:

- The Westcoast Pipeline is located within 10 km to the east of the City. Use of natural gas from this pipeline will eliminate the need for the construction of any new major pipeline infrastructure.
- The routes for proposed liquefied natural gas pipelines all pass within roughly 100 km north of Prince George, providing access to future natural gas liquids.
- Prince George is a main hub for CN Rail, with connectivity to ports in Prince Rupert, Kitimat and Vancouver for export of products.
- BC Hydro has a major north-south transmission line that runs to the east of Prince George, which will provide the Project with access to green, high-voltage power supply from the new Site C dam.
- The Fraser River is one of the largest rivers in western Canada, providing ample water supply to meet cooling water and steam requirements.
- The population of the City is roughly 75,000 and the immediate region exceeds 100,000, with a labour force that is expected to provide the employment base necessary to support a major manufacturing facility.
- Prince George has had a history of industrial activity in the forestry sector. The population is supportive of resource development and value-add industries.

The proposed Project Area location is approximately 12 km south of the Prince George city centre and 8 km south-west of the Prince George airport. The closest residence to the site is approximately 1.5 km to the northeast.

Alternative site locations were considered, but the other locations did not meet all the requirements of the Ethylene Project or had specific drawbacks relative to the proposed site. More detail regarding these options will be discussed within future application documentation. The Project Area has been selected for the following reasons:

- It was previously developed for industrial uses (for log storage and use as a gravel pit), minimizing the Project's impact on undisturbed land.
- It provides direct access to the CN rail line with no new rail lines or spurs required.
- It lies adjacent to, and provides access to, the Fraser River.
- Close proximity to high voltage power lines.
- Close proximity to the Westcoast Pipeline.
- Adjacent to the majority of Prince George's fabrication facilities, providing the opportunity to have module assembly completed close to the construction site, thereby minimizing the amount of module transportation required.
- Within the City limits, reducing the distance of travel required by the majority of the workforce and minimizing travel-related risks for personnel over the life of the Project.

The Project Area is within the Regional District of Fraser-Fort George (RDFFG), which is comprised of 4 municipalities (including Prince George) and 7 electoral areas (Regional District of Fraser-Fort George, 2019).

The Project Area is located on fee-simple land within the city limits of Prince George and falls within the Traditional Territory of the Lheidli T'enneh Nation. The potential impacts of the Project on Aboriginal and treaty rights, and the interests of Lheidli T'enneh Nation and other Indigenous groups will be considered by WCOL as part of the Application.

3.2 Land Ownership and Legal Description

The WCOL Project Area is comprised of 2 private land parcels in the BCR Industrial Site, located within the Prince George city limits. The land titles and ownership for the proposed Project Area, as well as the land immediately adjacent, is depicted in Figure 3.1. Legal descriptions and information regarding these land parcels are presented in Table 3.1 and Table 3.2.

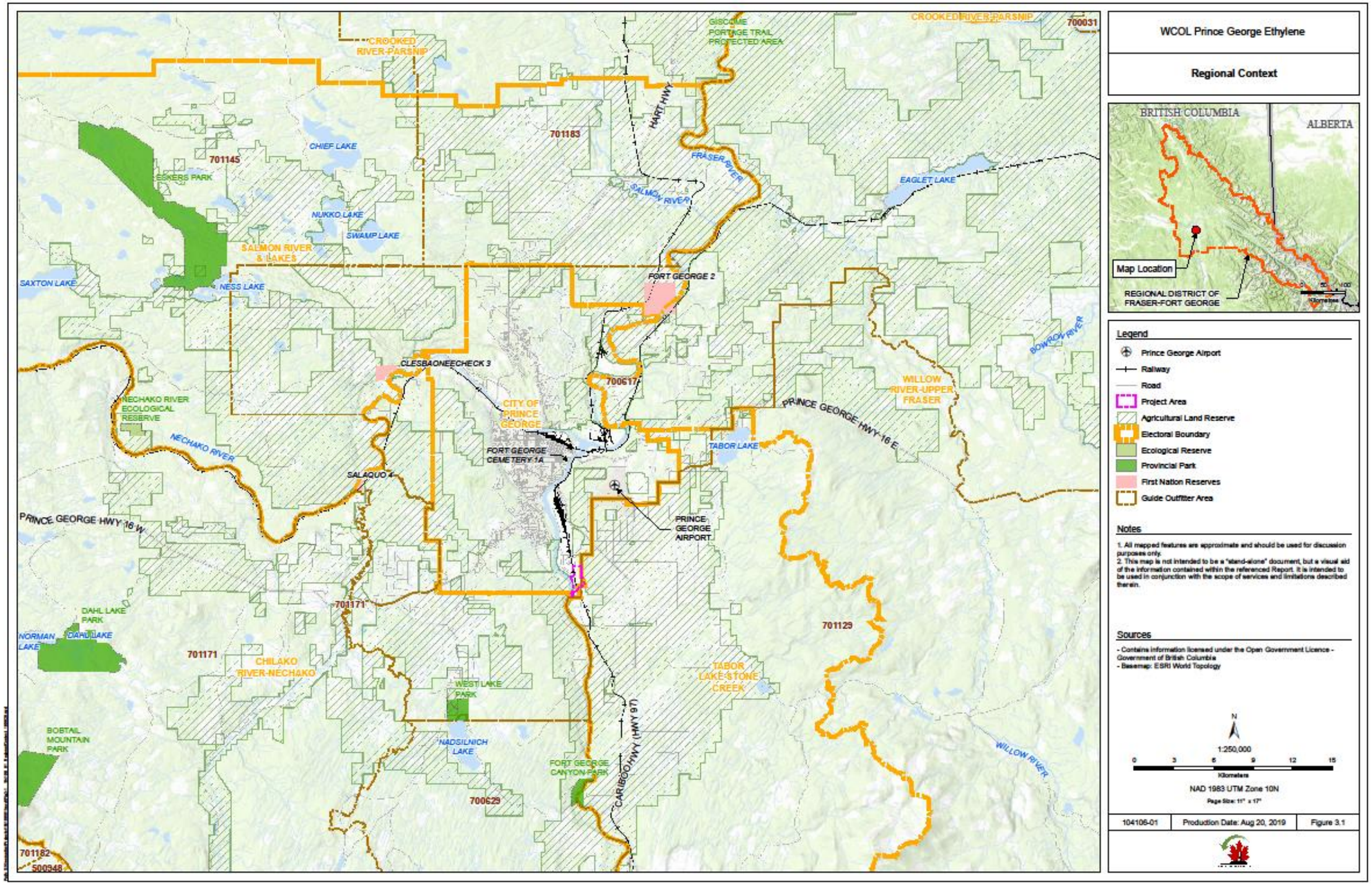

Figure 3.1: Land Titles and Ownership of Project Area and Surrounding Land.

Table 3.1: WCOL Project Area Description and Ownership.

Site Owner/Administrator	596848 BC Ltd. WCOL option to purchase
Site Location	Prince George, BC
Approximate Geographic Coordinates	53°49'27.5"N; 122°43'29.5"W
Proposed Project Area	The total Project Area is approximately 120 hectares. The Ethylene Plant will occupy only a portion of the total site

Table 3.2: Legal Description of WCOL Project Area.

Parcel ID	Type	Owner/Administrator	Legal Description
027-985-032	Fee Simple	Private	Lot 1 Plan BCP41694 District Lot 752 Land District 05 and DL 1565, 1566
014-996-952	Fee Simple	Private	Part 1 SE District Lot 751 Land District 05 LYING E OF PL A227

(PGMap, 2019) (ParcelMap BC, 2019) (BC Assessment, 2019)

The Project Area is located within an under-utilized, existing industrial park. The northern portion of the Project Area was previously used as a log storage yard. The southern parcel was later used as a gravel pit.

3.3 Water Use

The following sections describe anticipated water usage by the Ethylene Project, as well as pre-existing water users and licences that exist on or around the Project Area location.

3.3.1 WCOL Water Use

Table 3.3 summarizes the water requirements and water distribution throughout the Ethylene Plant. As the largest consumer of water within the WCOL Development, the Ethylene Plant will be the water licence holder. The Ethylene Plant will provide wastewater handling, and treated water will be sold to the NGL Separation Plant as a service to meet water requirements.

Table 3.3: Water Usage and Distribution in the Ethylene Plant.

Water Usage Component	Water Diversion and Use
Raw Water Withdrawal and Treatment Raw water supply between 600 and 650 m^3/h of to meet water requirements for the Ethylene Plant.	• Water will be withdrawn from either the Fraser River or from ground water wells, or a combination of the two, and treated to meet the various process requirements. • Raw water will be treated as required to remove suspended solids, hardness, etc., making it suitable for make-up to the cooling water system.
Cooling Tower The Cooling Tower will circulate between 25,000 and 35,000 m^3/h of cooling water to the Ethylene Plant. It will rejecting up to 1,500 GJ/h of heat via evaporation.	• Following adequate treatment, cooling water make-up will be fed to the Cooling Tower. • Water losses from the Cooling Tower will primarily be from evaporation, as well as a minor amount of drift (entrained water droplets). • Evaporation will cause the concentration of dissolved minerals, such as calcium, to increase within the circulating cooling water stream. • Thus, to prevent mineral deposition on heat exchangers in the facility, a small blowdown stream will be withdrawn from the circulating cooling water to maintain acceptable mineral content in the system. • Treated river water will be continuously used as make-up to the cooling water system to replace these losses.
Ethylene Plant Cooling Water	• Non-contact cooling water will be continuously circulated to the Ethylene Plant and passed through heat exchangers to remove heat from the ethylene production process. • The warm cooling water will be returned and cooled by direct contact with ambient air in the Cooling Tower.

Water Usage Component	Water Diversion and Use
Boiler Feedwater Make-up	• Treated water will be further treated to remove hardness and other contaminants to meet stringent boiler feedwater requirements. This treatment is expected to include ion exchange beds. Regeneration of ion exchange beds will result in a water stream that will be returned to the river. • Make-up water will be continuously added to the steam system to replace the blowdown and losses. • Make-up water will be continuously added to the dilution steam system. • Minor amounts of treated water will be required as make-up to the Ethylene Plant amine system.
Steam System The steam system will have the capacity to produce roughly 450 t/h of VHP steam.	• High-pressure steam will be generated from waste heat in the Ethylene Plant and used to power steam turbine drivers and provide process heat to heat exchangers throughout the ethylene production process. • The majority of the steam will be condensed and recycled (minimal losses), but a small blowdown stream (1 to 2% of total steam production) will be continuously removed from the steam system to prevent hardness concentrations from cycling up and causing damaging deposits to occuring the boiler tubes or heat exchange equipment. • Blowdown will likely be recycled to the Quench Water system for re-use.

Water Usage Component	Water Diversion and Use
Water Effluent to River The Ethylene Plant will discharge between 70 and 120 m^3/h of combined blowdown from various process operations.	• Cooling Tower blowdown and demineralized water treatment regeneration streams will be combined. • These streams will have elevated mineral levels as dissolved solids from the fresh river water withdrawal becomes concentrated in this stream. This combined blowdown stream will be treated and cooled to meet the requirements of the environmental discharge permits prior to being returned to the Fraser River.
Dilution Steam System	• Dilution steam will be added to ethane feed to reduce coking rates in the Pyrolysis Furnaces. • Water present in the Pyrolysis Furnace effluent will condense within the upper portions of the Quench Tower (quench water). • The quench water will undergo treatment to remove heavy C5+ hydrocarbons and then will undergo stripping to remove light hydrocarbons and be subsequently used to generate dilution steam. This closed system will maximize water re-use. • Trace amounts of dissolved hydrocarbons that exist within the treated quench water can cause buildup during dilution steam production; thus, a blowdown stream will be withdrawn. • The blowdown will likely be recycled as cooling water make-up.

Water Usage Component	Water Diversion and Use
Utility and Potable Water	• Clean, filtered utility water will be required for various minor consumers, such as pump seal flushes. Most of this water will be recovered from the process and recycled. • Potable water will be provided for various operations of the plant, including but not limited to eye washing stations, emergency showers, kitchen, and lavatory uses. • Potable and utility water will be supplied from the Prince George municipal water supply. • Sanitary sewer collection will be included where required, and sanitary sewage/water will be collected and sent to the Prince George sewage collection system. • No process water will be tied into the city sewage system.

3.3.2 Current Water Use in the Project Area

The only non-Project water uses within the WCOL Project Area are 2 water wells (Well Tag Numbers 56895 and 74538) (iMapBC, 2019). It is not yet known if process water for the Ethylene Plant will be withdrawn from these wells.

Additionally, no previous water licences exist within the Project Area. There is one water licence approximately 4 km downstream from the Project Area that withdraws from the Fraser River. This licence is for placer mining purposes and is for 0.005 m^3/s (iMapBC, 2019). This licence is not affiliated with the WCOL Project and will not be affected by the Project.

3.4 First Nations Reserves and Indigenous Traditional Territories

A search of the provincial Consultative Areas Database identified that all construction activities associated with the Project will be within the Traditional Territory of the Lheidli T'enneh First Nation (Government of BC, 2019). The Nazko First Nation is another Indigenous group that has a claimed territory that lies on the west side of the Fraser River, across from the Project Area for the Ethylene Plant.

The Project Area, the City of Prince George and the surrounding region are within the Traditional Territory of the Lheidli T'enneh First Nation (Lheidli T'enneh n.d.). Project activities and components therefore have the potential to directly interact with the rights and interests, uses and activities of the Lheidli T'enneh First Nation.

There are 4 Lheidli T'enneh reserves. The closest Lheidli T'enneh reserve is approximately 8 km north of the Project Area (PGMaps) and comprises the Fort George Cemetery 1A (iMap BC), which lies within the Prince George city limits. All other Lheidli T'enneh First Nation reserve lands are located outside the Prince George city limits. Table 3.4 illustrates the land use designation of the reserve lands as described in the Lheidli T'enneh First Nation Land Use Plan (Lheidli T'enneh 2017).

Table 3.4: Overview of Lheidli T'enneh First Nation Reserve Land.

First Nation	Reserve Number and Name	Proximity to WCOL Main Site	Land Use Designation
Lheidli T'enneh	IR #1 Ts'unk'ut – Lheidli T'enneh Cemetery(Fort George 1)	Approximately 8 km north of WCOL Project Area (within Prince George city limits)	• Cultural/Heritage Site for Lheidli T'enneh First Nation
Lheidli T'enneh	IR #2 Khast'an Lhughel – North and South Shelley (Fort George 2)	Approximately 14 km northeast of Project Area	• Community Development • Industrial • Agriculture and Resource • Cultural
Lheidli T'enneh	IR #3 Lhezbaonichek – Clesbaoneecheck	Approximately 18 km northwest of Project Area	• Community Development • Agriculture and Resource
Lheidli T'enneh	IR #4 Dzulhyazchun Tsalakoh – Salaquo	Approximately 15 km northwest of Project Area	• Agriculture and Resource • Heritage/Cultural

(iMapBC, 2019), (Lheidli T'enneh Lands Authority, 2017)

The Nazko First Nation administrative centre is located in Nazko, 112 km west of Quesnel. The Nazko First Nation Statement of Interest identifies the Nazko Traditional Territory as extending from Quesnel to Prince George (BC Treaty Commission 2019). The Statement of Interest does not overlap with the Project site; however, Project activities have the potential to indirectly interact with the rights and interests of Nazko First Nation, for example by interacting with air or water resources.

