Canada Gas-to-Liquids Project

Volume 1: Project Description

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Abbreviations

°C .............................................................................................. degrees Celsius
AAAQO .......................................................... Alberta Ambient Air Quality Objectives
AAFC ............................................................ Agriculture and Agri-Food Canada
ACIMS .......................................................... Alberta Conservation Information Management System
AENV .......................................................... Alberta Environment (now ESRD)
AEP .............................................................. Alberta Environmental Protection
AESO .......................................................... Alberta Electric System Operator
AIH .............................................................. Alberta’s Industrial Heartland
AIHA .......................................................... Alberta Industrial Heartland Association
ANPC .......................................................... Alberta Native Plant Council
API .............................................................. American Petroleum Institute
ASU .............................................................. air separation unit
ATR .............................................................. auto-thermal reformer
BAC .............................................................. booster air compressor
bbl/d .......................................................... barrels per day
BFW .............................................................. boiler feed water
BPSD .......................................................... barrels per stream day
CAPP .......................................................... Canadian Association of Petroleum Producers
CCC .......................................................... Calgary Chamber of Commerce
CCME .......................................................... Canadian Council of Ministers of Environment
CCS .............................................................. carbon capture and storage
CEAA .......................................................... Canadian Environmental Assessment Agency
CEPA .......................................................... Canadian Environmental Protection Act
CH₄ .............................................................. methane
CME .......................................................... Canadian Manufacturers and Exporters
CO₂ .............................................................. carbon dioxide
CO₂ₑ ........................................................... carbon dioxide equivalent
CSI .............................................................. corporate social investment
cSt .............................................................. centistokes
CWS .......................................................... Canada Wide Standards
DMDS .......................................................... dimethyl disulphide
EIA .............................................................. environmental impact assessment
EMS .......................................................... environmental management system
EPC .............................................................. engineering, procurement and construction
EPCM ........................................................ engineering, procurement and construction management
EPEA .......................................................... Environmental Protection and Enhancement Act
ERCB .......................................................... Energy Resources Conservation Board
ERG...................................................................................................................................................... external recycle gas
ESRD .................................................................................................................................................. Alberta Environment and Sustainable Resource Development
FEED .................................................................................................................................................... front-end engineering and design
FT ......................................................................................................................................................... Fischer Tropsch
FTS ....................................................................................................................................................... Fischer Tropsch synthesis
g .......................................................................................................................................................... grams
GAC .......................................................................................................................................................... granular activated carbon
GHG ....................................................................................................................................................... greenhouse gas
GJ ............................................................................................................................................................. gigajoule
GJ/h .......................................................................................................................................................... gigajoules per hour
GTL ........................................................................................................................................................... gas-to-liquids
H₂ ............................................................................................................................................................ hydrogen
H₂O ........................................................................................................................................................... water
HDPE .................................................................................................................................................. high-density polyethylene
HERU ................................................................................................................................................... heavy ends recovery unit
HP ............................................................................................................................................................. hydrogen production or high pressure
HPU .......................................................................................................................................................... hydrogen production unit
kg CO₂e/bbl ........................................................................................................................................... kilograms of carbon dioxide equivalent per barrel
kg/h .......................................................................................................................................................... kilogram per hour
kg/m³ ....................................................................................................................................................... kilogram per cubic metre
km/h .......................................................................................................................................................... kilometres per hour
kPa ........................................................................................................................................................... kilopascal
kPaA .......................................................................................................................................................... kilopascal absolute pressure
LPG .......................................................................................................................................................... liquefied petroleum gas
m ............................................................................................................................................................... metre
m³ ............................................................................................................................................................ cubic metre
m³/a ........................................................................................................................................................... cubic metres per annum
m³/h .......................................................................................................................................................... cubic metres per hour
MAC ......................................................................................................................................................... main air compressor
mg/kg ....................................................................................................................................................... ratio of milligrams to kilograms
MISS ....................................................................................................................................................... maintenance integrity safety standard
ML/d ......................................................................................................................................................... million litres per day
MLA .......................................................................................................................................................... Member of the Legislative Assembly
MMSCFD ...........................................................................................................................................thousand standard cubic feet per day
MOC .......................................................................................................................................................... management of change
MP ........................................................................................................................................................... medium pressure
mph .......................................................................................................................................................... miles per hour
Mt/a .......................................................................................................................................................... megatonnes per annum
MW ........................................................................................................ megawatt
N/A ........................................................................................................ not applicable
N/P .......................................................................................................... not present
N$_2$O .................................................................................................................................... nitrous oxide
NCIA ........................................................................................................ Northeast Capital Industrial Association
NFPA ........................................................................................................ National Fire Protection Association
NGO ........................................................................................................ non-government organiz
NO$_x$ ................................................................................................................................ oxides of nitrogen
NPRI ....................................................................................................... National Pollution Release Inventory
NPV ........................................................................................................ net present value
NR CAER ..................................................................................................... Northeast Region Community Awareness and Emergency Response
NR ........................................................................................................... not rated
OC ............................................................................................................ oil contaminated
PDA ........................................................................................................ Project disturbance area
PDD .......................................................................................................... public disclosure document
PHA ......................................................................................................... process hazard analysis
PM 2.5 ...................................................................................................... fine particulate matter
PM ........................................................................................................... particulate matter
POC ........................................................................................................ potentially oil contaminated
ppm ......................................................................................................... parts per million
Project ..................................................................................................... Canada GTL Project
PSA .......................................................................................................... pressure swing absorption
PSI ......................................................................................................... process safety information
PSM ........................................................................................................ process safety management
PSSR ...................................................................................................... pre-startup safety review
pTOR ..................................................................................................... proposed Terms of Reference
PU ........................................................................................................... production upgrading
R&D ....................................................................................................... research and development
RO ........................................................................................................ reverse osmosis
SARA ...................................................................................................... Species at Risk Act
Sasol ....................................................................................................... Sasol Canada Holdings Limited
SEA ........................................................................................................ socio-economic assessment
SG ........................................................................................................... synthesis gas
SGU ......................................................................................................... synthesis gas unit
SHE .......................................................................................................... safety, health and environment
SIA ......................................................................................................... Strathcona Industrial Association
SIL ........................................................................................................... survey intensity level
SO$_2$ ....................................................................................................... sulphur dioxide
SOP .......................................................................................................... standard operating procedures
SPD™ .................................................................................................. Slurry Phase Distillate™
1 INTRODUCTION

1.1 Application

Sasol Canada Holdings Limited (Sasol) is applying to Alberta Environment and Sustainable Resource Development (ESRD) for approval to construct, operate, decommission and reclaim a gas-to-liquids (GTL) facility (Canada GTL Project or Project). The Project is a petrochemical manufacturing facility, as defined under the Activities Designation Regulation.

The Project will be located in Strathcona County, in Alberta’s Industrial Heartland (AIH)—an area zoned for heavy industrial development. The Project’s site is approximately 4 km northeast of Fort Saskatchewan and 40 km northeast of Edmonton.

This document comprises the application and provides:

- an application for approval under the Environmental Protection and Enhancement Act (EPEA) to construct, operate and decommission the GTL facility
- applications under the Water Act to divert water from the North Saskatchewan River and in the GTL facility
- an environmental impact assessment (EIA) for the Project
- a socio-economic assessment for the Project
- a project description
- a description of the community and stakeholder engagement and consultation program

1.2 Project Proponent

The Project proponent is Sasol Canada Holdings Limited—a subsidiary of Sasol Limited. For clarification purposes, all references in the application to Sasol refer to Sasol Canada Holdings Limited. References to Sasol Limited are for the purposes of providing information on Sasol Limited’s global operations, experience, proprietary technology, research and development activities and policies in areas such as safety, health and environment (SHE) and corporate social investment (CSI).

Sasol Limited is an international integrated energy, petrochemicals and chemicals company, driven by innovation. Sasol Limited creates value through its proven proprietary fuel technology and talented employees providing sustainable energy solutions world-wide. Headquartered in South Africa, Sasol Limited operates in 38 countries, with a combined workforce more than 34,000. It is listed on the New York Stock Exchange, the Johannesburg Stock Exchange and the Dow Jones Sustainability Index.

With more than 60 years’ experience, Sasol Limited is the world’s largest producer of synthetic fuels and is a world leader in GTL and coal-to-liquids technology. For example, ORYX GTL—a 32,400 barrel per day plant in Qatar, is a joint venture between Sasol Limited and Qatar Petroleum and is among the most advanced gas-to-liquids facilities in the world. Sasol Limited is involved in a gas-to-liquids facility nearing
completion in Nigeria, and in a joint venture for a proposed gas-to-liquids facility in Uzbekistan. Sasol Limited is also proceeding with front end engineering and design (FEED) for a gas-to-liquids facility in Louisiana, in the United States of America (USA).

In Canada, Sasol owns a 50% working interest in two long-life shale gas assets in northeast British Columbia: Farrell Creek and Cypress A, the operator of which is Talisman Energy Inc.

1.3 The Project

1.3.1 Description

The GTL facility in Strathcona County would monetize Canada's clean, abundant natural gas resources to produce high-quality transportation fuels and petrochemical feedstock in a cost-efficient and environmentally conscious way. The Project will produce three liquid petroleum products: GTL diesel, GTL naphtha and liquefied petroleum gas (LPG). GTL facilities do not produce elemental sulphur or petroleum coke. GTL diesel has a high cetane number and is nearly sulphur and aromatics free. GTL's low-sulphur content and high cetane number also make it a desirable blending component with conventional petroleum products. Lifecycle greenhouse gas emissions are comparable with or less than conventional fuels produced from a modern oil refinery.

The Sasol Slurry Phase Distillate™ (Sasol SPD™) process is at the core of Sasol Limited's GTL technology (see Figure 1-1). The three-step process combines three leading proprietary technologies:

1. natural gas is combined with oxygen to form a synthesis gas using auto-thermal reforming technology
2. synthesis gas is converted by Fischer Tropsch synthesis (proprietary conversion process) to a broad-range hydrocarbon stream, also called waxy synfuel
3. The waxy synfuel is processed into GTL diesel, GTL naphtha and LPG by mild hydroprocessing and hydrocracking

Figure 1-1 Sasol SPD™ Process
1.3.2 Site Selection

Sasol undertook a diligent and lengthy process for selecting the Project’s site based on a list of criteria. A number of locations in British Columbia and Alberta were evaluated. Sasol determined that AIH would be the best location for the Project.

During site selection, Sasol worked closely with the counties and municipal partners of AIH and with the Alberta Industrial Heartland Association (AIHA) to ensure all options were considered. A site owned by Total E&P Canada Ltd. for a previously proposed oil sands upgrader was selected by Sasol as the most appropriate location for the Project because it best satisfied all of the selection criteria, including:

- proximity and access to large natural gas networks (important for establishing gas-to-liquids facilities)
- industrial zoned lands
- suitable environmental setting where potential effects of a proposed large energy-related industrial facility had previously been assessed
- proximity to required third-party infrastructure, including pipeline, rail and road transportation networks and utilities
- the use of third-party water supply infrastructure from the North Saskatchewan River
- access to highly skilled workforce and fabrication facilities
- excellent potential for integration with regional development, including potential for synergies with other companies and the Northeast Capital Industrial Association

Sasol has secured an option to purchase the Project’s site from Total E&P Canada Ltd.

1.3.3 Location

The Project will be located in Strathcona County in AIH—an area zoned for heavy industrial development. The Project disturbance area (PDA) is approximately 526 ha about 4 km northeast of Fort Saskatchewan and 40 km northeast of Edmonton (see Figure 1-2). The PDA is located in Section 19, Township 55, Range 21, west of the fourth meridian (19-55-21, W4M). It also lies in the west half of Section 20, the north half and portions of the south half of Section 18, and a portion of NW 17-55-21, W4M. Sasol is planning to use a third-party water intake site located approximately 6 km north of the PDA on the North Saskatchewan River.
1.3.4 Scope and Capacity

The Project will convert natural gas to liquid petroleum products. The GTL facility will have a nominal design capacity (defined as an approximation of the projected annualized facility capacity) of 96,000 barrels per day of GTL diesel, GTL naphtha and LPG combined. A phased approach will be adopted when constructing the Project. Each of the two proposed phases is equivalent to a nominal design capacity of 48,000 barrels per day.

The nominal design production capacity converts to 103,900 barrels per stream day (51,950 barrels per stream day, per phase) of liquid fuels through process optimization opportunities associated with product specifications and local conditions. Approval is therefore being sought for a production capacity of 103,900 barrels per stream day. The respective products would be shipped by pipeline and rail to identified markets.

The Project comprises the Sasol SPD™ process together with the required supporting process units, utilities and offsite units that support the primary processing components. The GTL facility includes external interfaces with third-party services and suppliers.

The Project’s primary processing components include:

- natural gas reforming (auto thermal reforming)
- FT synthesis
- product upgrading (hydrocracking, hydrotreating, distillation and isodewaxing)
- oxygen production
- hydrogen production (steam methane reforming)
- power generation
- utilities
- supporting infrastructure

1.4 Schedule

Pre-feasibility assessments for the Project were completed in 2010. In spring 2011, Sasol established an office in Calgary. A comprehensive feasibility study for the Project was completed in late spring 2012. During this period, Sasol engaged in discussions with government, industry and other stakeholders and undertook activities in support of the Project’s environmental impact assessment. These discussions and activities continued throughout 2012. Formal consultation with communities and stakeholders was initiated in September 2012. Consultation will continue throughout the life of the Project as part of Sasol’s commitment to public consultation and community engagement. On December 3, 2012 Sasol announced that in 2013 it would proceed with pre-FEED activities for the Project.

The Project’s pre-FEED phase is expected to last between 18 to 42 months. For the purpose of this application, a 30-month pre-FEED timeline is used. The comprehensive FEED phase will commence after the conclusion of pre-FEED activities and corporate approval for FEED. Subject to regulatory approvals and the final corporate investment decision (Project corporate sanction), Sasol anticipates the
commencement of construction of phase 1 of the Project in the first half of 2018. The anticipated timeline for the start-up of phase 1 of the GTL facility is 2021. For the Project’s schedule, see Figure 1-3.

Sasol proposes to execute the Project in two phases. The purpose of this phased approach is to limit potential risks associated with construction constraints, such as material availability and manufacturing of long-lead equipment, and availability of suitably skilled labour. Based on internal assessments Sasol determined that phasing the Project would result in better management of capital costs and labour requirements. While the GTL facility will be constructed in two phases, this application seeks approval for both phases of the Project.

1.5 Need for the Project

Natural gas has emerged as a major product in the global resource market. It is considered the cleanest and most efficient of the three major fossil fuels (coal, crude oil and natural gas). Sasol Limited is a recognized world leader in GTL technology with a business strategy to seek out global opportunities to build new GTL facilities. Sasol Canada Holdings Limited is positioned to convert natural gas from Alberta’s supply system into higher value liquid petroleum products.

Natural gas is one of Canada and Alberta’s largest energy resources. Technological advances have unlocked previously inaccessible natural gas supplies, making natural gas an increasingly plentiful and affordable energy source in North America. These conditions have made the construction of Canada’s first GTL facility a viable proposition.

GTL facilities add value to natural gas by converting it into high-quality petroleum products that are often in short supply, most notably GTL diesel fuel and GTL naphtha. GTL is an advanced petrochemical processing technology that offers attractive integration opportunities with the existing refining and petrochemical sectors and aligns with the Alberta government’s goals for value-added natural resource development in the province. As a multi-billion dollar investment, the GTL facility will launch a new industry that monetizes the value of Alberta’s natural gas resources, promotes economic diversification, creates new employment opportunities in Alberta and will generate significant revenues for all three levels of government in Canada.
Figure 1-3 Project Schedule

* The time range is 18 to 42 months
1.6 Project Benefits

The GTL facility and products will add value to transportation fuels markets in western Canada. The Project offers a commercial alternative to conventional crude oil refining and adds to the oil sands value chain through domestic production of diluents (GTL naphtha) for bitumen transportation and produces cleaner burning GTL transportation fuels virtually free of sulphur and aromatic compounds. The GTL fuels, when used in transportation, would reduce emissions of particulates, nitrogen oxides, carbon monoxide and other pollutants helping to improve air quality.

The GTL value proposition is further enhanced by the opportunity to create jobs and stimulate economic growth in Canada. The Project supports Alberta and Canada’s strategic imperative to add value to its abundant natural resources. Economic benefits include:

- using contracting and consulting services during the application development and engineering stages
- advancing AIH’s long-time vision to be a nationally important and strategically located centre for energy processing and industrial manufacturing
- supporting local, regional and provincial businesses providing supplies and services
- contributing to total employment (direct, indirect and induced) through construction, which is estimated to be 33,510 person-years of employment. The Project will employ 890 fulltime operations workers annually. Based on an expected 25-year operating life, the Project will generate 39,500 person-years of total operations-related employment, including indirect and induced activity. Combined, construction and operations are expected to generate 73,010 person-years of direct, indirect and induced employment, the majority of which is expected to accrue to the regional study area. These estimates do not include employment generated by sustaining maintenance activities (periodic turnarounds), which will create additional employment effects throughout the Project’s operating life.
- contributing to the fiscal balance of three levels of government through tax payments (based on 2012 values), including:
  - municipal property tax payments, which will begin in 2022 and will reach $49 million annually once the GTL facility becomes fully operational
  - Alberta corporate income taxes, which will average $320 million annually
  - federal corporate taxes, which will average $480 million annually once the Project is fully operational and has reached full payout

Total taxes payable (between 2027 and 2045) by the Project is $5.48 billion provincially and $8.23 billion federally. On a net present value (NPV) basis, this results in $960 million in Alberta corporate tax and $1.44 billion in federal corporate tax.
NPV estimates are heavily discounted because of the long timeframe between 2012 and 2027, when the Project payout period begins. To provide perspective, if the Project were to begin operations in 2012, the NPV value for the same number of operating years would be:

- $2.81 billion in Alberta corporate tax
- $4.21 billion in Federal corporate tax

### 1.7 Alternatives to the Project

The Project involves conversion of natural gas from Alberta’s supply network to high-quality petroleum products using technically viable and commercially proven technology. The GTL facility converts natural gas resources into clean, high-value products that are in short supply in the Canadian market with the opportunity to be exported to new markets. This aligns with the Government of Alberta’s value-add strategies for product and market diversification from its energy resources. The GTL facility would use up to 1 billion cubic feet per day of natural gas to support a nominal capacity of 96,000 barrels per day. This is a significant value-add opportunity for Alberta and Canada.

Sasol believes there are no functionally different alternatives to the Project that would meet the needs of and derive the benefits of the Project. The alternative of not proceeding with the Project would result in the loss of the benefits associated with the Project.

Other uses for natural gas such as enhanced exports of natural gas out of Alberta, building gas monetization facilities (e.g., LNG) outside Alberta, or converting coal fired plants to gas-fired plants are not regarded as comparable alternatives to the Project that brings a new value-add industry to Alberta and to Canada.

Alternative means of carrying out the Project that are technically and economically feasible are considered in Section 3.15, Alternative Design Considerations.

### 1.8 Regulatory Approvals

Sasol is requesting approval under Part 2, Division 2, Sections 60, 61 and 66 of the *Environmental Protection and Enhancement Act* (EPEA) for the construction, operation, decommissioning and reclamation of a GTL facility. Sasol also requests licenses under Sections 49, 50 and 51 of the *Water Act* to divert water from the North Saskatchewan River and to divert surface water from the Project site. Approval is also requested under Sections 36 and 37 of the *Water Act* to place, construct, operate and maintain works (the GTL facility) that affect the flow of surface water runoff. This application includes an EIA report, which meets the terms of reference for the EIA report issued by ESRD on November 26, 2012.
For the Project, Sasol requires the following primary approvals from ESRD (see Table 1-1):

### Table 1-1 Primary Approvals

<table>
<thead>
<tr>
<th>Approval</th>
<th>Legislation</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval to begin construction, operation and reclamation of a GTL facility</td>
<td><em>EPEA, Part 2, Division 2, Sections 60, 61 and 66</em></td>
<td>ESRD</td>
</tr>
<tr>
<td>Approval for placing, constructing, operating and maintaining works that affect the flow of water</td>
<td><em>Water Act, Sections 36 and 37</em></td>
<td>ESRD</td>
</tr>
<tr>
<td>Licence to divert water from the North Saskatchewan River and to divert natural surface waters on, around or away from the Project site</td>
<td><em>Water Act, Sections 49, 50, 51</em></td>
<td>ESRD</td>
</tr>
<tr>
<td>License to divert natural surface waters using the works of another</td>
<td><em>Water Act, Section 52</em></td>
<td>ESRD</td>
</tr>
</tbody>
</table>

**NOTE:**
The *Water Act* Applications (for diversion of water) is included in Appendix 1B.

### 1.8.1 Ancillary Approvals

Sasol also intends to apply for ancillary approvals needed for the Project (see Table 1-2).

Sasol received clearance under the *Historical Resources Act* for the lands within the PDA on November 19, 2012.

### Table 1-2 Ancillary Approvals

<table>
<thead>
<tr>
<th>Approval</th>
<th>Legislation</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development permit and other required municipal authorizations</td>
<td><em>Municipal Government Act, Strathcona County Land Use By-Law</em></td>
<td>Strathcona County</td>
</tr>
<tr>
<td>Electrical power generation and transmission</td>
<td><em>Hydro and Electric Energy Act</em></td>
<td>Alberta Utilities Commission</td>
</tr>
<tr>
<td>Wastewater well and disposal scheme</td>
<td><em>Oil and Gas Conservation Act</em></td>
<td>Energy Resources Conservation Board (ERCB)</td>
</tr>
<tr>
<td>Approval of a waterworks system (for potable water)</td>
<td><em>EPEA</em></td>
<td>ESRD</td>
</tr>
</tbody>
</table>
1.9 Contents of the Application

This application comprises two volumes:

- **Volume 1: Project Description**, which includes six sections:
  - Section 1: Introduction
  - Appendix 1A: Concordance Table
  - Appendix 1B: Water Act Applications
  - Section 2: Public Consultation
    - Appendix 2A: Community and Stakeholder Contacts
    - Appendix 2B: Consultation Materials
  - Section 3: Process Description
  - Section 4: Project Execution
  - Section 5: Management Plans
    - Appendix 5A: Clubroot Management Program
  - Section 6: EIA Summary

- **Volume 2: Environmental Impact Assessment**, which includes 16 sections:
  - Section 1: Introduction
  - Section 2: Assessment Methods
  - Section 3: Air
  - Section 4: Noise
  - Section 5: Light
  - Section 6: Groundwater
  - Section 7: Hydrology
  - Section 8: Surface Water Quality
  - Section 9: Aquatic Resources
  - Section 10: Terrain and Soils
  - Section 11: Vegetation
  - Section 12: Wildlife and Wildlife Habitat
  - Section 13: Human Health Risk Assessment
  - Section 14: Land Use
  - Section 15: Historical Resources
  - Section 16: Socio-Economic Assessment
1.10 Communication with Applicant

Communication with Sasol concerning regulatory applications should be directed to:

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Sasol Canada Holdings Limited.
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Mr. Martin Waterhouse
Country President & General Manager
Development & Production North America
Suite 1600, West Tower
215 – 9th Avenue SW
Calgary, Alberta. T2P 1K3
mike.nel@ca.sasol.com
2 PUBLIC CONSULTATION

2.1 Introduction

Sasol is committed to a public consultation program that will last throughout the life of the Canada Gas-to-Liquids (GTL) Project (the Project). As an owner and operator of GTL facilities globally, Sasol understands that public consultation to support proposed new projects must be undertaken in a manner that also improves understanding of GTL technology. The public consultation program developed for the Project addresses this requirement. The program also reflects Sasol’s commitment to provide communities and stakeholders with meaningful and continuous opportunities to learn and ask questions that can support informed decision-making about possible Project effects and options for mitigation.

This section describes the public consultation program developed for the Project, including:

- Implementation of the consultation program
- outcomes to date
- ongoing consultation as the Project advances through the regulatory review and approval process and beyond

2.2 Strategic Framework and Approach

The public consultation program was developed as an integrated and continuous program that will be implemented in phases to meet or exceed regulatory requirements for public consultation. The program was also designed to achieve Sasol’s rigorous standards for public consultation. Phases 1 and 2 of the program covered the period of the Project’s pre-feasibility activities and feasibility study and ended with the submission of this application for the Project’s regulatory approval. Phase 3 of the public consultation program will cover the period spanning the regulatory review and approval process, the outcomes for which will be submitted to Alberta Environment and Sustainable Resource Development (ESRD) through the supplemental information request process or as required by ESRD.

Phases 1 and 2 of the public consultation program were designed and implemented according to the following strategic framework and approach. For details on phase 3 of the program, see Section 2.5.1.

2.2.1 Phase 1

In phase 1, the goal was to initiate high-level dialogue with government and industry to explore Sasol’s interest in building a GTL facility in Canada. This initial phase began in fall 2010 with a pre-feasibility assessment team identifying potential locations for a GTL facility in western Canada. In late spring 2012, detailed discussions with government officials confirmed the regulatory approval process for the Project. Notable achievements in phase 1 included:

- the establishment of Sasol’s Canadian head office in Calgary
• a Project team created in Calgary and South Africa to assess the business case for building a GTL facility in Alberta
• the completion of the Project’s comprehensive feasibility study
• engagement with three levels of government, industry and community members and stakeholders to introduce Sasol and its GTL technology and identify and understand expectations and requirements for approving, constructing and operating a GTL facility in Alberta
• a site option agreement with Total E&P Canada Ltd. for the purchase of the Project lands in Strathcona County

During phase 1, Sasol continued its discussions with industry to better understand issues related to constructing and operating a large industrial facility in Alberta, and to identify opportunities for collaboration.

2.2.2 Phase 2

Phase 2 of the public consultation program commenced in early summer 2012 with the conclusion of formal discussions with ESRD on the proposed Terms of Reference (pTOR) for the Project’s environmental impact assessment (EIA). During phase 2, Sasol also completed a review of previous EIAs in Alberta’s Industrial Heartland (AIH), including the EIA completed by Total E&P Canada in 2007 for the same site selected for the Canada GTL Project. Sasol’s review of previous EIAs in AIH provided an understanding of community and stakeholder issues and concerns about industrial projects in the region. Sasol also began informal discussions with landowners and industry near the Project site to build relationships and enhance Sasol’s understanding of the issues and concerns landowners and industry might have.

The formal launch of the public consultation program in support of the regulatory application occurred on September 13, 2012 with the publication of the first public notice advertisement for the Project’s pTOR. At this time Sasol established a community relations office in Sherwood Park to support community and stakeholder engagement. Sasol also participated in conferences and community events and meetings with interested parties for the purpose of providing information and responding to questions.

2.2.3 Program Commitment and Guiding Principles

Sasol will engage and consult with communities and stakeholders to provide ample opportunity for creating awareness and understanding of the Project and the technology that will be used to convert natural gas to higher-value products. Sasol is committed to working with communities and stakeholders to address issues and concerns to achieve mutually beneficial solutions. Responsiveness to community and stakeholder expectations is regarded by Sasol as a critical requirement for success in creating value for its shareholders.

Sasol conducts its public consultation activities in a manner that reflects and fully supports the following guiding principles:

• respect for the values and rights of others
• openness to different points of view and opinions
• trust worthiness and living up to commitments
• acknowledge the important contributions communities and stakeholders make to business activities
• transparency and collaboration
• continuous improvement to public consultation practices for the mutual benefit of everyone involved

Phases 1 and 2 of the public consultation program created awareness of the Project and of GTL technology, both in AIH and provincially. This has been achieved in part through the creation of opportunities for Sasol to meet with provincial and local officials, industry, businesses, communities and stakeholders potentially affected by the Project. Table 2-1 summarizes the opportunities for community and stakeholder input.

Table 2-1 Opportunities for Community and Stakeholder Input

<table>
<thead>
<tr>
<th>Activity</th>
<th>Opportunity for Input</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed, prepared and refined community and stakeholder engagement program before public launch; set up a Sasol Canada website; arrangements for establishment community office in Sherwood Park</td>
<td>Yes, through meetings, discussions and responses to questions</td>
<td>Fall 2010 to Spring 2012</td>
</tr>
<tr>
<td>Organized public events</td>
<td>• Public launch to support regulatory application • Open house • Presentations</td>
<td>• September 2012 • September 2012 • Ongoing</td>
</tr>
<tr>
<td>Direct mail</td>
<td>Yes, through meetings &amp; discussions</td>
<td>Ongoing</td>
</tr>
<tr>
<td>One-one-one meetings</td>
<td>Yes, through meetings &amp; discussions</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Participation in regional initiatives</td>
<td>Yes, through meetings &amp; discussions</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Prepared EIA and socio-economic assessment</td>
<td>Yes, through meetings &amp; discussions</td>
<td>Summer 2011 to Spring 2013</td>
</tr>
</tbody>
</table>

2.2.4 Program Goals

The following goals have shaped and will continue to guide the public consultation program for the Project:

• to effectively identify and make contact with potentially affected communities and stakeholders
• to actively look for opportunities to incorporate comments and feedback from communities and stakeholders into the design and execution of the public consultation program
• to identify communities and stakeholder issues and concerns specific to the Project
• to provide communities and stakeholders with concise, clearly written and timely information about the Project so as to support their understanding of potential Project effects
• to provide communities and stakeholders with opportunities and venues to learn about Sasol’s GTL technology and the Project, ask questions and receive feedback from Sasol
2.2.5 Regulatory Expectations

Alberta regulators have established that project proponents have an obligation to consult with potentially affected communities and stakeholders in a manner that enables communities and stakeholders to make informed decisions about potential project-related effects. As the approval regulator of the Project, ESRD has, through section 1 A, B and C of the final TOR for the EIA report, issued on November 26, 2012, directed that the public consultation program:

- describe the concerns and issues expressed by the public, including Aboriginal communities, and the actions taken to address those concerns and issues, including how input from the public and Aboriginal communities was incorporated into Project development, mitigation, monitoring and reclamation
- describe consultation undertaken with the public, including Aboriginal communities
- describe plans to maintain public and Aboriginal community engagement and consultation following completion of the EIA to ensure that public and Aboriginal communities will have a forum to express their views on the ongoing development, operation and reclamation of the Project

The public consultation program addresses the requirements as specified in the TOR. In addition to ESRD’s expectations, the program addresses the expectations of regional officials, including those of Strathcona County where the Project will be located.

2.2.5.1 Socio-Economic Assessment

Section 6 of the TOR requires that a socio-economic assessment (SEA) for the Project be completed. The SEA includes identifying, assessing and mitigating the Project’s effects on issues of importance to residents, landowners, rights holders, workers, industry, government officials and other groups located in AIH. The SEA (see Volume 2, Section 16) complements the public consultation program by providing additional understanding of the Project’s effects on local communities and stakeholders and the mitigation that will be undertaken by Sasol to address those effects.

2.2.5.2 Public Disclosure

The Project’s public consultation was formally launched in the second week of September 2012. The public disclosure program included distributing a public disclosure document (PDD) with a covering letter from Sasol’s President for New Business Development. The PDD and covering letter were sent to potentially affected communities and stakeholders, including residents, landowners and occupants within
5 km of the Project site boundary, as well as other groups and organizations. (For further information on
the identification of communities and stakeholders, see Section 2.3.1). For a summary of the Project's
community and stakeholder list, see Table 2-2. The PDD was placed on Sasol Canada’s website. The
public disclosure program also included preparing and distributing materials to support the release of the
Project’s pTOR for the EIA.

2.2.5.3 Proposed Terms of Reference for EIA

The pTOR for the EIA report were prepared and advertised beginning September 13, 2012 in:

- Alberta Sweetgrass
- Edmonton Sun
- Fort Saskatchewan Record
- Lamont Leader
- Morinville Free Press
- Redwater Review
- Sherwood Park/Strathcona County News
- Sturgeon Creek Post
- The Edmonton Journal

The pTOR and the PDD were also distributed to six venues for public viewing:

- Edmonton Public Library
- Lamont County Administrative Building
- Sturgeon County Centre
- Fort Saskatchewan Public Library
- Strathcona County Hall
- Alberta Environment and Sustainable Resource Development office in Edmonton

The notice period for submitting comments on the pTOR to ESRD was 45 days, ending
November 2, 2012.

2.2.5.4 Final Terms of Reference for EIA

The public notice for the final TOR for the EIA report was published in the Fort Saskatchewan Record on
December 6, 2012 and in Lamont Farm and Friends on December 7, 2012. Sasol contacted individuals
and groups on the community and stakeholder list to advise that the TOR had been issued and could be
obtained on Sasol Canada’s website. Sasol also offered to send the TOR to those who requested a paper copy.
2.2.5.5 Program Monitoring and Evaluation

The public consultation program is monitored and evaluated using formal and informal methods. The purpose is to assess on an ongoing basis whether the program’s goals are being met and whether there is a need for additional activities or refinements in the content or timing of existing activities. Monitoring and evaluation methods include:

- formal and informal feedback from government, community members and stakeholders through:
  - face-to-face meetings
  - comments submitted through Sasol Canada’s website
  - issues and media tracking
  - formal evaluation forms at public events
- a formal community and stakeholder contact database to record interaction between Sasol and communities and stakeholders. The database is designed to identify all issues or concerns about the Project made known to Sasol and tracks and monitors follow-up action required by Sasol. The database is also designed to track comments that have the potential to influence the ongoing development of the design and operations of the Project.

2.3 Public Consultation Program

2.3.1 Identified Communities and Stakeholders

The Project is located in AlH on private land that was recently the subject of a full EIA and public consultation program for an oil sands upgrader. The region is zoned for industrial use and, as a consequence, has undergone numerous and extensive public engagement initiatives. Potentially affected communities and stakeholders and their issues and concerns are therefore well-known. This served as a starting point for developing the community and stakeholder list for the Project. Previous EIAs and their public consultation programs—especially the EIA completed for the site where the GTL facility will be built—were reviewed. These reviews provided Sasol with insights into regional issues and concerns and an initial list of potentially affected communities and stakeholders.

The preliminary community and stakeholder list was then supplemented through a search of land titles within 5 km of the Project site boundary. The revised list was entered on the community and stakeholder contact database in a way that allows Sasol to identity crown disposition holders, local authorities, landowners, occupants and residents within 3 km and 5 km of the Project site boundary.

The community and stakeholder list is continually updated for accuracy and to add new contacts. The list currently comprises 713 entries. For a summary of the community and stakeholder list, see Table 2-2.

Appendix 2A provides a chronology of community and stakeholder contacts, excluding contacts at the open house held on September 26, 2012 in Fort Saskatchewan.
Table 2-2  Community and Stakeholder List – Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Community or Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents and landowners within 1.6 km of Project site boundary</td>
<td>17</td>
</tr>
<tr>
<td>Residents and landowners between 1.6 km and 5 km of Project site boundary</td>
<td>111</td>
</tr>
<tr>
<td>Stakeholders with direct interest in the Project lands</td>
<td>Access Pipeline; Alliance Pipeline Ltd.; Corridor Water Services Commission; Enbridge Pipeline Inc.; Fortis Alberta; Gulf Chemical &amp; Metallurgical; Hutterian Brethern Church of Scotford; InterPipeline (Corridor) Inc.; LAMCO Gas Co-Op Ltd.; Nova Gas Transmission Ltd.; Pembina Pipeline Corporation; Praxair Canada Inc.; Province of Alberta; Shaw Cable Systems; Shell Canada; Suncor Energy Services Inc.; Telus; Westcan Wireless</td>
</tr>
<tr>
<td>Subsurface Disposition Holders</td>
<td>Britt Resources; Encana Corporation; Redwater Energy; Gary Groves Westover; John Willis Westover</td>
</tr>
<tr>
<td>Businesses</td>
<td>Aim Pumps &amp; Procurement Inc.; ATCO Energy Solutions Ltd.; Boysdale Camp Foundation; Cactus Holdings Ltd.; CCS Corporation; CN Railway; CN Worldwide Distribution Services (Canada) Inc.; Echo Lane Farms Ltd.; Fort Industrial Estates Ltd.; Fort Industry Management Corp Ltd.; Fort Saskatchewan Ethylene Storage Corporation; GFL Holdings LTD.; Green Leaf Farms Ltd; Hall's Auto and Truck Parts (2001) Ltd.; Harvest Operations Corp.; Hydro Scotford; Josephberg Properties Inc.; Josephburg Airport - TBRR Holdings; Keyera Energy Ltd.; Lan-gees Investments Corp.; Manderley Turf Products INC.; Masterblasters; Norbest Farms LTD.; PBR&amp;R Holdings LTD.; Pembina NGL Corporation; Petrogas Energy Services Ltd.; Phoenix Land Services; Provident Energy; Reperio Resources Corp.; Ryzac Holdings LTD.; S &amp; D Fort Saskatchewan Industrial Park Ltd.; Strathcona County No. 20; TBRR Holdings; Tempo Gas Station; Triple Five International Developments LTD.</td>
</tr>
<tr>
<td>Industry</td>
<td>Air Liquide Canada Inc.; Amoco Canada Petroleum Company LTD; AltaLink LP; ATCO Gas and Pipelines Ltd.; Aux Sable Canada Ltd; BA Energy (Value Creation Inc.); BP Canada Energy; Canadian Pacific Railway; Canexus Chemicals Canada LP; Dow Chemical Canada ULC ; CH2M Hill; Enhance Energy Inc.; Fortis Alberta; Fort Hills Energy Corporation c/o Petro-Canada Oil Sands Inc.; Gibson Energy Partnership Ltd.; Guardian Chemicals Inc.; Imperial Oil; North West Redwater Partnership; Kinder Morgan Canada Inc.; Plains Midstream Canada ULC; Nova Chemicals Ltd.; Prospec Chemicals; Ltd. Rio Tinto (Alcan); Shell Chemicals Canada; Statoil Canada Ltd.; Total E&amp;P Canada Ltd.; TransAlta; TransCanada Pipelines; Williams Energy (Canada), INC.</td>
</tr>
<tr>
<td>Municipal and regional government</td>
<td>City of Edmonton; City of Fort Saskatchewan; Lamont County; Strathcona County; Town of Bruderheim; Town of Gibbons; Town of Redwater; Town of Bon Accord.</td>
</tr>
<tr>
<td>Provincial government</td>
<td>Alberta Economic Development Authority; Alberta Education; Alberta Energy; Alberta Enterprise and Advanced Education; Alberta Environment and Sustainable Resource Development Energy; Resources Conservation Board; Alberta Health Services; Alberta Human Services; Alberta Innovates; Alberta International and Intergovernmental Relations; Alberta Tourism and Innovation; Alberta Treasury Board and Finance; Alberta Transportation</td>
</tr>
<tr>
<td>Federal government</td>
<td>Canadian Environmental Assessment Agency; Citizenship and Immigration Canada; Environment Canada; Industry Canada; Fisheries and Oceans Canada; Foreign Affairs and International Trade Canada; Natural Resources Canada</td>
</tr>
</tbody>
</table>
Table 2-2  Community and Stakeholder List – Summary (cont’d)

<table>
<thead>
<tr>
<th>Category</th>
<th>Community or Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Associations and Organizations</td>
<td>Alberta Health Services; Elk Island Catholic Schools; Elk Island Public Schools; Family &amp; Community Support Services – City of Fort Saskatchewan; Heartland Emergency Services Hall (Station #4); Josephburg Agricultural Society; Nanaksar Gurdwara - Gursikh Temple; University of Calgary – PES; Portage College</td>
</tr>
<tr>
<td>Business/Industry Associations and Organizations</td>
<td>Alberta Capital Region Wastewater Commission; Alberta Chamber of Resources; Alberta Economic Development Authority; Alberta Industrial Heartland Association; Canadian Association of Petroleum Producers; Canadian Petroleum Producers Institute; Canadian Society for Unconventional Resources; Chemistry Industry Association of Canada; Fort Air Partnership; Fort Saskatchewan Chamber of Commerce; Industrial Gas Consumers Association of Alberta; Northeast Capital Industrial Association; Northeast Region Community Awareness Emergency Response; Strathcona Chamber of Commerce; Strathcona Industrial Association</td>
</tr>
<tr>
<td>Non-government organizations (NGOs)</td>
<td>Alberta Conservation Association; Almount Emissions Inc.; Citizens for Responsible Development – River Valley Alliance; Fort Saskatchewan Naturalist Society; North Saskatchewan Watershed Alliance; Sherwood Park Fish and Game Association; Ducks Unlimited; Pembina Institute</td>
</tr>
<tr>
<td>Aboriginal</td>
<td>Alexander First Nation; Saddle Lake First Nation</td>
</tr>
</tbody>
</table>

2.3.2 Consultation Activities

The public consultation program in phase 2 comprised a mix of activities that were designed and implemented to support the following key program goals:

- to create awareness of Sasol
- to create awareness of Sasol Limited, its international experience, GTL technology and commitment to value-add processing and related benefits
- to ensure that potentially affected communities and stakeholders can access information on a timely basis to help them understand the Project and its effects

The following public consultation activities were undertaken:

- distributing Project information and updates using the postal system, couriers and Internet
- holding face-to-face meetings
- advertising
- interacting through telephone, email and written correspondence
- holding an open house
- giving community presentations
- participating in community events
- establishing a community relations office in Sherwood Park
- establishing and promoting a toll-free number for information
- providing fact sheets, brochures and other information materials on Sasol Canada’s website
2.3.2.1 **Consultation Materials**

Information materials were developed to support the public consultation program, including a public disclosure document, fact sheets, brochures and advertisements. The program was further supported by regulatory materials such as the pTOR and final TOR, which were placed on Sasol Canada’s website. In support of the program’s monitoring and evaluation, Sasol will assess the need for updating or augmenting its consultation materials. For copies of consultation materials, see Appendix 2B.

2.3.3 **Community-Based Consultation Activities**

2.3.3.1 **Open House**

An open house was held at the Dow Centennial Centre in Fort Saskatchewan on September 26, 2012. An estimated 150 stakeholders attended the event. The three-hour event was promoted through:

- direct mail using community and stakeholder contact database lists
- paid advertising in 14 regional and local daily and weekly newspapers
- e-invitation to an expanded government and industry list
- copies of the open house newspaper ad in the pTOR information packages distributed to public venues
- electronic signboard advertising onsite at the Dow Centennial Centre
- Sasol Canada website

Analysis of the participant registration forms showed that, of the attendees:

- 24% identified themselves as industry representatives
- 23% identified themselves as residents in AIH
- 18% identified themselves as government representatives
- 15% identified themselves as workers in AIH
- 6% identified themselves as representatives of non-government organizations (NGOs), including environmental groups
- 4% identified themselves as landowners
- 1% identified themselves as representatives of environment organizations
- 12% self-identified as *other*, which included representatives of non-specified businesses, First Nations or the news media
Representatives from Sasol and Sasol Limited’s South Africa office attended the open house to meet attendees and answer questions about the company and the Project. The open house included information display boards and take-away materials about the socio-economic benefits of the Project, the environmental benefits of GTL technology and Sasol’s international operations. The open house also included formal presentations and a question-and-answer component. The results of the on-site participant evaluation survey showed that:

- of the 71% of respondents who asked questions during the event, 94% said they were satisfied with the information provided by Sasol
- 90% of the respondents who commented on the information provided by Sasol at the open house said it helped them to formulate questions
- 52% of the respondents indicated they wanted follow-up contact with Sasol

Contact information for these respondents was recorded, and in all cases Sasol followed up. Questionnaire forms were also used at the open house to record questions that required follow-up information or action by Sasol. The required follow up was completed successfully. The open house evaluation form showed that 99% of respondents rated the event as either excellent or good.

2.3.3.2 Collaboration with Government

**Federal Government**

Sasol has held face-to-face meetings with senior government officials in several federal departments, including Natural Resources Canada (NRCan), Industry Canada (IC) and Citizenship and Immigration Canada (CIC) (see Appendix 2A for additional information). The purpose of the meetings was to introduce Sasol and its global operations, its commitment to higher value added processing of natural resources and its interests in building Canada’s first GTL facility in Alberta. The discussions provided an opportunity to learn about the federal government’s policies and intentions with respect to foreign investment in Canada’s energy sector and its strategies and policies in areas of relevance for the Canada GTL Project.

In addition, Sasol met with the federal Member of Parliament (MP) for Edmonton Sherwood Park, the constituency where the Project is located.

Sasol met with the Canadian Environmental Assessment Agency (CEA Agency) on October 4, 2012 to review Project information. On November 1, 2012, Sasol received a letter from the CEA Agency advising that a federal environmental assessment under the Canadian Environmental Assessment Act (CEAA 2012) was not required because the Project did not meet the definition of a designated project under CEAA 2012.

**Provincial Government**

Sasol has met with elected officials and senior officials from the Government of Alberta. The purpose of the meetings was to introduce Sasol and Sasol Limited’s global operations, its commitment to higher value added processing of natural resources and its interest in building Canada’s first GTL facility in Alberta. The discussions provided an opportunity to learn about the provincial government’s policies and
intentions with respect to foreign investment in Alberta’s energy sector and its strategies and policies in areas of relevance for the Canada GTL Project. In November 2012, Sasol had the opportunity to have a face-to-face meeting with the Premier of Alberta to discuss the Project and its benefits for the province. See Appendix 2A for additional information.

Sasol has met with Members of the Legislative Assembly (MLAs) representing Fort Saskatchewan-Vegreville, Sherwood Park and Strathcona-Sherwood Park to provide updates on Project activities.

Sasol has built a positive relationship with the Government of Alberta and is a strong supporter of the province’s commitment to value-added processing. Sasol will continue to share its international experiences and best practices with provincial officials and to keep them aware of Project activities and planning.

**MUNICIPAL GOVERNMENT**

Sasol has worked closely with elected officials and senior staff of the member governments of Alberta’s Industrial Heartland (AIH), especially Strathcona County and Fort Saskatchewan. These discussions were for the purpose of exchanging information to create awareness and understanding of the Project’s economic benefits to the region. The relationships that have been built provide a solid foundation for further discussions as the Project proceeds through the regulatory review and approval process. As a result of these discussions, Sasol has a better understanding of regional issues and priorities. This information will be helpful to Sasol as the Project proceeds in ongoing design and planning, including discussions related to community investment.

Sasol has met with elected officials and senior staff of the City of Edmonton to discuss the Project and the opportunities it could create for Edmonton and the Capital Region. In addition to face-to-face meetings, Sasol has made presentations to the Board of the Alberta’s Industrial Heartland Association (AIHA), an organization of municipalities dedicated to sustainable eco-industrial development. Its membership comprises the Mayors of Strathcona County, Fort Saskatchewan, Sturgeon County, Lamont and the City of Edmonton. Its three associate members include the Mayors of the Town of Bruderheim, Gibbons and Redwater. Sasol has also made presentations at community events such as “Life in the Heartland” and Chamber of Commerce events in Sherwood Park and Fort Saskatchewan.

**2.3.3 Collaboration with Aboriginal Community**

The Project disturbance area (PDA) falls exclusively on private land. ESRD has directed Sasol to inform and periodically meet with Saddle Lake First Nation to discuss the Project and any potential effects it might have on its community members. Sasol sent the Project’s public disclosure package to the Chief of Saddle Lake First Nation and invited the Chief to the Open House held on September 26, 2012 at the Dow Centennial Centre in Fort Saskatchewan.

On November 2, 2012, Sasol met with the Consultation and Traditional Land Use Director of Saddle Lake First Nation to discuss the Project and to learn more about the interests and priorities of this First Nation community. The meeting was very helpful to Sasol and a commitment was made to have a follow-up meeting to continue the discussion about opportunities for Saddle Lake First Nation’s involvement in the Project during its construction and operational phases.
Sasol has also met with representatives of Alexander First Nation for the purpose of sharing information about the Project and GTL technology. Sasol was given information about the Alexander First Nation and the importance it places on employment and training, sustainability and developing new economic opportunities for its members, including partnerships with industry.

2.3.3.4 Collaboration with Industry

Consultations with various industry players in AIH as well with supporting service providers for major projects have taken place since 2010 through mail, e-mail, phone calls or face-to-face meetings. In addition, Sasol has made presentations at various industry conferences to explain the Project and its economic benefits, and followed up with interested parties by providing information by mail, e-mail, phone calls or through face-to-face meetings. Sasol has identified and established contact with all companies with right-of-way interests affected by the Project, including pipeline rights holders (see Table 2-1), for the purpose of collaborating on arrangements for coordinating Project requirements. A database has been developed to record businesses and suppliers who have expressed interest in participating in business opportunities created by the Project.

2.3.3.5 Collaboration with Environmental Groups

Sasol has met with the Pembina Institute to discuss GTL technology and the environmental benefits of this technology over traditional refining methods. The Pembina Institute invited Sasol to participate in an invitation-only government/industry forum in British Columbia on energy development and environmental responsibility. On November 6, 2012, Sasol met with the Pembina Institute to discuss the forum results and to share additional information on GTL technology. See Appendix 2A for additional information.

2.3.3.6 Collaboration with Non-government Organizations

Sasol continues to identify and assess opportunities for engagement with non-government organizations (NGOs). To date Sasol has engaged with the following NGOs:

- Northeast Capital Industrial Association (NCIA). Sasol has been an association member since January 2013.

- Canadian Manufacturers and Exporters (CME) – Sasol met with representatives from CME to discuss the opportunities and challenges of investing in Canada and the strengths of the CME working with governments to address issues affecting the competitiveness of companies operating in Canada.

- Chemistry Industry Association of Canada (CIAC) – Sasol had initial discussions with the CIAC about its activities in relation to supporting the chemistry industry in Canada. Sasol provided the CIAC with information on GTL technology and explained the economic benefits of the Project to Canada and its synergies with chemical operations in the region.

Additionally, Sasol has exchanged information with the North Saskatchewan Watershed Alliance to explain GTL technology and to respond to questions related to water use in the region. Sasol is a member of the Canadian Society of Unconventional Resources (CSUR). Sasol is also a member of the
Calgary Chamber of Commerce and is seeking membership with the Chambers in Sherwood Park and Fort Saskatchewan in 2013.

### 2.3.3.7 Regional Collaboration

Sasol understands the importance of regional collaboration and recognizes that participation in regional initiatives can be an effective strategy for understanding and mitigating local and regional concerns associated with the Project and industrial development in AIH. Sasol is a member of the NCIA, and is also committed to participating in further regional associations and organizations as Project planning and development advances. For a detailed discussion of Sasol’s commitments and intentions with respect to its support for regional collaboration, see Volume 2, Section 16.5.2.

### 2.4 Public Consultation Program Outcomes – Summary

To date, community and stakeholder environmental and socio-economic issues and concerns have been initially identified and in some instances have been resolved. See Table 2.3 for a summary of community and stakeholder concerns that have been identified, and Sasol’s responses. This input from communities and stakeholders has been important. Section 2.5 summarizes how public input has influenced the Project. Appendix 2A provides a chronology of Sasol’s contacts with communities and stakeholders.

#### Table 2-3 Community and Stakeholder Concerns Expressed to Date

<table>
<thead>
<tr>
<th>Concern</th>
<th>Description</th>
<th>Sasol Response</th>
</tr>
</thead>
</table>
| Air quality                    | • Additional industrial projects will increase air emissions, further contributing to a decline in air quality  
<pre><code>                             | • Uncertainty surrounding air emissions associated with gas-to-liquids technology                                                            | The TOR for the Project’s EIA requires an assessment of the Project’s effects on air quality. The Project will comply with all applicable regulatory requirements, including ongoing monitoring and reporting. Mitigation measures to reduce effects on air quality will be incorporated and presented in the application for regulatory approval. (See Volume 2, Section 3.) |
</code></pre>
<p>| Employment and vendor opportunities | Community expectations that local residents and businesses will benefit from new industrial development | The Project workforce will be sourced according to the following priorities: capital region, Alberta, Canada and internationally, if needed. Sasol will continue to refine its hiring and procurement policies with the aim of identifying contracting and employment opportunities for qualified Alberta workers and businesses. (See Volume 2, Section 16.) |</p>
<table>
<thead>
<tr>
<th>Concern</th>
<th>Description</th>
<th>Sasol Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental monitoring</td>
<td>Community concerns that there is insufficient monitoring of environmental effects of industrial operations</td>
<td>Sasol understands the importance of rigorous environmental monitoring. Sasol will comply with all regulatory requirements for monitoring. The Canada GTL Project regulatory application will include commitments for responsible monitoring and reporting environmental effects. (See Volume 1, Sections 3 and 5 and Volume 2, Sections 3 to 13.)</td>
</tr>
<tr>
<td>Flaring</td>
<td>Community concerns about safety</td>
<td>GTL facilities are inherently safe and have a number of measures to ensure safe operation under all scenarios. Flaring is used as a safety measure for off-gas disposal during upset scenarios. Sasol will comply with all regulatory requirements for flaring. (See Volume 1, Section 3.)</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Community concern that industrial facilities may adversely affect the quality and quantity of groundwater</td>
<td>The TOR for the Project’s EIA specifically requires an assessment of the Project’s effects on groundwater. Sasol will identify and present mitigation measures to address any issues or concerns identified in the EIA report, including groundwater monitoring during the construction, operational and decommissioning phases of the Project. Sasol will comply with all regulatory policies, directives and related requirements. (See Volume 2, Section 6.)</td>
</tr>
<tr>
<td>Light pollution</td>
<td>Community concern that nighttime light from industrial facilities create light trespass, glare or sky glow, causing nuisance, distraction and potential safety issues</td>
<td>The Project’s EIA will include a light impact assessment. Sasol will include in its regulatory application a number of measures to reduce light effects. Sasol is also committed to continuing assessment of the need for additional measures as the Project progresses through the design and development and regulatory process. (See Volume 2, Section 5.)</td>
</tr>
<tr>
<td>Noise from Project operations</td>
<td>Community concerns that new industrial projects will result in increased noise levels creating nuisance and potential adverse health and safety risks to humans and wildlife</td>
<td>The TOR specifically requires an assessment of the Project’s noise effects. The assessment will include effects associated with railway traffic noise. Sasol will comply with all applicable regulatory policies and directives on noise. Sasol will respond and take action to manage any noise complaints received. As part of the noise assessment, Sasol will determine measures to reduce noise (see Volume 2, Section 4).</td>
</tr>
<tr>
<td>Concern</td>
<td>Description</td>
<td>Sasol Response</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Odour</td>
<td>Community concern about nuisance odours from industrial facilities</td>
<td>Sasol will create a public reporting protocol to allow community members to report odours. Sasol will address concerns raised. (See Volume 1, Section 5.3.23).</td>
</tr>
<tr>
<td>Safety</td>
<td>Production of hydrogen sulphide and preparedness for emergencies</td>
<td>The GTL facility will produce small amounts of hydrogen sulphide. Sasol, like all operators of industrial facilities in AIH, will be required to have an approved emergency response plan. Sasol is also committed to working with local and provincial authorities and with other industrial operators and stakeholders in AIH on coordinated planning and responses to deal with emergencies. (See Volume 1, Section 5.9.)</td>
</tr>
<tr>
<td>Traffic</td>
<td>Community concerns that new industrial projects result in increased traffic causing delays and safety issues</td>
<td>Sasol is aware of community concerns related to the effects of new projects on local traffic. Sasol will undertake a Traffic Impact Assessment to more specifically identify the effects of the Canada GTL Project on local traffic. Sasol will also undertake a number of measures to reduce or manage traffic effects, including extensive use of bussing to transport workers to and from the Project site; staggered shift schedules and scheduling deliveries during off-peak periods.</td>
</tr>
<tr>
<td>Visual aesthetics</td>
<td>Residents’ concerns about the aesthetic qualities of their community</td>
<td>Sasol is aware of community interest in the visual appearance of the GTL facility. Opportunities for community feedback will be provided.</td>
</tr>
<tr>
<td>Water</td>
<td>Community concerns regarding water use and conservation, especially water drawdown from North Saskatchewan River</td>
<td>Sasol is committed to responsible water use and is designing the Canada GTL facility with a view to maximizing water efficiency through recovery and reuse of water, minimizing raw water intake and effluent generation, and supporting water efficiency management practices. For more information. (See Volume 1, Section 3.15.2.)</td>
</tr>
</tbody>
</table>
2.4.1 Public Consultation Influence on the Project

The feedback and comments received through the public consultation program influenced the Project in several noteworthy ways. Modifications have been made to the plot plan to enhance mitigation measures to reduce traffic effects related to site access. Community concerns related to light and noise influenced the mitigations measures identified in Volume 2, Section 4 and Section 5. Similarly, concerns regarding flaring influenced Sasol’s approach outlined in Section 3.6.2. Community feedback on concerns about raw water withdrawal from the North Saskatchewan River and water recovery and reuse reinforced Sasol’s commitment to water efficiency. Comments relating to community expectations to participate in the Project’s economic opportunities influenced Sasol’s commitments for sourcing workers and suppliers for the Project. Community contacts and relationships established to date provide a positive foundation for ongoing dialogue with stakeholders.

2.5 Commitment to Continuing Consultation

Sasol recognizes that the Project is at an early stage in the regulatory review and approval process. In phase 3 of the public consultation program, Sasol will continue to create opportunities for stakeholders to enhance their understanding of GTL technology and the Project. Sasol will also continue to seek ways to incorporate the community and stakeholder feedback it receives.

Sasol’s public consultation program is built on the principle that affected communities and stakeholders will have ongoing opportunities to learn about the Project, to ask questions and offer comments about issues or concerns. To date, the program is viewed as having:

- established relationships with communities and stakeholders in AIH
- identified initial issues and concerns

The Project has established a foundation that will support Sasol’s commitment to continual consultation throughout the Project’s life.

A summary of Sasol’s commitments to communities and stakeholders for continuous and meaningful consultation on the Project follow:

- Will continue to meet or exceed regulatory requirements for community and stakeholder consultation, including all requirements for Aboriginal consultation.
- Will keep regulators updated on the status of the Project’s consultation activities.
- Will continue to monitor, adjust and implement the public consultation program to fulfill the Program’s guiding principles and goals.
- Will maintain, update and expand the community and stakeholder list.
- Will continue to advertise and promote Project information events to support awareness and public participation.
- Will continue to engage communities and stakeholders in meaningful and timely discussions to enhance understanding of Project-specific issues and concerns and to identify mutually acceptable mitigation.

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• Will assess the need for expanding consultation with stakeholder groups as the Project progresses to detailed planning.
• Will identify partnership opportunities with regional organizations as the Project transitions to detailed design planning and development.
• Will hold an open house in fall 2013.
• Will continue to learn and gather information about community investment preferences, priorities and requirements to support the development of a corporate social investment (CSI) plan for the Project when it transitions to construction and operational phases.

2.5.1 Public Consultation Program – Next Stage

Phase 3 of the Program will continue community and stakeholder relationship-building, beginning with the notice of application. This process will provide Sasol with additional insight into how the public views the Project. Sasol will work diligently to address specific concerns brought to its attention through this process and will keep regulators informed of the progress it makes in achieving mutually acceptable resolution of identified issues and concerns. Sasol will continue to provide regular updates on the Project’s ongoing development through face-to-face meetings, distribution of materials using various media and participation in public events and group presentations. It will organize and publicize an open house in fall 2013. It will continue to monitor, adjust and augment its consultation activities to ensure that the principles and goals of the public consultation program are met.

2.5.2 Contributing to Community Quality of Life

Sasol Limited takes pride in its goal to be a company that stakeholders and communities view positively as a responsible corporate citizen. In part, this goal is achieved through Sasol Limited’s policy commitment and support for community development and corporate social investment (CSI). Its investments in communities focus on sustainable development, and are people-centred and needs-driven. Examples include support for assessing community needs and priorities, community involvement, leadership development and capacity building. For more detailed information on Sasol Limited’s CSI commitment and policy, see Section 5.2.

As a company new to Canada, and at the earliest stage of seeking regulatory approval for its first Canadian project, Sasol is learning about Alberta and AIH. The opening of its community relations office in Sherwood Park and its ongoing discussions and meetings with residents, organizations and government officials are providing Sasol with the important input it will need to formulate a CSI plan to support the Project. Sasol understands that the Project can positively contribute to the quality of life in Alberta and AIH, and is committed to ensuring it does. The Project’s CSI program will be developed to best reflect:

• the information Sasol is gathering about regional needs, priorities and opportunities for community investment
• input from Sasol staff and adherence to corporate goals and policies
3  PROCESS DESCRIPTION

3.1  Introduction

The section discusses:

- the process configuration of the GTL facility
- Sasol Limited’s proprietary Slurry Phase Distillate™ process
- the process descriptions of each of the process units of the Canada Gas-to-Liquids Project (the Project)
- mass and energy balances with materials requirements and measurements
- GTL facility feedstock, products and byproducts
- plot plan and considerations during design with regard to health safety and the environment
- alternatives considered in the design of the Project

3.2  Project Overview

The Project will include a Gas-to-Liquids facility (GTL facility), which will use Sasol Limited’s proprietary Slurry Phase Distillate™ (SPD™) process (see Section 3.3) to convert natural gas into three liquid fuels:

- GTL diesel
- GTL naphtha
- liquefied petroleum gas (LPG)

The GTL facility will be constructed in two phases, with each phase designed for a nominal production capacity of 48,000 barrels per day, or 96,000 barrels per day when both phases are operational. This production capacity converts to 103,900 barrels per stream day through process optimization opportunities associated with product specifications and local conditions. The products produced at the GTL facility will serve the fuel market needs of western Canada and, over the long-term, potentially market needs elsewhere in North America. For a summary of the Project’s key capacities, see Table 3-1. For an overview of the GTL facility, see Figure 3-1. The products produced at the GTL facility are very low in sulphur and aromatics. Since the Project will be constructed in two phases, construction of the processing units will also be phased. Construction phasing is discussed in Section 4 (see Table 4-1).
Utility system and offsite facilities

Fuel system

Steam, condensate, BFW & power systems

Water & effluent systems

Offsite facilities

Raw water

Brine

Power

Evaporation

Natural gas

GTL diesel

GTL naphtha

Air separation unit

Hydrogen production unit

Hydrogen

Supporting units

Oxygen

LPG

Step 1: NG reforming

Synthesis gas unit

Heavy ends recovery unit

Synthesis gas unit

Heavy ends recovery unit

Synthesis gas unit

FT synthesis unit

FT synthesis unit

Water treatment unit

Water treatment unit

Product upgrading unit

Product upgrading unit

Figure 3-1   Facility Overview
Table 3-1  Key Capacities of the GTL Facility (includes both Phases)

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Units</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>MMSCFD</td>
<td>989</td>
</tr>
<tr>
<td>Raw water</td>
<td>ML/d</td>
<td>22.5</td>
</tr>
<tr>
<td>GTL diesel</td>
<td>BPSD</td>
<td>75,400</td>
</tr>
<tr>
<td>GTL naphtha</td>
<td>BPSD</td>
<td>27,800</td>
</tr>
<tr>
<td>LPG</td>
<td>BPSD</td>
<td>700</td>
</tr>
<tr>
<td>Peak power export</td>
<td>MW</td>
<td>99</td>
</tr>
</tbody>
</table>

NOTES:
1 Raw water usage includes water required for the prospective carbon capture unit. Use before carbon capture unit installation is 14.3 ML/d.
2 Surplus power is variable depending on the operating scenario and seasonal power requirement differences.