Figure 3.2 depicts the Traditional Territories of Indigenous Groups relative to the Project Area.

See Section 5.1 for additional considerations related to Indigenous groups.

3.5 Land Use Plans

The land use and land designations associated with the Project Area land parcels and the surrounding locations are discussed in the following section.

3.5.1 Land and Resource Management Plan and Provincial Land Designation

The Project Area resides within the Settlement and Agriculture resource management zone, as stated in the Land and Resource Management Plan. This plan outlines land use and resource development strategies on Crown land, defined within the plan area (City of Prince George , 1999). However, because the Project Area land parcels are designated as private, the plan is not applicable (City of Prince George , 1999).

The eastern portion of the Project Area is within the Agricultural Land Reserve (ALR). The ALR is a zone defined by the Provincial Agricultural Land Commission wherein agriculture is recognized as the priority use (Government of BC, 2014). Further information regarding the ALR is addressed within Section 3.5.3.

3.5.2 Prince George Official Community Plan

The WCOL Project Area falls under the City of Prince George Official Community Plan (OCP), a document that lays out objectives and policies regarding land use and development within the city. The proposed WCOL Project aligns with many of the overall objectives presented in this document, including those presented in Table 3.5.

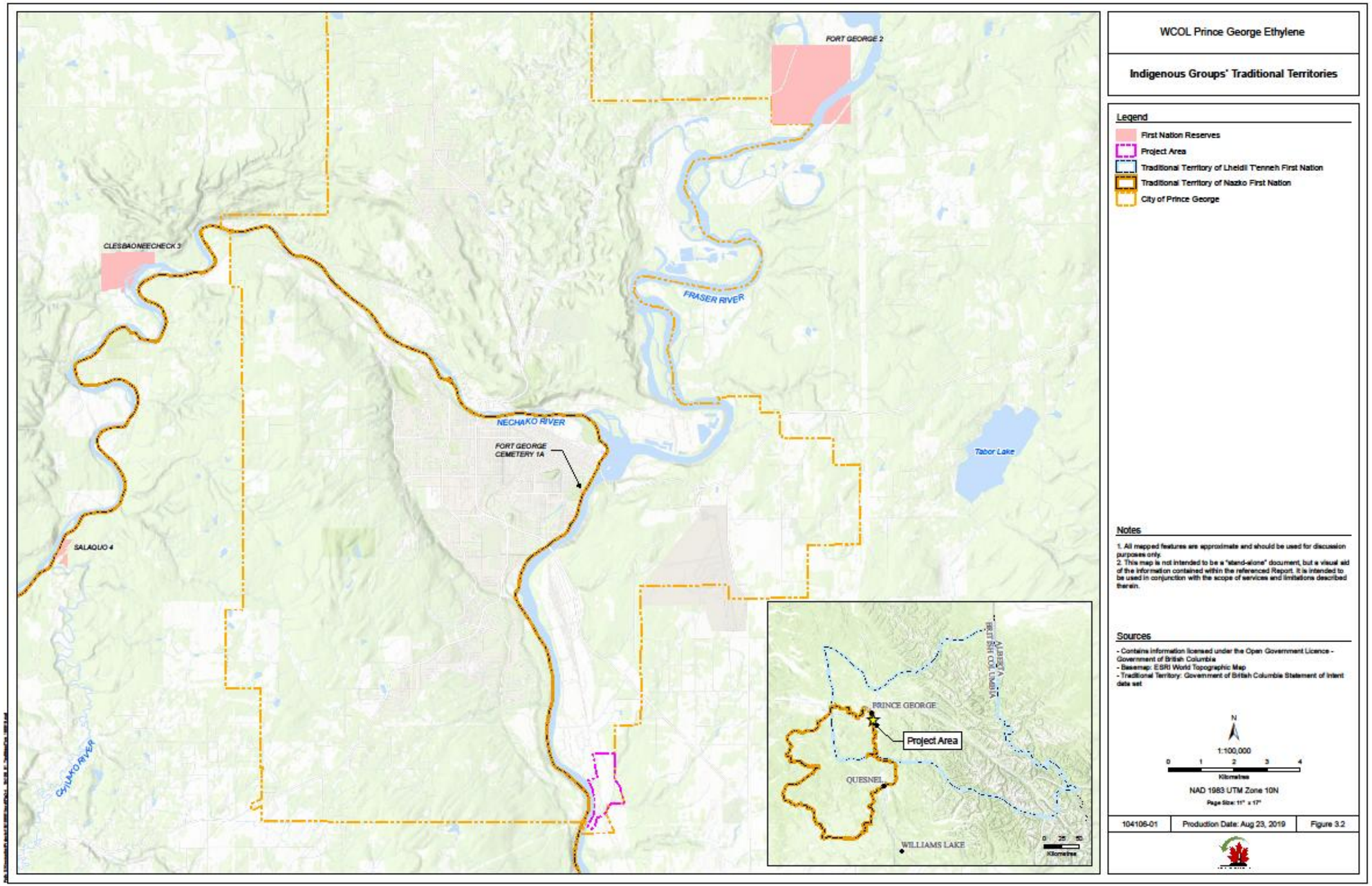

Figure 3.2: Indigenous Groups' Traditional Territories Relative to Project Area .

Table 3.5: Alignment between City of Prince George OCP Overall Objectives and WCOL Project.

OCP Objective	WCOL Project Alignment
Objective 5.1.5 – Support institutions that enhance our knowledge-based economy such as University of Northern British Columbia (UNBC), College of New Caledonia (CNC), and commercial and trades training opportunities.	• Numerous indirect benefits will be associated with the Project, including training at local institutions (UNBC and CNC). • Many of the positions created by the Project will be highly skilled and require specialized training.
Objective 5.1.6 – Support the Growth Management strategy by matching employment growth with population growth.	• During the construction period of the Project, the workforce is expected to peak between 2,000 and 3,000. • Long-term employment is expected to include between 140 and 180 permanent employees. • To support maintenance and operation activities, the Project is expected to engage between 25 and 50 contract employees.

(City of Prince George , 2012)

The development also aligns with many of the OCP's industrial-sector objectives, including those listed in Table 3.6.

Table 3.6: Alignment between City of Prince George OCP General Industrial Objectives and WCOL Project.

OCP Objective	WCOL Project Alignment
Objective 8.3.20 – Minimize impacts on adjacent areas.	• The proposed Project Area location is a previously developed site. Little additional disruption of the surrounding area is likely to occur during construction phases. • Given the Project Area's proximity to existing amenities and utilities, additional construction of adequate tie-ins will be minimized.

OCP Objective	WCOL Project Alignment
Objective 8.3.22 – Encourage use of currently serviced land and existing amenities such as transit access, road networks, rail lines, and utilities	• Access to the site will be via existing transport and access roads (Willow Cale Road and Northern Crescent). At this time no need for access road construction or maintenance is anticipated before Project phases begin. • Existing CN Rail tracks will be used for product loading and transport, and less than 20 km of track needs to be developed to accommodate rail loading facilities for products and coproducts. Note that rail is not directly within the Project scope of this EA. • Secondary BC Hydro Transmission lines run adjacent to plant, and new transmission lines to be developed for tie-in purposes are anticipated to range between less than 5 km up to 40 km).

(City of Prince George , 2012)

To ensure alignment with OCP Future Land Use, WCOL has reviewed future development permit areas (Schedules D1-D5) and determined the following:

- Based on Schedule D-1, there exists a groundwater protection area north of the Project Area, but none on or immediately adjacent to the Project Area itself (City of Prince George , 2011).
- From Schedule D-2, the Project Area encompasses areas identified as a Riparian Protection Development Permit Area. These zones encompass the Fraser River (bordering the western portion of the Project Area) and Haggith Creek, which runs through the Project Area. These zones will be further discussed in Section 3.5.3. (City of Prince George , 2014).
- The Project Area is not classified as a Wildfire Hazard area, based on Schedule D-3. There is a hazard area located approximately 1 km northwest of the Project Area. The Ethylene Project will be fitted with appropriate fire protection (City of Prince George , 2011).
- The western border of the Project Area (that which borders the Fraser River) is classified as a flood hazard area based on Schedule D-4 (City of Prince George , 2011).
- Based on Schedule D-5, the Project Area does not exist close to Intensive Residential Development areas (City of Prince George, 2014).

- Based on the City of Prince George's Active Transportation Plan, shared bike lanes exist on the roads surrounding the Project Area, including Sinnich Road and Penn Road. However, none extend into the Project Area Location.

Future land use designations as outlined by the OCP, together with WCOL's alignment plan, are further discussed in Section 3.5.3.

Within the city limits of Prince George, there exist no provincial parks, eco-reserves, or protected areas (iMapBC, 2019). The closest protected parks/lands are Fort George Canyon Provincial park (approximately19 km south of Prince George) and West Lake Provincial Park (approximately 14 km southwest of Prince George) (iMapBC, 2019). As previously mentioned, the Fraser River, which borders the western portion of the Project Area, and Haggith Creek, which intersects portions of the Project Area, are identified as Riparian Protection Development Permit Areas.

Prince George features a multitude of municipal parks, but none exist close to the Project Area; the nearest Park is Parkridge Creek Park, which is approximately 2 km northwest of the Project Area. To the north of the Project Area lies an area of land which is designated as an Open Space based on Green Belt classification (City of Prince George, 2016).

Figure 3.3 depicts the Project Area relative to regional land designations, including First Nation's Reserves and Provincial Parks.

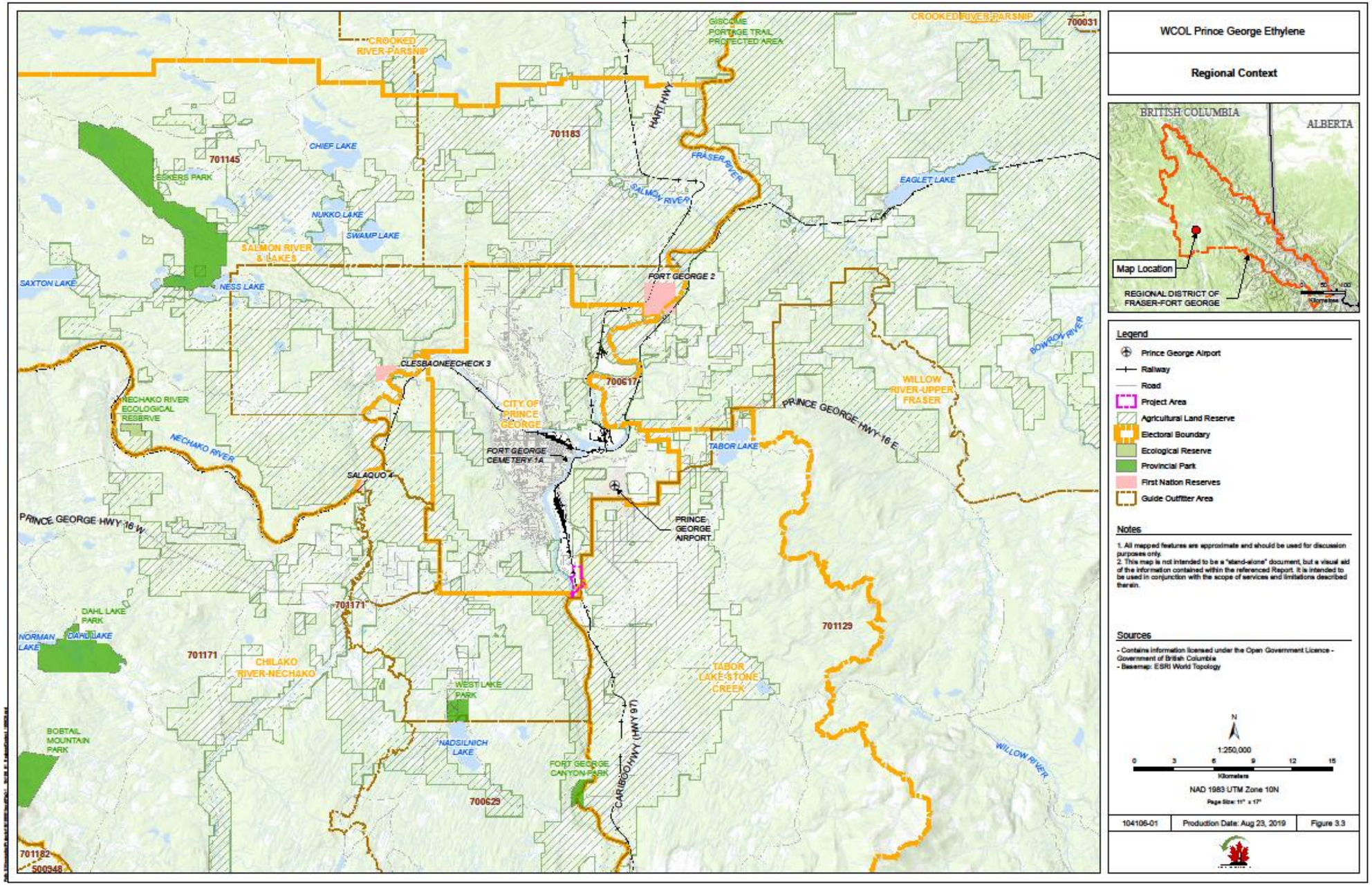

Figure 3.3: Project Area Relative to Regional Land Designations.

3.5.3 Rezoning under the OCP

PID: 014-996-952 (Northern Parcel)

Based on OCP Future Land Use, depicted within Figure 3.4, the parcel of land on which the Project is proposed is designated as:

- Business District, Medium Industrial
- Rural Resource (City of Prince George, 2018)

To accommodate the proposed facility on site, WCOL will submit an OCP Amendment application to re-designate the property to:

- Business District, Heavy Industrial (City of Prince George, 2018)

Zoning information is summarized below, and depicted within Figure 3.5.

Table 3.7: Zoning Information for WCOL Northern Parcel.

Parcel ID	Current Zoning	Required Rezoning
014-996-952	• AG (Green Belt) • AF (Agriculture and Forestry)	• M6: Special Heavy Industrial

(PGMap, 2019)

PID: 027-985-032 (Southern Parcel)

Current OCP designations, depicted in Figure 3.4, define this parcel of land as:

- Business District, Light Industrial
- Business District, Medium Industrial
- Rural Resource (City of Prince George, 2018)

To accommodate the proposed facility on site, WCOL will submit an OCP Amendment application to re-designate the property to:

- Business District, Heavy Industrial
- Utility
- Rural Resource (City of Prince George, 2018)

Zoning information for this parcel is presented in Table 3.8 below, and depicted in Figure 3.5.

Table 3.8: Zoning Information for WCOL Southern Parcel.