MMSCFD = Million standard cubic feet per day
ML/d = Million litres per day
BPSD = barrels per stream day
MW = megawatts

Natural gas will be sourced from existing Canadian natural gas networks.

Except for start-ups, the GTL facility will be self-sufficient for its power needs, producing steam-generated electricity from off gases and waste heat recovered from the SPD™ process. Surplus power is variable depending on the operating scenario and seasonal power requirement differences. Excess power will be sold to the provincial power grid through AltaLink’s power transmission system.

Water efficiency is a key priority to Sasol and specifically a core design feature of the Project. The GTL facility will produce water and is designed to reuse it. The Project’s raw water needs will be sourced from a third-party intake structure on the North Saskatchewan River. There is no requirement for a river effluent outfall. Brine water generated will be managed through onsite deep well disposal. Approval for the disposal well and scheme will be sought in a separate application to the Energy Resources Conservation Board (ERCB).

The Project will be connected to external infrastructure that includes natural gas, raw water, product pipelines, a high voltage electric power line and telecommunications interfaces. Transportation system interfaces include primary site access from Range Road 220 and the construction of rail connections to Canadian Pacific and Canadian National railway systems. GTL diesel will be distributed to market by rail, and GTL naphtha and LPG will be transported by pipeline.

3.3  Sasol Slurry Phase Distillate™ Process

Sasol’s SPD™ process is a combination of Haldor Topsøe’s auto-thermal reforming, Sasol’s slurry phase Fischer Tropsch (FT) and Chevron’s hydrocracking and hydrotreating technologies, designed to convert natural gas into world leading quality fuel products. The process is well suited to the production of GTL diesel and GTL naphtha. All three technologies are commercially proven.

A high level overview of the three step Sasol SPD™ process is provided in Section 1 (see Figure 1-1).
The SPD™ process involves three steps:

1. Natural gas is combined with oxygen to form a synthesis gas using auto-thermal reforming technology.
2. Synthesis gas is converted by Fischer Tropsch synthesis to a broad-range hydrocarbon stream, also called waxy synfuel.
3. The waxy synfuel is processed into GTL diesel, GTL naphtha and LPG by mild hydroprocessing and hydrocracking.

To provide the oxygen to support the reforming process, air separation technology is also inherently essential to, and a substantial component of, the process. The air separation unit (ASU) is typically based on a cryogenic air separation technology that also supplies nitrogen, plant and instrument air.

For a more detailed block flow diagram, see Figure 3-2. Additional details regarding process descriptions (see Sections 3.3.1 to 3.3.5), descriptions of the supporting units (see Section 3.4), utility descriptions (see Section 3.5) and offsite facility descriptions (see Section 3.6) are also provided.

### 3.3.1 Synthesis Gas Unit

The synthesis gas unit (SGU) (see Figure 3-3) produces synthesis gas, (a mixture of mainly hydrogen and carbon monoxide), by reacting natural gas with steam and oxygen. Haldor Topsøe ATR proprietary technology is used for the synthesis gas unit. The unit operates with natural gas and external recycle gas from the heavy ends recovery unit (HERU) as hydrocarbon feed sources for the process. Steam, oxygen and a small amount of hydrogen make up the other feed streams to the unit. Three identical synthesis gas trains (i.e., three ATRs) will be built in each of the two Project phases. A common process condensate stripper will be used for each phase of three trains.

The trace amounts of sulphur species in the natural gas from the pipeline network are converted to hydrogen sulphide through hydrogenation and then removed from the gas through catalytic absorption. The sulphur-free natural gas is fed to the prereformer to reform heavier hydrocarbons. Hydrogen used to remove the sulphur from the natural gas is sourced from the hydrogen production unit and routed via the product upgrading unit.

External recycle gas is recycled from the HERU. First the external recycle gas is compressed and then conditioned in the gas conditioning vessel, after which it is routed to the auto-thermal reformer (ATR).
Figure 3-2   Sasol SPD™ Process

NOTE: For information on stream destination, see Table 3-3.
Figure 3-3  Synthesis Gas Unit
The combined prereformed natural gas and conditioned external recycle gas streams, in the presence of steam and oxygen, are reformed in the ATR to produce synthesis gas. The synthesis gas is cooled in three stages. Most of the heat is recovered through the generation of high-pressure steam. Most of the generated steam is routed to the users, although a small portion is used internally in the SGU.

Water is condensed and separated from the synthesis gas in the process condensate separator and sent to the process condensate stripper. In the process condensate stripper, dissolved gases are stripped from the process condensate with steam. Steam leaving the stripper is used internally in the unit. A small part of the stripped process condensate is used as washing water in the process condensate separator and the balance is sent to the effluent bio-treatment unit for treatment. The treated water is reused in the water systems.

Boiler blow down (from the generation of high-pressure steam) and hot condensate from the process heaters are recovered and reused after treatment in the condensate polishing system. The collection of SGU water, boiler blow down and hot condensate is referred to as SGU condensate.

### 3.3.2 Fischer Tropsch Synthesis Unit

The FT synthesis unit (see Figure 3-4), converts synthesis gas from the SGU to wax and hydrocarbon condensate (collectively called waxy synfuel). Water is produced in the synthesis process and is separated from the hydrocarbon streams. The FT water is processed in the water treatment unit followed by the bio-treatment unit for reuse.

Synthesis gas from the SGU is mixed with the internal recycle gas before being fed to the FT synthesis vessel. The FT synthesis vessel contains a slurry phase fluidized bed with Sasol proprietary catalyst suspended in the wax. Wax is separated from the catalyst and wax slurry and withdrawn from the vessel. The withdrawn wax is cooled with boiler feed water and treated in the wax treatment system to prepare the wax for processing in the product upgrading unit. After treatment, the wax is routed to intermediate tankage and the product upgrading unit. A solid waste material is generated in the wax treatment process, which is placed in covered bins and sent to the thermal oxidizer.

The synthesis vessel overhead product is cooled in the overhead cooler and separated into three streams, FT water, hydrocarbon condensate and FT tail gas. The FT water stream is routed to the water treatment unit for recovery of oxygenated hydrocarbons for use as liquid fuel before the water is sent for further treatment in the effluent treatment unit before reuse in the water system. The hydrocarbon condensate stream is sent to the HERU for stabilization. The FT tail gas stream is split between the internal recycle gas and FT tail gas to the HERU to recover heavier hydrocarbons.

Heat generated in the synthesis process is recovered through the production of medium-pressure steam in internal steam coils. Medium pressure steam is sent to the steam system. Boiler feed water used in the production of medium-pressure steam is first preheated by cooling the wax thereby increasing the heat recovered and energy efficiency of the unit.
Figure 3-4  Fischer Tropsch Synthesis Unit
3.3.3 Heavy Ends Recovery Unit

The HERU (see Figure 3-5) has two main purposes. Firstly, heavier hydrocarbons from the FT tail gas are recovered by cooling the gas. The HERU also strips CO, CO₂ and other light gases from recovered hydrocarbon condensate streams before routing to the product upgrading unit.

FT tail gas is cooled to condense heavier hydrocarbons. Liquids in the stream are knocked out in the wet condensate knockout drum and sent to the hydrocarbon condensate holdup drum. The gas stream from the knockout drum is washed in the water wash tower using demineralized water to remove any trace levels of organic acids and oxygenated hydrocarbons in the gas. After use, the wash water is combined with the water from the wet condensate drum and sent to the water treatment unit. The tail gas from the wash water tower is dried in the molecular sieve drier system.

The dried tail gas passes through the main cryogenic exchanger to the dry condensate rectifier where additional hydrocarbons are condensed and recovered. The main cryogenic exchanger is used for heat integration around the dry condensate rectifier to optimize the refrigeration package requirements. The amount of hydrocarbon condensate recovered is maximized.

The dry condensate rectifier is a distillation column designed to maximize the recovery of heavier hydrocarbons before the remaining stream is split between being recycled to the synthesis gas unit and being used in the fuel system. Recovered hydrocarbon condensate passes through the cryogenic exchanger before being sent to the CO₂ stripper for stabilization.

Hydrocarbon condensate from the wet condensate knockout drum, hydrocarbon condensate stream from the FT synthesis unit and oxygenated hydrocarbons from the water treatment unit are combined in the hydrocarbon condensate holdup drum. The combined stream goes to the CO₂ stripper, where it is stabilized by stripping the light components from the liquid streams. The stripped light components are sent to the fuel gas system. Stripped hydrocarbon condensate is pumped to the product upgrading unit.

3.3.4 Water Treatment Unit

The water treatment unit (see Figure 3-6) is designed to degas FT water at low-pressure, skim off free oil from the water and separate oxygenated hydrocarbons from the water by distillation. For additional information on the full extent of water treatment steps used to enable water reuse, see Sections 3.5.1, 3.5.2, 3.5.4 and 3.15.2.

Water streams containing entrained free oil and dissolved oxygenated hydrocarbons will flow from FT synthesis, HERU and product upgrading unit to a collection drum. The water stream from the product upgrading unit is the only stream that contains trace amounts of sulphur. In the collection drum, the liquid feed streams are allowed to settle and the liquid is fed under gravity to the feed surge tank. Vent gases from the drum, with a small amount of sulphur, are routed to the flare system.
Figure 3-5  Heavy Ends Recovery Unit
Figure 3-6  Water Treatment Unit
In the feed surge tank, any entrained oil floats to the surface and is removed by oil skimming nozzles located on the tank. The skimmed oil layer in the tank is withdrawn and sent to an oil drum.

The water from the surge tank is pumped through a coalescer package to remove solid impurities and any remaining traces of free oil from the water stream. The separated oil is collected and sent to the oil drum. The oil-free water from the coalescer is routed to the primary separation column.

The contents of the oil drum are routed to the hydrocarbon condensate and aqueous slops tank in the intermediate tankage unit and then onto the product upgrading unit for reprocessing.

Oxygenated hydrocarbons are stripped from the water feed in the primary separation column. The oxygenated hydrocarbons which go overhead in the distillation column, are routed to the liquid fuel system and those withdrawn from the distillation column as a side stream, are sent to the HERU. The treated process water exiting the bottom of the primary column is sent to the steam and condensate system for heat recovery before being sent to the effluent bio-treatment unit for further treatment.

### 3.3.5 Product Upgrading Unit

The product upgrading unit (see Figure 3-7, Figure 3-8 and Figure 3-9) hydrocracks and hydrotreats the wax and hydrocarbon condensate before fractionating the mixed hydrocarbon stream into GTL diesel, GTL naphtha and LPG. The product upgrading unit is divided into three sections, conversion, dewaxing and LPG processing. One product upgrading unit will be constructed for each Project phase. The product upgrading unit constructed for Phase 1 will contain common dewaxing and LPG processing sections for both phases.

Intermediate storage is provided between the FT synthesis unit and HERU and the product upgrading to ensure operability and stability of the process. Wax and stabilized hydrocarbon condensate are received from the FT synthesis and HERUs via the intermediate tanks.

Sulphur is required to support the catalytic conversions and as there is no sulphur in the feed streams, trace amounts of dimethyl disulphide (DMDS) are injected into the hydrocracker and hydrotreater feed streams. The DMDS will be stored in the DMDS injection drum and will be kept under pressure through nitrogen blanketing to prevent evaporation into atmosphere. To reduce the potential for spillages during transportation or off-loading and because of the very small quantities involved, the DMDS will be stored in a drum with a one year storage capacity.

**CONVERSION SECTION**

The wax stream is preheated in the hydrocracker feed heater before being hydrocracked using Chevron’s process technology. The product of the hydrocracker is mixed with the hydrocarbon condensate feed stream before entering the hydrotreater.

The hydrotreater saturates olefins, converts oxygenated hydrocarbons to paraffins and suppresses the formation of mercaptans.
Figure 3-7  Product Upgrading Unit – Conversion Section
Figure 3-8    Product Upgrading Unit – Dewaxing Section
Figure 3-9  Product Upgrading Unit – LPG Processing Section
The hydrotreater product is cooled and sent to a separator where vapour is separated from the liquid. The vapour is rich in hydrogen, with some light hydrocarbons, and is therefore recycled to the hydrocracker and hydrotreater after compression in the recycle gas compressor.

The liquid stream from the separator is routed to the fractionator feed heater where it is heated before entering the main fractionation column and light and heavy diesel stripper system to be separated into unstabilized naphtha, light diesel, heavy diesel and unconverted oil.

Unconverted oil is recycled to the hydrocracker for reprocessing with the wax stream.

Unstabilized naphtha from the main fractionation column overhead is condensed and routed to the naphtha stabilizer where lighter hydrocarbons are separated from the liquid to produce GTL naphtha, which is routed to final product storage.

**LPG PROCESSING SECTION**

Overheads from the naphtha stabilizer are routed to the deethanizer where ethane and lighter gases are removed so that the final LPG product meets the Reid vapour pressure specification. The light gases are routed to the fuel gas system for use in the product upgrading unit. The LPG is further treated in the LPG fractionator to separate the butane from the propane. The propane product (LPG) is odourized before being routed into the transmission pipeline to a third party in the Alberta Industrial Heartland (AIH). The butane is vapourized and routed to the fuel system.

**DEWAXING SECTION**

To meet the required diesel cold flow properties, heavy diesel is routed to the dewaxer after it is preheated in the dewaxer feed heater. Before heating, hydrogen is added to the heavy diesel. The heated mixture of diesel and hydrogen enters the dewaxer where the waxy material is catalytically isomerized into isoparaffins. The dewaxer output is progressively cooled in a series of heat exchangers and sent to a separator. The hydrogen-rich vapour stream from the separator is compressed in the dewaxer recycle gas compressor and recycled. The isomerized heavy diesel is routed to the dewaxer stripper to strip off light components formed in the dewaxer. The stripped heavy diesel is combined with the light diesel from the light diesel stripper to form GTL diesel, cooled and sent to final product tankage. The dewaxer stripper overhead is cooled and a portion is used as dewaxer stripper reflux and the rest recycled back to the main fractionation column. The non-condensable light gases are routed to the fuel system for internal consumption in the product upgrading unit.

Hydrogen from the HPU is compressed and distributed to the hydrocracker, dewaxer and SGU.

Sulphur containing water produced in the product upgrading unit is removed from the process in the various separator drums, combined and routed to the water treatment unit for treatment.
3.4 Supporting Process Units

3.4.1 Hydrogen Production Unit

The hydrogen production unit (HPU) supplies hydrogen to the product upgrading unit and SGU (see Figure 3-10). The HPU will consist of two identical trains. The final HPU design will be selected based on competitive tendering with specialist suppliers offering their individual proprietary technology. A typical HPU involves the following processing steps: feed treatment, reforming, shift conversion and pressure swing adsorption (PSA).

In feed treatment, sulphur and other trace impurities in the natural gas are absorbed onto a catalyst bed. The desulphurized feed is mixed with steam and passed into the steam reformer where it is converted to synthesis gas.

Synthesis gas is sent to the shift conversion step where it is processed to increase the amount of hydrogen by reacting carbon monoxide with steam in the presence of a shift catalyst, also known as the water gas shift reaction.

On exiting the shift converter the hydrogen rich synthesis gas is routed to the PSA. The PSA operates on a repeating cycle of treating the gas to produce a pure hydrogen stream and then regenerating the adsorption material.

During the step for hydrogen production, the synthesis gas passes over one or more adsorbent beds and the solid granular adsorbent material selectively adsorbs the non-hydrogen components of the gas, leaving a high purity hydrogen product. Regeneration is the process of desorbing the absorbed components from the adsorbent materials. The desorbed gas (PSA tail gas) will be used as fuel in the unit.

3.4.2 Air Separation Unit

Through a cryogenic air separation process, the air separation unit (ASU) produces high purity gaseous oxygen and high purity nitrogen (see Figure 3-11). During normal operation, the ASU will also provide plant and instrument air. Six or more (depending on the final ASU vendor) trains will be required to supply the quantities of oxygen required.

The final ASU design will be selected based on competitive tendering with specialist suppliers offering their individual proprietary technology. This section provides a generic description of the type of ASU expected to be selected.
Figure 3-10  Typical Hydrogen Production Unit
Figure 3-11   Typical Air Separation Unit
Atmospheric air is filtered and compressed in a multistage main air compressor (MAC) before it is cooled and dried by molecular sieves. A fraction of the clean, dry air is compressed further in a booster air compressor (BAC) and cooled before entering the main heat exchanger, where it is cooled against the oxygen product stream and the waste nitrogen streams. The air pressure is reduced and air is then passed to the cryogenic high-pressure and low-pressure columns, where a pure oxygen stream is distilled from the air. The liquid oxygen from the low-pressure column is pumped to the required pressure and vaporized in the main heat exchanger before leaving the ASU to the SGU. The nitrogen from the high-pressure column also passes through the main heat exchanger before leaving the unit for distribution. The excess nitrogen is vented to atmosphere from the main heat exchanger.

The air compressors (MAC and BAC) are driven by high-pressure steam turbine drives equipped with air cooled steam condensers.

Liquid oxygen and liquid nitrogen storage and vaporization facilities are provided. The liquid oxygen will be used to back up the oxygen production in case of short term ASU train shutdowns. The liquid nitrogen storage capacity will be used to support unit or GTL facility emergency shutdown.

### 3.5 Utility System Overview

The utility systems consist of several components as follows.

**WATER AND EFFLUENT**

The water and effluent systems cover the treatment of water including raw water, treated process water and the capture and reuse of storm water for provision of water of the right qualities (including cooling, boiler feed and potable water).

FT water is treated and used as the primary source of water (see Section 3.3.4). The upgrading and use of the FT water, together with the optimal use of air coolers and the capturing, processing and recycling of water, reduces the quantity of raw water required.

**STEAM, CONDENSATE AND POWER**

The steam system manages the distribution of steam from producers to consumers. Steam is generated primarily from recovered process heat and off gases with less than 1% of steam generated through the combustion of natural gas. The condensate system is designed to recover the water after the steam was used and treats it for reuse as boiler feed water. Excess steam is routed to the steam turbine generators (STGs) to generate power for internal consumption. Power surplus from the GTL facility will be exported to the AltaLink power transmission system grid.

**FUEL**

Recovered off gases and liquid fuel are consumed by fired heaters for high-pressure steam production. The fuel system is designed to ensure that there is no surplus fuel.
3.5.1 Water and Effluent Systems

For an illustration of water and effluent systems, see Figure 3-12.

3.5.1.1 Raw Water Source

Raw water will be sourced from the North Saskatchewan River from a third party water intake structure and routed to the GTL facility for use in the utility system and as potable water. The Project will receive river raw water via a third party owned and operated pipeline.

The water requirement of 22.5 ML/d (938 m³/h) includes the needs for raw water during normal operation, start-up, shutdown and emergency scenarios for both phases in operation and allows for the water required by a future carbon capture unit. The water system will initially be installed only to serve the GTL facility’s needs before the installation of the carbon capture unit. The raw water requirement is 14.3 ML/d (597 m³/h) before the carbon capture unit installation. Rain water will be used in the GTL facility when available instead of raw water and will result in a lower raw water requirement for those periods. Rain water is stored in the storm water ponds.

3.5.1.2 Raw Water Treatment

Raw water is treated to produce the water qualities identified in Table 3-2.

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarified water</td>
<td>Fire water</td>
</tr>
<tr>
<td>Filtered water</td>
<td>Cooling tower make-up</td>
</tr>
<tr>
<td></td>
<td>ASU make make-up</td>
</tr>
<tr>
<td></td>
<td>Utility water</td>
</tr>
<tr>
<td>Potable water</td>
<td>Potable water users</td>
</tr>
<tr>
<td></td>
<td>Building fire water</td>
</tr>
<tr>
<td>Demineralized water</td>
<td>Make-up to utility and process areas</td>
</tr>
</tbody>
</table>

The treatment processes are described in the subsections following.
Figure 3-12  Water and Effluent Systems Overview
CLARIFICATION AND SAND FILTRATION

Raw water entering the GTL facility is treated by clarification to remove suspended solids (sludge). The clarified water is transferred to a set of ponds, which have sufficient capacity to store water to operate the GTL facility at full capacity for five days. These ponds also provide storage for an additional 6,500 m$^3$ fire water reserve, which can only be accessed by the fire water system. The clarified water ponds will be designed to minimize seepage in accordance with the relevant standards.

Clarified water is filtered by sand filtration and stored in a tank with capacity to store one day's filtered water requirement for the GTL facility at full operation. Filtered water is distributed to the cooling towers and for use as utility water. The balance of the filtered water is treated further to produce potable and demineralized water.

The silt from the sand filters is combined with clarifier sludge and is transferred to sludge dewatering.

SLUDGE DWATERING

Clarifier sludge and sand filter mud is thickened and dewatered in preparation for offsite disposal to a third party disposal site. The recovered water is recycled back to the clarifier.

ULTRA FILTRATION AND REVERSE OSMOSIS TREATMENT

Filtered watered is treated by ultra-filtration and reverse osmosis. The inclusion of these process steps reduces the chemical and salt consumption of the downstream demineralization step and therefore reduces the quantity of salts contained in the brine disposal stream. The reverse osmosis configuration helps to increase water recovery. A portion of the ultra-filtration permeate is treated by the potable water system. The balance of the ultra-filtration permeate is treated by reverse osmosis and sent for demineralization. The concentrate from these systems is routed to the brine system.

POTABLE WATER TREATMENT

Potable water is produced by ultraviolet sterilization of ultra-filtered water followed by final chemical disinfection to meet the required potable water standard. The potable water quality will be in accordance the Guidelines for Canadian Drinking Water Quality and Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems. The potable water system is isolated from the effluent system.

The potable water tank is sized such that it would be able supply fire water to the building sprinkler system.

DEMINERALIZATION AND POLISHING

The demineralization package consists of mixed bed resin polishers and treats two types of reverse osmosis permeate: reverse osmosis permeate derived from raw water as described above and reverse osmosis permeate from the effluent treatment system. The latter is first passed through granular activated carbon filters to remove possible organic material.
The demineralized water is distributed to the steam system as make-up to the boiler feed water system and to the various process areas. Effluent from these units is routed to the brine system.

### 3.5.1.3 Cooling Water

The cooling water system supplies cooling water to various units in the GTL facility and uses treated process water as the primary source of make-up. Additional make-up to the process cooling towers comes from treated raw water, although this is less than 10% of the total makeup to the cooling towers. The blow down is treated at the ultra-filtration and reverse-osmosis process. The recovered water is used as feed to the demineralization package. The quality of the blow down is controlled through the cycles of concentration of the cooling towers. It is anticipated that the cooling towers will operate at six cycles of concentration.

### 3.5.1.4 Effluent and Bioeffluent

The effluent treatment system treats process water (water from the HPU, condensate from ASU air intakes and treated process water from the water treatment unit) and water from drainage headers in the GTL facility. Treated effluent is reused while sludge resulting from the treatment is disposed of in the thermal oxidizer.

The GTL facility drainage systems are designed to minimize mixing of storm water and other effluents as far as practical, thereby reducing the volumes of streams to be treated. This is achieved by segregation of the streams at source (according to quality and through the design of the containment, collection and processing systems). The effluent treatment system is designed to contain a 24 hour, 1:100 year storm event. Storm water from the developed areas of the GTL facility will be captured and reused. Storm water from undeveloped areas will go through natural drainage courses to the North Saskatchewan River.

Effluent water will generally be classified into categories as follows.

**Clean Storm Water**

This is normally clean water from areas such as perimeter roads. Provision is made for clean storm water to be reused as raw water.

Developed areas will be grouped with each area draining to a localized sump from where it will be pumped to the main storm water ponds.

**Potentially Oil Contaminated (POC) Water**

This is water from paved and bunded areas, where there is a low possibility of mixing with oil and hydrocarbon (e.g. tank bund areas). POC water is routed to the effluent treatment plant where it is treated and re-used.
**OIL CONTAMINATED (OC) WATER**

This is water from areas of high probability of mixing with hydrocarbons and drainage of water containing hydrocarbons water (e.g., pump bases). These streams are collected separately, and treated in the effluent treatment system for reuse.

**SANITARY WASTEWATER**

Water from domestic activities such as showers, ablution facilities, and so forth, is collected separately and screened to remove solid material before treatment at the bio-treatment system.

**PROCESS WATER**

The main component of this stream is FT water. This effluent requires bio-treatment before reuse as process cooling water, as described in the following subsections.

### 3.5.1.5 Water Treatment

**OILY WATER TREATMENT**

OC and POC water are treated by an American Petroleum Institute (API) oil-water separator (an API separator is a gravity based oil water separator) followed by dissolved air floatation. The product water is further treated by the effluent bio-treatment. Oily sludge resulting from the API separator and dissolved air floatation is disposed of by thermal oxidation.

**EFFLUENT BIO-TREATMENT**

The effluent bio-treatment unit treats process water streams (mainly FT water) and other aqueous effluent streams and upgrades these to a suitable quality for reuse as utility water and process cooling water make-up. Effluents are cooled and equalized before entering the bio-treatment unit by an aerobic biological treatment process to reduce the organic content of the effluent feed stream. Effluent from the biologically active environment is filtered to remove the biological matter, producing a high quality effluent which is virtually solids free. A portion of the sludge is routed to the sludge dewatering unit.

**SLUDGE DEWATERING**

The sludge dewatering expels water from the sludge and recycles the filtrate to the effluent bio-treatment and the sludge is disposed of by thermal oxidation.

**COOLING TOWER BLOW DOWN TREATMENT**

Cooling tower blow downs are treated by ultra-filtration and reverse osmosis. The resulting permeate is routed to the demineralization system via granulated activated carbon filters. In excess of 80% of the water is recovered in the reverse osmosis system.
BOILER BLOW DOWN WATER REUSE

Boiler blow down streams are flashed to recover low-pressure steam before the remaining liquid is reused as cooling tower makeup.

3.5.2 Steam, Condensate, Boiler Feed Water and Power Systems

The steam, steam condensate, boiler feed water and power systems are represented in Figure 3-13.

3.5.2.1 Saturated Steam

SATURATED HIGH-PRESSURE STEAM

The SGU is the largest producer of saturated high-pressure steam (68 bar gauge), which is produced from recovered process heat. The SGU consumes a portion of the steam generated and exports the balance to the steam system for distribution. The HPU also produces saturated high-pressure steam, which is also distributed to the process. GTL facility steam requirements are supplemented by steam from the steam boilers particularly during start-up and certain GTL facility transient operations when steam from the process is not available with the required stability or quantities. These boilers produce saturated high-pressure steam by firing natural gas during the transient and start up scenarios and process off gas during normal operation.

Most of the saturated high-pressure steam produced is superheated and used primarily for driving compressor turbines to improve the GTL facility energy efficiency. Steam is also consumed by various process heaters. The steam condensate produced is referred to as hot condensate; for a description of its treatment for recovery, see Section 3.5.2.3. A portion of steam is consumed by the process and is not recovered as steam condensate. Saturated high-pressure steam is continuously letdown to the saturated medium-pressure steam header to manage fluctuations in the high-pressure steam system.

SATURATED MEDIUM-PRESSURE STEAM

The FT synthesis unit is the largest producer of saturated medium-pressure steam (11 bar gauge), which is produced from recovered process heat. The other contributors to the system are the product upgrading unit and the letdown from the saturated high-pressure header. The thermal oxidizer also produces a small quantity of steam (in the order of 3 t/h) recovered to the medium-pressure steam header. Further engineering development of the thermal oxidizer will confirm the net quantity of steam recoverable and the current steam system has conservatively assumed the amount to be negligible to the overall system.

Most of the saturated medium-pressure steam produced is superheated and used primarily for driving the steam turbine generators and compressor turbines. Steam is also consumed by various process heaters. Hot steam condensate recovery to the boiler feed water system is described in the text following. The saturated low-pressure steam system is supplemented by a letdown of medium-pressure steam to the low-pressure steam header. Fluctuations in the medium-pressure steam system are managed by a continuous letdown through a condenser to the steam condensate system.
Figure 3-13  Steam, Condensate, Boiler Feed Water and Power Systems
SATURATED LOW-PRESSURE STEAM

The largest source of saturated low-pressure steam is the letdown from the medium-pressure steam header. Low-pressure steam (3.5 bar gauge) is also recovered from hot condensate, which is flashed before recovery to boiler feed water. The major portion of low-pressure steam is consumed by the boiler feed water system. Steam is used directly in the deaerator where the low-pressure steam is consumed, ultimately reporting as boiler feed water.

3.5.2.2 Superheated Steam

Superheated steam is generated by dedicated steam superheaters, which are fired on a combination of fuel gas, natural gas and liquid fuels. The system has been configured to efficiently use energy by producing superheated high-pressure steam in the radiant section and superheated medium-pressure steam in the convection section (heat recovery) of the fired heater.

SUPERHEATED HIGH PRESSURE STEAM

The largest superheated high-pressure steam consumers are the ASU compressor turbines. The power for compression of the air to the ASUs varies depending on the ambient conditions of the air and thus the steam consumption of the ASU compressor turbines is seasonal. The other consumers are compressors in the FT synthesis area as well as process steam requirements for the SGU. The condensate from turbines is recovered to the boiler feed water system as cold condensate.

SUPERHEATED MEDIUM PRESSURE STEAM

The largest consumers of superheated medium-pressure steam are the STGs. Other users include compressor turbines in the SGU and product upgrading areas. Condensates from these users are recovered by the cold condensate system. A small quantity of steam is also consumed by the process in the product upgrading area.

3.5.2.3 Condensate and Boiler Feed Water

HOT STEAM CONDENSATE

Condensate from process steam exchangers are polished through activated carbon filters and polished (mixed resin beds) before recovery as boiler feed water. The polishing step ensures that potential impurities from the process do not enter the boiler feed water system. Hot condensate is routed to the deaerator after the polishing step.

COLD STEAM CONDENSATE

Cold condensate is a result of air or water cooled condensation and routed to the deaerator without further treatment.
**Process Condensate from the SGU**

Process condensate from the SGU is treated in a similar way to hot condensate i.e., activated carbon filtration followed by demineralization.

**Deaerator (Boiler Feed Water System)**

The deaerator removes air from the condensate streams by stripping them with saturated low-pressure steam. Losses in the system (because of process consumption of steam and blow down) are made up by the addition of demineralized water. High-pressure and medium-pressure boiler feed water are distributed to the various steam producers. Boiler feed water blow downs are used as make-up to process cooling towers.

### 3.5.2.4 Power Systems

The GTL facility has been designed for optimum heat recovery and energy efficiency. Process off-gases are recovered and are first used in the fuel gas system. Recovered off-gases in excess of the GTL facility fuel requirements are subsequently routed to the boilers where they are used to generate steam. All steam generated through process cooling and the combustion of process off gases is collected in a common steam system. Steam is used primarily for driving steam turbines for compressors, process heating and process steam. Surplus steam is routed to steam turbine generators where power is generated. Power generation is therefore achieved through the recovery of process off gases and surplus steam from process cooling requirements (process heat recovery). Therefore co-generation is used to generate the power. Power surplus to the requirements of the GTL facility is generated through this configuration. Excess power is exported to the AltaLink power transmission system.

As power is generated through the recovery of waste energy streams from the process, initial power requirements need to be imported as these streams will not be available at start-up. The GTL facility has a black start import requirement of 40 MW.

The ASU steam turbines driving the air compressors are a large consumer of steam. Seasonal variations in the compression requirements result in a seasonal swing in the steam demand of the unit. This swing is accommodated by varying the amount of excess steam routed to the STGs and hence the amount of power which is generated. In addition, seasonal variations in the ambient air temperature result in seasonal variation in the number of fans operating in the air cooler banks. The net result is approximately 23 MW seasonal variations in the power exported.

### 3.5.3 Fuel System

The fuel system manages four types of fuel to meet the fired heater demands in the GTL facility (i.e., natural gas, fuel gas, oxygenated hydrocarbons and product upgrading fuel gas) (see Figure 3-14).
Figure 3-14  Fuel System
3.5.3.1 Natural Gas

The primary source of fuel gas is the recovered process off gases. Although the design of the GTL facility has been to minimize the consumption of natural gas for fuel purposes, there are instances where natural gas is required to be used for combustion:

- fired heater burner pilots
- fired heater stability
- start-up
- heating value correction for flare gases

3.5.3.2 Fuel Gas

Sulphur free fuel gas is produced by the HERU (excess tail gas) providing for most of the GTL facility fuel requirements. All fuel gas is consumed by the GTL facility with the production of steam in the high-pressure steam boilers providing the flexibility to match the available with the consumed fuel gas quantities.

3.5.3.3 Oxygenated hydrocarbons

Sulphur free oxygenated hydrocarbons are a byproduct of FT synthesis unit and are consumed by the steam superheaters as a liquid fuel.

3.5.3.4 Product Upgrading Fuel Gas

Off-gases from the product upgrading area are consumed by fired heaters. The fuel requirements are supplemented by fuel gas from the fuel gas system. Sulphur levels in product upgrading fuel gas are very low.

3.5.4 Sanitary Waste

Sanitary waste will be screened to remove solid material and the liquid effluent will be routed to the effluent bio-treatment system mentioned in section 3.5.1.4 above. The sanitary sludge will be disposed of offsite.

3.6 Offsite Facilities

3.6.1 Overview

The offsite facilities support the processing units as well as the utility units. The offsite units consist of the:

- flare system
- thermal oxidizer
- intermediate tankage
• final product storage and export
• rail loading facility
• brine disposal well

3.6.2 Flare System

The flare system serves as the final safety measure to safeguard personnel, capital equipment, and the environment during over-pressure and emergency depressurization scenarios. Additionally, the flare system will occasionally be used during abnormal operating periods to dispose of gases, which cannot be contained through normal control procedures. Such scenarios might arise during start-up and shutdown operations or short-term/transient over-pressure situations.

The flare system comprises three distinct subsystems, these are:

• main flare (with independent high and low-pressure collection headers)
• cold and LPG flare
• vent gas system

For the flare system arrangement, see Figure 3-15.

The main flare system comprises of the low-pressure and high-pressure flare headers. High pressure relief streams (greater than 15 bar gauge pressure) that might contain water or that have a higher temperature than 40°C discharge to the high-pressure flare system. The high-pressure flare header discharges into the main flare knock out drum.

The low-pressure flare header collects relief gas from safety devices set at pressures below 15 bar gauge. This will be a low-pressure flare system, designed with minimum back-pressure to relieve low-pressure equipment. The low-pressure flare header also receives heated cold reliefs and LPG reliefs from the cold relief knock-out drum. The low-pressure flare header discharges to the main flare knock out drum.

Cold streams from the HERU, are conveyed through the cold relief header to the cold relief knock out drum and combined with the LPG from the product upgrading unit. In the knock out drum heavier hydrocarbons are removed and the vapour is sent through a closed loop heating system. The preheated reliefs are then routed to the low-pressure flare header in the low-pressure flare system.

The hydrocarbon liquids from the flare knock out drum are sent to intermediate tankage where they will be rerouted for treatment.
The vent gas system serves the waxy relief streams from the FT synthesis unit and the vent gases from tanks and vessels. Waxy reliefs tie into the waxy relief flare header and are routed to the head space of the seal drum to allow disengagement of any entrained waxy material. Furthermore, vents from low-pressure equipment tie into the vent flare header from which it is sent to a vent blower. The vent blower pushes the vent reliefs to the same seal drum as used for the waxy reliefs. From the seal drum a combined stream, waxy reliefs and vent reliefs, is sent to the flare burners. The design for the flare system is such that there will be one high-pressure and low-pressure flare per phase but in a single derrick (flare structure) for the total GTL facility (see Figure 3-15).

The flare system design will comply with the following industry practices and the applicable codes, standards and specifications:

- Alberta Energy and Utilities Board (EUB) *Flaring Directive 60 for Gas Plant Flaring, Incinerating, and Venting*
- Canadian Council of Ministers of environment (CCME) *Environmental Code of Practice for the Measurement and Control of Fugitive VOC Emissions from Equipment Leaks*
3.6.3 Thermal Oxidizer

Waste products are processed in the thermal oxidizer unit to recover energy through the generation of steam and reduce the volume for final disposal. The streams that will be processed in the unit include the solid waste material from the FT synthesis, oily sludge (API separator and dissolved air floatation sludge) from effluent treatment and bio sludge from bio-effluent treatment. Streams will be combusted in the presence of air with natural gas to achieve total combustion of all hydrocarbon combustible material. The thermal oxidizer will generate ash, safe for disposal at a landfill site. The third party landfill site to be used will be confirmed during development.

The thermal oxidizer will consist of two independent trains. One train is to service two phases of FT synthesis unit and the second train will service the effluent and bio-effluent treatment units. The thermal oxidizer unit will typically consist of the following process steps:

- combustion and energy recovery through steam generation
- flue gas cleanup technology will be selected during the future engineering development and the atmospheric emissions will comply with the Alberta Ambient Air Quality Objectives
- ash handling (cooling and drumming) to ensure a safe-to-handle ash

Material waiting for processing will be kept to a minimum and will provide for continuous operation of the process units and the thermal oxidizers. Sufficient space will be available for safe, environmentally acceptable staging.

3.6.4 Intermediate and Final Product Storage and Dispatch

3.6.4.1 Intermediate Tankage

Intermediate tankage provides storage capacity for intermediate and off-spec products, wax, recovered oils, GTL diesel and GTL naphtha, thus ensuring plant flexibility during start-up and upset conditions.

The intermediate tankage unit includes the following tanks (and number of tanks):

**HYDROCARBON CONDENSATE AND AQUEOUS SLOP TANK (1)**

This tank provides storage for recovered hydrocarbons from various process units. The hydrocarbons collected in this tank are pumped to the product upgrading unit for reprocessing. The water portion from the tank can be sent to the water treatment unit or the effluent treatment unit.

**GTL DIESEL AND GTL NAPHTHA PRODUCT REWORK TANK (1)**

In the event that GTL naphtha, GTL diesel or both are off-specification, the off-specification product will be routed to the product rework tank to allow for it to be reworked into the process.
**INTERMEDIATE WAX TANKS (2) AND WAX TANKS (2)**

The intermediate wax tanks provide storage for intermediate wax from within the FT synthesis unit and the wax tanks provide storage for low temperature FT wax from FT synthesis unit before being sent to product upgrading. Together these tanks provide surge volume between the gas processing units and the product upgrading and serve to decouple these two systems.

**GTL DIESEL RUNDOWN TANKS (2)**

GTL diesel produced in the product upgrading unit is sent to the rundown tanks, which provide buffer storage between product upgrading and final product storage allowing for additive dosing and final certification of the products. Each of these tanks provides one day storage of GTL diesel production.

**CHEMICAL DOSING SYSTEM**

GTL diesel is dosed with conditioning additives to meet the diesel specifications.

**STEAM CONDENSATE FLASH SYSTEM**

This system collects all condensate produced from the medium-pressure saturated steam used for tank heating.

### 3.6.4.2 Final Product Storage Tanks

No LPG will be stored on site. All LPG produced at the GTL facility will be sent by pipeline to off-site buyers with their own LPG storage capacity.

The final product storage system consists of:

- GTL naphtha storage tanks (2)
- GTL diesel storage tanks (3)

The total storage requirements for the GTL naphtha and GTL diesel product tanks are four days and seven days production. The maximum storage capacity proposed for the GTL facility will be approximately 200,000 to 300,000 m³. Final product certification of the GTL naphtha product is done in the final product storage system. If the GTL naphtha product is off-spec it can be rerouted to the product rework tank for reprocessing in the product upgrading unit.

The final certified GTL naphtha product is pumped from the storage tanks into the product export pipeline whereas the certified GTL diesel is pumped to rail loading facilities.

The final diesel transfer pumps in final product storage and export unit will supply the rail loading facility with GTL facility diesel for dispatch via rail.
3.6.5 Rail Loading Facility

Diesel will be exported by rail. The rail loading facility will operate for 12 hours per day and with one shift per day. Unit trains will be dispatched daily from the rail loading facility. The rail yard will have a separate control room, located close by, which will monitor and coordinate rail car activities.

The rail loading facility will be provided with water collection systems as per the rest of the process areas. In addition, any large spills of diesel will be contained and will be able to be returned to intermediate tankage for reprocessing.

3.6.6 Brine Water Disposal

Brines are collected from residual streams generated from condensate polishing and demineralization packages and the reverse osmosis packages located in the raw water and effluent treatment areas. A Class Ib well will be used to dispose of the brine water into the Nisku Formation. Although two full capacity wells will be constructed to ensure availability of the disposal route, the brine will only be routed to one well at a time. An application for a Class Ib disposal well will be sought from the ERCB.

3.7 Mass and Energy Balances

3.7.1 Process Mass Balance

For the process mass balance, see Table 3-3; stream numbers are shown in Figure 3-2.

3.7.2 Utility Balances

Utility balances are presented for the following:

- water systems
- steam, condensate and boiler feed water
- energy balance (fuel and power)

Seasonal operation results in varying power export (see Section 3.5.2.4). The seasonal fluctuations in power are represented in the power distribution tables. Water balances do not account for the contribution of storm water.

3.7.2.1 Water Balance

For the water system, see Figure 3-12; for stream flows, see Table 3-4.
### Table 3-3  Process Mass Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Natural gas</td>
<td>From pipeline to SGU</td>
<td>785</td>
<td></td>
</tr>
<tr>
<td>P-2</td>
<td>Oxygen</td>
<td>From ASU to SGU</td>
<td>924</td>
<td></td>
</tr>
<tr>
<td>P-3</td>
<td>Boiler feed water</td>
<td>To SGU</td>
<td>2,667</td>
<td></td>
</tr>
<tr>
<td>P-4</td>
<td>Superheated high-pressure steam</td>
<td>To SGU</td>
<td>345</td>
<td></td>
</tr>
<tr>
<td>P-5</td>
<td>Hydrogen</td>
<td>From HPU to SGU and product upgrading</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>P-6</td>
<td>Heavy ends recovery wash water</td>
<td>From the demineralized water system</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>P-7</td>
<td>Heavy ends recovery off gas</td>
<td>To fuel system</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>P-8</td>
<td>Stripping steam</td>
<td>To product upgrading</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>GTL diesel</td>
<td>—</td>
<td>385</td>
<td></td>
</tr>
<tr>
<td>P-10</td>
<td>GTL naphtha</td>
<td>—</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>P-11</td>
<td>LPG</td>
<td>—</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>P-12</td>
<td>Product upgrading off gas</td>
<td>To product upgrading fuel system</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>P-13</td>
<td>Oxygenated hydrocarbons</td>
<td>To fuel system</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>P-14</td>
<td>Vent gases</td>
<td>From water treatment to flare</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>P-15</td>
<td>Treated process water</td>
<td>To bioeffluent treatment</td>
<td>855</td>
<td></td>
</tr>
<tr>
<td>P-16</td>
<td>SGU condensate</td>
<td>To condensate recovery (includes SGU water, boiler blow down and hot condensate)</td>
<td>877</td>
<td></td>
</tr>
<tr>
<td>P-17</td>
<td>High-pressure steam</td>
<td>Net export from SGU</td>
<td>2,190</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>4,810</td>
<td>4,810</td>
</tr>
</tbody>
</table>

### Table 3-4  Water System Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-1</td>
<td>OC water</td>
<td></td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>W-2</td>
<td>Boiler blow down</td>
<td></td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>W-3</td>
<td>Other process water</td>
<td>From ASU air condensate, HPU</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>S-9</td>
<td>Granulated activated carbon (GAC) back flush</td>
<td></td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>P-15</td>
<td>Treated process water</td>
<td>855</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-4</td>
<td>Sanitary waste</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-5</td>
<td>Raw water(^1)</td>
<td>597</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-6</td>
<td>Sludge(^1)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-7</td>
<td>Utility water</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-8</td>
<td>ASU makeup water</td>
<td>68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-9</td>
<td>Potable water</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-10</td>
<td>Polisher brines</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-11</td>
<td>Brines</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-12</td>
<td>Demineralized water</td>
<td>To steam system</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>P-6</td>
<td>Heavy ends recovery wash water</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W-13</td>
<td>Sanitary sludge(^2)</td>
<td>For disposal by third party</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Produced from third party vendor.

\(^2\) Produced from third party vendor.
### Table 3-4  Water System Balance (cont’d)

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN  (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-14</td>
<td>Biotreatment sludge</td>
<td>To thermal oxidizer</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>W-15</td>
<td>Evaporation</td>
<td>Includes losses related to drift</td>
<td></td>
<td>1,374</td>
</tr>
<tr>
<td>W-16</td>
<td>Oily sludge</td>
<td>To thermal oxidizer</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>1,716</strong></td>
<td><strong>1,716</strong></td>
</tr>
</tbody>
</table>

**NOTES:**
1. Dewater sludge water content is 0.1 t/h.
2. Sludge for External Disposal water content is 0.2 t/h.
3. Water balance performed without carbon capture unit in operation (equivalent to 14.3 Ml/d).

#### 3.7.2.2  Steam, Condensate and Boiler Feed Water Balance

For the steam, condensate and boiler feed water system, see Figure 3-12; for stream flows, see Table 3-5. For power production, see Table 3-6 and Figure 3-13.

### Table 3-5  Steam, Condensate and Boiler Feed Water System Mass Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>IN  (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>FT synthesis unit</td>
<td>2,349</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td>Steam from product upgrading</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td>Saturated process steam</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>P-17</td>
<td>Steam from SGU</td>
<td>2,190</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td>Steam from HPU</td>
<td>149</td>
<td></td>
</tr>
<tr>
<td>S-5</td>
<td>Steam from boilers</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>superheated process steam</td>
<td></td>
<td>366</td>
</tr>
<tr>
<td>S-7</td>
<td>boiler feed water</td>
<td></td>
<td>5,446</td>
</tr>
<tr>
<td>W-12</td>
<td>Demineralized water</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>W-10</td>
<td>Polisher brines</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>P-16</td>
<td>SGU condensate</td>
<td>877</td>
<td></td>
</tr>
<tr>
<td>W-2</td>
<td>Boiler blow down</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>S-8</td>
<td>GAC back flush</td>
<td></td>
<td>52</td>
</tr>
<tr>
<td>S-9</td>
<td>Vents and losses</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>5,991</strong></td>
<td><strong>5,991</strong></td>
</tr>
</tbody>
</table>
### Table 3-6  Power Production

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>IN (MW)</td>
<td>OUT (MW)</td>
</tr>
<tr>
<td>E-1</td>
<td>Total power production</td>
<td>212</td>
<td>221</td>
</tr>
<tr>
<td>E-2</td>
<td>Internal use</td>
<td></td>
<td>136</td>
</tr>
<tr>
<td>E-3</td>
<td>Export</td>
<td>76</td>
<td>99</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>212</td>
<td>212</td>
</tr>
</tbody>
</table>

### 3.7.3 Energy Balance

The stream flows indicated (see Table 3-7) are represented in Figure 3-14 and show the demand and supply of fuels. For the demand and supply of power, see Table 3-8.

### Table 3-7  Fuel Distribution

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Total</th>
<th>F-1</th>
<th>P13</th>
<th>P-7</th>
<th>P-12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Units</td>
<td>Energy Available/ In</td>
<td>Natural Gas Consumed</td>
<td>Oxygenated Hydrocarbons Consumed</td>
<td>Heavy Ends Recovery Off Gas Consumed</td>
</tr>
<tr>
<td>Lower heating value</td>
<td>KJ/kg</td>
<td>47,869</td>
<td>18,900</td>
<td>11,408</td>
<td>59,687</td>
<td></td>
</tr>
<tr>
<td>Steam super heater</td>
<td>MW</td>
<td>59</td>
<td>34</td>
<td>401</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGU</td>
<td>MW</td>
<td>63</td>
<td></td>
<td>570</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boilers</td>
<td>MW</td>
<td>77</td>
<td></td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPU</td>
<td>MW</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offsites</td>
<td>MW</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product upgrading</td>
<td>MW</td>
<td>3</td>
<td>75</td>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>MW</td>
<td>1,542</td>
<td>259</td>
<td>34</td>
<td>1,141</td>
<td>108</td>
</tr>
</tbody>
</table>

### Table 3-8  Power Distribution

<table>
<thead>
<tr>
<th>Description</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power In (MW)</td>
<td>Power Out (MW)</td>
</tr>
<tr>
<td>Power generation</td>
<td>212</td>
<td>221</td>
</tr>
<tr>
<td>SPD™ and supporting units</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Water system</td>
<td>27</td>
<td>23</td>
</tr>
<tr>
<td>Steam, condensate and power</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>Offsites</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Fuel</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Export</td>
<td>76</td>
<td>99</td>
</tr>
<tr>
<td>Transmission losses</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>212</td>
<td>212</td>
</tr>
</tbody>
</table>
3.7.4 Carbon Balance

For carbon balance by stream, see Table 3-9.

Facility carbon efficiency is the ratio of carbon in the GTL facility products to the total carbon fed to the GTL facility, which for the Project is 70.2%.

Table 3-9 Carbon Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Units</th>
<th>Comment</th>
<th>In (ton of Carbon)</th>
<th>Out (ton of Carbon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Natural gas</td>
<td>Process feed to SGU</td>
<td>569</td>
<td></td>
</tr>
<tr>
<td>P-18</td>
<td>Natural gas</td>
<td>Process feed to HPU</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>F-1</td>
<td>Natural gas</td>
<td>Used as fuel for the GTL facility</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>GTL diesel</td>
<td></td>
<td>312</td>
<td></td>
</tr>
<tr>
<td>P-10</td>
<td>GTL naphtha</td>
<td></td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>P-11</td>
<td>LPG</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO\textsuperscript{2}</td>
<td></td>
<td></td>
<td>179</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>600</strong></td>
<td><strong>600</strong></td>
</tr>
</tbody>
</table>

NOTE:
\textsuperscript{1} Total from all the flue gas streams. 179 t/h carbon equates to 179 x (44/12) = 656 t/h CO\textsuperscript{2}.

3.7.5 Sulphur Balance

There are three sources of sulphur: the sulphur contained in the natural gas, sulphur added to the product upgrading process (in the form of DMDS) to aid the catalytic conversions of the feed streams and the odourizing agent for the LPG product.

All the sulphur contained in the natural gas fed to the process units is captured in the process through catalytic absorption. The sulphur remains captured and is removed from the GTL facility in the spent catalyst.

Fired heaters will be designed to fully combust hydrogen sulphide in the natural gas fed to them. Fired heaters will in normal operation use process off gases, which are sulphur free (except for the product upgrading fired heaters).

Small amounts of the sulphur added to the product upgrading process report to the liquid products. An equally small amount ends up in the off gases recovered for use in the product upgrading fuel system where it is combusted in fired heaters. The fired heaters will be designed to fully combust the hydrogen sulphide. The vast majority is dissolved in the process water from the unit and is stripped from the water in the water treatment unit where it is sent to flare. Sulphur dosing to the product upgrading process will, therefore, be kept to the absolute minimum required for effective catalyst functioning. The flare will be designed to fully combust any hydrogen sulphide.

A schematic showing the sulphur relevant streams is shown in Figure 3-16. The associated sulphur balance is given in Table 3-10.
Figure 3-16  Sulphur Balance Schematic
Table 3-10  Sulphur Balance

<table>
<thead>
<tr>
<th>Stream No</th>
<th>Description</th>
<th>Comment</th>
<th>IN  (t/d)</th>
<th>OUT (t/d)</th>
<th>SO₂ (t/d)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-18</td>
<td>Natural gas¹</td>
<td>Used as process feed to the HPU</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-5</td>
<td>Hydrogen</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z-3</td>
<td>Off gas</td>
<td>Used as an internal fuel in the HPU</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z-4</td>
<td>Absorbed sulphur</td>
<td>On the catalyst and removed as part of the spent catalyst</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Sub-Total</strong></td>
<td></td>
<td>0.02</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Synthesis gas unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-1</td>
<td>Natural gas⁽¹⁾</td>
<td>Used as process feed to the SGU</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-19</td>
<td>Synthesis gas</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Z-5</td>
<td>Absorbed sulphur</td>
<td>On the catalyst and removed as part of the spent catalyst</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Sub-Total</strong></td>
<td></td>
<td>0.54</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-1</td>
<td>Odourizing agent ²</td>
<td>For LPG odourizing</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-2</td>
<td>DMDS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-1</td>
<td>Natural gas</td>
<td>Used as a GTL facility fuel</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-15</td>
<td>Treated water</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P-13</td>
<td>Oxygenated hydrocarbons</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>GTL diesel</td>
<td></td>
<td></td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>P-10</td>
<td>GTL naphtha</td>
<td></td>
<td></td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>P-11</td>
<td>LPG ²</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td></td>
<td>0.41</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-6</td>
<td>Product-upgrading burners flue gas</td>
<td></td>
<td></td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Z-7</td>
<td>Boilers and superheater packages flue gas</td>
<td></td>
<td></td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>Z-8</td>
<td>SGU burners flue gas</td>
<td></td>
<td></td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>Z-9</td>
<td>HPU burners flue gas</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Z-10</td>
<td>Thermal oxidizer flue gas</td>
<td></td>
<td></td>
<td>0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Z-11</td>
<td>Flare system flue gas</td>
<td></td>
<td></td>
<td>0.35</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td></td>
<td>0.39</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>0.97</td>
<td>0.97</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
¹ Sulphur content assumed to be 15 ppm (max) in natural gas feed.
² Actual odourizing agent quantity is 0.0039 t/d (0.16 kg/h).
3.7.6 Thermal Efficiency

Thermal efficiency is the ratio of the energy in the GTL facility products to the energy fed to the GTL facility. Not considering power as a product, the GTL facility thermal efficiency is 57%, which increases to 58% when including the energy value of power exported to the AltaLink transmission system.

3.8 Material Measurements

Materials entering and exiting the GTL facility will be measured according to a measurement plan, which will be developed during the next stage of the Project. The measurement plan will address the following measurements:

- materials crossing the GTL facility fence in pipelines (raw water, natural gas, LPG and GTL naphtha) will have continuous automatic metering and recording at or near the GTL facility fence
- bulk materials received by truck and rail will be measured with a weighbridge
- GTL diesel will be metered using automatic meters in the rail car loading arms

3.9 Catalyst and Chemical Materials Requirements

The list of catalysts and chemicals outlined in the final TOR, Section 2.4E were considered. Those relevant to the Project are shown in Table 3-11 and Table 3-12.

<table>
<thead>
<tr>
<th>Table 3-11 Catalyst Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Type</td>
</tr>
<tr>
<td>Synthesis Gas Unit</td>
</tr>
<tr>
<td>Synthesis Gas Unit</td>
</tr>
<tr>
<td>FT Synthesis Unit</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
</tr>
<tr>
<td>Product Upgrading Unit</td>
</tr>
<tr>
<td>Product Upgrading Unit</td>
</tr>
<tr>
<td>Product Upgrading Unit</td>
</tr>
<tr>
<td>Product Upgrading Unit</td>
</tr>
<tr>
<td>Steam and Condensate Unit</td>
</tr>
<tr>
<td>Steam and Condensate Unit</td>
</tr>
<tr>
<td>Steam and Condensate Unit</td>
</tr>
</tbody>
</table>
### Table 3-12  Chemical Consumption

<table>
<thead>
<tr>
<th>Unit or System Type</th>
<th>Description</th>
<th>Purpose</th>
<th>Amount</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthesis Gas Unit</td>
<td>Phosphate</td>
<td>Water treatment</td>
<td>0.8 t/a</td>
<td></td>
</tr>
<tr>
<td>FT Synthesis Unit</td>
<td>Arbocell</td>
<td>Filter aid</td>
<td>204 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>diesel</td>
<td>Start Up requirement (once off)</td>
<td>275 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maleic acid</td>
<td>Wax treatment</td>
<td>273 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Perlite</td>
<td>Filter aid</td>
<td>321 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wax</td>
<td>Start-up requirement</td>
<td>1600 tons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filter bags</td>
<td>Wax clean up</td>
<td>Note 1</td>
<td>—</td>
</tr>
<tr>
<td>Heavy Ends Recovery Unit</td>
<td>Diesel</td>
<td>Initial startup requirement for CO₂ stripper</td>
<td>100 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethylene</td>
<td>Low temperature refrigerant</td>
<td>6.3 m³/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Propane</td>
<td>High temperature refrigerant</td>
<td>4 m³/a</td>
<td></td>
</tr>
<tr>
<td>Product Work-up Unit</td>
<td>DMDS</td>
<td>Sulphiding chemical</td>
<td>2.3 m³/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diesel</td>
<td>Start-up requirement</td>
<td>2400 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Naphtha</td>
<td>Start-up requirement</td>
<td>600 m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methyl mercaptan</td>
<td>LPG odourization dosing</td>
<td>2.2 t/a</td>
<td></td>
</tr>
<tr>
<td>Water System</td>
<td>Alum</td>
<td>Coagulant</td>
<td>876 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anti-scaling chemical</td>
<td>Antiscale for reverse osmosis units</td>
<td>6.8 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Citric acid</td>
<td>Resin cleaner</td>
<td>137 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Demin water resin</td>
<td>Resin cleaner</td>
<td>Note 1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Polymer</td>
<td>Water treatment</td>
<td>Note 1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Activated carbon</td>
<td>Water filtration</td>
<td>Note 1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Sodium carbonate</td>
<td>Raw water chemical dosing</td>
<td>67 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium hydroxide</td>
<td>Water pH Adjustment</td>
<td>131 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium hypochlorite</td>
<td>Water disinfectant</td>
<td>1717 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphuric acid</td>
<td>pH correction</td>
<td>209 t/a</td>
<td></td>
</tr>
<tr>
<td>Steam and Condensate Unit</td>
<td>Hydrazine</td>
<td>Oxygen scavenger</td>
<td>51 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpholine</td>
<td>Corrosion inhibitor</td>
<td>116.5 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium hydroxide</td>
<td>Water pH adjustment</td>
<td>164.3 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphuric acid</td>
<td>pH correction</td>
<td>146.3 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphates</td>
<td>Anti-scalant</td>
<td>11.4 t/a</td>
<td></td>
</tr>
<tr>
<td>Cooling Water System</td>
<td>Calcium hydroxide</td>
<td>Antiscale</td>
<td>61.8 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TBD</td>
<td>Dispersant</td>
<td>34.3 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TBD</td>
<td>Corrosion inhibitor</td>
<td>68.5 t/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium hypochlorite</td>
<td>Water disinfectant</td>
<td>547.6 t/a</td>
<td></td>
</tr>
<tr>
<td>Air and Nitrogen System</td>
<td>Molecular sieves</td>
<td>Liquid filtration</td>
<td>Note 1</td>
<td>Note 1</td>
</tr>
</tbody>
</table>
Table 3-12  Chemical Consumption (cont’d)

<table>
<thead>
<tr>
<th>Unit or System Type</th>
<th>Description</th>
<th>Purpose</th>
<th>Amount</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent Treatment Unit</td>
<td>Iron chloride</td>
<td>Coagulant</td>
<td>1332.5</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Sodium hypochlorite</td>
<td>Water disinfectant</td>
<td>210.2</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Sulphuric acid</td>
<td>pH correction</td>
<td>96.4</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Anti-scale chemical</td>
<td>Antiscale</td>
<td>4.4</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Polymer</td>
<td>TBD</td>
<td>70.1</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Citric acid</td>
<td>Resin cleaner</td>
<td>63.1</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Demulsification agent</td>
<td>Demulsification agent</td>
<td>455.5</td>
<td>t/a</td>
</tr>
<tr>
<td>Process Bio-Effluent Treatment</td>
<td>Phosphoric acid</td>
<td>Macronutrient</td>
<td>87.6</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Sodium hydroxide</td>
<td>Water ph adjustment</td>
<td>2278</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Micronutrient</td>
<td>Micronutrient</td>
<td>271.6</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Sodium Hypochlorite</td>
<td>Water disinfectant</td>
<td>96.4</td>
<td>t/a</td>
</tr>
<tr>
<td></td>
<td>Membrane filtration agent</td>
<td>Cleaning agent</td>
<td>113.9</td>
<td>t/a</td>
</tr>
<tr>
<td>General</td>
<td>Urea</td>
<td>Required during commissioning</td>
<td>Note 1</td>
<td>—</td>
</tr>
<tr>
<td>General</td>
<td>Acetic Acid</td>
<td>Required during commissioning</td>
<td>Note 1</td>
<td>—</td>
</tr>
</tbody>
</table>

NOTE:  
1 To be confirmed in the next phase of the Project.

The catalysts and chemicals will be stored with separate containment to reduce the potential for interaction (in accordance with industry standards and applicable health and safety guidelines) and the areas will be bunded to contain spills and any POC storm water if not stored under roof. Bunded area contents will be drainable to a sewer. The drain system will be compatible with the contents of the drain fluids.

Chemicals have been classified according to Canadian legislation and are listed in Table 3-13.

Table 3-13  Chemical Classification Information

<table>
<thead>
<tr>
<th>Chemical</th>
<th>NPRI Threshold Category</th>
<th>Transportation of Dangerous Goods Class</th>
<th>CEPA 1999 toxics</th>
<th>Domestic Substances List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum oxide (Al₂O₃)</td>
<td>1A</td>
<td>—</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Arbocel BW40 (cellulose)</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Calcium hydroxide</td>
<td>—</td>
<td>4.3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Citric acid</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>DMDS</td>
<td>—</td>
<td>3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ethylene</td>
<td>5</td>
<td>2.1</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>F—T synthesis reactor wax (paraffin and hydrocarbon waxes)</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Granular activated carbon (carbon)</td>
<td>—</td>
<td>4.2</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>GTL diesel</td>
<td>—</td>
<td>3</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>GTL naphtha</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrazine</td>
<td>1A</td>
<td>3</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
### Table 3-13  Chemical Classification Information (cont’d)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>NPRI Threshold Category</th>
<th>Transportation of Dangerous Goods Class</th>
<th>CEPA 1999 toxics</th>
<th>Domestic Substances List&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocarbon condensate</td>
<td>5</td>
<td>—</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>1A</td>
<td>8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Iron chloride (fecl₃)</td>
<td>—</td>
<td>8</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Maleic acid</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Methyl mercaptan</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Morpholine</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Perlite Fitraflo 4251</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Phosphate — Na₃PO₄.12H₂O</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>—</td>
<td>8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Potassium phosphate</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Propane</td>
<td>5</td>
<td>2.1</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Silica Gel Cecagel E1</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>—</td>
<td>—</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>—</td>
<td>8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>—</td>
<td>8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>1A</td>
<td>8</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Urea</td>
<td>1A</td>
<td>1.1D</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

NOTE:
<sup>1</sup> Meets Government of Canada Categorization Criteria.

### 3.10  Facility Wastes

Consequential waste is generated during the construction and operation of the Project. The waste streams can be classified as hazardous and nonhazardous streams and further categorized as solid, liquid and sludges.

The GTL facility is designed such that all potential waste streams are contained during emergency, start-up and shutdown scenarios.

#### 3.10.1  Solid Waste

Different types of solid wastes (e.g., spent catalyst, ash, consumables) will be collected and stored in segregated areas (in accordance with industry standards and applicable health and safety guidelines) before being transported to the appropriate final destination (e.g., recycling, metal recovery, landfill, thermal oxidation). The Project will make use of reputable third parties for the disposal of the wastes and will be engaged during the front end engineering design (FEED) phase.