Parcel ID	Current Zoning	Required Rezoning
027-985-032	• AG (Green Belt) • AF (Agriculture and Forestry) (ALR designation) • M5 (Heavy Industrial) • M2 (General Industrial)	• M6 (Special Heavy Industrial)

(PGMap, 2019)

The eastern portion of this parcel is within the Agricultural Land Reserve (ALR), as can be seen within Figure 3.4. Prior to land use application, WCOL will undertake the proper application procedures with the designated regulatory agencies.

Development Permit Area

As previously mentioned, Riparian Protection Development Permit Areas have been identified on the WCOL Project Area. Before construction, land alteration or tree removal begins, WCOL will obtain the required permits and permissions from the designated regulatory agencies.

3.5.4 Lheidli T'enneh Land Use Plan

The Lheidli T'enneh Land Use document serves to provide support for decisions regarding land use on reserve. General reserve land objectives include:

- Enhancement and protection of culturally and environmentally sensitive areas, as well as Traditional Knowledge
- Ensure sustainable land development
- Include community input to land use decisions
- Strengthen relationships with Prince George and the RDFFG on land management issues

This Land Use Plan is prepared in alignment with the Lheidli T'enneh Land Code, which provides legal authority for planning, developing, conservation and management of Lheidli T'enneh lands.

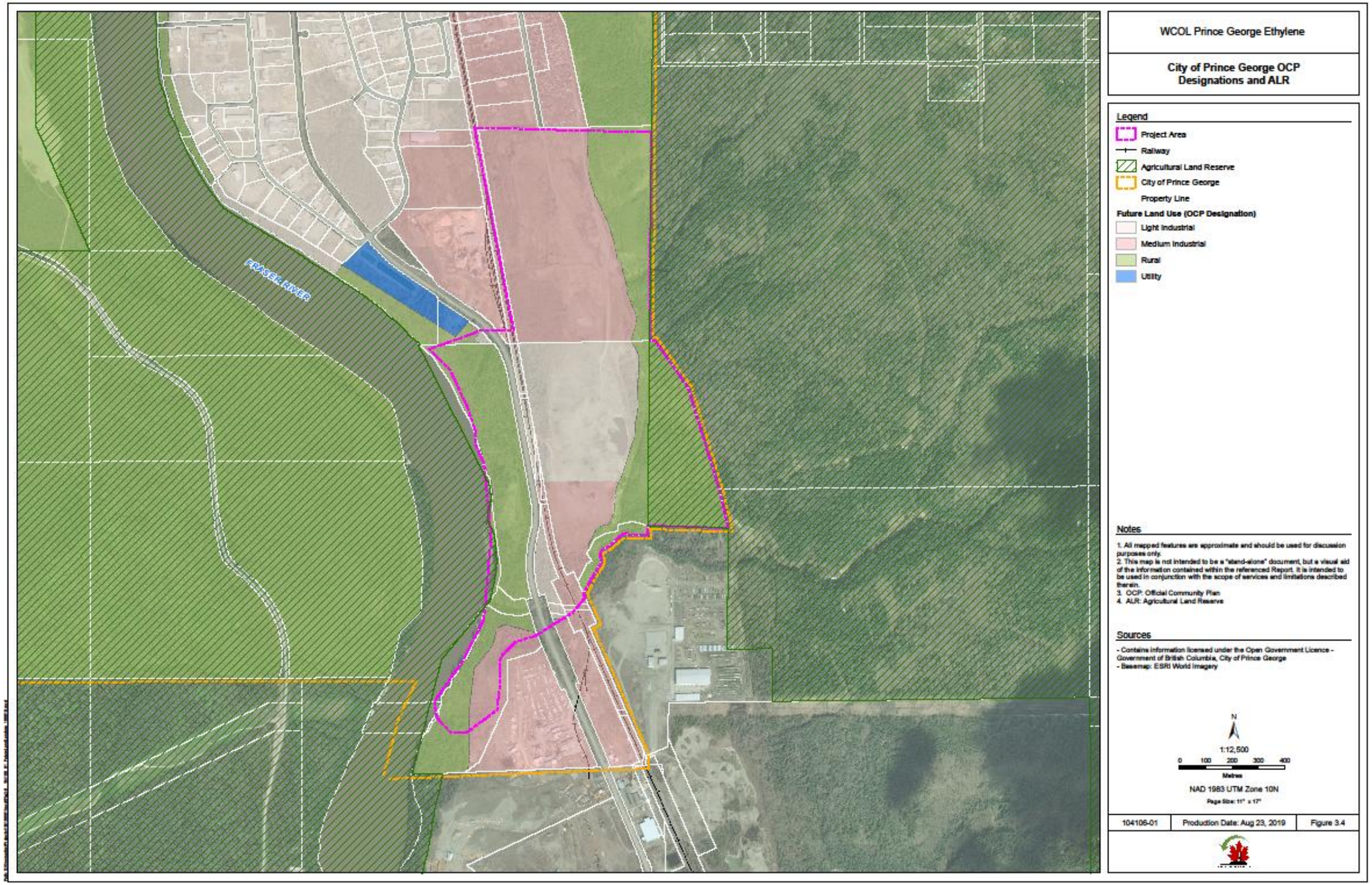

Figure 3.4: City Prince George OCP Designations of Project Area and Surrounding Area and Relevant ALR Designations.

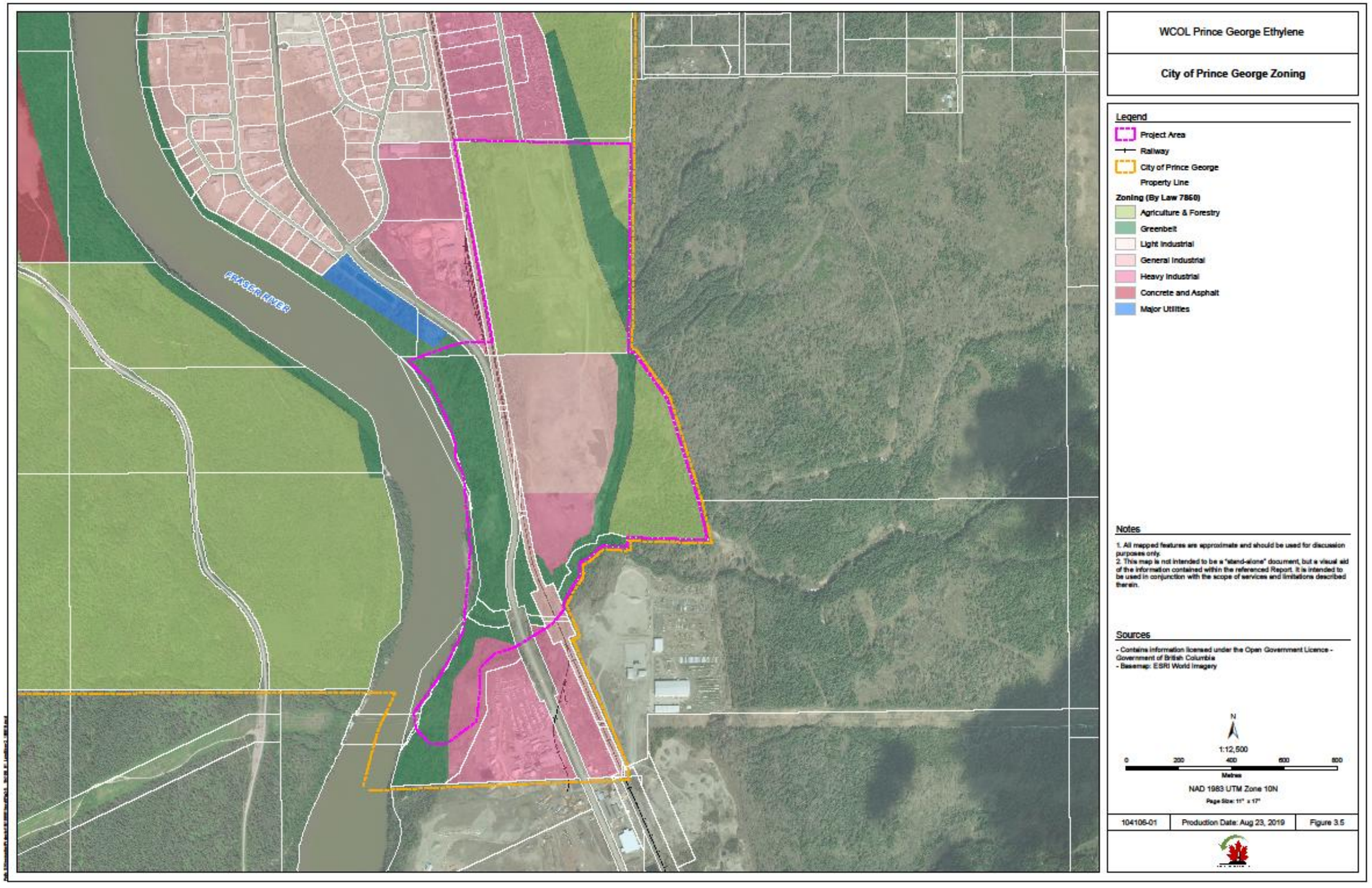

Figure 3.5: City of Prince George Zoning of Project Area and Surrounding Area.

4 Environmental Setting and Effects

The following sections provide an overview of the environmental settings in and around the Project Area. Information was gathered from publicly available sources, including scientific literature, grey literature (e.g., technical reports, government reports), and EA documentation from other projects in the area of the proposed Project. Sources of information include the following:

- Publicly available data and reports from:
  - Lheidli T'enneh First Nation (including the Lheidli T'enneh Land Use Plan)
  - Nazko First Nation
  - Statistics Canada (including the census data for City of Prince George)
  - Environment and Climate Change Canada
  - BC Ministry of Environment and Climate Change Strategy (including the BC Air Data Archive)
  - BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - BC Assembly of First Nations (including the Community Profiles for Lheidli T'enneh First Nation and Nazko First Nation)
  - City of Prince George (including the Official Community Plan & Heritage Register)
  - Regional District of Fraser-Fort George
  - Prince George Air Improvement Roundtable (including the Prince George Airshed database)

- Publicly available reports from other projects and activities in the region:
  - Blackwater Gold Project
  - Merrick Pipeline Project
  - Gisome Quarry and Lime Plant
  - Isle Pierre Wind Project
  - Mount George Wind Park Project
  - Pembina Condensate Pipeline Project
  - Prince George Wood Residue Fired Cogeneration Project
  - Hart Water Supply Improvements Fishtrap Island Collector Well Project

This information will be augmented with data from Project-specific studies that will be undertaken to support the environmental, economic, social, health and heritage effects assessments for the Project.

4.1 Biophysical Setting

4.1.1 Atmospheric Environment

Climate and Weather

The Project Area has experienced subarctic climate conditions as recently as the 1961 to 1990 climate normal period. Due to recent warming, the area has changed to a humid continental climate. Based on 1981 to 2010 climate normal data for the Prince George Airport (ECCC, 2019), average monthly temperatures ranged from -7.9°C in January to 15.8°C in July. Cold continental arctic air masses dominate in the winter, although air flows are restricted by the Columbia and Rocky Mountains to the east, creating milder winters than the latitude and elevation may suggest. Summer days are warm, with an average daily maximum of 22.4°C in July, but nights are often cool, with an average daily minimum less than 10°C. Located in the rain shadow of the Coast Mountains, the area tends to be dry, receiving only 595 mm of precipitation annually. Other than a somewhat drier spring, there is little precipitation difference between the seasons (Pike, Redding, Moore, Winkler, & Bladon, 2010).

Air Quality

The Project area is situated within the Prince George airshed. Located at the confluence of the Nechako and Fraser rivers, this is an area that is susceptible to poor air quality conditions. The Prince George airshed has a number of emission sources, including industrial facilities, residential heating and wood smoke, transportation corridors and road dust. Influenced by frequent light winds and temperature inversions in the winter, these air emissions tend to remain trapped in the river valley. In addition, the airshed has been subject to elevated pollutant concentrations due to wildfires in the region (PGAIR, 2019).

Air quality monitoring in the airshed consists of one core station located at the Plaza 400 in downtown Prince George, which measures particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide, nitrogen dioxide, ozone, and total reduced sulphur. Several other stations in the area also measure 1 to 3 of the aforementioned pollutants. In 2017, 24-hour PM_{10} and $PM_{2.5}$ concentrations at Plaza 400 exceeded the BC ambient air quality objectives 3.2% and 6.5% of the time, respectively. Most of these exceedances were a result of wildfires. The remaining exceedances generally occurred during the winter and were a result of wood-burning emissions combined with stagnant meteorological conditions. There are no BC ambient air quality objectives for total reduced sulphur; however, in 2017, total reduced sulphur concentrations at Plaza 400 exceeded the pollution control objectives for the forest products industry more than 11% of the time. All other pollutants were less than relevant BC ambient air quality objectives (MOECCS, 2019).

Acoustic Environment

There is no historical information available on noise levels in or around the Project Area. However, the Project is located on previously disturbed land within an existing industrial area. Nearby industrial operations include the CN Rail yard and associated rail tracks, a wood pellet production facility, a lumber yard and several freight shipping and trucking companies. Noise levels in the area are expected to be relatively high. A noise monitoring program will be conducted to collect baseline noise levels in the Project Area in support of an Environmental Assessment Application.

4.1.2 Freshwater Environment

Groundwater

Two groundwater wells (Well Tag Numbers 56895 and 74538) are present in the Project area (iMap BC, 2019), as depicted within Figure 4.1. As described in Section 3.3, it is not yet known if these wells will be used as groundwater supply for Project process water requirements. Further design will be developed prior to the application to determine the raw water source(s).

Fish and Fish Habitat

The Project area is bounded by the Fraser River to the east and has 2 drainages that flow through its boundaries: an unnamed drainage and Haggith Creek. Figure 4.1 depicts the existing water use and watercourses relative to the Project Area.

Unnamed Drainage

The unnamed drainage, located at the north end of the Project Area, is a straight, low-gradient, first-order drainage that is approximately 260 m in length from its origin to its confluence with the Fraser River. The drainage is vegetated, and based on the topographic characteristics of the region, is likely a rainfall and snowmelt catchment for the surrounding area. No historical fish information is available for the drainage.