The catalysts used in the different processing units are standard industry catalysts and chemicals and are similar to catalysts and chemicals used in petrochemical facilities, specifically for the hydrogen production, hydrogen recovery, water treatment and product upgrading. The FT catalyst contains the same basic constituents as other petrochemical and hydrop processing units. Catalysts containing precious
metals will be collected and sent to a reputable contractor for metal recovery. There are metal recovery facilities in Ontario and the United States.

3.10.2 Liquid Waste

Brine water is generated with increased reuse of water. Reverse osmosis units are used to recover usable water. Brine water from the GTL facility will be disposed by means of deep well injection. POC and OC water will be contained and treated in the GTL facility. The recovery of water in the GTL facility is discussed in Section 3.5.1.

3.10.3 Sludges

The API separator sludge, oily sludge and bioeffluent sludge will be collected and routed to the thermal oxidizer for energy recovery as well as waste minimization.

3.10.4 Sanitary Waste

Sanitary sewage is expected to be produced in the amount of approximately 0.13 m$^3$ per person per day. Sewage arising will be screened to remove solids before treatment by the aerobic biological treatment facility. The solid material from the screening will be collected and transported to a third party disposal company.

3.11 GTL Product Qualities

3.11.1 GTL Diesel

GTL diesel is a high quality, fully synthetic, middle distillate fuel produced from natural gas. Potential applications for GTL diesel include:

- a key component for refineries to upgrade lower quality middle distillates
- a key component in specifically formulated premium quality automotive diesel fuel grades
- a neat diesel fuel for niche applications, offering significant emissions reduction potential

GTL diesel has the following high quality features (see Table 3-14 for additional details):

- virtually no sulphur
- very high cetane number rating
- virtually no aromatics and almost odourless
- almost exclusive paraffinic composition
### Table 3-14 Estimated Properties of GTL Diesel without Additives

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur</td>
<td>&lt;5 ppm</td>
</tr>
<tr>
<td>Cetane Index</td>
<td>&gt;65</td>
</tr>
<tr>
<td>Aromatics</td>
<td>&lt;0.5 wt%</td>
</tr>
<tr>
<td>Density at 15°C</td>
<td>770 kg/m³</td>
</tr>
<tr>
<td>95% volume recovered</td>
<td>336°C</td>
</tr>
<tr>
<td>Cloud point</td>
<td>-31°C</td>
</tr>
<tr>
<td>Flash point</td>
<td>&gt;55°C</td>
</tr>
<tr>
<td>Kinematic viscosity at 40°C</td>
<td>1.6 cSt</td>
</tr>
</tbody>
</table>

#### 3.11.2 GTL Naphtha

GTL naphtha is highly paraffinic, typically more than 97% paraffin content, with virtually no aromatics. For additional details, see Table 3-15. The production process ensures that GTL naphtha has virtually no sulphur or metallic contaminants. Potential applications for GTL naphtha include:

- steam cracker feedstock, where demonstrated benefits include higher yields of desirable olefins and a lower coking rate in furnace tubes
- feedstock for catalytic reforming processes
- ethanol denaturing
- bitumen diluents

### Table 3-15 Estimated Properties of GTL Naphtha

<table>
<thead>
<tr>
<th>Property</th>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 15°C</td>
<td></td>
<td>679 kg/m³</td>
</tr>
<tr>
<td>Distillation (v/v)</td>
<td>Initial boiling point</td>
<td>22°C</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>44°C</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>84°C</td>
</tr>
<tr>
<td></td>
<td>90%</td>
<td>118°C</td>
</tr>
<tr>
<td></td>
<td>End point</td>
<td>143°C</td>
</tr>
<tr>
<td>Sulphur</td>
<td></td>
<td>&lt;5 ppm (wt)</td>
</tr>
<tr>
<td>PONA</td>
<td>Aromatics</td>
<td>&lt;1 vol %</td>
</tr>
<tr>
<td></td>
<td>Naphthenes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Olefins</td>
<td>&lt;1 vol %</td>
</tr>
<tr>
<td></td>
<td>Paraffins</td>
<td>&gt;95 vol %</td>
</tr>
<tr>
<td>Reid vapour pressure at 37.8°C</td>
<td></td>
<td>&lt;88 kPa</td>
</tr>
<tr>
<td>Oxygenated hydrocarbons content</td>
<td></td>
<td>&lt;50</td>
</tr>
<tr>
<td>Benzene</td>
<td></td>
<td>&lt;1 vol %</td>
</tr>
</tbody>
</table>
3.11.3 Liquified Petroleum Gas

See Table 3-16.

Table 3-16 Estimated Properties of LPG

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane</td>
<td>97.8 vol %</td>
</tr>
<tr>
<td>Propene (propylene)</td>
<td>&lt;5.0 vol %</td>
</tr>
<tr>
<td>Butane and heavier hydrocarbons</td>
<td>&lt;2.5 vol %</td>
</tr>
<tr>
<td>Total sulphur content</td>
<td>&lt;123 mg/kg</td>
</tr>
<tr>
<td>Vapour pressure (37.8°C)</td>
<td>1,297 kPa</td>
</tr>
<tr>
<td>Density at 15°C</td>
<td>509 kg/m³</td>
</tr>
</tbody>
</table>

3.12 Tanks

All tanks (apart from water ponds) will be aboveground tanks (see Tables 3-17 to 3-22). Tanks will include level gauging to monitor inventory and level of material. The material of construction is such as to prevent corrosion of the tanks. Tanks in condensate and aqueous service are epoxy lined. The tanks are situated in bund walls to ensure secondary containment of the tank contents, should there be a leak.

All tanks will comply with CCME Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks (CCME-EPC-87E) and ERCB Directive 55 Storage Requirements for Upstream Petroleum Industry.

3.13 Fire Protection

3.13.1 Fire Water

Fire water is supplied from the raw water pond in the raw water treatment system. The supply will be via a fire water ring main network where supply will be maintained by jockey pumps and fire water supply pumps, both of which have both electrically and diesel driven pumps. The ring mains network piping will be below the frost depth and piping above ground (specifically risers and dead ends) will be heat traced.

A sprinkler system is provided for buildings. This is supplied with potable water from the potable water storage tank.

Runoff caused by the use of firewater will be locally contained in the process unit drainage system and then released to the POC sewer for treatment in the effluent treatment system.

The fire water system (pumps, hydrants, monitors and manifolds) will be designed in accordance with the requirements of National Fire Protection Association (NFPA) 20: Standard for the Installation of Stationary Pumps for Fire Protection, and the Alberta Fire Code and Alberta Building Protection.

All buildings will have fire detection and suppression systems (sprinklers and portable (handheld) fire extinguishers) to meet federal, provincial and municipal standards.
<table>
<thead>
<tr>
<th>Name</th>
<th>Description of Tank</th>
<th>Number of Tanks</th>
<th>Size of Tank</th>
<th>Type of Tank</th>
<th>Type of Service</th>
<th>Vapour Pressure (kPaa)</th>
<th>Type of Vents</th>
<th>Vapour Recovery System</th>
<th>Material of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>083-TK-001</td>
<td>Product rework</td>
<td>1</td>
<td>42</td>
<td>20</td>
<td>Internal floating roof tank roof</td>
<td>GTL naphtha/GTL diesel</td>
<td>1-61</td>
<td>—</td>
<td>No</td>
</tr>
<tr>
<td>083-TK-002</td>
<td>HC Condensate and Aqueous Slops</td>
<td>1</td>
<td>40.2</td>
<td>20</td>
<td>Internal floating roof</td>
<td>Condensate and aqueous slops</td>
<td>22</td>
<td>—</td>
<td>No</td>
</tr>
<tr>
<td>083-TK-003</td>
<td>Intermediate wax</td>
<td>2</td>
<td>23.5</td>
<td>20</td>
<td>Cone fixed roof</td>
<td>Untreated wax</td>
<td>80</td>
<td>Vent to atmospheric stack</td>
<td>Yes</td>
</tr>
<tr>
<td>083-TK-004</td>
<td>Wax</td>
<td>2</td>
<td>23.5</td>
<td>20</td>
<td>Cone fixed roof</td>
<td>Treated wax</td>
<td>80</td>
<td>Vent to atmospheric stack</td>
<td>Yes</td>
</tr>
<tr>
<td>083-TK-006</td>
<td>GTL diesel Rundown</td>
<td>2</td>
<td>29.3</td>
<td>20</td>
<td>Cone fixed roof</td>
<td>GTL diesel</td>
<td>1</td>
<td>Vent to atmospheric stack</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Nitrogen blanketing system.
2. Epoxy lined.
### Table 3-18  Final Product Storage Tanks

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of Tank</th>
<th>Number of Tanks</th>
<th>Size of Tank</th>
<th>Type of Tank</th>
<th>Type of Service</th>
<th>Vapour Pressure (kPaa)</th>
<th>Type of Vents</th>
<th>Vapour Recovery System</th>
<th>Material of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>084-TK-001 A/B</td>
<td>GTL naphtha product</td>
<td>2</td>
<td>25.1 20</td>
<td>Internal floating roof</td>
<td>GTL naphtha</td>
<td>&lt;61</td>
<td>-</td>
<td>No</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>084-TK-002 A-C</td>
<td>GTL diesel product</td>
<td>3</td>
<td>46.4 20</td>
<td>Cone fixed roof(1)</td>
<td>GTL diesel</td>
<td>1</td>
<td>Vent to atmospheric stack</td>
<td>Yes</td>
<td>Carbon steel</td>
</tr>
</tbody>
</table>

**NOTE:**
Nitrogen blanketing system

### Table 3-19  Chemical Storage Tanks

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of Tank</th>
<th>Number of Tanks</th>
<th>Size of Tank</th>
<th>Type of Tank</th>
<th>Type of Service</th>
<th>Vapour Pressure (kPaa)</th>
<th>Type of Vents</th>
<th>Vapour Recovery System</th>
<th>Material of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>087-TK-001</td>
<td>NaOH bulk storage</td>
<td>1</td>
<td>7.6 200</td>
<td>Cone fixed roof</td>
<td>Sodium hydroxide</td>
<td>1</td>
<td>Conservation vent</td>
<td>No</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>087-TK-002</td>
<td>NaOCl bulk storage</td>
<td>1</td>
<td>7.6 200</td>
<td>Cone fixed roof</td>
<td>Sodium hypochlorite</td>
<td>1</td>
<td>Conservation vent</td>
<td>No</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>045-TK-001</td>
<td>Storage tank</td>
<td>1</td>
<td>3.3 3.4</td>
<td>Cone fixed roof</td>
<td>Maleic acid</td>
<td>1</td>
<td>Conservation vent</td>
<td>1</td>
<td>316L stainless steel</td>
</tr>
<tr>
<td>045-TK-002</td>
<td>Storage tank</td>
<td>1</td>
<td>2.4 3.4</td>
<td>Cone fixed roof</td>
<td>Maleic acid</td>
<td>1</td>
<td>Conservation vent</td>
<td>1</td>
<td>316L stainless steel</td>
</tr>
</tbody>
</table>
### Table 3-20  Water System Tanks

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of Tank</th>
<th>Number of Tanks</th>
<th>DIMENSIONS (L x W x D) / (D x T/T) (m)</th>
<th>Material of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>071-TK-002</td>
<td>Clarified raw water tanks</td>
<td>1</td>
<td>9.2 x 12</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-003</td>
<td>Works drainage sump</td>
<td>1</td>
<td>10.1 x 10.1 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>071-TK-004</td>
<td>Filtered/clean water sump</td>
<td>1</td>
<td>16 x 16 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>071-TK-005</td>
<td>Mud sump</td>
<td>1</td>
<td>8.5 x 8.5 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>071-TK-006</td>
<td>Filtered water tanks</td>
<td>1</td>
<td>16.4 x 16.5</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-007</td>
<td>Potable water storage tank¹</td>
<td>1</td>
<td>5.8 x 6</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-009 A/B</td>
<td>Ultra filtration membrane tanks</td>
<td>2</td>
<td>11 x 3 x 4.32</td>
<td>Concrete</td>
</tr>
<tr>
<td>071-TK-010</td>
<td>Ultra filtration permeate tank</td>
<td>1</td>
<td>8.5 x 9</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-011</td>
<td>Ultra filtration reject tank</td>
<td>1</td>
<td>3.9 x 4.8</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-012</td>
<td>Reverse osmosis permeate tank</td>
<td>1</td>
<td>11 x 11</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-013 A/B</td>
<td>Demin water storage tanks</td>
<td>2</td>
<td>15 x 15.5</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-014</td>
<td>Regen washwater sump</td>
<td>1</td>
<td>1.5 x 1.5 x 1.5</td>
<td>Concrete</td>
</tr>
<tr>
<td>071-TK-015</td>
<td>Brine collection tank</td>
<td>1</td>
<td>10.500 x 11</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>071-TK-021 A/B</td>
<td>Raw water reservoirs</td>
<td>2</td>
<td>110 x 55 x 4</td>
<td>Concrete</td>
</tr>
</tbody>
</table>

**NOTE:**
Sized for 24-hour potable water and 30-minute sprinkler water.
## Table 3-21  Effluent System Tanks

<table>
<thead>
<tr>
<th>Name</th>
<th>Description of Tank</th>
<th>Number of Tanks</th>
<th>DIMENSIONS (L x W x D) / (D x T/T) (m)</th>
<th>MOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>076-TK-001</td>
<td>First flush sump</td>
<td>1</td>
<td>70 x 35 x 5</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-002</td>
<td>Second flush sump</td>
<td>1</td>
<td>70 x 35 x 5</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-003</td>
<td>Storm water/ fire water sump</td>
<td>1</td>
<td>70 x 52.4 x 5</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-004 A/B/C</td>
<td>Api separation tanks</td>
<td>3</td>
<td>43.5x 24 x 2</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-009</td>
<td>Oily works drainage sump</td>
<td>1</td>
<td>6.2x 3.5 x 6.9</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-010</td>
<td>Bio-sludge filtrate sump</td>
<td>1</td>
<td>7.5 x 3.7 x 6.2</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-013 A/B</td>
<td>Ultra filtration membrane tanks</td>
<td>2</td>
<td>11 x 3 x 4.3</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-005 A/B</td>
<td>Slop oil tanks ^</td>
<td>2</td>
<td>2.1 x 2.1</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-011</td>
<td>Treated effluent tank</td>
<td>1</td>
<td>4.6 x 5.7</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-012</td>
<td>Ultra filtration feed tank</td>
<td>1</td>
<td>9.5x 9.5</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-014</td>
<td>Ultra filtration permeate tank</td>
<td>1</td>
<td>8.5 x 9</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-015</td>
<td>Ultra filtration reject tank</td>
<td>1</td>
<td>3 x 3.5</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-017</td>
<td>Reverse osmosis permeate tank</td>
<td>1</td>
<td>8.5 x 9</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-019</td>
<td>Brine collection tank</td>
<td>1</td>
<td>3 x 3</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>076-TK-026</td>
<td>Product work-up oily water sump</td>
<td>1</td>
<td>5 x 3 x 3.6</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-027</td>
<td>Intermediate tankage oily sump</td>
<td>1</td>
<td>12.4 x 7.5 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-028</td>
<td>GTL facility oily sump</td>
<td>1</td>
<td>13.6 x 8.2 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-029</td>
<td>Tankage area oily water sump</td>
<td>1</td>
<td>8.6 x 5.2 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-030</td>
<td>Effluent plant oily water sump</td>
<td>1</td>
<td>5 x 3 x 3.6</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-031</td>
<td>Gas loop POC sump</td>
<td>1</td>
<td>4.8x 4.7 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-032</td>
<td>ASU POC sump</td>
<td>1</td>
<td>4.8x 4.7 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-033</td>
<td>Utilities POC sump</td>
<td>1</td>
<td>4.8 x 4.7 x 4</td>
<td>Concrete</td>
</tr>
<tr>
<td>076-TK-034</td>
<td>Tankage area POC sump</td>
<td>1</td>
<td>4.8 x 4.7 x 4</td>
<td>Concrete</td>
</tr>
</tbody>
</table>
Table 3-22  Biotreatment Tanks

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Service</th>
<th>Number Of Tanks</th>
<th>Dimensions (Dia X T/T) (Mm X Mm)</th>
<th>Material of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>177-TK-001 A/B</td>
<td>Equalization tank</td>
<td></td>
<td>38,000 X 20,000</td>
<td>Concrete</td>
</tr>
<tr>
<td>177-TK-002 A/B</td>
<td>Aeration tanks</td>
<td></td>
<td>70,200 (L) x 38,800 (W) x 5,500 (H)</td>
<td>Concrete</td>
</tr>
<tr>
<td>177-TK-003</td>
<td>Sodium hydroxide tank</td>
<td></td>
<td>2 500 x 3 200</td>
<td>Epoxy-lined carbon steel</td>
</tr>
<tr>
<td>177-TK-004</td>
<td>Foam collection tank</td>
<td></td>
<td>5,200 (L) x 3,200 (W) x 3,200 (H)</td>
<td>Concrete</td>
</tr>
<tr>
<td>177-TK-005 A-P</td>
<td>Membrane tanks</td>
<td></td>
<td>12,200 (L) x 2,800 (W) x 4,000(H)</td>
<td>Concrete</td>
</tr>
<tr>
<td>177-TK-006</td>
<td>pH control tank</td>
<td></td>
<td>9,200 X 20,000</td>
<td>Concrete</td>
</tr>
<tr>
<td>177-TK-007</td>
<td>Rework tank</td>
<td></td>
<td>17,000 x 10,100</td>
<td>Epoxy-lined carbon steel</td>
</tr>
</tbody>
</table>
3.13.1.2 Fire and Gas Detection

The GTL facility will be equipped with a dedicated fire and gas system. The system will alarm all buildings and identified process areas. The system will also be integrated to fire suppression utility systems such as deluge to provide automated fire-fighting actions where required. Area gas and smoke detectors will be incorporated into the overall system to provide for gas leak detection and smoke detection as required by risk analysis and Alberta regulation. The fire and gas system will be linked to specified heating, ventilation and air-conditioned units to provide for emergency shutdown or isolation of air intake vents during certain emergencies. The system will be linked to dedicated site emergency response centres and any community emergency response department as required by Alberta laws.

3.13.1.3 Fireproofing

Process equipment, vessels, critical piping and structures will have fireproofing consistent with Sasol’s experience, industry norms, codes and standards.

3.14 Operation, Control and Automated Safeguarding

Most of the GTL facility process and support utilities will be operated continuously (24 hours per day) although selected portions such as the GTL naphtha and GTL diesel export systems will be operated intermittently as operation dictates.

Normal operation and safeguarding of the GTL facility will be by operators located, at all times, in the central control room. Control room operators will control and monitor the GTL facility via the operator consoles of the GTL facility distributed control system (DCS) and CCTV coverage of critical areas of the GTL facility. The DCS will provide automation of routine actions and alert the operator to excursions from normal operating limits.

It is anticipated that a minimum number of field operators will also be required in addition to the control room operators to monitor the process units locally. Sufficient local instrumentation will be provided to allow field operators to determine operating conditions of the process and equipment for the required local tasks.

The GTL facility will be provided with a safety instrumented system to provide automated safeguarding against excursions from normal operating limits. The design, installation, operating and maintenance of the safety instrumented system will be in accordance with international codes, regulations and best practices.

Dedicated burner management systems will be provided to ensure safe, orderly operation of fuel firing equipment. The burner management system will be certified according to the appropriate Canadian Standards Association and NFPA standards. The burner management system will be a standalone system using the same hardware and software as the safety instrumented system to ensure system integrity and availability.

A fire and gas system is provided as discussed in Section 3.13.1.2.
The GTL facility will be provided with a factory wide terrestrial trunked radio system for communication between maintenance, operations and control room personnel. This will be supplemented with a plant wide telephone network consisting telephones in all substations, instrument buildings and identified buildings. A public address system is provided with annunciation speakers available in all substations, instrument buildings, and administration buildings. In addition to emergency sirens linked to the fire and gas system, emergency announcements will also be enabled through the public address system.

### 3.15 Plot Plan and Layout

Sasol has developed the Project's layout (see Figure 3-17) with a risk based approach and company best practices so that the requirements for layout, arrangement, spacing and accessibility are met. The layout:

- supports risk management objectives to eliminate, and if not possible, reduce the risks from and to factors such as: the environment; weather conditions; neighbours, employees; the GTL facility, and the public
- provides adequate, safe access for operating, maintenance, and emergency activities
- ensures that critical operating units and emergency systems support the safe operation of the GTL facility during different operating modes
- provides adequate, safe access for constructability of the GTL facility
- optimizes the layout and arrangement of piping, utilities and other facilities
- logically groups operational units and activities together
- handles lifecycle strategies and potential expansion for the GTL facility

The plot layout meets the internationally recognized *Global Asset Protection Guidelines 2.5.2 Oil and Chemical Plant Layout and Spacing* (September 2001). In addition to these guidelines, Sasol also applies NFPA and API standards.

The layout for the GTL facility has been specially developed for the Project and is influenced by Sasol's extensive experience in design, construction and operation of similar facilities. Several areas were addressed specifically in developing the plot layout (see Figure 3-17) to achieve the above stated requirements.

**PREVAILING WIND DIRECTION**

Two wind directions prevail on the site, northwest during spring and summer, and south-southwest during fall and winter. Air separation units (ASUs) have been located upwind to minimize the potential for hydrocarbon intake. Occupied buildings such as the administration, training and central control buildings have also been located on the western boundary to be upwind of process units. The locations of cooling towers will reduce the impact of fogging on process units, heavily travelled areas, roads and rail adjacent to the GTL facility. Air coolers will be positioned to avoid reticulation of air. Wind direction has also been considered when locating equipment in process areas (such as fired heaters) relative to one another.
PHASED CONSTRUCTION

The relative positioning of the Phase 1 and Phase 2 footprints has been considered to ensure the required separation and safety distances for construction are met and to ensure optimal access for construction. A benefit is that the access and workspace provided for the construction of the second phase is also used through the GTL facility's life as space required for turnarounds.

QUALITATIVE RISK ASSESSMENT

A qualitative risk assessment was completed to ensure that the risk exposure beyond the site is minimized by good placement of process units within the site boundaries. During the development of the Project, a detailed quantitative risk assessment will be undertaken.

EASEMENTS AND SETBACKS

A setback of 30 m has been used to separate the facilities from site boundaries and other easements. The layout also considered minimizing the crossings over third-party pipelines both in number and frequency for operation and construction.

OCCUPIED BUILDINGS

Personnel buildings such as administration, control room, gatehouse, workshops and stores are located up/crosswind of the process units, to ensure the safety of personnel. Where possible, they have also been located close to the boundaries of the site so that they can be accessed without entering the main process areas. The qualitative risk assessment was also used to ensure that they are adequately spaced from the process units.

PROCESS ACTIVITY GROUPING

Process activities which are similar in nature or form a natural operating group are grouped together on the site layout.

MINIMIZE FOOTPRINT

Whilst maintaining the required safety and access distances between process units and steps, the layout of the GTL facility has been minimized. Minimizing the layout supports minimizing the number of easement crossings, locating risks further from the GTL facility boundaries and increasing safety distances. Additionally, the Project's scope is reduced, reducing the overall environmental impacts.

SITE ACCESS

Site vehicle access is via Range Road 220, running north-south at the site's western boundary. The administration area and warehouse are at the western edge of the site for ease of access, and because this is a safe entry and exit point given prevailing wind directions.
Rail connections have been proposed on the north-west and southern site boundaries (to be confirmed by the rail operators), with rail lines along the outer eastern and northern boundaries. These access points and routing eliminate the need for rail crossings during normal operation except for the rail crossing on Range Road 220.

**CONSTRUCTION SPACE**

Adequate construction space is allocated north of the processing facility. The space will be used for the fabrication of super modules, staging area, manufacturing oversized equipment, piping spool fabrication and lay down.

**POWER GRID CONNECTION**

Current understanding is that the Project will connect to the 410S substation and that power will come into the site from the north. The switch plant is on the north side of the process areas close to the power generation facilities.

**CARBON CAPTURE AND COMPRESSION**

Adequate space has been allocated for the installation of the carbon capture and compression facilities.

### 3.16 Alternatives Design Considerations

#### 3.16.1 Sasol Slurry Phase Distillate™ Process Unit Technologies

The Sasol SPD™ process uses the Sasol slurry phase FT process to produce a hydrocarbon product that is easily converted to high quality diesel by mild hydrocracking. To best meet the Project’s objectives, an integrated process was created. Sasol selected the most suitable technologies and created a unique technology alliance to support the Sasol SPD™ process. The Sasol SPD™ process involves a Haldor Topsøe ATR, the Sasol slurry phase FT process, and a version of refinery hydrocracking technology. Three core units are integrated into an overall design together with an air separation unit, a hydrogen production unit, some effluent treatment facilities, and the necessary energy integration and utility units. Since both the ATR and the FT process generate energy, and oxygen production is a large consumer of energy, integrating the units is critical to an efficient process.

The production of synthesis gas from methane is the first step in the Sasol SPD™ process. Several technologies are available for this step, although the requirement for a hydrogen-to-carbon monoxide (H₂/CO) ratio of approximately 2:1 means that the partial oxidation technology, either catalytic or non-catalytic, will be most suitable. Sasol has had experience with ATR, a catalytic partial-oxidation process, for 50 years. The Sasol Synfuels plant in Secunda operates 16 ATR units. Two large ATRs based on Haldor Topsøe’s 0.6 steam-to-carbon ratio technology are in operation in Sasolburg.
Sasol believes that its selection of ATR is the only technically and economically feasible choice to achieve the Project’s objectives for the following reasons:

- the ability to be built at a single train size of at least 16,000 barrels per day
- the ability to achieve an H₂/CO ratio of 2:1 with a small tail gas recycle
- an unparalleled track record of experience
- the opportunities for further scale-up in the future

The FT process is ideally suited to a GTL process because the selectivity of the product spectrum leads to an optimum overall design. Sasol had many years of success with Arge or tubular fixed-bed FT reactors and dry fluidized-bed hydrocarbon synthesis. With the successful commissioning of a slurry phase FT plant at Sasolburg in 1993 and the development of a cobalt-based catalyst, the slurry phase FT process was the clear choice for building the GTL facility.

The main advantages of the slurry phase FT process over fixed bed alternatives are:

- the slurry bubble column reactor is simpler, has a lower pressure drop and the high heat transfer coefficient achieved makes it more suitable for the highly exothermic FT reaction
- it offers more isothermal operation and better control of selectivity
- the smaller catalyst particles offer higher reaction efficiency
- catalyst addition and removal is simpler and online addition and removal are possible
- it allows a much greater scale of operation and train size

In the Oryx GTL plant in Qatar, the Sasol SPD™ process used Chevron’s hydrotreating and hydrocracking technologies and catalyst in the product work-up unit. These and other hydrocracking technologies are well-suited to convert the FT wax and hydrocarbon condensate streams into high quality GTL products.

The combination of the Haldor Topsøe ATR, the Sasol slurry phase FT process, and refinery hydrocracking technology created the Sasol SPD™ process. When combined with a state-of-the-art air separation unit, the Sasol SPD™ process can be constructed in a single train at 16,000 to 24,000 barrels per day capacities. Together with the energy integration and process simplification achieved by Sasol, this capacity enables an economically feasible GTL process. Sasol believes the combination of technologies selected is commercially proven and that other combinations would not provide alternative means that are equally economically and technically feasible for carrying out and achieving Project objectives.

Sasol believes the combination of technologies selected is commercially proven and that other combinations would not provide an alternative that meets means of carrying out and achieving Project objectives that are equally economically and technically feasible.

### 3.16.2 Minimizing Raw Water Intake

GTL water systems are highly integrated, which is possible only if the properties of the various water streams, their chemical contents and interactions between the chemical components are well understood.
Over the years, Sasol has learned how best to integrate the various water systems to recycle and re-use the water as much as possible to reduce the net raw water intake. By doing so, it is possible to reduce the effect of operations on the environment.

Wastewater recycling and re-use is practical and economically viable on a large scale, however, an integrated water management approach is an essential component and it must cover the following key aspects:

- knowing and understanding the various water streams and systems with respect to quantities, qualities, cause and effect, costs and integration. Detailed analysis is used to achieve this understanding and to support decision-making.
- measurement, monitoring and management information systems with key performance indicators and objectives to ensure proactive management of the water systems in an integrated and holistic way
- application of best management practices (e.g., reduction at source) through the implementation of appropriate technologies in an innovative and cost effective way

Sasol Technology—a subsidiary of Sasol Limited and a business partner to other business units—is responsible for research and development and technology innovation. The effluent treatment technology developed by Sasol Technology, together with leading water technology companies, was applied to treat process water and effluents for use as cooling water makeup without the need for further treatment. The effluent treatment unit uses a combination of biological and membrane processes to produce a raw water substitute. Captured storm water is also treated through the effluent treatment system as a raw water substitute. Air cooling was used to further reduce the need for cooling water (the main source of water loss). More than 60% of the GTL facility’s water requirement is supplied by treated water.

Cooling tower blow downs are treated by ultra-filtration and reverse osmosis to recover more than 70% of the water.

To decrease salt consumption, ultra-filtration, reverse osmosis and mixed bed polishers were used rather than the traditional ion exchange resin beds for demineralized water preparation. This approach has the added benefit of reducing the brine stream and the amount of makeup water required. Sasol believes that the technologies selected to reduce raw water intake are the only technically demonstrated and economically feasible means to achieve the Project’s economic, environmental and production objectives.

3.16.3 Optimizing Heat Recovery

Over the years, Sasol Limited has built up practical experience that is used to develop an optimal design that balances thermal efficiency and related environmental benefits against capital cost, operability and reliability. Reasonable balance means avoidance of overly heat integrated processes or utility systems that may lead to longer start-up times, more frequent process upsets or trips and increased flaring, all of which negatively affect production and increase emissions.

As discussed in the steam system (see Section 3.5.2), there are three main process units where steam is generated: the SGU, FT synthesis unit and HPU. These units all make use of commercially proven steam generation systems, some of them containing extensive proprietary know how.
The availability of the large quantities of steam generated from process heat recovery drove the decision to make use of steam drives for the majority of compressor applications. Steam surplus to the GTL facility needs is used in STGs to produce power. Part of this power is used to meet the internal demand, while the remainder is exported to the AltaLink power transmission system.

During design of the GTL facility, various high-pressure, medium-pressure and low-pressure steam use configurations were investigated. For example, high-pressure versus medium-pressure steam for power generation and running all compressor drives on high-pressure steam rather than having a mix of high-pressure and medium-pressure steam drivers. These utility configurations were evaluated using a range of criteria including economics, start-up time, trip/upset scenarios, installed equipment utilization capacity. The utility configuration, as described in section 3.5.2 above was selected since it gave the most optimal and robust design.

In addition to heat recovery and reuse, extensive heat integration was investigated and applied. This was done by first identifying the various streams that needed to be heated and cooled. The “right fit” streams were matched, where “right fit” takes into account similar heat loads, temperatures of the available streams, close proximity to each other on the layout, availability of streams in-line with the start-up sequence, avoiding unnecessary trips, where after a gap analysis was done using pinch analysis and the design was further refined. There are numerous examples of heat integration, including several feed-effluent heat exchangers, extensive boiler feed water pre-heating and condensate stripping with low-pressure steam to produce boiler feed water. These pieces of equipment are standard in the petrochemical industry, but applied in a manner to ensure a system that delivers optimum integration.

3.16.4 Minimization and Recovery of Process Off Gases

Quantities of process off gases were minimized in the design by considering alternative process conditions which resulted in less process off gases and secondly recovery of material in the process off gases. The HERU is a process unit with the objective of recovering material from the FT synthesis unit tail gas but smaller systems have also been included such as vent condensers on drums in the FT synthesis unit where heavier material in vents to flare have been condensed from the stream with the aid of cooling water. From an alternative design perspective, the focus was on maximizing the recovery of light hydrocarbon gasses in the tail gas (typically in the C2, C3 and C4 range). The use of mechanical refrigeration was selected as the best way to achieve this. Alternative means, such as a sponge oil absorption system or using tail gas expansion across a turbo expander, can be used at lower recoveries, which results in more light gasses routed to the flare. This is less attractive from an environmental perspective.

After the minimization and maximum recovery of product material, the remaining viable off gases have been collected in the fuel systems and used as a source of fuel. As discussed in section 3.5.3 the majority of the GTL facility’s fuel needs have been supplied by the recovered process off gases.

Off gas in the product upgrading unit is used as fuel gas in the unit.

The HPU off gases from the process condensate stripper and the PSA will be used as a fuel gas in the fired heater in the unit.
Flaring during start-up and shutdown scenarios will be minimized through optimization of the start-up and shutdown procedures.

Requirements for short-term transient over-pressure scenarios are minimized through the optimization of the pressure control strategy.

### 3.16.5 Effects of Technically and Economically Feasible Alternative Means on the Environment

When considering technically and economically feasible alternative means of carrying out the Project development, evaluation criteria included comparing the effect of each alternative on the environment (see Table 3-23).

#### Table 3-23 Alternative Means and Effects on the Environment

<table>
<thead>
<tr>
<th>Structure</th>
<th>Project Design</th>
<th>Alternative</th>
<th>Environmental Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water intake structure</td>
<td>Use third-party intake structure</td>
<td>Build new intake structure</td>
<td>By selecting to use a third-party intake structure, the North Saskatchewan River will not be affected.</td>
</tr>
<tr>
<td>Water treatment and reuse</td>
<td>High treatment and reuse of water without effluent outfall (except for brine wells)</td>
<td>Effluent release back to the North Saskatchewan River</td>
<td>By choosing not to release effluent to the North Saskatchewan River, the river will not be affected and a pipeline is not required. The quantity of raw water required is also reduced.</td>
</tr>
<tr>
<td>Electrical power source</td>
<td>Cogeneration</td>
<td>Purchase power from Alberta’s power grid</td>
<td>By using cogeneration, the GTL facility will produce surplus power, which will be exported to the grid. This reduces the amount of natural resources needed for power generation. The cogeneration facility also provides the opportunity to use process off gasses, instead of flaring.</td>
</tr>
</tbody>
</table>

Environmental drivers were also used when considering the plot layout and construction methodology (modularized versus stick built).

### 3.17 Carbon Capture

Carbon capture facilities to reduce the GTL facility CO₂ footprint are under consideration for future installation if shown to be economically viable after completing Phase 2 of the Project.

Potential effects of installing such a carbon capture unit have been identified as those that follow.

#### Raw Water Consumption

The capture unit would be a consumer of steam and cooling water. Make-up to the system to account for this additional use would require an estimated additional 341 m³/h of raw water. The water license being sought will include this quantity of raw water.
**BRINES DISPOSAL**

Increasing the raw water intake increases the need for water effluent treatment resulting in an increase of 14 m$^3$/h of the brines stream for disposal. This additional capacity would be handled by installing additional brine wells at the time of the unit installation.

**NATURAL GAS**

Capturing carbon in the process off gas reduces the heating value of the GTL facility’s fuel gas, which in turn requires that additional natural gas must be added to the fuel system to meet the GTL facility’s fuel gas energy requirements.

**POWER IMPORT**

When the carbon capture unit is operational the GTL facility will become an importer of power because the GTL facility’s power requirements increase (additional power demand from the carbon capture process unit) and the amount of process off gas to produce power is reduced.

The effect of carbon capture on the GTL facility is summarized in Table 3-24.

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Stream Name</th>
<th>Change (+ is increase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-5</td>
<td>Raw water</td>
<td>341 m$^3$/h</td>
</tr>
<tr>
<td>E-3</td>
<td>Power export</td>
<td>-109 MW</td>
</tr>
<tr>
<td>W-11</td>
<td>Brines</td>
<td>14 m$^3$/h</td>
</tr>
<tr>
<td>F-1</td>
<td>Natural gas (to fuel)</td>
<td>4 MW</td>
</tr>
</tbody>
</table>

**3.18 Transportation**

An integrated supply chain study, to assess the inbound, onsite and outbound logistics, was performed. In summary the investigations and study concluded that the road and rail infrastructure have the capacity available to handle additional volumes that the GTL facility will have to source from and place into the market. Transportation of the various elements is discussed in the sections to follow.

**3.18.1 Process Chemicals, Maintenance, Repair and Overhaul, and Services**

All seven high-volume chemicals required (97% of non-proprietary, non-specialty by volume) are available from producers in North America. The primary mode of transportation for process chemicals is road supply, except for one or two high volume chemicals where rail transport may be required. Most maintenance repair and overhaul) materials can be sourced locally from distributors in Alberta or direct from original equipment manufacturers and producers in North America.
Inbound traffic for process chemicals and maintenance repair and overhaul goods will amount to 16 rail cars and 27 road trucks per month. For transportation details identified on the major chemical requirements, see Table 3-25 and Table 3-26.

Table 3-25  Mode of Transportation – High- and Low-Volume Chemicals

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Preferred Mode of Transport</th>
<th>Mode Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMDS</td>
<td>Rail</td>
<td>High volumes long distances</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>Road</td>
<td>Very short distance</td>
</tr>
<tr>
<td>Alum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maleic acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl mercaptan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citric acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morpholine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrazine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-scaling chemical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3-26  Mode of Transportation – Proprietary Chemicals

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Preferred Mode of Transport</th>
<th>Mode Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbocell</td>
<td>Road</td>
<td>Lower volumes</td>
</tr>
<tr>
<td>Product upgrading catalyst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drier package ceramic balls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drier package silica gel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catalyst bed supports</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogenator catalyst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphur absorber/guard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External recycle gas conditioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerereformer catalyst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATR catalyst</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT catalyst</td>
<td>Rail</td>
<td>Import</td>
</tr>
<tr>
<td>Perlite</td>
<td></td>
<td>Import</td>
</tr>
<tr>
<td>Molecular sieve</td>
<td></td>
<td>Import</td>
</tr>
<tr>
<td>Cation exchange resin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Granular activated carbon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anion exchange resin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.18.1.1 Products

GTL diesel will primarily be marketed as a premium refinery blend component into the western Canada market. Rail is considered to be the primary mode of transport from the GTL facility and makes access to more distant markets in the US (Alaska, California, Idaho and Washington) also possible. The preferred route to reach these distant markets would be raling it and exporting through the Port of Vancouver.

GTL naphtha will be sold as a bitumen diluent into local western Canada markets. A newly constructed pipeline from the GTL facility to Sherwood Park, Edmonton will route the naphtha into the CRW diluent pool in Edmonton.

LPG will be sold to fractionators in AIH and Edmonton area. Product will be routed to a central off-taker via a newly constructed pipeline.

3.19 Facility Turnarounds

One production phase start-up and shutdown will occur every two years and a total shutdown, i.e., the entire GTL facility shutdown, would occur every four years.

3.20 Information about the First Phase (nominal 48,000 barrels per day)

See Tables 3-27 to 3-33 for detailed capacity and mass balance information.

Table 3-27 First Phase Key Capacities of the GTL Facility

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Units</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>MMSCFD</td>
<td>494</td>
</tr>
<tr>
<td>Raw water</td>
<td>ML/d</td>
<td>7.2</td>
</tr>
<tr>
<td>GTL diesel</td>
<td>BPSD</td>
<td>37,700</td>
</tr>
<tr>
<td>GTL naphtha</td>
<td>BPSD</td>
<td>13,900</td>
</tr>
<tr>
<td>LPG</td>
<td>BPSD</td>
<td>350</td>
</tr>
<tr>
<td>Peak power export</td>
<td>MW</td>
<td>47</td>
</tr>
</tbody>
</table>

NOTES:

1. Raw water usage excludes water required for the prospective carbon capture unit post Phase 2.
2. Surplus power is variable depending on the operating scenario and seasonal power requirement differences.

MMSCFD = Million standard cubic feet per day
ML/d = Million litres per day
BPSD = barrels per stream day
MW = megawatts
### Table 3-28  First Phase Process Mass Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN  (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Natural gas</td>
<td>From pipeline to SGU</td>
<td>393</td>
<td></td>
</tr>
<tr>
<td>P-2</td>
<td>Oxygen</td>
<td>From ASU to SGU</td>
<td>462</td>
<td></td>
</tr>
<tr>
<td>P-3</td>
<td>Boiler feed water</td>
<td>To SGU</td>
<td>1,335</td>
<td></td>
</tr>
<tr>
<td>P-4</td>
<td>Superheated high-pressure steam</td>
<td>To SGU</td>
<td>173</td>
<td></td>
</tr>
<tr>
<td>P-5</td>
<td>Hydrogen</td>
<td>From HPU to SGU and product upgrading</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>P-6</td>
<td>Heavy ends recovery wash water</td>
<td>From the demineralized water system</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>P-7</td>
<td>Heavy ends recovery off gas</td>
<td>To fuel system</td>
<td></td>
<td>180</td>
</tr>
<tr>
<td>P-8</td>
<td>Stripping steam</td>
<td>To product upgrading</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>GTL diesel</td>
<td></td>
<td></td>
<td>193</td>
</tr>
<tr>
<td>P-10</td>
<td>GTL naphtha</td>
<td></td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>P-11</td>
<td>LPG</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>P-12</td>
<td>Product upgrading off gas</td>
<td>To product upgrading fuel system</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>P-13</td>
<td>Oxygenated hydrocarbons</td>
<td>To fuel system</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>P-14</td>
<td>Vent gases</td>
<td>From water treatment to flare</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>P-15</td>
<td>Treated process water</td>
<td>To bioeffluent treatment</td>
<td>428</td>
<td></td>
</tr>
<tr>
<td>P-16</td>
<td>SGU condensate</td>
<td>To condensate recovery. Includes SGU water, boiler blow down and hot condensate.</td>
<td>439</td>
<td></td>
</tr>
<tr>
<td>P-17</td>
<td>High pressure steam</td>
<td>Net export from SGU</td>
<td></td>
<td>1,095</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>2,408</strong></td>
<td><strong>2,408</strong></td>
</tr>
</tbody>
</table>

### Table 3-29  First Phase Water System Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN  (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-1</td>
<td>OC water</td>
<td></td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>W-2</td>
<td>Boiler blow down</td>
<td></td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>W-3</td>
<td>Other process water</td>
<td>From ASU air condensate, HPU</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>S-9</td>
<td>GAC back flush</td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>P-15</td>
<td>Treated process water</td>
<td></td>
<td>428</td>
<td></td>
</tr>
<tr>
<td>W-4</td>
<td>Sanitary waste</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>W-5</td>
<td>Raw water</td>
<td></td>
<td>299</td>
<td></td>
</tr>
<tr>
<td>W-6</td>
<td>Sludge¹</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>W-7</td>
<td>Utility water</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>W-8</td>
<td>ASU makeup water</td>
<td></td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>W-9</td>
<td>Potable water</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>W-10</td>
<td>Polisher brines</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>W-11</td>
<td>Brines</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>W-12</td>
<td>Demineralized water</td>
<td>To steam system</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>P-6</td>
<td>Heavy ends recovery wash water</td>
<td></td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3-29  First Phase Water System Balance (cont’d)

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>Comment</th>
<th>IN (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-13</td>
<td>Sanitary sludge(^2)</td>
<td>For disposal by third party</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>W-14</td>
<td>Biotreatment sludge</td>
<td>To thermal oxidizer</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>W-15</td>
<td>Evaporation</td>
<td>Includes losses related to drift</td>
<td></td>
<td>688</td>
</tr>
<tr>
<td>W-16</td>
<td>Oily Sludge</td>
<td>to thermal oxidizer</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>859</strong></td>
<td><strong>859</strong></td>
</tr>
</tbody>
</table>

**NOTES:**
1. Dewater sludge water content is less than 0.1 t/h.
2. Sludge for External Disposal water content is 0.1 t/h.
3. Water balance performed without carbon capture unit in operation (equivalent to 7.2 ML/d)

### Table 3-30  First Phase Steam, Condensate and Boiler Feed Water System Mass Balance

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Description</th>
<th>IN (t/h)</th>
<th>OUT (t/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>FT synthesis unit</td>
<td>1,175</td>
<td></td>
</tr>
<tr>
<td>S-2</td>
<td>Steam from product upgrading</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>S-3</td>
<td>Saturated process steam</td>
<td></td>
<td>31</td>
</tr>
<tr>
<td>P-17</td>
<td>Steam from SGU</td>
<td>1,095</td>
<td></td>
</tr>
<tr>
<td>S-4</td>
<td>Steam from HPU</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>S-5</td>
<td>Steam from boilers</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>superheated process steam</td>
<td></td>
<td>183</td>
</tr>
<tr>
<td>S-7</td>
<td>boiler feed water</td>
<td></td>
<td>2,723</td>
</tr>
<tr>
<td>W-12</td>
<td>Demineralized water</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>W-10</td>
<td>Polisher brines</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>P-16</td>
<td>SGU condensate</td>
<td>439</td>
<td></td>
</tr>
<tr>
<td>W-2</td>
<td>Boiler blow down</td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>S-8</td>
<td>GAC back flush</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>S-9</td>
<td>Vents and losses</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>2,997</strong></td>
</tr>
</tbody>
</table>

### Table 3-31  First Phase Power Production

<table>
<thead>
<tr>
<th>Description</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IN (MW)</td>
<td>OUT (MW)</td>
</tr>
<tr>
<td>E-1</td>
<td>103</td>
<td>107</td>
</tr>
<tr>
<td>E-2 Internal use</td>
<td>68</td>
<td>60</td>
</tr>
<tr>
<td>E-3 Export</td>
<td>35</td>
<td>47</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>103</strong></td>
<td><strong>107</strong></td>
</tr>
</tbody>
</table>
Table 3-32  First Phase Fuel Distribution

<table>
<thead>
<tr>
<th>Stream Number</th>
<th>Total</th>
<th>F-1</th>
<th>P13</th>
<th>P-7</th>
<th>P-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Units</td>
<td>Energy Available/ In</td>
<td>Natural Gas Consumption</td>
<td>Oxygenated Hydrocarbons Consumption</td>
<td>Heavy Ends Recovery Off Gas Consumption</td>
</tr>
<tr>
<td>Lower heating value</td>
<td>KJ/kg</td>
<td>47,869</td>
<td>18,900</td>
<td>11,408</td>
<td>59,687</td>
</tr>
<tr>
<td>Steam super heater</td>
<td>MW</td>
<td>29</td>
<td>17</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>SGU</td>
<td>MW</td>
<td>32</td>
<td></td>
<td>285</td>
<td></td>
</tr>
<tr>
<td>Boilers</td>
<td>MW</td>
<td>38</td>
<td></td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>HPU</td>
<td>MW</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offsites</td>
<td>MW</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product upgrading</td>
<td>MW</td>
<td>2</td>
<td></td>
<td>38</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>MW</td>
<td>772</td>
<td>130</td>
<td>17</td>
<td>571</td>
</tr>
</tbody>
</table>

Table 3-33  First Phase Carbon Balance

<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Units</th>
<th>Comment</th>
<th>In (ton of Carbon)</th>
<th>Out (ton of Carbon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Natural gas</td>
<td>Process feed to SGU</td>
<td>285</td>
<td></td>
</tr>
<tr>
<td>P-18</td>
<td>Natural gas</td>
<td>Process feed to HPU</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>F-1</td>
<td>Natural gas</td>
<td>Used as fuel for the GTL facility</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>GTL diesel</td>
<td></td>
<td></td>
<td>156</td>
</tr>
<tr>
<td>P-10</td>
<td>GTL naphtha</td>
<td></td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>P-11</td>
<td>LPG</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CO₂</td>
<td></td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>301</td>
<td>301</td>
</tr>
</tbody>
</table>

NOTE:
1 Total from all the flue gas streams. 90 t/h carbon equates to 90 x (44/12) = 330 t/h CO₂
3.21 Symbol Sheet

See Figure 3-18.
4 PROJECT EXECUTION

4.1 Introduction

The Canada Gas-to-Liquids (GTL) Project (the Project) incorporates more than six decades of focused commitment by Sasol Limited to world-class research, development and innovation in Fischer Tropsch (FT) technology and excellence in project management and execution. Sasol Canada Holdings Limited (Sasol) is a subsidiary of Sasol Limited. This section describes Sasol Limited’s global experience with large, complex and capital-intensive energy projects and describes how Sasol will use that experience and knowledge during the Project’s construction, operational and decommissioning phases. It also identifies controls for managing the Project’s inputs, outputs and risks, and describes how the Project will be integrated with regional development in Alberta’s Industrial Heartland (AIH).

4.2 Sasol’s Experience

Sasol Limited was created in 1950 and today its global operations span 38 countries. The company is listed on the New York and Johannesburg Stock Exchanges, has a workforce of more than 34,000 staff, and produces more than 120 products. It is consistently rated by scientists, researchers and engineers as a top employer, reflecting the company’s ongoing and substantial investment in research and development (R&D) to support not only its patented technologies and products, but environmental sustainability.

4.2.1 Project Experience

Sasol Limited has executed many large and complex petrochemical and chemical projects. These projects represent many billions of dollars of investment around the world. The company is proud of its expertise and success in planning, designing and building, operating and maintaining large industrial facilities. The company’s technical expertise, ingenuity and project execution skills will support the Project.

4.2.2 Construction Experience

The construction phase will be planned, managed and executed using a staged-gate approach. Construction activities will be managed by a dedicated and highly experienced team using proprietary in-house project management protocols. Sasol will ensure the Project conforms to Sasol Limited’s rigorous and proven construction and technical specifications and procedures while incorporating local best practices to achieve on-time, on-budget Project execution.
4.2.3  Operations Experience

Sasol Limited is the world’s largest producer of synthetic fuels and a global player in petrochemical and chemical manufacturing. It mines coal in South Africa, produces gas in Mozambique and oil in Gabon. It has extensive manufacturing, marketing, retail and distribution operations in South Africa, Europe, Asia and the Americas. It also has significant R&D operations in South Africa, the United States and Europe.

In the past 10 years, Sasol Limited has focused particularly on commercializing its GTL technology internationally. In a joint venture partnership with state-owned Qatar Petroleum, it built and is successfully operating the ORYX GTL facility. It also has a participating interest in a GTL facility in Nigeria. It has announced plans for GTL facilities in Uzbekistan and Louisiana.

4.3  Engineering, Procurement and Construction

Sasol Limited’s staged-gate approach to building new facilities involves establishing specialized project teams and identifying specific requirements that must be met at each stage for the projects to advance. The process involves specific evaluation criteria for each stage. Evaluations are carried out by experienced senior executives to ensure the required level of information has been attained, verified and measured against the company’s technical and operational quality standards and business performance criteria. The status of stakeholder and community relationships is also assessed on an ongoing basis.

Sasol Limited understands the importance of the early stage of a project. Referred to as front-end loading, it is at this stage that a project execution plan is developed and refined. The execution plan takes into account specific aspects of a project, including market conditions, engineering, construction methodologies, labour market conditions and strategy, contracting strategies, selection of contractors and suppliers for each project phase and stakeholder and community engagement.

Quality control systems are also identified at this time to help define and measure project success in key areas, including:

- workplace health and safety
- environmental sustainability
- return on investment
- adherence to Sasol Limited’s commitment to social responsibility, including establishing and maintaining mutually beneficial relationships with stakeholders and communities where it operates

4.3.1  Organization Structure

The Sasol office in Calgary opened in March 2011 staffed with highly experienced personnel selected from Sasol Limited’s global operations. These staff members have specialized knowledge in planning new GTL projects. Their expertise has been augmented with locally recruited specialists knowledgeable about developing energy projects in Alberta, including activities related to regulatory approval processes and public consultation. On December 3, 2012, Sasol Limited announced its decision to proceed with pre-FEED (front-end engineering and design) activities for the Project before starting FEED. The announcement indicated that Sasol would execute its option to purchase the Project site from Total E&P
Canada and would continue to advance the Project’s regulatory application through the review and approval process as planned.

At the FEED stage, the Sasol Project team will be responsible for selecting a main engineering contractor and related contractors and consultants for completing the FEED, and managing procurement and construction requirements. Sasol envisages a mixed contracting strategy for the Project execution.

In addition to the main engineering contractor hired to oversee the FEED, under the mixed contracting strategy, Sasol will contract one or more qualified engineering, procurement and construction (EPC) companies which will be responsible for certain packages (e.g., air separation unit, hydrogen production unit).

Additionally, Sasol will select a main automation contractor to oversee development of process automation specifications and integration, and a main information management contractor to identify and procure business systems, including technical requirements.

The organizational structure for the Project’s construction phase will be developed during the FEED stage and will support the overall contracting strategy. For the conceptual organizational structure that will be put in place during construction, see Figure 4-1.

Figure 4-1  Project Organization

4.3.2  Capital Costs

The capital cost estimate for the Project to the end of construction for phase 1 is $6 billion to $9 billion (2012 U.S. dollars). The total capital cost estimate for the construction of both phase 1 and 2 is $11 billion to $16 billion (2012 U.S. dollars). These cost estimates are based on Sasol’s detailed cost estimate model, which uses the most current cost data from engineering contractors and other economic information related to fees and rates applicable for the Project. The estimate is subject to a variety of factors, including: variability in world markets for steel, equipment and raw materials; worldwide currency exchange rate fluctuations; labour demand; module yard availability; construction activities underway and weather conditions during the construction period.
4.3.3  Engineering

The Project’s feasibility study began in early 2011 and was completed in Q2 2012. Feasibility is part of the front-end loading process in which alternatives are developed, evaluated and selected.

Sasol plans to begin FEED preparatory activities in 2015 (based on a pre-FEED duration of 30 months). The goal is to further develop the Project to ensure that it meets or exceeds performance expectations and that the Project goal is achieved.

The main engineering contractor will be responsible for:

- FEED
- detailed engineering and procurement on behalf of the owner
- construction management including startup support (engineering, procurement and construction management [EPCM])

Sasol expects to have a single main engineering contractor to handle the EPCM work for the entire scope of the GTL facility to avoid interface risks. The Project will be divided into smaller packages during FEED to support an effective execution strategy. The packages could be EPC packages or construction packages.

4.3.4  Procurement

Key elements of the Project’s procurement and contracting strategy are:

- purchasing will be conducted on behalf of Sasol by the main engineering contractor or directly by EPC package contractors. For certain construction packages or disciplines (e.g., civil construction and insulation), this will include both labour and material supply.
- Sasol’s global purchasing strategy will be applied. Vendor lists for equipment and materials will be defined in the FEED phase, based on a global supply study inclusive of Sasol’s approved vendors (i.e., local, regional and Canadian vendors as well as main engineering contractor vendor data).
- sourcing locations will consider cost, delivery schedule, capacity and specifications. For most equipment and material categories, local sourcing in Canada and North America will be preferred.
- it is anticipated that there could be about six to eight discrete equipment or package types that are too large to transport fully assembled to the Project site. These items might require various levels of preassembly followed by final assembly on site. The Project site will be designed to accommodate various assembly options (see Section 3, Figure 3-1).
- systems and quality control procedures will be developed to monitor equipment and material quality and on-time delivery of all goods and services. The Sasol team and the main engineering contractor will establish dedicated teams to track and manage quality and delivery.
- one or two controlled marshalling yards will be established to manage the receipt and distribution of equipment and material. Sasol, through the main engineering contractor, will retain control over the receipt, storage, prioritization and movement of Project equipment and materials.
4.3.5 Project Controls

Sasol will develop Project controls during FEED that will be used during Project execution. The primary goal is to proactively identify, report and mitigate any variations that might affect commitments made to shareholders. The secondary goal is to address the engineering and integration of modularization into site activities to ensure adherence to the Project schedule and quality requirements. The quality control procedures and specifications, including safety, health and environmental (SHE) aspects will form part of the future contracts.

The following measures will be applied throughout the execution phase:

- results of the Project execution controls will be reviewed at regular monthly meetings and will require project management, engineering management and commercial signoff
- the Sasol Project team will develop Project execution reports for decision making and intervention; they will be used by the venture management team and mandating committee (senior management and technical specialists)
- continuous, systematic and detailed Project reviews and audits will be conducted by specialized experts. Areas of focus will include:
  - quality
  - SHE
  - engineering
  - commercial/cost

Reviews will ensure the Project is developed and executed in accordance with Project goals and adheres to regulatory requirements, approval conditions, applicable federal, provincial and local regulations, and Sasol’s internal specifications and standards. Sasol will ensure that contractors also fulfill the requirements of the respective specifications, procedures and applicable regulations.

4.3.6 Construction

The Project will be constructed in two phases. Phase 1 is expected to begin in the first half of 2018 with startup and operations to begin in 2021. The second phase will begin after phase 1 is completed, depending on specific market conditions at that time. Infrastructure established during construction of phase 1 will also be used for phase 2 to the extent possible. The following principles will be developed during FEED and applied to mitigate construction-related effects of the Project:

- Detailed planning and sequencing will be used to minimize peak workforce and construction traffic volumes.
- A modular construction approach will be used to the maximum economic and practical extent to optimize construction workforce efficiency, thereby minimizing the site workforce volume. Module construction will be located both on- and off-site. Super modules will be assembled on-site.
• Sasol will undertake a traffic impact assessment before starting construction to identify and address requirements that may be identified with respect to additional traffic loads, construction noise or other construction-related effects. See also Volume 2, Section 16 for additional information on traffic effects and the mitigation measures that will be undertaken by Sasol.

• Detailed plans based on logistics studies will be developed for heavy loads and will include compliance to permitting requirements.

• Project-specific SHE standards will be developed and rigorously applied. These standards will comply with regulatory requirements and support Sasol’s goal of zero harm. Compliance with all SHE requirements will be audited by Sasol regularly.

• Construction labour will be preferentially sourced from the local community and accommodated in existing local facilities. Under these circumstances, a construction camp will not be required for the Project. The forecast capacity to support construction of the Project solely with local labour will be evaluated during FEED. If it is necessary to supplement the local workforce, additional labour will be progressively sourced from Alberta, Canada and internationally in consultation with the relevant authorities. The availability of sufficient local accommodation will be further evaluated during the FEED and execution stages of the Project. For additional information on construction workforce effects and mitigation measures that will be undertaken by Sasol, see Volume 2, Section 16.

Further to the specific measures detailed during FEED, the following general construction approaches will also apply:

• construction will be controlled by Sasol through the services of a reputable main engineering contractor who will be responsible for managing the site and all construction activities, including emergency response planning

• construction labor will be sourced and managed on an open site basis

• the construction site will be divided into manageable work packages, which will result in manageable construction areas. It is expected that each area would be self-contained and functionally self-supporting. Common support services, which will be identified as the Project develops, will be shared among the construction areas. The goal is to have a single contractor responsible for all activities in each designated construction area.

• the site will be fenced at the property line. Access gates for workforce and deliveries will be established at appropriately evaluated locations, and access will be controlled at each access point. Security precautions will be employed to safeguard the site.

• construction laydown areas will be established within the fenced area. The construction strategy for the Project will also require that module, pipe spool and equipment fabrication facilities be established within the fenced area.

• construction lay down areas will include facilities for messing and ablutions, and will serve as mustering points in emergencies

• the power and potable utilities required for construction (i.e., capacity and timing) will be quantified and integrated into the overall Project requirements
4.3.6.1 Construction Methodology

Equipment and material will be managed through one (or possibly two) marshalling yards. The primary marshalling yard will be located at the site and may be supplemented by additional yards in Edmonton. All equipment and material will be received, inspected and stored in the marshalling yard(s) before distributing it to the required location. Construction locations and construction processes include:

- module fabrication yards – piping prefabrication, building modules and pre-cast concrete preassembled or manufactured in specialized workshops in the Edmonton area; modules will be either shipped directly to the Project site and installed or assembled in super modules at the site module assembly yard and transported to the final location using self-propelled module transport (SPMT)

- site module assembly yard – super modules will be assembled in a dedicated area at the site yard, and assembly (of modules, super modules and module assembly components fabricated off shore) will begin as soon as they are transported to the site yard

- site – field erection, directly at jobsite areas (stick built)

- large-vessel assembly site – this area will be on site

- significantly oversized equipment will be assembled on site

Various modules will be fabricated, including:

- box-type modules – process or pipe rack structure component for transport to the site; each module will have relevant structural steel along all edges

- skid-type modules – structural steel along base only for pump, lube skid-type modules

- super modules – major process or pipe rack structures too large for road transport; super modules will be stick built on-site or assembled from smaller box modules, and will be moved using SPMT

- vendor-fabricated equipment and equipment modules – cooling tower cells, air coolers and fired heater sections

4.3.6.2 Site Preparation

The Project's site preparation will generally adhere to the following sequence:

- site clearing
- soil stripping and stockpiling
- site levelling, grading and dewatering
- underground piping and supporting infrastructure development, including civil engineering and establishment of site fabrication facilities, laydown areas and module yards
- construction will include a combination of stick-built and modular-build activities; fabrication of the main pipe racks of the GTL facility (modules and stick-built) will be completed first, followed by fabrication of process unit modules and stick-built sections
- construction of utilities, off-sites and third-party infrastructure connections will be carried out simultaneously


4.3.6.3 Pipeline Right-of-Way Management

The site is constrained by several third-party pipeline rights-of-way that run through the site (see Figure 4-2). Section 2, Table 2-2 lists companies that hold easements (listed under stakeholders with direct interest in the Project lands). Preliminary studies show that two of the pipeline rights-of-way are no longer in service. These two pipelines will be relocated.

Sasol will work with respective pipeline owners to ensure agreement on appropriate measures required to manage safety risks during construction and operation of the GTL facility. The following measures will be incorporated into Project design and construction:

- a minimum setback of 30 m will be maintained between the GTL facility and the rights-of-way
- Sasol will obtain crossing agreements for both the construction and operations phases of the Project
- right-of-way crossings will be minimized
- fencing and signage will be provided around pipeline rights-of-way, where appropriate
- single-crossing areas will be used, where possible, for transporting materials during construction
- right-of-way crossings will be designed, built and maintained with approval of pipeline owners
- during any construction within the setback, an approved pipeline right-of-way inspector will be on site and pipeline owners will be afforded the opportunity to have representatives present

Sasol has initiated contact with all pipeline owners to review the GTL facility plot plan and pipeline constraints. Sasol plans to consult pipeline owners before construction begins and will ensure ongoing communication during Project operations.

4.3.6.4 Project Construction Phasing

For the process units that will be constructed during each phase of the Project, see Table 4-1.

<table>
<thead>
<tr>
<th>Phase 1 Process Units</th>
<th>Phase 2 Process Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air separation unit (Trains 1–3)</td>
<td>Air separation unit (Trains 4–6)</td>
</tr>
<tr>
<td>Synthesis gas unit (Trains 1–3)</td>
<td>Synthesis gas unit (Trains 4–6)</td>
</tr>
<tr>
<td>FT synthesis unit (Trains 1–2)</td>
<td>FT synthesis unit (Trains 3–4)</td>
</tr>
<tr>
<td>Heavy ends recovery unit (Train 1)</td>
<td>Heavy ends recovery unit (Train 2)</td>
</tr>
<tr>
<td>Water treatment unit (Train 1)</td>
<td>Water treatment unit (Train 2)</td>
</tr>
<tr>
<td>Product upgrading unit (Train 1)</td>
<td>Product upgrading unit (Train 2)</td>
</tr>
<tr>
<td>Hydrogen production unit (Train 1)</td>
<td>Hydrogen production unit (Train 2)</td>
</tr>
</tbody>
</table>

Utilities and offsites will be installed according to the requirements of each phase. The detail development of these requirements will be completed during FEED and will consider pre-investment, constructability, and construction and operational safety.
Infrastructure on Project Lands

Acknowledgements: Original Drawing by Stantec

Boundaries: National Road Network, Alberta. Pipelines received from Ministry of Petroleum 20130810.