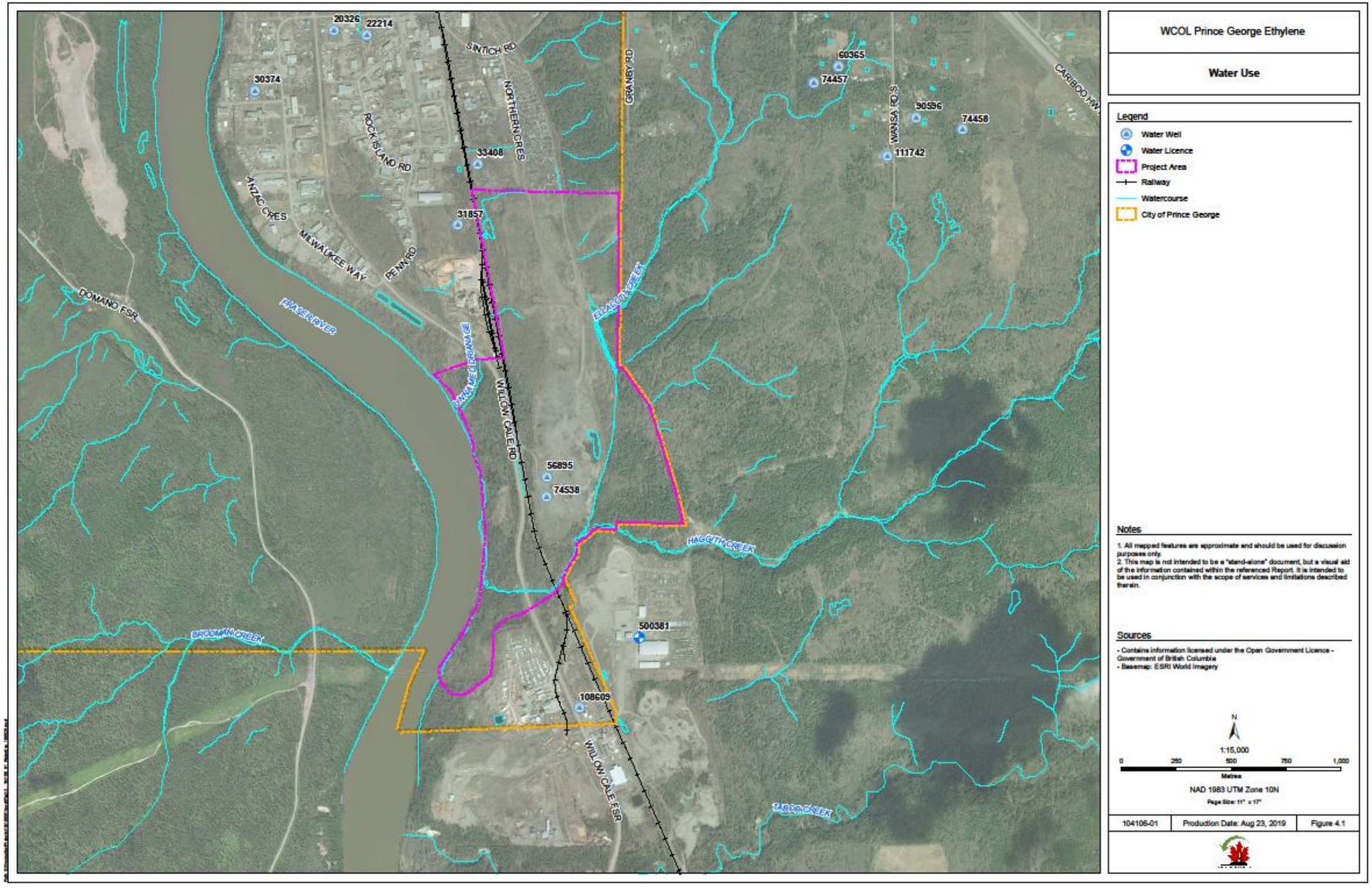

Figure 4.1: Water Use on Project Area and Surrounding Area.

Haggith Creek

Haggith Creek is a meandering, third-order drainage, approximately 14.5 km in length, and originates in the elevated plateau east of the Project Area. The riparian vegetation surrounding the creek is largely intact in the Project Area except for 2 existing watercourse crossings associated with the rail line and Willow Cale Road. Based on the documented presence of various fish species, Haggith Creek likely supports fish populations during various life stages at different times of the year. Known historic fish species occurrences are presented in Table 4.1 below.

Fraser River

The Fraser River in the vicinity of the Project Area is characterized as a productive deep run habitat with variable substrate and a straight channel pattern and ranges in width from 200 to 250 m. The river supports a variety of fish species through various life stages. Documented fish species occurrences in the Fraser River are presented in Table 4.1. The table lists those species identified in the vicinity of Prince George as identified in the BC Habitat Wizard (BC 2019a) database and does not represent all the species present in the Fraser River. It is anticipated that additional species are present in the river at this location during various life stages (e.g., rearing, migration, overwintering).

Table 4.1: Documented Fish Species Occurrences in Watercourses in or adjacent to the Project Area.

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Fraser River			
Chinook Salmon	*Oncorhynchus tshawytscha*	Yellow	Special Concern
Rainbow Trout	*Oncorhynchus mykiss*	Yellow	Not listed
Redside Shiner	*Richardsonius balteatus*	Yellow	Not listed
Peamouth Chub	*Mylocheilus caurinus*	Yellow	Not listed
Mountain Whitefish	*Prosopium williamsoni*	Yellow	Not listed
Largescale Sucker	*Catostomus macrocheilus*	Yellow	Not listed
White Sucker	*Catostomus commersonii*	Yellow	Not listed
Prickly Sculpin	*Cottus asper*	Yellow	Not listed
White Sturgeon	*Acipenser transmontanus*	Red	Endangered
Pygmy Whitefish	*Prosopium coulterii*	Yellow	Not at Risk
Northern Pikeminnow	*Ptychocheilus oregonensis*	Yellow	Not listed
Leopard Dace	*Rhinichthys falcatus*	Yellow	Not at Risk

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Haggith Creek			
Bull Trout	*Salvelinus confluentus*	Blue	Special Concern
Chinook Salmon	*Oncorhynchus tshawytscha*	Yellow	Special Concern
Northern Pikeminnow	*Ptychocheilus oregonensis*	Yellow	Not listed
Rainbow Trout	*Oncorhynchus mykiss*	Yellow	Not listed
Redside Shiner	*Richardsonius balteatus*	Yellow	Not listed

Notes:

1. Common names – BC Habitat Wizard (Government of BC, 2019)
2. Conservation status -

Source – BC Species and Ecosystem Explorer 2019

4.1.3 Terrestrial Environment

The Project Area is surrounded by the Fraser River to the west, mature mixed forest to the east, and industrial operations to the north and south. A large area where the Project facilities will be located has previously been cleared of vegetation.

The Project Area is located outside any active Wildlife Habitat Areas, Ungulate Winter Range, or Old Growth Management Areas (iMap BC, 2019). Furthermore, there is no critical habitat for federally protected terrestrial species at risk within or near the Project Area boundary (iMap BC, 2019).

Biogeoclimatic Zone and Ecoregion

The Project Area is located in the Sub-boreal Spruce (SBS) biogeoclimatic zone, between the moist hot (mh) subzone to the west and the moist cool 1 (mk) subzone to the east. In the SBS mh area, Douglas-fir (*Pseudotsuga menziesii*) and paper birch (*Betula papyrifera*) can be found with beaked hazelnut and thimbleberry making up the understorey. In contrast, in the SBS mk region, lodgepole pine and hybrid white spruce dominate the landscape, with wild sarsaparilla (*Aralia nudicaulis*), black huckleberry (*Gaylussacia baccata*), and bunchberry (*Cornus canadensis*) found in the understorey (Meidinger, Polar, & Harper, 1991).

Further, the Project Area is located in the southeastern area of the Nechako Lowland Ecosection, in the southern portion of the Fraser Basin Ecoregion, which lies within the Sub-boreal Ecoprovince. This is an area of flat to gently rolling lowland with evidence of glaciation, including eskers, drumlins and meltwater channels (Meidinger, Polar, & Harper, 1991).

Terrain and Soils

The Project Area is located directly adjacent to the Fraser River and is comprised predominantly of fluvial soils. Specifically, the soil series associated with this area is Fraser or McGregor (Dawson, 1998). Fraser soils are well or moderately well drained and are Othic Gray Luvisols, made up of silt loam or silty clay surface and subsurface soils (Dawson, 1998). McGregor soils are mainly Regosols, lacking soil development due to recent deposition, or Gleysolic soils in depressions and low-lying, poorly drained areas. They can be characterized by silt loam or sandy loam soil textures (Dawson, 1998).

Vegetation

Nearly 800 vascular plants are known to occur in the Prince George Forest District (BC E-Flora, 2018). Only 11 provincially listed at-risk species have the potential to occur in the Project Area (Table 4.2; (BC CDC, 2019)).

Table 4.2: At-risk Plant Species with Potential to Occur in the Project Area (BC CDC, 2019).

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
American Sweet-flag	*Acorus americanus*	Blue	Not listed
Sprengel's Sedge	*Carex sprengelii*	Blue	Not listed
-	*Meesia longiseta*	Blue	Not listed
-	*Myrinia pulvinata*	Red	Not listed
Pygmy Waterlily	*Nymphaea tetragona*	Blue	Not listed
Davis' Locoweed	*Oxytropis campestris* var. *davisii*	Blue	Not listed
Whitebark Pine	*Pinus albicaulis*	Blue	Endangered
-	*Pohlia elongata*	Blue	Not listed
-	*Rhodobryum roseum*	Blue	Not listed
-	*Sphagnum wulfianum*	Blue	Not listed
Short-flowered Evening Primrose	*Taraxia breviflora*	Red	Not listed

Terrestrial Wildlife

The Prince George Forest District has abundant and diverse wildlife. There is potential to find over 250 bird species nesting and migrating through the area and over 50 mammal species as well as 7 amphibians and reptiles using the area.

Birds

There is a diversity of bird species in the Prince George area. Known occurrences of species at risk include the BC red-listed American white pelican (*Pelecanus erythrorhynchos*) and the federally Threatened olive-sided flycatcher (*Contopus cooperi;* (BC CDC, 2019)). With over 250 birds found in the area, only the provincial and federal at-risk avian species with the potential to occur in the Project Area are listed in Table 4.3.

Table 4.3: At-risk Bird Species with Potential to Occur in the Project Area (BC CDC, 2019).

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
American Bittern	*Botaurus lentiginosus*	Blue	Not listed
American White Pelican	*Pelecanus erythrorhynchos*	Red	Not listed
Barn Swallow	*Hirundo rustica*	Blue	Threatened
Black Swift	*Cypseloides niger*	Blue	Not listed
Bobolink	*Dolichonyx oryzivorus*	Blue	Threatened
Broad-winged Hawk	*Buteo platypterus*	Blue	Not listed
Common Nighthawk	*Chordeiles minor*	Yellow	Threatened
Eared Grebe	*Podiceps nigricollis*	Blue	Not listed
Great Blue Heron, *herodias* subspecies	*Ardea herodias herodias*	Blue	Not listed
Long-billed Curlew	*Numenius americanus*	Blue	Special Concern
Northern Goshawk, *atricapillus* subspecies	*Accipiter gentilis atricapillus*	Blue	Not listed
Olive-sided Flycatcher	*Contopus cooperi*	Blue	Threatened
Rusty Blackbird	*Euphagus carolinus*	Blue	Special Concern

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Short-eared Owl	*Asio flammeus*	Blue	Special Concern
Sharp-tailed Grouse, *columbianus* subspecies	*Tympanuchus phasianellus columbianus*	Blue	Not listed
Winter Wren	*Troglodytes hiemalis*	Blue	Not listed

Mammal, Amphibians and Reptiles

Hunting is a popular recreational activity in the Prince George area due to the diversity of ungulates. In the Project Area, there is potential to come across mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), moose (*Alces americanus*) and elk (*Cervus elaphus*), as well as the provincially red-listed and federally Threatened southern mountain caribou (*Rangifer tarandus*). Table 4.4 lists the ungulates as well as the other mammals and their conservation status with the potential to occur in the Project Area (BC CDC, 2019).

Table 4.4: Mammal Species with The Potential To Occur In The Project Area (BC CDC, 2019).

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Mule Deer	*Odocoileus hemionus*	Yellow	Not listed
White-tailed Deer	*Odocoileus virginianus*	Yellow	Not listed
Moose	*Alces americanus*	Yellow	Not listed
Caribou	*Rangifer tarandus*	Red	Threatened
Elk	*Cervus elaphus*	Yellow	Not listed
Cougar	*Puma concolor*	Yellow	Not listed
Lynx	*Lynx canadensis*	Yellow	Not listed
Striped Skunk	*Mephitis mephitis*	Yellow	Not listed
American Marten	*Martes americana*	Yellow	Not listed
Fisher	*Pekania pennanti*	Blue	Not listed
Least Weasel	*Mustela nivalis*	Yellow	Not listed
Short-tailed Weasel	*Mustela erminea*	Yellow	Not listed
Long-tailed Weasel	*Mustela frenata*	Yellow	Not listed
American Mink	*Neovison vison*	Yellow	Not listed
Northern River Otter	*Lontra canadensis*	Yellow	Not listed

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Wolverine	*Gulo gulo*	Blue	Special Concern
Black Bear	*Ursus americanus*	Yellow	Not listed
Grizzly Bear	*Ursus arctos*	Blue	Special Concern
Coyote	*Canis latrans*	Yellow	Not listed
Grey Wolf	*Canis lupus*	Yellow	Not listed
Red Fox	*Vulpes vulpes*	Yellow	Not listed
Common Raccoon	*Procyon lotor*	Yellow	Not listed
Meadow Jumping Mouse	*Zapus hudsonius*	Yellow	Not listed
Western Jumping Mouse	*Zapus princeps*	Yellow	Not listed
Bushy-tailed Woodrat	*Neotoma cinerea*	Yellow	Not listed
House Mouse	*Mus musculus*	Yellow	Not listed
Deer Mouse	*Peromyscus maniculatus*	Yellow	Not listed
Southern Red-backed Vole	*Myodes gapperi*	Yellow	Not listed
Western Heather Vole	*Phenacomys intermedius*	Yellow	Not listed
Meadow Vole	*Microtus pennsylvanicus*	Yellow	Not listed
Long-tailed Vole	*Microtus longicaudus*	Yellow	Not listed
Northern Bog Lemming	*Synaptomys borealis*	Yellow	Not listed
Muskrat	*Ondatra zibethicus*	Yellow	Not listed
Yellow Pine Chipmunk	*Neotamias amoenus*	Yellow	Not listed
Masked Shrew	*Sorex cinereus*	Yellow	Not listed
Dusky Shrew	*Sorex obscurus*	Yellow	Not listed
Western Water Shrew	*Sorex navigator*	Yellow	Not listed
Woodchuck	*Marmota monax*	Yellow	Not listed
Hoary Marmot	*Marmota caligata*	Yellow	Not listed
Yellow-bellied Marmot	*Marmota flaviventris*	Yellow	Not listed
Columbian Ground Squirrel	*Urocitellus columbianus*	Yellow	Not listed
Red Squirrel	*Tamiasciurus hudsonicus*	Yellow	Not listed
Northern Flying Squirrel	*Glaucomys sabrinus*	Yellow	Not listed
Porcupine	*Erethizon dorsatum*	Yellow	Not listed
Beaver	*Castor canadensis*	Yellow	Not listed
Mountain Beaver	*Aplodontia rufa*	Yellow	Special Concern
Snowshoe Hare	*Lepus americanus*	Yellow	Not listed
Long-eared Bat	*Myotis evotis*	Yellow	Not listed
Little Brown Bat	*Myotis lucifugus*	Yellow	Endangered
Silver-haired Bat	*Lasionycteris noctivagans*	Yellow	Not listed
Big Brown Bat	*Eptesicus fuscus*	Yellow	Not listed

There are 7 species of herptiles (amphibian and reptiles) that could potentially occur in the Project Area, including western toad, which is listed federally as being of Special Concern. Table 4.5 lists the herptiles potentially found in the Project Area (BC CDC, 2019).