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4.3.7 Commissioning Framework

A preliminary commissioning framework has been developed. The commissioning framework will be further developed during FEED.

It is anticipated for each Project phase, approximately 24 months before operations begin, a dedicated commissioning team will be created and tasked with supporting startup operational requirements, including initial training and startup, procedures development, startup planning, operational support and pre-startup safety review (PSSR). The team will also provide support to operations by:

- transferring knowledge learned from Sasol Limited’s existing worldwide operations, including its extensive experience in the commissioning and startup of new GTL facilities
- coordinating the handover and transition from construction to pre-commissioning, commissioning and operations

The commissioning team will continue to support the operations of the GTL facility as needed in the early stage of operations.

4.3.8 Construction Labour

Site construction is forecasted to start the first half of 2018, and an estimated 5,000 construction workers will be required at peak construction. This is inclusive of the site and module yards and includes all disciplines typically required for the construction of an integrated process facility, including:

- earthworks
- civil and structural
- buildings (bricklayers, trades)
- piping (welders, fitters)
- electrical
- instrumentation
- painting & insulation
- supervision
- trades helpers and labourers

A construction camp is not required. The forecast capacity to support Project construction solely with local labour will be further evaluated during FEED. If it is necessary to supplement the local workforce, additional labour will be progressively sourced from Alberta, Canada, North America and internationally as required. The availability of sufficient local accommodation will also be further evaluated.
4.3.9 Schedule

The Project’s schedule has been developed based on the modular construction sequencing and the overall integrated construction plan (see Figure 1-3). Scheduling for each phase will be updated as required.

Sasol anticipates that:

- for phase 1, the time from final investment decision to operations readiness will be 45 months. This timeline takes into account a reduction in site work during winter months
- the schedule will match the commissioning framework plan requirements
- site work is expected to begin in the first half of 2018, subject to regulatory approvals and Project-sanctioning requirements

4.4 Operations

Sasol will use Sasol Limited’s international operating experience to set up and develop all systems required for an effective organization. This includes hiring and training a skilled local workforce. Systems to identity hazards and risks are considered part of normal operations and will be implemented at the GTL facility.

4.4.1 Organization

The operational workforce plan estimates that about 890 workers will be needed to operate and maintain the GTL facility. Most staff will be recruited from the local communities and Alberta. In addition, Sasol will provide opportunities for international experts from within its organization to work at the site to assist with knowledge transfer and training and development of the Canadian workforce in the GTL facility’s specialized technology. It is also expected that some Canadian workers will be assigned to Sasol Limited’s existing operating facilities during the FEED stage to become familiar with the GTL process.

4.4.2 Operating Costs

The operating cost for the two phases (excluding feedstock) on an annualized basis ranges from $19 to $26 per barrel (on U.S. 2012 basis). Operating costs could vary depending on input costs at the time (e.g., costs for energy and labour costs).

4.4.3 Management Systems

The Project will be designed to have state-of-the-art, comprehensive and integrated automated management systems to ensure the GTL facility’s operation and maintenance conforms to Sasol policies, procedures, protocols and quality standards, regulatory requirements and community expectations. These systems will support Sasol’s commitment to zero harm and continuous improvement, and reflect Sasol Limited’s global experience in building, operating and maintaining GTL facilities. The automated systems will include management information systems, business systems, manufacturing execution systems, and information management and information technology.
4.4.4 Pre-operations Activities

The Project reflects Sasol Limited’s holistic approach to designing and building new GTL facilities. Operational considerations form an integral part of decision-making at every engineering stage from the initial pre-feasibility study through to detail design and construction. All systems and procedures required to safely operate the GTL facility will be developed before commissioning and operation. These systems and procedures will be developed in greater detail during FEED and detailed design.

Most key personnel will be hired at least one year before the start of operations. Key operations staff will be trained at Sasol Limited's international facilities and all remaining staff will be trained in Canada. All personnel will be trained in the relevant operational procedures, SHE requirements per operating area and the SHE requirements for the GTL facility.

Following construction of the GTL facility, all equipment will be registered and operational procedures and policies will be in place to support safe commissioning and operation.

A PSSR will be conducted before startup of each phase.

4.5 GTL Inputs and Outputs

4.5.1 Feedstock – Natural Gas

The GTL facility will be designed and suited to operate with typical natural gas qualities coming from the Alberta system. A new pipeline will be installed by a third party to connect the Project with natural gas networks such as:

- Alliance Pipeline
- Nova Gas Transmission Limited (Alberta System)

These networks have third-party rights-of-way running through the site or adjacent to the southern boundary of the site.

4.5.2 Power Import and Export

External power is required to start the GTL facility. Once operational, the GTL facility will be a net exporter of power. The Project will be connected to the AltaLink transmission system. The connection voltage level will be finalized based on the requirements of the Alberta Electric System Operator (AESO), AltaLink and the Project.

4.5.3 Raw Water

Sasol is planning to use a third-party intake structure to withdraw water from the North Saskatchewan River to meet its raw water requirements. The necessary arrangements will be finalized during the FEED phase of the Project. Required water volumes are discussed in Section 3.5.1.1.
4.5.4 Products

4.5.4.1 LPG

LPG will be routed to processing facilities in AIH via a third-party pipeline. No LPG storage will be provided on-site.

4.5.4.2 GTL Naphtha

GTL naphtha will be routed via a third-party pipeline to a terminal in the Edmonton area from where it will be routed to the diluent markets in northern Alberta.

4.5.4.3 GTL Diesel

GTL diesel will be distributed via rail to local and western Canadian markets.

4.6 Regional Development Integration

Sasol has engaged in discussions with provincial and Strathcona County officials and with other local jurisdictions comprising AIH, industry and other stakeholders to identify how the Project can integrate with existing and future regional development and contribute to the province’s long-term economic prosperity. The Project seeks to build Canada’s first GTL facility and represents a major achievement in provincial and national policies to encourage higher-value processing of natural resources in Canada. As such, the Project strongly aligns with the founding principles of AIH and with its current and long-range development plans to attract new industries that can further support its vision to be Canada’s energy-related value-added centre.

Sasol selected AIH from other potential sites in Canada because of its natural fit with requirements deemed essential for a commercially feasible project. These include proximity to natural gas supplies and required transportation infrastructure.

Sasol is working closely with authorities and planning officials in AIH regarding future planning for area infrastructure with a view to achieving better understanding of the effects on the Project, including opportunities for achieving efficiencies. Through its consultation program Sasol is also in regular contact with other industries and businesses in the region and with stakeholders, which provides additional insights into infrastructure issues and requirements. The traffic impact assessment, when completed, will also provide important information for Sasol.

Additionally, an extensive modularization strategy has been developed that focuses on modularization in the Edmonton area and assembly of super modules at the Project site. The strategy also identifies the requirements for fabricating large pieces of equipment that cannot be transported to site.

Regional public and private utility infrastructure has been identified to meet the GTL facility’s water and power needs. Sasol is committed to accessing and, where necessary, enhancing existing regional infrastructure and will look for opportunities to partner with others to reduce costs, minimize the environmental footprint and avoid unnecessary duplication of infrastructure.
In keeping with its commitment to work cooperatively with other industries and companies operating in the region, Sasol has recently become a member of the Northeast Capital Industrial Association (NCIA). Through its involvement with the NCIA, Sasol hopes to identify additional opportunities for joint action especially in the areas of environmental protection, public safety and enhanced infrastructure efficiency.

Sasol maintains a culture of open, honest and respectful communication in all interactions with government, industry, local communities and stakeholders, with a focus on making a positive difference in the communities where it operates. Sasol will throughout the life of the Project engage in continuous and meaningful dialogue with its regional neighbors and partners. As planning progresses, Sasol will look for additional opportunities for memberships or alternative options for affiliation with other regional initiatives relevant for the Project.

### 4.7 Project Risk Management

Sasol follows a structured approach to risk identification and risk management. This includes:

- formal risk reviews, which cover all aspects of the Project (e.g., Project execution, engineering, business development and SHE)
- an approach that focuses on identifying risks, their severity and associated consequences, and subsequently identifying measures to minimize and mitigate identified risks
- incorporating actions resulting from risk management in a master schedule for governance purposes
- assigning responsibility for the risk management process to the GTL venture director

#### 4.7.1 Design and Technology Risks

Technologies selected for the Project have been chosen exclusively from available commercially demonstrated technologies. The selection of these technologies is based on Sasol Limited’s considerable operating experience and in-house technical and R&D expertise. This experience is not limited only to the individual technologies involved, but also applies to the successful integration of these technologies to operate in unison.

The lessons learned from the startup and operations of the ORYX GTL plant in Qatar have been, and will continue to be, incorporated in the design for the GTL facility.

The successful capacity scale-up of the FT technology from the ORYX design is well within the design capabilities of Sasol for FT technology development. Sasol will apply proven internal scale-up development processes and has completed studies and demonstration-scale operations to address all foreseeable risks posed by the scale-up.

The design of the Project will be undertaken by a reputable international main engineering contractor experienced in designing facilities within Alberta. Sasol will make use of people experienced in the design and operation of FT technologies to oversee the contractor to ensure that the breadth and depth of Sasol Limited’s knowledge and experience are incorporated into the design. There are no noteworthy design or technology risks associated with the Project.
4.7.2 Environmental Risks

The Project will be designed to meet or exceed applicable standards and regulations. Environmental risk assessments will occur at all stages of the Project, from initial design through construction, operations, closure and reclamation, in compliance with Sasol’s environmental management system (EMS). The EMS is a quality review process that continually evaluates the effectiveness of the planning, management and response to environmental risks. The information from the EMS will enable Sasol to better understand Project-related environmental risks and to identify mitigation to address identified risks. Project-related risks and mitigation strategies identified include:

- risk assessments that will be undertaken in an objective manner to identify mitigation strategies
- water management planning for storm runoff events
- specific designs for facility shutdown scenarios
- response procedures for natural disasters such as tornadoes or floods
- controlled emission release response
- emission release management and response planning
- waste management (hazardous and non-hazardous)
- effluent management
- land risk management
- emergency response planning

4.7.3 Regulatory Risks

There is a potential risk that the Project could experience a longer-than expected approval process because it will be Canada’s first GTL facility. Sasol has undertaken an extensive program of education to increase understanding of its GTL technology and is committed to working closely with Alberta government officials, AIH, and local communities and stakeholders during the review and approval process to create understanding and long-term, mutually beneficial relationships.

4.7.4 Execution Risks

The Project faces the potential risk from the uncertainty surrounding the extent of new large-scale industrial projects that could be under construction in Alberta and specifically in AIH between 2018 and 2021, the anticipated construction timeline for phase 1 of the Project. These timeframes are tentative and could expand if shortages of resources are experienced. An active construction market, influencing the availability and price of labour as well as equipment, is the most significant driver of cost and schedule risk for the Project. However, there are no additional large-scale industrial projects disclosed for the study area used for Project’s socio-economic assessment (see Volume 2, Section 16.3.2.1).

The Project’s phased development will reduce risks during the construction period. This approach provides adequate flexibility in terms of planning and execution. Project development plans will be adjusted according to changes in the market. The phased construction approach reduces the required
number of people on site, thereby improving site safety because of lower site saturation. It also provides an effective way to manage costs.

Sasol will make use of international engineering, construction and procurement companies with world-leading systems to ensure that the Project is executed according to plan.

### 4.7.5 Economic and Market Risks

As more natural gas and crude oil production comes online, a downward pressure on price for these commodities occurs if supply exceeds demand. Low natural gas prices provide an opportunity for the Project in that it reduces the feedstock cost to support the operation. However, the Project also depends on the value of oil because pricing for the products being produced (i.e., GTL diesel and GTL naphtha) is based on oil prices. Therefore, any downward pressure on oil prices could create a challenge for the Project’s economics.

The ability to secure the required construction labour force in the local market will depend on the level of investment and development occurring at the same time as the Project. It is expected that the level of project activity will depend largely on oil prices.

The GTL products will be marketed primarily in western Canada but could also be exported to other Canadian and international markets.

### 4.8 Adaptive Management

Sasol Limited is a recognized world leader in GTL technology and in constructing, operating and maintaining facilities where it is used. Its proprietary technology and its GTL facilities worldwide are supported by R&D centres in several countries staffed by scientists and researchers committed to continuous improvement and refinements. The Project will use commercially proven and tested technologies. The adaptive management process as commonly applied involves:

- continuous assessment of operational needs and environmental issues
- selection, development, implementation and monitoring technology
- ongoing evaluation of design effectiveness in the context of environmental effects, regulatory requirements, community expectations and management goals, with adjustments made as required

All aspects of the management process are intrinsic to Sasol’s approach to planning, building and maintaining its GTL facilities and will be fully integrated into the Project.

Sasol is committed to ongoing dialogue with stakeholders and local communities to ensure it is aware and responsive to issues and concerns.
5 MANAGEMENT PLANS

5.1 Introduction

Sasol Limited values and is an advocate for sustainable development that balances economic, social and environment stewardship. Therefore, it places high importance on its commitments to social investment, environmental protection, and the health and safety of its employees, contractors and the communities where it operates. Sasol Limited is also committed to open and transparent consultation that is responsive to issues and concerns of regulators, governments and the public. It fulfills these commitments through corporate governance tools that include policies, principles, strategies, standards and procedures, and through external governance tools that ensure compliance with country-specific local and national legal requirements, the requirements of the security commissions and stock exchanges that regulate trading in its stock, and requirements of the international agreements and initiatives it supports. Sasol Limited’s corporate social investment (CSI) and safety, health and environment (SHE) governance tools will shape and guide Sasol’s management of the Canada Gas-to-Liquids (GTL) Project (the Project).

5.2 Sasol’s Corporate Policies on Social Investment and Safety, Health and Environment

5.2.1 Corporate Social Investment

Sasol Limited CSI initiatives prioritize projects that are people-centred, needs-driven and support sustainable development of communities and individuals. People are one of Sasol Limited’s values—to create a caring, engaged and enabled work environment that recognizes both individual and team contributions in pursuit of high performance. Sasol Limited invests in the communities where people live, work and play. It works with local communities and governments to understand:

- a region’s needs
- how potential CSI projects might benefit the community
- the sustainability of projects
- overall stakeholder support for actions

Sasol Limited’s CSI focus areas include:

- education in science and technology
- health and welfare, including the social wellbeing of local communities
- environment, including conservation projects, environmental education and awareness and capacity-building
- job creation and capacity-building in local communities
• arts, culture and sports development in local communities
• crime prevention and community safety

Sasol Limited’s CSI initiatives are driven by five goals:

1. improving a community’s quality of life
2. fostering a spirit of cooperation and partnership with stakeholders
3. enhancing the social and economic wellbeing of society by creating opportunities
4. leading by example and establishing best practices
5. encouraging voluntary employee involvement

5.2.1.1 Project-specific Community Investment

Sasol Limited’s CSI policy and approach will be used by Sasol for the Project. See Section 2.5.2 for further details.

5.2.1.2 Safety, Health and Environment

Sasol Limited’s safety, health and environmental (SHE) policies recognize that its business and operational activities can have effects on the environment and on the safety and health of people. Therefore, protecting the environment and employees and contractors forms an integral part of planning and decision-making. Safety is a top priority and a core corporate value, with the goal of zero harm. Sasol Limited expects its employees and service providers globally to take personal responsibility to achieve zero harm in all day-to-day activities. The company invests in and manages its activities to responsibly manage environmental impacts, eliminate incidents, minimize risk and create a work environment that enables excellence in operational and business performance.

Sasol Limited’s SHE goals are achieved through the following commitments:

• conducting business with respect and care for people and the environment
• responsible utilization of natural resources
• consistently demonstrating visible and active leadership with employees and service providers
• promoting dialogue with stakeholders about SHE matters and performance
• complying with agreed corporate requirements that embrace the duty of care, including compliance with applicable laws
• taking decisions that add sustainable value in the short, medium and long term

Sasol Limited’s SHE goals and commitments are achieved through the following strategies:

• identifying hazards, assessing risks and implementing effective controls to prevent causes and mitigate possible consequences
• setting and periodically reviewing SHE objectives and targets and communicating progress
• using internationally recognized management systems, ensuring they are audited and identifying improvement opportunities to drive better SHE performance
• developing and implementing inherently safer and cleaner technologies
• holistically managing the health and wellness of its people
• responding effectively to emergencies involving its employees or service providers, operations and products
• benchmarking best SHE practices internationally
• learning from incidents to prevent reoccurrence
• informing and training all employees and service providers on SHE best practices

Sasol Limited’s integrated SHE management system comprises:

• management system leadership and planning
• legal and other requirements
• risk and change management
• objectives, targets and performance indicators
• resource and information management
• consultation, participation and communication
• people development
• supply chain management
• projects, design, construction, commissioning, decommission and rehabilitation
• surveillance, monitoring and measurement
• operational control and maintenance
• non-conformance management
• performance evaluation and reporting (includes audits and management review)

These key elements of the SHE management system respond to and address the mandatory requirements outlined in the following standards:

• Occupational Health and Safety Assessment Series (OHSAS) 18001:2007
• International Standards Organization (ISO) 14001:2004
• ISO 9001:2008
• Responsible Care, 1994
5.2.1.3 SHE External Governance Tools

Sasol Limited adheres to country-specific SHE legislation applicable to its operations and to the requirements of key initiatives or organizations that are applicable to Sasol Limited and its subsidiaries, including:

- The 1994 Responsible Care Program of the South African Chemical and Allied Industries Association (CAIA)
- United Nations (UN) Global Compact (2001)
- Global Reporting Initiative (2003) DJSI and JSE SR
- Equator principles for major projects (same as International Finance Corporation)
- Johannesburg Stock Exchange and New York Stock Exchange listing requirements

5.2.1.4 Project-specific Safety, Health and Environment Planning

Sasol Limited’s internal and external SHE governance tools will be utilized to support the Project. This will be achieved by using the company’s Policy Declaration process. Under this process, Sasol will develop site- and operational-specific procedures, policies and management systems before Project start up and operations to ensure compliance with Canadian and Alberta regulatory requirements and consistency with Sasol Limited’s corporate requirements. At this time, Sasol has identified the following programs to mitigate the Project’s safety-related risks.

**PROCESS SAFETY MANAGEMENT**

Process safety management (PSM) aims to ensure process integrity by preventing loss of containment of hazardous chemicals, preventing loss of control of energy, and preventing associated adverse consequences. PSM requires contingency plans to be in place to mitigate—as much as practical—the potential consequences of such an incident. PSM includes 16 elements:

1. Employee Participation
2. Process Safety Information (PSI)
3. Process Hazard Analysis (PHA),( e.g., man-machine interfaces, and Inherently Safe Design)
4. Standard Operating Procedures (SOPs)
5. Training
6. Service Provider Management
7. Pre-Start-up Safety Review (PSSR)
8. Maintenance Integrity Safety Standard (MISS)
9. Work Permits
10. Management of Change (MOC)
11. Incident Investigation
12. Emergency Planning and Response
13. Compliance Audits
14. Trade Secrets
15. PSM Metrics
16. Audit Protocols

5.2.1.5 Environment

Environmental management includes pollution prevention and control, eliminating and mitigating environmental effects of operations, and energy efficiency. For Project-specific details, see Section 5.3 through Section 5.8.

5.3 Air Quality Management

An air management program has been designed to control air emissions from the GTL facility. The overall general principles guiding air quality management for the GTL facility include:

- adopting plant-wide energy integration to maximize energy conservation
- using recovered off gas streams, sludge wastes and solid wastes as an energy source
- using low-NOx (oxides of nitrogen) burners to reduce NOx emissions
- providing vapour recovery for storage tanks containing volatile hydrocarbons
- providing plot space and tie-in points for possible future carbon dioxide (CO2) capture

5.3.1 Emissions Estimation Basis

Source parameters and associated emissions rates for the GTL facility are based on design experience and standard industry practices. The source types include:

- heater, furnace, and boiler stacks
- waste to energy thermal oxidizer stacks
- vent stacks
- flare stacks
- storage tanks
- process areas
- cooling towers

For air emission source parameters associated with the GTL facility, see Volume 2, Appendix 3A. The actual emissions associated with the Project are expected to be less than those used for the air quality assessment, as the assessment includes conservative assumptions.
5.3.2 Emission Controls

5.3.2.1 Engineering and Procurement Stage

Several mitigation measures to manage emissions have been incorporated in the design:

- The heater, furnace and boiler stacks will be fired varyingly with natural gas and recovered off gas. As these gas streams have very low sulphur contents, sulphur dioxide (SO$_2$) emissions from these stacks will correspondingly be low.

- NO$_X$ emissions from the heater, furnace and boiler stacks will meet the more stringent of the Canadian Council of Ministers of Environment (CCME1998) emission limits and the Alberta Environment and Sustainable Resource Development (ESRD 2007) compliance limits. CCME emission limits for NO$_X$ are 40 g/GJ for units with heat inputs greater than 105 GJ/h, and 26 g/GJ for units with heat inputs between 10.5 and 105 GJ. ESRD compliance limits for NO$_X$ are 40 g/GJ for alternate gas streams (e.g., recovered off gas) and 26 g/GJ for natural gas. NO$_X$ emissions are expected to be less than those associated with these limits because of continuous improvements in technology. On an annual basis, the objective is to approach or meet the ESRD performance target of 15.8 g/GJ.

- The use of a gaseous fuel, such as natural and recovered off gas, for the heater, furnace and boiler stacks will reduce fine particulate matter (PM$_{2.5}$) emissions relative to the use of liquid or solid fuels.

- The selection of control technology to reduce emissions from the two thermal oxidizer stacks has not been finalized. Various control technologies that are under consideration include: fabric filters and dry sorption for the solid waste thermal oxidizer; and electrostatic precipitators and wet scrubbing for the sludge waste thermal oxidizer.

- The flare tips will be designed to ensure efficient combustion of the gas streams. The events that could lead to upset flaring will be controlled to reduce the frequency and duration of these events. An ongoing monitoring program will explore opportunities for improvement opportunities. SO$_2$ emissions from the flare stacks are low as the sulphur content of the gas streams directed to the flare are low.

- Fugitive emissions from three of the storage tanks will be reduced by using internal floating roof tanks. Ten of the tanks will be tied into a vapour recovery system (VRS) to reduce fugitive emissions associated with handling and storage of the products.

- Fugitive emissions from the process areas will be reduced with the use of appropriate control valves, seals, and gaskets.

- Cooling towers will use drift eliminators to reduce liquid emissions. Chemical additives will be used to reduce environmental effects. These additives control internal corrosion, scaling and fouling of the circulating water system.

Emission-control strategies in the design and equipment selection will be further refined during the engineering, procurement and construction stage.
5.3.2.2 Construction Emission Control

Sasol recognizes the importance of air quality management during the construction phase. The main emission sources during construction are associated with fugitive dust resulting from surface disturbance activities and from transportation and construction equipment and vehicle exhausts. Cleared vegetation will be mulched rather than burned to reduce smoke emissions. The following mitigation will be adopted to reduce the potential for wind-blown dust under dry, windy conditions:

- Wet suppression will be used to control open dust sources. In extreme situations, construction activities might be temporarily halted until the dust conditions have passed.
- Temporary access routes and parking lots will be constructed at the site. Fugitive dust emissions can be reduced with the use of non-toxic chemical stabilization for semi-permanent or relatively long-term unpaved roads or parking lots.
- County access roads will be paved before construction.
- Hauling or other similar dust generating activities may be suspended when wind gusts exceed 40 km/h (25 miles per hour).
- Properly maintained construction vehicle equipment.

The following mitigation will be adopted to manage vehicle emissions:

- Bus transport will be made available to construction workers to reduce emissions associated with the use of individual vehicles. A non-idling policy will be introduced.
- Track-out controls will be implemented to prevent soil and mud from being spread onto public roadways by trucks and other vehicles entering and leaving the Project disturbance area (PDA).

Sasol views these as standard industry practices to manage construction activity emissions.

5.3.2.3 Operations Emission Control

A number of mitigation measures will be implemented to control emissions during operations:

- Sasol plans to operate and maintain all fired equipment to ensure combustion efficiencies are maintained. Source monitoring will confirm and to track the emissions from the main stacks.
- A leak detection and repair program will be implemented at the GTL facility and tank farm to find and repair the larger fugitive sources to reduce fugitive emissions.
- Flow rates to the vent stacks and flare stacks will be monitored continuously. Abnormal or upset flow rates will be documented. Operations will be reviewed in an effort to control the duration and frequency of major events.
- Emissions will be sampled and measured for trace contaminants, and if found, control measures will be implemented.
• Plant turnarounds and maintenance activities will be managed to ensure equipment is suitably depressurized and purged to reduce emissions. Sasol will examine opportunities to reduce emissions during these activities.

• A public reporting protocol will be developed to allow community members to report odours or other issues associated with the GTL facility operations facilitating prompt response from Sasol.

Feedback from the source and ambient monitoring programs will be reviewed to identify need for additional management actions.

5.3.3 Source Monitoring

A source monitoring program will be developed through discussions with ESRD; and the monitoring terms and conditions will form part of the Alberta Environmental Protection Enhancement Act (EPEA) approval. Larger stacks will be properly equipped with a continuous monitoring according to the Continuous Emissions Monitoring Systems Code, and these will be supplemented by stack surveys conducted according to the Alberta Stack Sampling Code. The results of the continuous monitoring and stack surveys will be reported in accordance with the terms and conditions identified in the EPEA approval. For further discussion about anticipated monitoring and reporting, see Volume 2, Section 3.

5.3.3.1 Ambient Monitoring

Ambient air quality monitoring can address a range of objectives, for example: local-scale monitoring to determine compliance with Alberta Ambient Air Quality Objectives (AAAQO) and Canada Wide Standards (CWS), monitoring to provide representative community exposures, regional scale monitoring to evaluate long-term environmental changes, monitoring to determine relative source contribution (e.g., urban versus industrial), and monitoring to determine background values.

Ambient air quality monitoring in the region is conducted by the Fort Air Partnership (FAP) to meet public, regulatory and industry needs. Sasol plans to work with ESRD and FAP to ensure their monitoring contribution complements the current program without leading to duplication of efforts. Sasol will actively participate in FAP’s regional monitoring initiatives.
5.4 Climate

5.4.1 Climate Change Effects

Effects of climate change on the Project are assessed qualitatively and the various stages of the GTL facility are ranked according to their sensitivity to climate changes (see Table 5-1). Direct effects could result from changes in climate parameters such as temperature, precipitation and wind extremes. Indirect effects could result from changes in groundwater and stream flow availability. GTL facility sensitivities to climate influences by stage include the following:

- **Construction** – Individual sensitivities for the construction stage are ranked as nil to low. The low rankings recognize that weather conditions can influence transportation of materials and construction activities. Overall, sensitivity for this stage is ranked as nil because the construction stage is short-term.

- **Operations** – Individual sensitivities for the operations stage are ranked as nil to moderate. The direct influences are all ranked as nil as the Project has been constructed to meet extreme weather criteria. The only moderate ranking recognizes the importance of possibly reduced water availability from the North Saskatchewan River through climate change. Overall, Project sensitivity for the operations stage is ranked as low.

- **Decommissioning** – Individual sensitivities for decommissioning are ranked as nil to low. The low rankings assume the Project area will be reclaimed to non-industrial land use following the life of the Project, and that the nature and success of site reclamation activities will depend on the climate at that time. Overall Project sensitivity for decommissioning is ranked as low.

More detailed climate change effects are discussed within each discipline section in Volume 2.

**Table 5-1 Project Sensitivities to Direct and Indirect Climate Change**

<table>
<thead>
<tr>
<th>Climate Parameter</th>
<th>Project Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Construction</td>
</tr>
<tr>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td>Mean temperature</td>
<td>Nil</td>
</tr>
<tr>
<td>Extreme temperature</td>
<td>Nil-Low</td>
</tr>
<tr>
<td>Mean rainfall</td>
<td>Nil</td>
</tr>
<tr>
<td>Mean snowfall</td>
<td>Nil</td>
</tr>
<tr>
<td>Extreme precipitation</td>
<td>Low</td>
</tr>
<tr>
<td>Extreme winds</td>
<td>Low</td>
</tr>
<tr>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td>North Saskatchewan River flow</td>
<td>Nil</td>
</tr>
<tr>
<td>Soil moisture groundwater</td>
<td>Nil</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>Nil</td>
</tr>
<tr>
<td>Extreme weather events</td>
<td>Low</td>
</tr>
</tbody>
</table>
5.4.2 Climate Change Policy

Sasol Limited is committed to on-going review and assessment of long-term absolute greenhouse gas (GHG) emission targets, as global developments in this area take place. The targets are contingent on technological advances, such as carbon capture and storage (CCS), increased use of renewable energy, as well as developments in the regulatory and fiscal environments where it operates.

The company is committed to the development and implementation of safer and cleaner technologies to reduce environmental risks. For production processes, cleaner production results from:

- conserving raw materials, water and energy
- eliminating toxic, carcinogenic and dangerous materials
- reducing the quantity and toxicity of gas emissions, liquid effluents and solid waste at source during production process

5.4.3 GHG Emissions Control

Energy efficiency design features for the Canada GTL Project follow:

- Fischer Tropsch (FT) synthesis and reforming results in heat release, and the recovered heat is used to generate steam. Process off-gases are recovered and used in the plant fuel gas system. Only 1% of the required steam is generated by the combustion of natural gas, the remaining is generated from waste heat and the use of process off gas.
- Steam is routed to a steam turbine generator to reduce the need for electricity generated off site. Any excess electrical power produced will be exported to the grid. Steam is also used to power compressor turbines.
- Thermal oxidizers reduce solid waste to landfills and produce heat that can be used by other areas of the Project.
- Efficient heater design and operation ensure optimum combustion and energy efficiencies.

Control measures for fugitive emissions described in the previous section will also reduce fugitive methane emissions:

- Fugitive emissions from three of the storage tanks will be reduced using internal floating roof tanks. Ten of the tanks will be tied into a VRS to reduce emissions associated with product handling and storage.
- Fugitive emissions from the process areas will be reduced by using appropriate control valves, seals and gaskets. During operations, a leak detection and repair program will be implemented to find and repair fugitive sources.

Sasol will examine carbon capture opportunities for implementation after phase 2. If they are economically feasible, carbon capture opportunities might include removal of CO₂ from the process off gas before combustion in the fuel system. The HPU also has a CO₂-rich stream can also be considered for carbon capture. At this point, the carbon capture readiness is addressed by allowing for the appropriate plot space and tie-in points.
5.4.4 Project GHG Emissions

The GHG emissions during operations comprise CO$_2$, methane (CH$_4$) and nitrous oxide (N$_2$O). The main sources of GHG emissions during operations are (see Table 5-2):

- combustion sources. The CO$_2$ emissions result from the combustion of fuel that contains hydrocarbons and from the thermal oxidizers (due to the waste material that contains hydrocarbons). Most of the Project’s direct GHG emissions are associated with heaters, boilers and furnace stacks (about 84%).

- HPU methane feedstock. The HPU converts steam (H$_2$O) and CH$_4$ into hydrogen (H$_2$) and CO$_2$. The HPU methane feedstock contribution is approximately 8.7% of the Project’s total.

- fugitive sources. Methane accounts for most of the fugitive GHG emissions.