Table 4.5: Amphibian and Reptile Species with the Potential to Occur in The Project Area (BC CDC, 2019).

Common Name	Scientific Name	Provincial Conservation Status	Federal Conservation Status
Western Toad	*Anaxyrus boreas*	Yellow	Special Concern
Columbian Spotted Frog	*Rana luteiventris*	Yellow	Not listed
Pacific Tree (Chorus) Frog	*Pseudacris regilla*	Yellow	Not listed
Wood Frog	*Lithobates sylvaticus*	Yellow	Not listed
Western Long-toed Salamander	*Ambystoma macrodactylum*	Yellow	Not listed
Common Garter Snake	*Thamnophis sirtalis*	Yellow	Not listed
Western Terrestrial Garter Snake	*Thamnophis elegans*	Yellow	Not listed

4.2 Social, Economic, Health and Heritage Setting

4.2.1 Social Setting

The City of Prince George is the largest city in northern BC, with a population of 74,003 at the time of the 2016 census. As of 2016, the City's population had grown by 2.8% in 5 years (since the 2011 census; (Statistics Canada, 2017)). With a median age of 38.4, Prince George has a relatively young population, compared to the provincial median age of 43.0. Within the population, approximately 15.1% self-identify as Aboriginal and 52.6% are female (Statistics Canada, 2017).

Prince George's profile in the region is heightened by its 2 post-secondary educational facilities, namely CNC and UNBC, which together have over 8,000 students enrolled (UNBC, 2019). The City has several health care facilities, including the University Hospital of Northern British Columbia, which is the largest healthcare facility in northern BC (UNBC, 2019).

The Regional District of Fraser-Fort George (RDFFG) is located in the central interior region of BC and comprises 4 municipalities and 7 electoral areas (RDFFG, n.d.). It was incorporated as regional district on March 8, 1967, to

provide its rural residents with joint and shared services and coordinated administrative and government services at a time when the region was experiencing rapid growth due to the booming forestry and resource industries (RDFFG, n.d.). Currently RDFFG is providing more than 90 local government services to a population of approximately 94,500 (2016 census data), including emergency response, waste management, fire protection and land use planning services (Statistics Canada, 2017).

Indigenous communities (First Nation reserves) and the Traditional Territories of the Lheidli T'enneh First Nation and Nazko First Nation are shown on Figure 4.2.

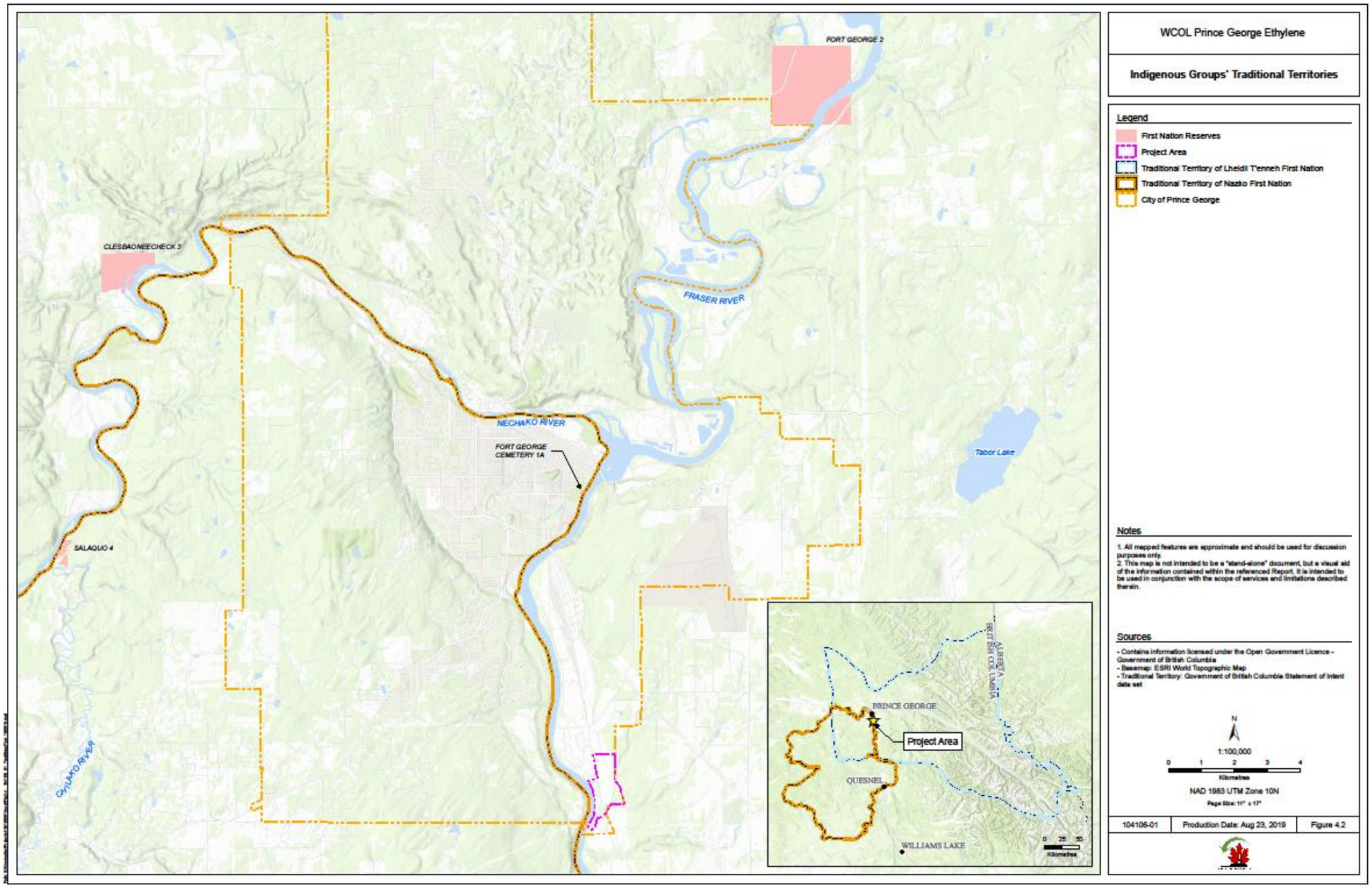

Figure 4.2: Repeat of Indigenous Groups.

The Lheidli T'enneh First Nation is of the Dakelh people. Lheidli T'enneh means "the people from confluence of 2 rivers" (BCAFN, 2019). As of July 2019, the Lheidli T'enneh First Nation had a registered population of 454 of which 49.8% were female. Within the registered population, 21.6% live on a Lheidli T'enneh First Nation Reserve (INAC, 2019).

The Nazko First Nation is also of the Dakelh people with a registered population of 405 as of July 2019, of which 48.9% were female. Within the registered population, 28.1% live on a Nazko First Nation Reserve (INAC, Registered Population: Nazko First Nation, 2019).

4.2.2 Land and Water Use

Current use of lands and resources for traditional purposes as well as non-traditional land and water use in the vicinity of the Project Area are described in this section.

Information on Traditional Use presented in this section has been obtained from publicly available sources.

Lheidli T'enneh First Nation Traditional Land Use

The Lheidli T'enneh First Nation lived in seasonal camps near the Nechako and Fraser Rivers and throughout their Traditional Territory prior to first contact and up to the early 1900s. The Traditional Territory was used seasonally for hunting, fishing, trapping and resource gathering, including fishing for salmon and other fish in the spring and summer and hunting in the mountains in the fall. The locations of the seasonal camps or resource harvesting activities were dependent on ecological and seasonal shifts such as species migratory movements and species abundance (e.g., salmon runs), and changes in water levels (Lheidli T'enneh Lands Authority, 2017).

Lheidli T'enneh Cemetery IR #1A (Ts'unk'ut) is in the City of Prince George and is located approximately 8 km north of the Project Area. Members of the Lheidli T'enneh First Nation continue to use the cemetery as a burial ground for their people (Lheidli T'enneh Lands Authority, 2017).

Nazko First Nation Traditional Land Use

The Traditional Territory of the Nazko First Nation extends from Quesnel to Prince George and was used for hunting, fishing, trapping and resource gathering (BC Treaty Commission, 2019). Traditional Uses included fishing in various lakes, cambium harvesting in the pine forests, and utilizing footpaths to trade and travel (Nazko First Nation, n.d.). Nazko First Nation members continue to actively fish, hunt and trap in their Traditional Territory for such species as moose and kokanee (ERM 2015).

Non-traditional Land and Water Use

The Project Area is situated in a developed industrial park within the Prince George BCR Industrial Area. Large portions of the Project Area have been previously cleared of vegetation from former land uses. The northern section of the Project Area was previously used as a log storage yard and later as a gravel pit.

No timber harvesting rights (e.g., Timber Licence, Licence to Cut, Special Use Permit) are actively held in or adjacent to the Project Area (iMap BC, 2019).

There are no federal or provincial designated parks or protected areas in or adjacent to the Project Area. The nearest provincial parks are Fort George Canyon Park, located approximately 14 km to the south, and West Lake Park, located approximately 12 km southwest of the Project Area (iMap BC, 2019).

An area directly adjacent to the northwestern boundary of the Project Area on the west side of Willow Cale Road is designated as an Open Space based on City of Prince George Green Belt classification (City of Prince George, 2011). Open Spaces are considered recreational areas in the City of Prince George OCP guidelines. Refer to Section 3.5 for additional information on the City of Prince George OCP.

The nearest City-designated recreational trail is located approximately 1 km north of the Project Area. Based on the City of Prince George's Active Transportation Plan, shared bike lanes exist on many of the roads surrounding the Project Area, including Sinnich Road and Penn Road. None of these roads extend into the Project Area.

The Fraser River supports a variety of fish species that can be harvested for commercial or recreational purposes, including salmonids. The Project Area partially overlaps with one Guide Outfitter Licence area (No. 700617; (iMap BC, 2019)). The river is also navigable by passenger and fishing vessels as well as recreational crafts such as kayaks or canoes. There are no boat launch locations adjacent to or near the Project Area.

4.2.3 Economic Setting

Historically, the economy in and around Prince George was based on fur trading, agriculture, and commercial trading. The city emerged as an important transportation hub with the arrival of the Grand Trunk Pacific Railway (now CN Rail) in 1914 (City of Prince George, 2017). The relative importance of these resource industries has changed over the years, but Prince George has established itself as one of the more well-diversified communities in northern BC and continues to serve as an important transportation hub through its highways and railways connecting regional businesses, resources (e.g., minerals and mines, forest products) and agricultural products to national and international markets (City of Prince George, 2017), (City of Prince George, 2017).

A considerable percentage of the labour force population works in service- and transportation-related employment sectors, with 24.7% of total labour force population aged 15 years and over in sales and services occupations and 18.5% in trades, transport, and equipment operators and related occupations in 2016 (Statistics Canada, 2017). Approximately 5.2% and 3.0% of the labour force population work in the natural and applied sciences and the natural resources, agriculture and related production sectors, respectively. The unemployment rate in 2016 was 9.3%, compared to 6.7% in BC overall; however, the prevalence of low-income earners in Prince George was 13.3%, lower than the provincial average of 15.5%. In 2015, the median total income of households in Prince George was $75,690, compared to the Canadian median of 70,336 (Statistics Canada, 2017).

Economic activities of the Lheidli T'enneh First Nation and the Nazko First Nation include resource-based activities such as timber harvesting and natural resource management. The Lheidli T'enneh First Nation has several economic development initiatives that include a timber harvesting company in joint venture with Roga Contracting Ltd. and fisheries management with Fisheries and Oceans Canada (Lheidli T'enneh, n.d.). The Nazko Economic Development Corporation works for the Nazko First Nation through the Chief and Council and oversees the operation of Nazko Logging Limited Partnership, Besikoh Fuel LP and Blackwater Camp Services (NEDC, 2019).

4.2.4 Health Setting

The Project Area is located in the Prince George Local Health Area (LHA), which is 1 of the 4 Northern Interior Health Service Delivery Areas, with approximately 76.4% of the Prince George LHA population living in the City of Prince George (Northern Health, 2016).

Environmental Quality

Current conditions related to air quality, noise and surface water quality are described in Sections 4.1.1 and 4.1.2.

Although the Project Area is currently untenanted, there are several land-based air emission and noise emission sources in proximity with commercial and industrial manufacturing, storage and distribution facilities to the north and south. Based on the past and current use of the lands in and around the Project Area, there is potential for the soil to contain contaminants of concern. Soil quality will be investigated as part of the Project's baseline study program.

The potential for contaminants of concern in surface water, soils and sediments will be investigated as part of a Human Health Risk Assessment undertaken for the Project. This risk assessment will characterize exposure potential by human receptors to all chemical and physical stressors based on measured (baseline) and predicted future concentrations or levels for the nearby population.

Social Determinants of Health

Social determinants of health include income, education, adequate housing, food security, early childhood development and many other factors. The 2012 socio-economic indices available for the Prince George LHA indicate that health outcomes (e.g., health problems, human economic hardship) in the region are generally lower than the BC average (Government of BC, 2013). The LHA also has a higher percentage of the population on income assistance than the provincial average. While the area has seen a significant reduction in serious violent and property crimes since 2006, the LHA's rate is still higher than the provincial average. For example, the total serious crime rate for the LHA was 14.2 per 1,000 in population in 2012 compared to the provincial average rate of 11.1 (Government of BC, 2013).

In 2015, the City had a lower average total income of $60,000 for its lone-parent economic families compared to the BC average of $63,004. However, low-income seniors are less prevalent in Prince George compared to the provincial average (Statistics Canada, 2016).

At the time of the 2016 survey, fewer adults in Prince George had completed post-secondary education than the provincial average (Statistics Canada, 2016).

Housing indicators, such as dwellings in need of major repairs and housing affordability, are a gauge of living conditions and community health and well-being. Dwellings in need of major repairs totalled approximately 7.9% in Prince George, contrasting with a 6.7% average across BC (Statistics Canada, 2016).

Child and youth health is critical to the overall health and well-being of a community. The vulnerability of young children in terms of social, physical, emotional, language and communication development was generally higher in the Prince George LHA compared to BC overall. Similarly, higher than provincial average percentage of children and youth were perceived to be at risk (Government of BC, 2013).

4.2.5 Heritage Setting

Heritage resources are protected under provincial and municipal legislation. The City of Prince George has a heritage register that lists 13 heritage sites within its jurisdiction. The register includes a Statement of Significance for each heritage site outlining its historical significance and heritage value. None of the registered heritage sites are located within or adjacent to the Project Area, with the nearest located approximately 7 km north of the Project Area (City of Prince George, 2017). In addition, the nearest archaeological potential area is more than 2 km north of the Project Area (City of Prince George, 2011).

The provincial archaeological database (Remote Access to Archaeological Data; RAAD) indicates no registered archaeological sites in the Project Area, with the nearest being approximately 500 m away on the west side of the Fraser River

(site ID FkRq-1). No archaeological studies (e.g., Archaeological Overview Assessment) have been registered for the Project Area (RAAD, 2019).

4.3 Potential Environmental Effects

To support BC EAO in determining the need for and potential scope of a provincial EA, a summary of the potential environmental, economic, social, heritage and health effects of the Project has been prepared based on general knowledge of the Project and the existing natural and human environment.

The construction and operation of the Project will alter the physical environment at and around the Project Area. Construction activities are anticipated to disturb vegetation, soils and existing ecological processes. Although subject to the final layout of the Project footprint, there is also potential for construction and operation activities to affect nearby surface watercourses. Atmospheric emissions and noise generated by the Project activities will alter the visual and noise conditions at or some distance from the Project Area. Accidents or malfunctions could alter the quality of air, soil and surface water. These changes in the physical environment may result in potential environmental, social, economic, heritage or health effects. Potential adverse effects (prior to the application of mitigation measures) are summarized in Table 4.6 along with the Project-related activities that may potentially cause these effects.

Because the Project is located approximately 180 km from the Alberta border, approximately 700 km from the Yukon border and approximately 500 km from the Canada-USA border (Alaska), no adverse environmental effects outside the province of BC are anticipated. Neither the legislation of other provinces nor inter-provincial/cross-border legislation is triggered by the Project. The scope of anticipated environmental effects is confined to the province of BC and the Project areas identified in this document.

Residual adverse effects associated with the Project have the potential to interact with the residual adverse effects from other past, present and reasonably foreseeable projects and activities leading to cumulative effects. As such, and in compliance with provincial guidelines and guided by industry standard guidance such as those from the Canadian Environmental Assessment Agency (CEAA, 2015) and (CEAA, 2017), a cumulative effects assessment will be conducted for the Project and presented in the Application. Types of developments and activities with the potential to interact cumulatively with the Project include:

- Past and current developments and activities at and near the Project Area
- Industrial, commercial and urban land development in Prince George and the RDFFG
- Commercial and recreational use of the Project Area and its surrounding environment, including the Fraser River

Given the current stage of development, knowledge of the Project's potential for generating residual effects is preliminary and therefore a fulsome understanding of cumulative effects is not possible. However, based on current knowledge of the Project's interactions and such residual effects of other projects and activities in the area, the following cumulative

interactions will, at a minimum, be investigated during scoping for the Project's cumulative effects assessment:

1. Air emissions (type and quantity) as they relate to other industrial emissions in the regional airshed.
2. Water extraction as it relates to the quantity of water available after consideration for other uses such as domestic and industrial. Metrics will likely include consideration for fish and fish habitat as well as human consumption.
3. Noise as it relates to published thresholds for industrial areas (i.e., OGC policy), taking into consideration the existing conditions in the Project Area.
4. Construction period effects such as the influx of workers and transportation needs that interact with the demands on infrastructure and public services as a result of other projects and activities.

Table 4.6: Potential Project-related Effects.

Component	Key Project Activities	Potential Adverse Project Effect
Environment		
Fish and Fish Habitat	• **Construction**: potential removal and displacement of aquatic vegetation, elevated surface erosion and runoff, disturbance of substrates and riparian vegetation and other habitat features during clearing and construction of access roads, construction of intake and outfall infrastructure and construction of stream crossings. • **Operations:** temporary disruption of habitat during maintenance and clearing activities associated with intake operations (e.g., backflushing, intake maintenance, clearing of rafted debris); deleterious releases into receiving waterbodies as a result of spills and upset conditions during normal operations. • **Decommissioning**: potential removal and displacement of aquatic vegetation, substrates, riparian vegetation and other habitat features during the removal and decommissioning of access roads, the intake and outfall infrastructure and any stream crossings.	• Loss of fish habitat during construction of the water intake and outfall structures. • Loss or degradation of aquatic habitat due to changes in water quality or nuisance effects resulting from noise generation by the Project. • Disturbance of fish life-stage activities (e.g. rearing, migration) during maintenance activities. • Fish entrainment related to operation of the intake structure on the Fraser River. • Increased surface erosion and runoff as a result of site clearing for construction and operations activities.

Component	Key Project Activities	Potential Adverse Project Effect
Groundwater	• **Construction**: Potential introduction of contaminants into shallow aquifers as a result of surface spills during establishment of wells. • **Operations:** Potential introduction of contaminants into shallow aquifers as a result of surface spills during operations on the site of wells. Potential impacts on surface water discharge levels as a result of groundwater extraction flow rates. Potential impact on adjacent licenced users ability to draw water based on hydraulic connectivity. • **Decommissioning**: Potential introduction of contaminants into shallow aquifers as a result of surface spills during decommissioning activities.	• Shallow aquifers can to be unconfined and thus may have limited protection from surface activities such as potential contaminant discharge (i.e., spills) that may adversely affect water quality. • Shallow aquifers can be subject to seasonal discharge/recharge effects and the addition of new wells in the area may have a detrimental effect on existing approved licence holders in the area. • Based on the hydrologic connectivity of the aquifer, groundwater extraction can influence levels in nearby surface watercourses based on withdrawal rates.
Terrestrial Vegetation (including riparian)	• **Construction**: Potential clearing and grubbing of areas not already cleared for industrial activity; potential grading when required for Project infrastructure; construction of buildings, laydown areas, and waste disposal and recycling facilities in accordance with applicable legislation; potential rehabilitation and stabilization of areas not required for the operation phase. • **Operation**: Planned and unplanned maintenance. • **Decommissioning**: Decommissioning Project components that contain hazardous waste and other chemicals.	• Permanent changes in available habitat may occur. • Habitat may be lost from construction and decommissioning of infrastructure. • Mortality associated with Project construction. • Proliferation of non-native and invasive species may reduce biodiversity and reduce habitat quality. • Changes in air, soil, or water quality may damage vegetation and degrade or reduce available habitat.

Component	Key Project Activities	Potential Adverse Project Effect
Terrestrial Wildlife	• **Construction**: Potential clearing and grubbing of areas not already cleared for industrial activity; potential grading when required for Project infrastructure; construction of buildings, laydown areas and waste disposal and recycling facilities in accordance with applicable legislation; potential rehabilitation and stabilization of areas not required for the operation phase. • **Operation**: Planned and unplanned maintenance. • **Decommissioning**: Decommissioning project components that contain hazardous waste and other chemicals.	• Loss or degradation of terrestrial habitat may occur due to changes in vegetation soil, water quality and air quality, or to nuisance effects resulting from noise generation by the Project. • Changes in movement patterns of wildlife may occur due to displacement by Project activities. • Injury or mortality to wildlife, may result from land clearing activities and from traffic associated Project infrastructure. • Indirect loss of habitat and potential habitat may occur due to sensory disturbance and change in behaviour associated with construction and operation activities, including noise, light, air emissions and human presence. • Barriers to movement may be created.

Component	Key Project Activities	Potential Adverse Project Effect
Economic		
Local and Regional Economy	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	• Direct and indirect Project demands for goods and services may influence the availability of goods and services at a local level. • Potential disruption of local businesses (e.g., increased road traffic near the Project Area).
Labour Market	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	• Project employment may result in changes to the local regional labour market. • Project employment may result in changes in local annual wage and salary levels as well as labour income.
Social		
Infrastructure and Services	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	• Project employment may result in temporary and permanent in-migration of workers, which could increase the demand for supporting social and health infrastructure, services and housing. • Increased road traffic may result in degradation of major roads in the area.

Component	Key Project Activities	Potential Adverse Project Effect
Current Use of Lands and Resources for Traditional Purposes	• **Construction**: Potential clearing and grubbing of areas not already cleared for industrial activity; potential grading when required for project infrastructure; construction of administrative buildings, laydown areas and waste disposal and recycling facilities in accordance with applicable legislation; potential rehabilitation and stabilization of areas not required for the operation phase. • **Operation**: All operation activities. • **Decommissioning:** Decommissioning project components that contain hazardous waste and other chemicals.	• Access to lands, waters and resources currently used for traditional purposes may be affected or disrupted. • The quality and quantity of the resources currently used for traditional purposes may be affected or reduced (e.g., from site clearing, increased road traffic). • The quality of the current use experience may be affected due to nuisance effects (e.g., noise, light) or changes in air quality. • The ability to transfer Indigenous knowledge and fulfill the cultural purpose of current use activities may be affected.
Land, Water, and Resource Use (including recreational and commercial uses)	• **Construction**: Potential clearing and grubbing of areas not already cleared for industrial activity; potential grading when required for Project infrastructure; construction of buildings, laydown areas, and waste disposal and recycling facilities in accordance with applicable legislation; potential rehabilitation and stabilization of areas not required for the operation phase. • **Operation:** All operation activities. • **Decommissioning**: Decommissioning project components that contain hazardous waste and other chemicals.	• Access to land, water and resources use at or adjacent to the Project Area may be affected. • Use of land, water and resources at or adjacent to the Project Area may be affected by potential changes in air quality, increases in road traffic, changes in the distribution, abundance or quality of resources (e.g., plants or other animals) and nuisance effects (e.g., noise, light).

Component	Key Project Activities	Potential Adverse Project Effect
Community Health and Well-being	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	• The influx of workers to the local communities surrounding the Project Area may result in adverse effects on vulnerable sub-populations, such as children and youth, seniors, and low-income families. Adverse effects may include: ▫Increased risk of communicable and non-communicable diseases ▫Increased drug and alcohol use ▫Increased crime ▫Adverse effects on mental health and wellness ▫Change in accidents and injuries ▫Increased pressure on health services structure and capacity ▫Adverse effects on community quality of life
Visual Quality	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	Physical changes to the site may affect the visual quality at the proposed site and surrounding area; however, the Project Area is already heavily industrialized.

Component	Key Project Activities	Potential Adverse Project Effect
Heritage		
Archaeological and Heritage Resources	• **Construction**: Potential clearing and grubbing of areas not already cleared for industrial activity; potential grading when required for project infrastructure; construction of buildings, laydown areas and waste disposal and recycling facilities in accordance with applicable legislation; potential rehabilitation and stabilization of areas not required for the operation phase. • **Operation**: Planned and unplanned maintenance. • **Decommissioning**: All decommissioning activities.	• Loss of or damage to archaeological and heritage resources (including contextual information) may occur due to ground disturbance or clearing associated with the Project.
Health		
Human Health	• **Construction**: All construction activities. • **Operation**: All operation activities. • **Decommissioning**: All decommissioning activities.	• Changes in air, water or soil quality may result in changes in health risks to individuals exposed to those media. • Changes in ambient noise conditions may result in direct and indirect changes to human health. • Changes in air, water or soil quality that alter the quality of country foods (both plants and animals) may affect the health of individuals who consume them.

4.4 Measures to Prevent or Reduce Potential Effects

Based on preliminary identification of potential Project-related adverse effects summarized above, initial measures to prevent or reduce these effects to an acceptable level have been incorporated or are currently being considered in the design of the Project. These include siting the facilities away from residential areas in an existing disturbed industrial area that has been partially cleared from previous operations. Additional design considerations include: sourcing the facilities' energy needs from the BC Hydro grid; using a low-carbon, clean-burning mixture of methane and hydrogen as a main fuel source for fired equipment; recovering heat from the Pyrolysis Furnaces to supply other Project processes; and investigating the supply of low-grade waste heat to a greenhouse operation. Additional design considerations are to be considered as much as possible. As the design of the Project continues to progress, additional measures to mitigate potential effects will be incorporated based on compliance with:

- Applicable federal and provincial legislations and regulations (e.g., *Fisheries Act*, *Environmental Management Act, Wildlife Act*).
- WCOL will follow applicable Canadian engineering codes and standards from organizations such as the Canadian Standards Association and Technical Safety BC. WCOL will reference and utilize codes, standards and recommended practices as appropriate from industry recognized organizations such as the National Fire Protection Association, American Society of Mechanical Engineers, American Petroleum Institute and the International Society of Automation.
- Best management practices (e.g., BC Noise Control Best Practices Guideline (BC OGC, 2009); Guidelines for Raptor Conservation during Urban and Rural Land Development in BC (Government of BC, 2013)).
- Future project management plans to be developed for the Project (e.g., Emergency Response Plan, Security Management Plan, Environmental Management Plans, Workforce Management Strategy).
- Project-specific measures identified during the EA process, the engagement and consultation processes, and permitting.

To confirm the effects of the Project and the effectiveness of the applied mitigation, WCOL will develop and implement monitoring programs during the construction and operation phases of the Project. Monitoring programs may include specifics for:

- Air quality
- Noise
- Freshwater fish and other aquatic life
- Terrestrial wildlife
- Discharges to air, water and land
- Cultural and heritage sites

The above list is not exhaustive and will be refined throughout the EA process.

5 Engagement and Consultation

WCOL is a strong advocate for the importance of engagement with local community when executing a major new project; WCOL Project team members have been meeting with local First Nations, different levels of government, various community institutions and members of the community throughout 2019. This section summarizes WCOL's approach to community engagement and consultation related to the Ethylene Project, and in this section, we summarize past and future engagement and consultation activities with Indigenous groups, regulators, government, the public and other potential stakeholders.

5.1 Indigenous Engagement

WCOL initiated early discussions with the Lheidli T'enneh First Nation on February 4 and 5, 2019; these discussions reflect WCOL's early commitment to this relationship. Since that introductory meeting, WCOL has continued to work with Lheidli T'enneh to develop a relationship, familiarize Lheidli T'enneh with the project, understand the Lheidli T'enneh First Nation's concerns and ambitions and socialize the project within the Lheidli T'enneh community. Following is a summary of key meetings and milestones to date:

Table 5.1: Engagements with Lheidli T'enneh.

Engagements with Lheidli T'enneh	
February 4–5, 2019	Meeting with Rena Zatorsky to introduce WCOL
March 28, 2019	Prince George Contractors Workshop #1 attended by Rena Zatorsky
April 10, 2019	Clayton Pountney elected Chief of Lheidli T'enneh First Nation for 2-year term
April 30, 2019	Introductory meeting with Chief Pountney and Council
June 19, 2019	Meeting with Chief Pountney and Rena Zatorsky
June 25, 2019	Non-disclosure Agreement signed between WCOL and Lheidli T'enneh
July 9, 2019	Meeting of WCOL and Mayor Hall with Lheidli T'enneh Chief and Council
July 10, 2019	Meeting with WCOL and Lheidli T'enneh Economic Development Team (Rena Zatorsky, Helen Buzas, Dolleen Logan and Scott Smith (the latter from Gowlings law firm)) to discuss Project scope and regulatory path forward
July 13, 2019	Presentation to Lheidli T'enneh community at their annual awards event

August 7, 2019	Public Open House held at Lheidli T'enneh First Nation's House of Ancestors
August 8, 2019	Draft Project Description forwarded to Lheidli T'enneh at the same time it was sent to EAO
September 11, 2019	Lheidli T'enneh provides WCOL with comments on Project Description

The discussions have evolved over the past several months, and we are now entering into formal negotiations.

The WCOL Project team has identified one other Indigenous group as potentially being affected by aspects of the Project, namely the Nazko First Nation. WCOL has contacted the Nazko First Nation and forwarded the copy of this Project Description to them.

WCOL will continue to collect feedback from the Lheidli T'enneh First Nation and other Indigenous groups through consultation and engagement processes throughout the regulatory application and review process. Based on early feedback, the following have already been identified as potential areas of interest and/or impact:

- Interests and concerns related to potential impacts on the Fraser River and its salmon fishery.
- Local area airshed concerns related to potential impacts on human health and especially, but not limited to, particulate matter ($PM_{2.5}$) and sulphur emissions.
- Concerns related to safety of the facility operation and management of potential accidents and malfunctions.
- Interest in participating in long-term economic benefits, such as investment in an equity position with the project and other opportunities.
- Interest in business and contracting opportunities related to the Project.
- Interest in employment, training and education programs related to the Project.
- Interest in participating in the EA process and other regulatory processes in a collaborative manner.
- A desire to identify areas of interest to be studied as part of the regulatory processes and participate in selection of qualified consultants or experts to study and assess these areas.

WCOL intends to continue to engage Indigenous groups to share Project information and work collaboratively with these groups to identify interests and concerns and identify approaches to mitigate potential adverse effects of the Project. These objectives will be achieved through timely communication of Project progress to the identified Indigenous community Project liaison; opportunities within the regulatory process to collect feedback, such as during Valued Components Selection and when preparing the submission in response to draft Application Information Requirements; general Project updates; and additional Indigenous community Project information-sharing sessions and participation in community events as may be requested by Indigenous groups.

WCOL understands that the Section 11 Order will identify and delegate procedural aspects of consultation to WCOL, specific to the EA process. Activities conducted following the Section 11 Order will follow the Indigenous Consultation Plan, which will be developed in alignment with the requirements outlined in the Section 11 Order.

5.2 Engagement with Stakeholders

This section summarizes the WCOL Project team's approach to engaging and consulting with local stakeholders, including local businesses and associations, other interested parties and various levels of government and describes WCOL's engagement efforts to date.

WCOL has worked with local community leaders to develop a preliminary list of stakeholders and community organizations that may have an interest in the Project and related facilities. This list will continue to be expanded and developed as WCOL continues to meet with members of the community to discuss the Project.

Table 5.2: Identification of Stakeholders.

Identification of Stakeholders
Local, Provincial and Federal Governments
City of Prince George
Local Members of the Legislative Assembly
Local Members of Parliament
Regional District of Fraser-Fort George
Community Organizations
University of Northern British Columbia (UNBC)
College of New Caledonia (CNC)
Northern Health
Prince George Airport Authority
Prince George Naturalists
Prince George Running Club
People's Action Committee for Healthy Air (PACHA)
Prince George Airshed (PG Air)
Northern Development Initiative Trust (NDIT)
Prince George Chamber of Commerce
Community Futures
Innovative Central Society

Identification of Stakeholders
Aboriginal Business Development Center
IMSS Immigrant and Multicultural Services Society
Independent Contractors and Business Association (ICBA)
Northern Regional Construction Association (NRCA)
Recycling and Environmental Action Planning Society (REAPS)
Rotary Club of Prince George
Kiwanis Prince George
University Hospital of Northern Prince George (UHNBC)
Community Associations (Blackburn, College Heights, Crescents, Hart, South Bowl, West Bowl)
Tourism Prince George
School District 57 (Prince George)
Spruce City Wildlife Association (SPWA)
British Columbia Employment Standards
Emergency Services
Prince George Fire Rescue
British Columbia Ambulance Service
Prince George RCMP
British Columbia Emergency Health Services (BCEHS)
St. John Ambulance
Fisheries
Freshwater Fisheries Society of BC
Canada Fisheries and Ocean

5.2.1 Engagement Activities to Date

WCOL initiated engagements with stakeholders and community organizations in February 2019. The primary purpose of the engagements to date has been to introduce the scope and execution strategy of the proposed Project and to gauge the general level of support and also the potential areas of concern within the community. During these engagements, WCOL has introduced stakeholders to the full scope of the Project and its associated facilities and businesses (see Section 1). Stakeholders whom WCOL has engaged to date on the Project are listed in Table 5.3 together with a summary of the engagement activity.

Table 5.3: Stakeholder Engagement.

Stakeholder	Date	Activity
City of Prince George	4-Feb-19 and subsequently	Presentation to Mayor and staff to introduce information related to the Project. Multiple follow-up meetings with City staff.
Northern Development Initiative Trust	5-Feb-19	Presentation to Northern Development Initiative Trust leadership to introduce information related to the Project.
Prince George Local Contractors	28-Mar-19	Afternoon workshop with over 20 local fabrication and construction contractors. Presentation to introduce information related to the Project, followed by informal question & answer and one-on-one discussions. This kicked off the process to solicit local contractor capability through a Request for Information (RFI) process.
CN Rail	11-Apr-19	Teleconference call with Western Canada leaders and managers to introduce the Project and solicit input on prospective locations and product movements.
Prince George Local Contractors	April and May 2019	Request for Information issued and responses received from over 40 local contractors on their capabilities relative to the Project scope. Information is being used as the basis for forming construction execution plan.
Prince George Local Contractors	29-Apr-19	Afternoon workshop with close to 40 local fabrication and construction Contractors. Presentation made to propose execution strategy and share early results of RFI process. Followed by informal question-and-answer session and one-on-one discussions.
CN Rail	30-Apr-19	Met with local Prince George leadership to review site location and feasibility of moving product by rail movement.
City of Prince George	24-June-19	Presentation to City Council to introduce information related to the Project.
College of New Caledonia	25-Jul-19	Met with College leadership to discuss the current education programs available and the types of skills and long-term employment required to support the Project.
Northern Development Initiative Trust	7-Aug-19	Follow-up meeting on strategy to develop and increase the capacity of local Prince George contractors to support fabrication and construction of facilities for the Project.
Prince George Airport Authority	7-Aug-19	Met with Board members and leadership to introduce the Project.

Stakeholder	Date	Activity
People's Action Committee for Healthy Air	7-Aug-19	Met with air quality advocates from the local community to introduce the Project and collect early input on areas of interest related to the Project and related facilities.
Prince George Public Open House	7-Aug-19	Two open events were held for open public participation. Presentation to introduce information related to the Project followed by an open question-and-answer session.
Prince George Naturalists	8-Aug-19	Met with local members of the naturalist group responsible for trail and park development in the area to introduce information related to the Project and collect feedback on potential areas of interest related to the Project.
Northern Regional Construction Association	8-Aug-19	Met with local membership to introduce information related to the Project, discuss their interest in potential opportunities for local members and collect feedback on potential areas of interest related to the Project.
Independent Contractors and Businesses Association	8-Aug-19	Met with local membership to introduce information related to the Project, discuss their interest in potential opportunities for local members and collect feedback on potential areas of interest related to the Project.
Economic Development Introduction	8-Aug-19	Met with representatives of local economic development organizations, including Community Futures, City of Prince George, Innovation Central Society, Aboriginal Business Development Centere, Northern Development Initiative Trust, Prince George Chamber of Commerce and IMSS Immigrant and Multicultural Services Society to introduce information related to the Project.

WCOL has also completed a significant engagement process with local suppliers, fabricators and constructors ("contractors") to introduce them to the construction efforts and long-term plant maintenance and sustaining capital requirements of the Project. These early engagements are required to identify the current capabilities of the local contracting community and also to determine where investment is required to expand these capabilities to effectively support the Project. WCOL is committed to efficiently maximizing local contractor capabilities during the construction phase of the Project to achieve a competitive capital cost for the Project and related facilities while also benefiting the local economy. This engagement process has consisted of a series of group presentations (see Table 5.3) and one-on-one meetings with over 40 additional contractor companies not listed in Table 5.3.

Key Areas of Interest

Through these early engagements with stakeholders and community organizations, WCOL has identified early areas of interest related to the Project:

- Support for the economic diversification in interior BC and the long-term employment opportunities during the operations phase of the Project, especially in light of the recent downturn in the forestry sector.
- Support for the local job creation and economic boost related to the proposed WCOL execution strategy and the maximization of local contractor involvement during the construction phase of the Project.
- Support for WCOL's positive approach of engaging with the community early.
- Local area airshed concerns related to potential impacts on human health and especially, but not limited to, particulate matter ($PM_{2.5}$) and sulphur emissions. These concerns are related to the "bowl" created by the Fraser and Nechako Rivers and inversions that trap pollutants, and what emissions the Project would add to this system.
- Interests and concerns related to potential impacts on the Fraser River as a result of water use by the Project.
- Concerns about increased rail traffic related to the transportation of hydrocarbons and finished products as a result of the Project.
- Concerns about increased traffic during the construction and operation phases, especially in the Prince George industrial park.
- Location of the Project area within the "bowl" (related to air emissions concerns above) and the potential visibility of the Project from the neighbourhood known as College Heights. There have also been off-setting comments from the public that they support the location of the facility on previously disturbed land allocated for industrial use.
- Concerns related to safety of the facility operation and management of potential accidents and malfunctions.
- Interest in participating in long-term economic benefits, such as investment in an equity position with the project and other opportunities.
- General interest in wanting to receive more detailed information related to the Project and to better understand the facilities and the operational requirements of the Project.

WCOL will continue to expand and develop this list through future engagement efforts related to the Project. Feedback received will be used in the scoping of existing conditions studies for the Project, identification and selection of Valued Components, and development of approaches to mitigate potential adverse effects of the Project as well as associated monitoring programs.

5.2.2 Planned Activities

The WCOL Project team is highly committed to ongoing engagement and consultation with potentially affected stakeholders and local community organizations. The Project is largely introducing a new industry into Prince George and central BC and one of the keys to success is to have an highly informed and supportive community, requiring a continuous effort to share the Project scope and to work collaboratively to identify measures within the Project which mitigate or address potential adverse effects of the Project.

Key planned engagement activities include:

- Holding general public Open Houses to share general Project information and then as areas of potential concern are identified, discuss in more detail actions to mitigate and address community concerns.
- Continuing to identify and meet with interested and potentially impacted stakeholders and community organizations.
- Holding contractor workshops and one-on-one meetings to further refine WCOL's execution strategy.
- Sharing Project information through the WCOL website, social media, radio and other media as appropriate.
- Continued engagement in relation to the regulatory process.

WCOL strongly believes that the long-term operational and commercial success of the Project depends on the support of the Prince George community and is therefore committed to developing long-term, trusting and positive relations with the community. The Project and related facilities will be a significant contributor to and diversify the local economy and will become a major component of the local community fabric for decades to come.

Engagement through the regulatory process will be guided by the Public Consultation Plan, which will be developed pursuant to the requirements outlined by the Section 11 Order issued by the BC EAO.

5.3 Engagement with Government and Regulatory Agencies

WCOL has initiated engagement with a number of regulatory agencies and government ministries and departments throughout 2019 (Table 5.4) and this list will continue to be updated throughout the Project planning and regulatory planning processes. WCOL has established a collaborative working process with BC EAO to support the EA process and intends to continue to work closely, openly and collaboratively with BC EAO and the Working Group for the duration of the EA process.

Table 5.4: Engagement with Government Agencies.

Organization	Engagement to Date
BC Environmental Assessment Office	Preliminary discussions initiated in May 2019 to review all related facilities and discussions related to the application requirements
BC Oil and Gas Commission	Preliminary discussions initiated in June 2019 to review all related facilities and discussions related to the application requirements
BC Ministry of Environment and Climate Change Strategy	Preliminary discussions with local Prince George Director to review related facilities and discuss proposed path forward for applications
BC Ministry of Environment and Climate Change Strategy	Preliminary discussions with Climate Action Secretariat and Clean Growth Branch to review expected GHG emissions associated with the Project
BC Ministry of Energy, Mines, and Petroleum Resources	Preliminary discussions through 2019 to introduce the Project and related facilities, the value-add opportunity and feedstock for the Project
BC Ministry of Jobs, Trade and Technology	Preliminary discussions through 2019 to introduce the Project and related facilities and initiating discussions related to the capability of Prince George to supply the skills and services required for the Project
BC Hydro	Initial discussions to introduce the Project and related facilities and potential to utilize grid power to lower GHG emissions intensity for all related facilities

WCOL has engaged with the elected officials whose ridings are affected by the proposed location for the Ethylene Project to provide an overview of the Project and related activities and to seek feedback related to the Project:

- Shirley Bond, Prince George-Valemount, BC (Member of the Legislative Assembly), Liberal
- Mike Morris, Prince George-Mackenzie, BC (Member of the Legislative Assembly), Liberal
- Hon. Bob Zimmer, Prince George-Peace River-Northern Rockies, BC (Member of Parliament), Conservative
- Hon. Todd Doherty, Cariboo-Prince George, BC (Member of Parliament), Conservative

6 Closing Remarks

West Coast Olefins Ltd. (WCOL) is proposing to develop an Ethylene Project (Project) that will utilize low-cost, abundant ethane extracted from natural gas in the existing Westcoast Pipeline (by Natural Gas Liquid Recovery Plant) to generate 1 million tonnes per year of ethylene product. The ethylene will be sold to a third-party Ethylene Derivative Plant to convert the ethylene into polyethylene and possibly mono-ethylene glycol, for export to Asian markets. The Project will also produce coproducts, including mixed C3 and mixed C4 hydrocarbons, Aromatic Concentrate, and Pyrolysis Fuel Oil, all of which will be sold to North American markets. The Project will create significant value to existing natural gas produced in BC, generating additional revenue for natural gas producers and local and provincial governments. The proposed location for the Project is on an existing industrial site within the City of Prince George.

The Project is estimated to cost between $2 billion and $2.8 billion, with the construction period expected to span from the spring of 2021 through the summer of 2023. The peak construction workforce is projected to reach between 2,000 and 3,000. Long-term job opportunities are estimated at 140 to 180 permanent direct employees and 25 to 50 contract employees during commercial operation. In addition to this, the local community will experience multiple indirect benefits, such as support of local services and inclusion of local institutions for training purposes.

The Ethylene Plant will be designed with latest technology and recycle/re-use strategies to minimize safety incidents, lost productivity, energy consumption and potential atmospheric emissions. The Project will utilize hydrogen-containing offgas produced by the Plant for the majority of the Plant's fuel requirements, resulting in a clean-burning fuel that will emit no odour and negligible particulate matter. The combination of new technology, a clean fuel source and use of electricity sourced from BC's existing grid will make the WCOL Ethylene Project a best-in-class environmental performer.

The industrial site that will contain the Project Area is located close to existing utilities and amenities including developed access roads and a nearby BC Hydro power supply. Minimal land disturbance is expected to occur during the development of the land or the construction of utility tie-ins.

WCOL understands the importance of engaging early and often with parties who may be affected by or have an interest in the Project, including local community groups, regulatory agencies and Indigenous groups. WCOL is committed to ongoing consultation with these parties, and we believe that by continuing to identify and engage with potentially affected groups we will succeed in managing the concerns of all interested parties throughout the lifecycle of the Project.

Potentially affected surrounding environment and land has been identified, and WCOL will undertake the proper application and permitting processes and consult the designated regulatory agencies as required.

In summary, WCOL intends to work closely with stakeholders to responsibly develop a Project that delivers a globally competitive and environmentally best-in-class facility, provides

value-add to a western Canadian resource and diversifies and strengthens the local and BC economy.

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8 Appendices

Appendix A: Environmental Regulatory Assessment Requirements

Table 8.1 identifies Environmental Assessment thresholds that are applicable to both the NGL Recovery Plant and the Ethylene Plant, as identified in BC and Canadian regulations.

Table 8.1: Comparison of NGL Recovery Plant and Ethylene Project Scope Against BCEAA and CEAA 2012 Threshold Guidelines.

Activity/ Component	BC Environmental Assessment Act	Canadian Environmental Assessment Act, 2012
Energy Storage	Permanent working storage volumes associated with the integrated WCOL project are below the threshold volumes.	Permanent working storage volumes associated with the integrated WCOL project are below the threshold volumes. Note: the federal threshold is a more stringent criterion than the BC regulation.
Natural Gas Processing	The WCOL NGL Extraction facility has the design capacity to process 58 million standard cubic metres per day (Sm^3/d) (threshold is less than 5.6 million Sm^3/d). However, all gas in the Westcoast Pipeline has already undergone processing in field gas plants. WCOL understands that this threshold is intended to apply to raw (potentially sour) gas processing and does not apply to gas already meeting pipeline specifications.	Natural gas from the pipeline has already been sweetened and therefore this threshold does not apply.
Water Diversion Project	WCOL's estimated raw water intake from the Fraser River is well below the diversion guideline of 10 million m^3/year.	WCOL believes that this guideline is not applicable to this project as this guideline is only applicable to inter-basin transfers.
Railway	WCOL is well below the threshold for new rail infrastructure.	WCOL is well below the threshold for new rail infrastructure.

Appendix B: NGL Recovery Plant Scope

The purpose of the NGL Recovery Project is to recover C2+ NGL from the Westcoast Pipeline and then separate this mixture of NGL into separate ethane, propane, butane, and condensate products, with each product meeting exacting specifications.

This Project consists of 2 Plants: the NGL Extraction Plant and the NGL Separation Plant. The 2 Plants will be located at separate sites:

- The NGL Extraction Plant will process rich natural gas from Enbridge's Westcoast Pipeline, removing NGLs (ethane, propane, butane, and C5+ condensate) and returning a lean, clean-burning natural gas to continue down the pipeline. The NGL Extraction Plant will be located at a site adjacent to the Westcoast Pipeline, less than 10 km from Prince George.
- The NGLs from the Extraction Plant will be sent to the NGL Separation Plant, where they will be split into 4 products: ethane, propane, butane and condensate. The ethane will be sent to the Ethylene Plant as feedstock. The propane and butane will be loaded on rail cars and sent to third-party Liquefied Petroleum Gas (LPG) marine export terminals in Prince Rupert or Kitimat for export to Asia. The condensate will be loaded in rail cars and sent to Alberta for sale into the condensate pool or could potentially be sold as feedstock to the Husky refinery located in Prince George. The NGL Separation Plant will be located adjacent to, but separate from, the Ethylene Plant on the Project Area in Prince George's industrial park.

The split of recovered NGL products is seen in Figure 8.1.

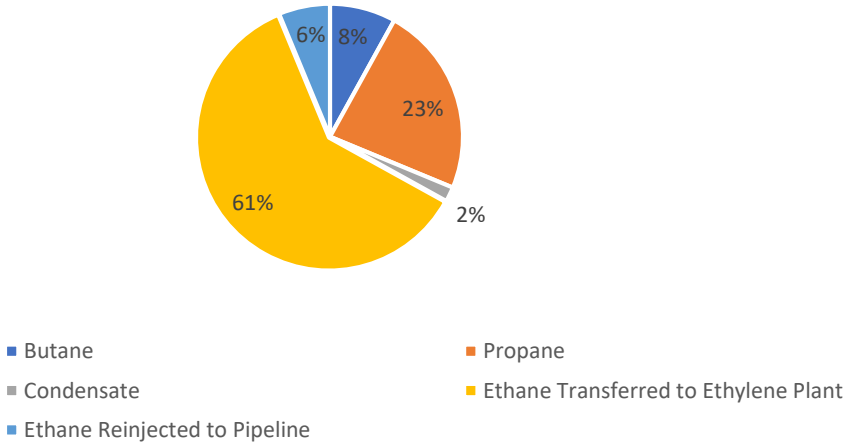

Figure 8.1: Distribution of Products Recovered from Natural Gas.

The assets that will form this Project will consist of the following facilities, equipment and activities (all capacities listed are preliminary and will be developed as engineering progresses):

- The **Extraction Plant** will be designed with a nominal capacity of 59,500,000 Sm^3/d (2.1 billion standard cubic feet per day) to roughly match the capacity of the Westcoast Pipeline. The Plant will be designed as a minimum of 2 parallel 50%-capacity trains to provide increased reliability for recovery of NGL from the Westcoast Pipeline. This facility will take natural gas from the Westcoast Pipeline and chill it to roughly -100°C so that the ethane and heavier NGL can be separated from the predominantly methane-containing lean natural gas stream in Demethanizer distillation towers. The lean natural gas will be compressed and returned to the southern leg of the Westcoast Pipeline. Design C2+ NGL volumes of roughly 16,000 m^3/d will be recovered, but the facility will be capable of higher recovery levels when the Westcoast Pipeline operates at higher NGL content. WCOL proposes to use electric motor drivers on the major Residue Gas Compressor service (in place of gas turbine drivers) to significantly reduce the GHG footprint of the Plant, pending sufficient supply and reasonable cost structure from BC Hydro. Major equipment in this plant will consist of mole sieve drier beds with direct fired regeneration heaters, heat exchangers (shell and tube, brazed aluminum cold boxes and aerial coolers), Turbo Expanders / Turbo Compressors, distillation towers, electric-driven compressors and process pumps.
- **Mixed C2+ NGL storage** will be located adjacent to the Extraction Site. The storage is expected to be buried, underground tube storage with a storage capacity of at least 7,500 m^3.
- An **NGL transfer line**, designed to transport up to 25,000 m^3/d of mixed C2+ NGL (ethane, propane, butane and condensate) from the Extraction Site to the Project Area. Routing for the Transfer Line will be determined once the location for the Extraction Site has been finalized, but WCOL will endeavour to follow existing pipeline or power line rights-of-way to minimize construction or operational impacts.
- All **utilities and infrastructure** required for the operation of the NGL Extraction Plant, mixed C2+ NGL storage and the initiating end of the NGL Transfer Line will be located at the Extraction Site.
- The **NGL Separation Plant** (located at the Project Area) will be designed with a nominal capacity of 16,000 m^3/d of mixed C2+ NGL feed (capacity to be evaluated as engineering proceeds). The facility processes the NGL sequentially through a Deethanizer, Depropanizer and Debutanizer to split the mixture into separate ethane, propane, butane and condensate products. Product ethane will be transfer to the Ethylene Plant for further value-add processing and the other products sent to storage for rail loading. Major equipment in this plant will consist of shell and tube heat exchangers and aerial coolers, distillation towers, electric-driven compressors and process pumps, a propane refrigeration system, mole sieve drier beds, caustic-based and fixed bed contaminant removal systems and direct-fired process heat medium heaters.
- **Storage facilities** for C2+ NGL feed and separated propane, butane and condensate products will be located in the Project Area. The NGL Separation Plant will also contain the storage for the Ethylene Plant coproduct storage: mixed C3, mixed C4, Aromatic Concentrate and Pyrolysis Fuel Oil. Major equipment in this system will include pressurized storage spheres or bullets, storage tanks, vapour recovery

systems and transfer pumps. Total hydrocarbon storage capacity of 15,000 to 25,000 m^3 is anticipated. Final volumes will be determined as engineering progresses. Storage facilities for coproducts from the Ethylene Plant will be operated on a fee-for-service basis for the Ethylene Plant owner and will provide services to load these products into rail cars for export of the products to petrochemical consumers either in the USGC or in Alberta. WCOL proposes that these facilities be allocated to the NGL Recovery Project, because the Ethylene Plant is estimated to produce less than 10% of the total hydrocarbon liquid volumes at the Project Area and incorporating the storage and rail loading into the NGL Recovery Project operation will be highly efficient, reducing capital and operating costs and the land disturbance required across all projects.

- **Rail loading facilities** for propane, butane and condensate products from the NGL Separation Plant and coproduct volumes from the Ethylene Plant (see previous bullet) will be located on the Project Area. Major components in these facilities will consist of connections to the CN Rail line that runs through the Project Area, rail sidings or ladder tracks capable of holding up to 500 rail cars, rail car loading stations, vapour recovery equipment, rail car maintenance / inspection facilities, weigh scales and locomotive(s) or other rail car moving equipment. Expected product volumes will result in the movement of an average of roughly 4 full Unit Trains of rail cars each week.
- **Utilities and infrastructure** required for the NGL Separation Plant, storage and rail loading facilities will be provided through a combination of systems dedicated to the NGL Recovery Project and fee-for-service utilities provided by the Ethylene Project (see Appendix D for details).

Appendix C: Ethylene Coproduct Storage

Ethylene coproducts (mixed C3, mixed C4, Aromatic Concentrate Coproduct, and Pyrolysis Fuel Oil Coproduct) will be stored within the General Hydrocarbon storage farm owned by the NGL Separation Plant. Storage requirements will be sold as a service to the Ethylene Plant by the Separation Plant. All volumes and rail car volumes in Table 8.2 are preliminary estimates and will be revised as engineering progresses.

Table 8.2: Ethylene Project Coproduct Storage.

Product	Storage Type	Purpose of Storage	Total Working Volume	Shipping Strategy
Mixed C3 Coproduct	Sphere (x1)	To provide nominally 7 days of storage for this coproduct to provide reliability to manage rail car inventories and rail system disruptions.	Approximately 1700 m^3 pressurized liquid (sphere). Volume and number of units to be finalized.	Deliver to petrochemical and refining markets by rail. 12 DOT 112 pressurized liquid (LPG) rail cars per week are expected to be loaded.
Mixed C4 Coproduct	Sphere (x1)	To provide nominally 7 days of storage for this coproduct to provide reliability to manage rail car inventories and rail system disruptions.	Approximately 1400 m^3 pressurized liquid (sphere). Volume and number of units to be finalized.	Deliver to petrochemical and refining markets by rail. 10 DOT 112 pressurized liquid (LPG) rail cars per week are expected to be loaded.

Product	Storage Type	Purpose of Storage	Total Working Volume	Shipping Strategy
Aromatic Concentrate Coproduct	Tank (x1 or x2, TBD)	To provide nominally 7 days of storage for this coproduct to provide reliability to manage rail car inventories and rail system disruptions.	Approximately 900 m^3 or 1720 m^3.storage tank (TBD). Volume and number of units to be finalized.	Deliver to petrochemical markets by rail. 11 DOT 111 liquid rail cars are expected to be loaded per week.
Pyrolysis Fuel Oil Coproduct	Tank (x1)	To provide nominally 7 days of storage for this coproduct to provide reliability to manage rail car inventories and rail system disruptions.	Approximately 900 m^3 storage tank. Volume and number of units to be finalized.	Deliver to refining markets by rail. 2 DOT 111 liquid rail cars are expected to be loaded per week.

Note: DOT – Department of Transport

Appendix D: Distribution of Utilities

Certain infrastructure and utilities will be a distributed entity between the Ethylene Plant and Separation Plant, with the utility being sold as a service to the NGL Separation Plant. The distribution of the utilities between the 2 projects is presented in Table 8.3.

Table 8.3: On-site Utility Distribution between Ethylene Project and NGL Separation Plant.

Utility	Ethylene Project (EA Application)	NGL Recovery Project (OGC Application)
Wastewater Collection/Closed Hydrocarbon Drain	• Wastewater collection, treatment, and disposal requirements will be provided by Ethylene Plant utilities on the Project Area.	• Wastewater and hydrocarbons requirements will be provided by Separation Plant utilities on the Project Area.
Fuel Gas	• Supplemental Fuel Gas Requirements for the Ethylene Plant will be provided via tie-ins to the Fortis Prince George supply pipeline.	• Fuel Gas Requirements for the Separation Plant will be provided via tie-ins to the Fortis Prince George supply pipeline.
Process Heat Medium	N/A	• Process heat medium requirements for reboilers will be provided by Separation Plant utilities on the Project Area.

Utility	Ethylene Project (EA Application)	NGL Recovery Project (OGC Application)
Instrument and Utility Air	• An instrument and utility air package will be present on the Project Area to service the needs of the Ethylene Plant. • Instrument and utility air will be sold as a service to the Separation plant as needed.	• Instrument and utility air requirements for the NGL Separation Plant will be provided via the Ethylene Plant utility service.
Utility Nitrogen	• A utility nitrogen package will be present on the Project Area to service the needs of the Ethylene Plant. • Utility nitrogen will be sold as a service to the Separation plant as needed.	• Utility nitrogen requirements for the NGL Separation Plant will be provided via the Ethylene Plant utility service.
Flare	• A flare system will be provided on the Project Area for the Ethylene Plant.	• A flare system will be provided on the Project Area for the Separation Plant.
Utility and Potable Water	• Utility and Potable water requirements will be provided to the Ethylene Plant via the Prince George municipal water supply.	• Utility and Potable water requirements will be provided to the Separation Plant via the Prince George municipal water supply.
Stormwater Containment	• A retention pond on the Project Area will provide Ethylene Plant stormwater containment requirements.	• The NGL Separation Plant may have a independent system.
Fire Protection System	• A fire water system on the Project Area will provide all fire water requirements for the Ethylene Plant. • Fire water will be sold as a service to the Separation Plant.	• Fire water requirements for the Separation Plant will be provided via the Ethylene Plant Utility Service.

Utility	Ethylene Project (EA Application)	NGL Recovery Project (OGC Application)
Raw Water Inlet and Storage	• The raw water intake and treatment systems, and storage will be provided on the Project Area to meet the water requirements of the Ethylene Plant.	N/A
Utility Boiler	• To provide the Ethylene steam requirements, a utility boiler will be present at the Project Area.	• Potential to supply excess steam from the Ethylene Plant to the NGL Separation Plant on a fee for service basis will be investigated.

Appendix E: Miscellaneous Rail Information

- Length of track to be developed on-site: Up to 15 km.
- Combined NGL Products and Ethylene Coproducts will load approximately 4 Unit Cars per week.
- Number of rail cars stored on-site: Up to 500 rail cars.