### Table 5-2 Project Direct GHG Operation Emissions (Annualized)

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Source Subtype</th>
<th>Fuel Use and Associated Emissions</th>
<th>Source Type (%)</th>
<th>Project Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stack Emissions</td>
<td>Heaters / Boilers / Furnaces</td>
<td>Fuel Gas Use (GJ/h LHV) 5,501</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$ (t/d) 13,544</td>
<td>84.47</td>
<td>84.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH$_4$ (t/d) 0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N$_2$O (t/d) 0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 13,646</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermal Oxidisers</td>
<td>Natural Gas Use (GJ/h LHV) 4.6</td>
<td>0.69</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$ (t/d) 109.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH$_4$ (t/d) 0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N$_2$O (t/d) 0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 110.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flares</td>
<td>Natural Gas Use (GJ/h LHV) 232.3</td>
<td>6.13</td>
<td>6.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$ (t/d) 690.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH$_4$ (t/d) 13.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N$_2$O (t/d) 0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 989.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrogen Production Unit</td>
<td>CO$_2$ (t/d) 1,408</td>
<td>8.72</td>
<td>8.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 1,408</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total for all Stacks</td>
<td>CO$_2$e (t/d) 16,154</td>
<td>100.00</td>
<td>99.86</td>
</tr>
<tr>
<td>Fugitive Emissions</td>
<td>Plant Process Unit Fugitives</td>
<td>CO$_2$ (t/d) 5.19</td>
<td>100.00</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH$_4$ (t/d) 0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N$_2$O (t/d) 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 22.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage Tank Fugitives</td>
<td>CO$_2$ (t/d) 0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH$_4$ (t/d) 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N$_2$O (t/d) 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (t/d) 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total for Fugitives</td>
<td>CO$_2$e (t/d) 22.46</td>
<td>100.00</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>Total Direct Emissions</td>
<td>CO$_2$e (t/d) 16,176</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (kt/a) 5,904</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO$_2$e (Mt/a) 5.904</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Project emissions include CO$_2$ (14,350 t/d), CH$_4$ 15.1 t/d) and N$_2$O (0.33 t/d). Total GHG emissions can be expressed as equivalent carbon dioxide (CO$_{2e}$). This conversion accounts for the higher warming potential of the CH$_4$ and N$_2$O relative to CO$_2$, and expresses each gas as the equivalent amount of CO$_2$ that would result in the same warming potential. The total CO$_{2e}$ emissions are 16,176 t/d (5,904 kt/a or 5.904 Mt/a). Further details regarding GHG emissions for the Project are provided in Volume 2, Appendix 3A.

During construction, GHG emissions are mainly from the operation of construction equipment and other vehicles, with smaller amounts resulting from land use changes. Decommissioning activities will produce similar emissions. Onsite GHG emissions during decommissioning could be 50% of construction values. Revegetation following decommissioning will offset the carbon release during construction. GHG emissions during construction and decommissioning represent a small portion of the GHG emissions associated with operations.

5.4.4.1 Alberta and Canada Total GHG Emissions

Many large GHG emitters in Canada began reporting their emissions through the Voluntary Challenge and Registry early in the 1990s. Other sources of indirect GHG data (energy consumption) are also available, which have enabled Canada to estimate annual GHG emissions values.

Based on the Environment Canada (2011) National Inventory Report, the 2010 GHG emissions are (expressed as CO$_{2e}$) 233 Mt/y for Alberta and 692 Mt/y for Canada (see Table 5-3). The Project emissions of 5.904 Mt/a CO$_{2e}$, account for 2.53% of the 2010 value, and 2.07% of projected 2020 Alberta GHG emissions. Project CO$_{2e}$ emissions of 5.904 Mt/a account for 0.85% of the 2010 national total GHG emissions, and 0.69% to 0.82% of projected 2020 national GHG emissions. The 2020 estimates are based on different industrial growth and GHG management options.

In 2010, the three primary GHG sources in Canada were:

- stationary combustion sources (45%)
- transportation (28%)
- fugitive sources (8%)

These sources fall under the Intergovernmental Panel on Climate Change energy sector, and collectively account for 81% of the national total.

GTL transportation fuel is cleaner burning than conventional diesel with a comparable, and potentially lower, GHG profile, offering significant environmental benefits. Because GTL fuels are virtually free of sulphur and aromatic compounds, their use in transportation would reduce emissions of particulates, nitrogen oxides, carbon monoxide and other pollutants, helping to improve air quality. Advanced life cycle assessment (LCA) analyses suggest that GHG emissions from GTL diesel are lower than emissions from conventional diesel and that on LCA basis GHG emissions from GTL are comparable to emissions from a modern day refinery.
Table 5-3  National and Provincial Greenhouse Gas Emissions (CO\textsubscript{2e})

<table>
<thead>
<tr>
<th>Reporting Year</th>
<th>Canadian GHG Emissions (Mt/a)</th>
<th>Project Emissions (% of Canada total)</th>
<th>Alberta GHG Emissions (Mt/a)</th>
<th>Project Emissions (% of Alberta total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>589</td>
<td>1.00</td>
<td>166</td>
<td>3.56</td>
</tr>
<tr>
<td>2000</td>
<td>718</td>
<td>0.82</td>
<td>219</td>
<td>2.70</td>
</tr>
<tr>
<td>2005</td>
<td>740</td>
<td>0.80</td>
<td>228</td>
<td>2.59</td>
</tr>
<tr>
<td>2006</td>
<td>726</td>
<td>0.81</td>
<td>233</td>
<td>2.53</td>
</tr>
<tr>
<td>2007</td>
<td>751</td>
<td>0.79</td>
<td>248</td>
<td>2.38</td>
</tr>
<tr>
<td>2008</td>
<td>731</td>
<td>0.81</td>
<td>240</td>
<td>2.46</td>
</tr>
<tr>
<td>2009</td>
<td>690</td>
<td>0.86</td>
<td>232</td>
<td>2.54</td>
</tr>
<tr>
<td>2010</td>
<td>692</td>
<td>0.85</td>
<td>233</td>
<td>2.53</td>
</tr>
<tr>
<td>2015</td>
<td>700 to 784</td>
<td>0.75 to 0.84</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2020</td>
<td>720 to 850</td>
<td>0.69 to 0.82</td>
<td>285</td>
<td>2.07</td>
</tr>
</tbody>
</table>

NOTES:
% calculation based on total emissions of CO\textsubscript{2e} (5.904 Mt/a).
Canada and Alberta GHG emissions from Environment Canada (2011).
The lower projections assume existing government measures; the higher projections assume no government measures.

5.4.4.2  GHG Intensity

The GHG intensity metric associated with operations is based on annual GHG emissions divided by the annual number of barrels of liquid product produced. Based on 103,900 bbl/d production, the Project GHG emission intensity would be 168.5 kg CO\textsubscript{2e}/bbl. As there are no other GTL facilities in Canada, there can be no comparison of emission intensities.

5.4.4.3  GHG Management Plan

Sasol’s GHG Management Plan will be guided by the Specified Gas Emitters Regulation established by the Government of Alberta, which is intended to set GHG intensity limits for large GHG emitters in the province. As a new facility, the GTL facility will be required to establish baseline emission intensity based on the third year of commercial operation. The GTL facility will be required to reduce emissions starting with the fourth year of commercial operations by 2% and then by 2% every year after, until the 12% reduction target has been achieved.

The GTL facility will comply with provincial and federal regulatory GHG reductions requirements in the timeframes specified. Specific plans for achieving these reductions will depend on market conditions at the time of their applicability and will include offsets credit trading, research and development in the deployment of new technology and other available options.
5.4.5 Sasol-Supported Research and Development Initiatives

Sasol Limited acknowledges and shares global concerns regarding the increased atmospheric concentrations of greenhouse gases (GHG) that contribute to climate change. The company believes that meeting the growing global demand for energy will accelerate greenhouse gas emissions unless technological solutions and management interventions are developed and implemented.

Sasol Limited acknowledges that a comprehensive approach to greenhouse gas (GHG) management needs to be adopted for its activities in accordance with its SHE Policy and Values.

Sasol Limited is committed to:

- reduce its GHG emissions
- introduce renewable energy and raw material sources such as biomass to supplement existing sources
- implement sustainable technology solutions aimed at improving carbon and energy efficiency

Sasol Limited makes a concerted effort to support its commitments to GHG management by:

- measuring and reporting on its global GHG emissions
- introducing and optimizing management interventions, including setting corporate targets for the reduction of GHG emissions intensity
- acquiring, developing and implementing energy and carbon efficient technologies and processes
- actively pursuing GHG mitigation related financial instruments such as the Clean Development Mechanism as a means to accelerate a reduction in its global GHG footprint
- assessing the future implications of GHG in new and existing ventures
- developing and maintaining knowledge and expertise on partnerships in the alternative energy, carbon sequestration and other applicable emerging fields
- work with governments and regulatory authorities in the countries where it operates to achieve optimum GHG management solutions
- applying sustainable development principles to all business activities

Sasol Limited supports the following GHG research and development initiatives:

**REPORTING**

Sasol Limited publicly reported GHG emission data since 1996. The reporting focused primarily on the direct and indirect emissions associated with its production processes. It also analyzed the emissions associated with the use of its primary product (namely GTL and CTL liquid fuel) and continuously assesses and reports the findings of studies regarding the lifecycle emissions associated with these products, including projected future GHG emissions.
As part of the company’s climate change response strategy, Sasol Limited adopted emission intensity reduction targets. This includes a commitment to reduce the GHG emissions intensity of its operations by 15% by 2020, from a 2005 baseline. Additional responses include:

- a carbon footprint calculator to assess the GHG footprint of new projects, enabling project teams to factor the cost of carbon into overall project costs
- a coordinated response to GHG issues
- an initiative coordinated by its SHE centre that reviews GHG targets for the group and clarifies the necessary measurements, definitions and units of reporting
- an external assurance provider to independently verify its global emission levels. Quantitative data on the GHG emissions for each business is included in its annual integrated report and sustainable development report.
- mandatory commitments for its operations in Italy and Germany in compliance with the European Emissions Trading System

**Energy Efficiency and Renewables**

Sasol Limited strives to meet emission targets in various ways, including:

- promoting energy efficiency in its existing plants and processes
- utilizing economically viable lower-carbon feedstocks
- improving its carbon-based technologies by building on the proven track record of Sasol Technology to commercialize innovations
- identifying waste-to-energy recovery projects
- investigating opportunities for CCS
- identifying opportunities for offset initiatives
- pursuing carbon-financing instruments such as the Clean Development Mechanism (CDM)
- investigating and investing in opportunities for renewable energy options such as concentrated solar power, wind and photovoltaic generation
- actively supporting and investigating the use of CCS technologies, supporting the development of technology for large-scale capture of CO₂ from dilute flue gas streams

**Research**

Sasol Limited is the largest private investor in scientific research and development in South Africa, particularly within the chemistry and chemical engineering disciplines. With the launch of a business unit called New Energy, the company is ensuring a focus on R&D activities towards finding energy solutions for a carbon-constrained future as well the commercialization of these technologies. It has entered into partnerships on climate-related issues with government and other industries to find viable solutions, and is contributing actively to international scientific and policy forums relating to climate change, including in particular those relating to CCS.
CARBON CAPTURE AND STORAGE

Sasol Limited’s New Energy division focuses on new technologies that can be integrated with its core technologies to lower its GHG footprint. CCS is an area of focus. Sasol Limited is a shareholder in the Technology Centre in Mongstad (TCM) Norway. The TCM was commissioned in May 2012 for the purpose of testing, verifying and demonstrating technology suitable for deployment at large-scale carbon capture facilities. Sasol Limited will not invest in future coal to liquids (CTL) or other coal-based plants without clear mitigation solutions being available, including ensuring that any new CTL plants are CCS ready.

Sasol Limited is a member of the UK-based Carbon Capture and Storage Association (CCSA), the Australian-based Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC), the U.S.-based Coalseq consortium and the North American Carbon Capture and Storage Association (NACCSA).

In South Africa, Sasol Limited is a founding member of the South African Centre for CCS. Its support includes assistance for the development of proposals to help design an appropriate regulatory environment for CCS in South Africa. The experience, expertise and commitments of Sasol Limited to these initiatives and to ongoing research and development in these important areas will support Sasol and the Canada GTL Project.

5.5 Conservation and Reclamation Plan

5.5.1 Introduction

The Conservation and Reclamation Plan outlines clearing, soil handling, soil storage and site preparation requirements for the Project. It also describes mitigation measures and options for reclaiming the land to equivalent capability after decommissioning and closure. Specific land use goals in effect for the area at the time of decommissioning will influence how the Project site is reclaimed; nevertheless, a Conceptual Closure Plan is presented based on current regulatory requirements. The plan addresses potential changes in land use zoning after decommissioning Project infrastructure (e.g., zoning is changed to accommodate non-industrial use similar to its current agricultural state).

The Conservation and Reclamation Plan refers to a Project disturbance area (PDA), which is described in Section 1.3.3 as the area that will be occupied by the Project. The PDA is approximately 526 ha in extent (see Figure 5-1). The Project footprint is located in the PDA and is defined as the land that will be cleared, stripped, graded and otherwise prepared for the construction of facilities.

5.5.2 Environmental Setting of the Project Development Area

5.5.2.1 Existing Land Use

About 60% of the PDA is currently in agricultural production (cultivated or pasture). Native vegetation occupies another 34% of the total area and industrial, rural residential and other related activities make up the remainder (see Table 5-4 and Figure 5-2). Third-party pipeline rights-of-way underlie parts of the PDA, although the surface is generally used for agricultural activities (see Figure 5-6).
SASOL GTL Project Disturbance Area

Land Use Patterns in the SASOL GTL Project Disturbance Area


Land Use Types
- Native Vegetation Community
- Cultivated Land
- Pasture
- Residential/Farmstead
- Industrial
- Project Disturbance Area
- Paved Access - Divided
- Paved Access
- Unpaved Access
- Railway
- Watercourse
- Waterbody
- Urban Area

Scale: 1:20,000

0 200 400 600 Metres

CANADA GTL PROJECT

5-2
Table 5-4  Distribution of Land Use Types in the PDA

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Area Occupied (ha)</th>
<th>Proportion of PDA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native vegetation communities</td>
<td>178.7</td>
<td>34.0</td>
</tr>
<tr>
<td>Cultivated Land</td>
<td>106.8</td>
<td>20.3</td>
</tr>
<tr>
<td>Pasture(^1)</td>
<td>207.7</td>
<td>39.5</td>
</tr>
<tr>
<td>Residential/Farmsteads</td>
<td>14.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Industrial – roads, gravel &amp; borrow pits and other disturbances/developments</td>
<td>17.9</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>525.7</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

NOTES:
Areas and proportions might not add up to totals because of rounding.
\(^1\) Third-party pipeline corridors underlie approximately 99 ha of the PDA and most are under agricultural use.

5.5.2.2 Terrain

Terrain units, or surficial deposits, are defined as contiguous areas with the same genetic or parent materials. The general methodology used to develop the extent of terrain units in the PDA are explained in Section 5.5.2.3.

Much of the northwestern part of the PDA has been reworked by aeolian activity to form low-relief dunes, which have created undulating topography with slopes of 2% to 9%, and some slopes up to 16%. The central area is predominantly glaciofluvial deposits and the southeastern portion consists of gently undulating glaciolacustrine deposits.

Surveyed elevations vary between 620 and 635 metres above sea level (masl) and, in general, relief is subdued and the terrain stable as a result. Terrain-based constraints for facility development include local areas of seepage and accumulation of surface organic material in isolated wetlands.

For the spatial distribution of the main surficial deposits in the PDA, see Table 5-5 and Figure 5-3.

Table 5-5  Distribution of Surficial Deposits in the PDA

<table>
<thead>
<tr>
<th>Surficial Deposits</th>
<th>Area Occupied (ha)</th>
<th>Proportion of PDA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeolian (windblown sediment)</td>
<td>120</td>
<td>22.8</td>
</tr>
<tr>
<td>Glaciofluvial (glacial river sediment)</td>
<td>251.2</td>
<td>47.8</td>
</tr>
<tr>
<td>Glaciolacustrine (glacial lake sediment)</td>
<td>72.8</td>
<td>13.8</td>
</tr>
<tr>
<td>Organic</td>
<td>63.5</td>
<td>12</td>
</tr>
<tr>
<td>Disturbed Lands</td>
<td>18.2</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>525.7</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

NOTE:
Areas and proportions might not add up to totals because of rounding.
Surficial Deposits in the SASOL GTL Project Disturbance Area

5.5.2.3 Soils

Soil mapping is a process that uses pedology and geomorphology to describe the earth’s surface in terms of a taxonomy that combines soil development with the physical and chemical properties of parent materials. Field data were used to verify expected trends in soil landscape composition with the end-product map that displays the interaction between soil type (series or map unit) and terrain characteristics (e.g., slope, aspect).

Soils and terrain data were collected during summer 2007 and 2008. Detailed soil profile information was recorded at 123 locations near the PDA. The overall inspection density fulfills the requirements of Survey Intensity Level (SIL) 1 (one site per 5 ha), which is the level recommended for site-specific soil-management planning by the Expert Committee on Soil Survey (1982). Soil attributes collected during the field program (e.g., topsoil depth, soil series, parent material) were used to assist in drawing and labelling soil map unit polygons. These polygons were then used to determine soil map unit spatial extents along with associated information such as topsoil volume and agricultural capability distribution.

The dominant soils in the updated PDA are Orthic Black Chernozems and their variants, which have developed on coarse-textured aeolian and glaciofluvial parent materials. These soils occupy roughly 395 ha (75%) of the PDA.

Orthic, Rego, Orthic Humic and Rego Humic Gleysols make up the second-most common soils in the PDA and account for about 82 ha (16%) of the area.

For a map showing soils in the PDA to the series level, see Table 5-6 and Figure 5-4.

5.5.2.4 Soil Reclamation Suitability Ratings

Reclamation suitability ratings were determined for the topsoil (upper lift) and subsoil (lower lift) of each undisturbed mineral soil series using Soil Quality Criteria Relative to Disturbance and Reclamation (SQCWG 1993) as well as physical and chemical data for the mapped soil series. These criteria were designed for undisturbed mineral soils; therefore, no suitability ratings were developed for organic soils (unless mineral soil was present) or for disturbed soils. The rating system describes suitability for soils as a reclamation material, with classes ranging from unsuitable to good (see Table 5-7).

Soil properties were compared with the diagnostic physical and chemical criteria described in Section 5.2.1, Table 6 and Table 7 (SQCWG 1993).

Soils in the PDA are rated poor to fair for reclamation suitability. Poor suitability ratings are mainly due to the very coarse soil textures or pH-related limitations. Droughty conditions and low nutrient-retention capacity are associated with coarse-textured soils and can affect reclamation success by inhibiting vegetation from establishing. Since the reclamation suitability rating system was developed only for assessing mineral soils, the two organic series found in the PDA were not rated. Existing disturbances were not inspected, sampled or given a suitability rating (see Table 5-8). The distribution of reclamation suitability classes is summarized in Table 5-9.
Soil Series Distribution in the SASOL GTL Project Disturbance Area

### Table 5-6  Distribution of Soil Series in the PDA

<table>
<thead>
<tr>
<th>Soil Series Name (Map Symbol)</th>
<th>Classification</th>
<th>Area Occupied (ha)</th>
<th>Proportion of PDA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucumber (CCBco)</td>
<td>Orthic/Calcereous/Rego/Gleyed Black Chernozem</td>
<td>46.6</td>
<td>8.9</td>
</tr>
<tr>
<td>Golden Spike (GSP)</td>
<td>Typic Mesisol</td>
<td>9.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Helliwell (HLW)</td>
<td>Orthic/Gleyed Dark Grey Chernozem</td>
<td>6.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Mundare 1 (MDR-1)</td>
<td>Orthic Black Chernozem</td>
<td>90.6</td>
<td>17.2</td>
</tr>
<tr>
<td>Mundare 2 (MDR-2)</td>
<td>Orthic Black Chernozem</td>
<td>188.1</td>
<td>35.8</td>
</tr>
<tr>
<td>Manatokan 1 (MNT-1)</td>
<td>Terric Mesisol</td>
<td>9.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Manatokan 2 (MNT-2)</td>
<td>Terric Mesisol</td>
<td>11.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Peace Hills-2 (PHS-2)</td>
<td>Orthic Black Chernozem</td>
<td>9</td>
<td>1.7</td>
</tr>
<tr>
<td>Peace Hills-3 (PHS-3)</td>
<td>Orthic Black Chernozem</td>
<td>54</td>
<td>10.3</td>
</tr>
<tr>
<td>Miscellaneous Gleysols (ZGW)</td>
<td>Gleysols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZGWco-1</td>
<td>Orthic and Rego Gleysols</td>
<td>12.6</td>
<td>2.4</td>
</tr>
<tr>
<td>ZGWco-2</td>
<td>Orthic and Rego Humic Gleysols</td>
<td>42.7</td>
<td>8.1</td>
</tr>
<tr>
<td>ZGWfi-1</td>
<td>Orthic and Rego Gleysols</td>
<td>16.3</td>
<td>3.1</td>
</tr>
<tr>
<td>ZGWfi-2</td>
<td>Orthic and Rego Humic Gleysols</td>
<td>10.6</td>
<td>2</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>82.2</td>
<td>15.6</td>
</tr>
<tr>
<td>Disturbed Lands (DL)</td>
<td>Disturbed Lands</td>
<td>18.2</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>525.6</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTE:**
Areas and proportions might not add up to totals because of rounding.

### Table 5-7  Soil Quality Criteria Relative to Disturbance and Reclamation

<table>
<thead>
<tr>
<th>Suitability Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>None to slight soil limitations that affect use for plant growth.</td>
</tr>
<tr>
<td>Fair</td>
<td>Moderate soil limitations that affect use but can be overcome by proper planning and good management.</td>
</tr>
<tr>
<td>Poor</td>
<td>Severe soil limitations that make use questionable; careful planning and very good management are required.</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>Limitations of soil chemical or physical properties are so severe that reclamation is not possible or economically feasible.</td>
</tr>
</tbody>
</table>

**SOURCE:** SQCWG 1993.
### Table 5-8  Reclamation Suitability Ratings in the PDA

<table>
<thead>
<tr>
<th>Soil Series Name (Map Symbol)</th>
<th>Topsoil Rating</th>
<th>Subsoil Rating</th>
<th>Main Topsoil Limitation</th>
<th>Main Subsoil Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cucumber (CCBco)</td>
<td>Fair</td>
<td>Poor</td>
<td>pH</td>
<td>Texture</td>
</tr>
<tr>
<td>Golden Spike (GSP)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Helliwell (HLW)</td>
<td>Poor</td>
<td>Poor</td>
<td>Texture</td>
<td>Texture</td>
</tr>
<tr>
<td>Mundare 1 (MDR-1)</td>
<td>Poor</td>
<td>Poor</td>
<td>Texture</td>
<td>Texture</td>
</tr>
<tr>
<td>Mundare 2 (MDR-2)</td>
<td>Poor</td>
<td>Poor</td>
<td>Texture</td>
<td>Texture</td>
</tr>
<tr>
<td>Manatokan 1 (MNT-1)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Manatokan 2 (MNT-2)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Peace Hills-2 (PHS-2)</td>
<td>Fair</td>
<td>Fair</td>
<td>pH</td>
<td>pH, Texture</td>
</tr>
<tr>
<td>Peace Hills-3 (PHS-3)</td>
<td>Fair</td>
<td>Fair</td>
<td>pH</td>
<td>pH, Texture</td>
</tr>
<tr>
<td>Miscellaneous Gleysols</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZGWco-1</td>
<td>Fair</td>
<td>Fair</td>
<td>pH</td>
<td>pH</td>
</tr>
<tr>
<td>ZGWco-2</td>
<td>Fair</td>
<td>Fair</td>
<td>pH</td>
<td>pH</td>
</tr>
<tr>
<td>ZGWfi -1</td>
<td>Fair</td>
<td>Fair</td>
<td>pH, Texture</td>
<td>pH, Texture</td>
</tr>
<tr>
<td>ZGWfi-2</td>
<td>Fair</td>
<td>Fair</td>
<td>pH, Texture</td>
<td>pH, Texture</td>
</tr>
<tr>
<td>Disturbed Lands (DL)</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
<td>N/R</td>
</tr>
</tbody>
</table>

**NOTE:**

N/R – Not rated.

### Table 5-9  Distribution of Reclamation Suitability Classes in the PDA

<table>
<thead>
<tr>
<th>Reclamation Suitability Class</th>
<th>Topsoil</th>
<th>Subsoil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>Proportion of PDA (%)</td>
</tr>
<tr>
<td>F (Fair)</td>
<td>191.9</td>
<td>36.5</td>
</tr>
<tr>
<td>P (Poor)</td>
<td>284.9</td>
<td>54.2</td>
</tr>
<tr>
<td>O (organic, not rated except for mineral subsoil)</td>
<td>30.7</td>
<td>5.8</td>
</tr>
<tr>
<td>ZDL (disturbed land, not rated)</td>
<td>18.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Total</td>
<td>525.7</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTE:**

Areas and proportions might not add up to totals because of rounding.
5.5.2.5 **Agricultural Land Suitability**

Agricultural land suitability indices were determined for each identified soil map unit according to the *Land Suitability Rating System for Agricultural Crops* (AAFC 1995). This system is used to evaluate pre-disturbance soils for agricultural productivity and provides the basis for soil-handling decisions that will support the return of equivalent land capability. The system is based on land and environmental conditions as they affect arable, dryland agriculture, and it assumes current management practices.

The seven agricultural land suitability classes and their associated subclasses are described in Tables 5-10 and 5-11. Land suitability classes for the study area were determined using physical and chemical data from representative soils in the PDA.

### Table 5-10 Agricultural Land Suitability Class Ratings

<table>
<thead>
<tr>
<th>Agricultural Capability Rating</th>
<th>Degree of Limitation (Index Points)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None to Slight (80–100)</td>
<td>No significant limitations for production of the specified crops.</td>
</tr>
<tr>
<td>2</td>
<td>Slight (60–79)</td>
<td>Slight limitations that may restrict the growth of the specified crops or require modified management practices.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate (45–59)</td>
<td>Moderate limitations that restrict the growth of the specified crops or require special management practices.</td>
</tr>
<tr>
<td>4</td>
<td>Severe (30–44)</td>
<td>Severe limitations that restrict the growth of the specified crops or require special management practices or both. This class is marginal for sustained production of the specified crops.</td>
</tr>
<tr>
<td>5</td>
<td>Very Severe (20–29)</td>
<td>Very severe limitations for sustained production of the specified crops. Annual cultivation using common cropping practices is not recommended.</td>
</tr>
<tr>
<td>6</td>
<td>Extremely Severe (10–19)</td>
<td>Extremely severe limitations for sustained production of the specified crops. Annual cultivation is not recommended even on an occasional basis.</td>
</tr>
<tr>
<td>7</td>
<td>Unsuitable (0–9)</td>
<td>Not suitable for the production of the specified crops.</td>
</tr>
</tbody>
</table>

**SOURCE:** AAFC 1995.

### Table 5-11 Agricultural Land Suitability Rating Subclasses

<table>
<thead>
<tr>
<th>Agricultural Capability Subclass</th>
<th>Type of Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C – Climate</td>
<td>General climatic restriction</td>
</tr>
<tr>
<td>A – Moisture</td>
<td>Inadequate moisture for optimal growth of the specified crops.</td>
</tr>
<tr>
<td>H – Temperature</td>
<td>Inadequate heat units for the optimal growth of the specified crops.</td>
</tr>
<tr>
<td>S – Soil</td>
<td>General soil restriction</td>
</tr>
<tr>
<td>M – Water holding capacity/texture</td>
<td>Specified crops are adversely affected by lack of water due to inherent soil characteristics.</td>
</tr>
<tr>
<td>D – Soil structure</td>
<td>Specified crops are adversely affected by soil structure that limits the depth of rooting, or by surface crusting that limits the emergence of shoots. Root restriction by bedrock, and by a high water table are considered separately (see R and W).</td>
</tr>
<tr>
<td>F – Organic matter</td>
<td>Mineral soil with low organic matter content in the Ap or Ah horizon (often considered a fertility factor).</td>
</tr>
<tr>
<td>E – Depth of topsoil</td>
<td>Mineral soil with a thin Ap or Ah horizon (often resulting from erosion).</td>
</tr>
</tbody>
</table>
Table 5-11 Agricultural Land Suitability Rating Subclasses (cont’d)

<table>
<thead>
<tr>
<th>Agricultural Capability Subclass</th>
<th>Type of Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>V – Soil reaction</td>
<td>Soil with a pH value either too high or too low for optimum growth of the specified crops.</td>
</tr>
<tr>
<td>N – Salinity</td>
<td>Soils with amounts of soluble salts sufficient to adversely affect the growth of the specified crops.</td>
</tr>
<tr>
<td>Y – Sodicity</td>
<td>Soils with amounts of exchangeable sodium sufficient to adversely affect soil structure or the growth of the specified crops.</td>
</tr>
<tr>
<td>O – Organic surface</td>
<td>Mineral soils having a peaty surface layer up to 40 cm thick.</td>
</tr>
<tr>
<td>W – Drainage</td>
<td>Soils in which excess water (not due to inundation) limits the production of specified crops. Excess water may result from a high water table or inadequate soil drainage.</td>
</tr>
<tr>
<td>Z – Organic soil temperature</td>
<td>Additional temperature limitation associated with organic soils – particularly where the regional climate has fewer than 1600 effective growing degree days.</td>
</tr>
<tr>
<td>R – Rock</td>
<td>Soils with bedrock sufficiently close to the surface to adversely affect the production of the specified crops.</td>
</tr>
<tr>
<td>B – Degree of decomposition or fibre content</td>
<td>Organic soils in which the degree of decomposition of the organic material is not optimum for the production of the specified crops.</td>
</tr>
<tr>
<td>G – Depth and substrate</td>
<td>Shallow organic soils with underlying material that is not optimum for the production of the specified crops.</td>
</tr>
<tr>
<td>L – Landscape</td>
<td>General landscape restriction</td>
</tr>
<tr>
<td>T – Slope</td>
<td>Landscapes with slopes steep enough to incur a risk of water erosion or to limit cultivation.</td>
</tr>
<tr>
<td>K – Landscape pattern</td>
<td>Strongly contrasting soils or non-arable obstacles that limit production of the specified crops or substantially affect management practices.</td>
</tr>
<tr>
<td>P – Stoniness and coarse fragments</td>
<td>Sufficiently stony (fragments coarser than 7.5 cm) or gravelly (fragments smaller than 7.5 cm in diameter) to hinder tillage or limit the production of specified crops.</td>
</tr>
<tr>
<td>J – Wood content</td>
<td>Organic soils with wood content or Eriophorum species sufficient to limit the production of the specified crops.</td>
</tr>
<tr>
<td>I – Inundation</td>
<td>Subject to inundation or flooding that limits the production of the specified crops.</td>
</tr>
</tbody>
</table>


Approximately 74% of the PDA area is rated as having slight or moderate limitations that restrict plant growth (Classes 2 and 3). Another 17% of the PDA area is made up of severe to extremely severe agricultural land suitability limitations (classes 4 through 6). Class 7 (soils not suitable for plant regrowth) was assigned to organic soils, which occupy slightly less than 6% of the local study area. The remaining 3% of the area was not rated due to previous disturbance. See Table 5-12 and Table 5-13 for details and Figure 5-5.
### Table 5-12  Agricultural Land Suitability Class Ratings in the PDA

<table>
<thead>
<tr>
<th>Soil Map Unit Codes</th>
<th>Climate Rating</th>
<th>Landscape Rating</th>
<th>Mineral Soil Rating</th>
<th>Land Suitability Class and Subclass</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCBco</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>59 (3)</td>
<td>3 M</td>
</tr>
<tr>
<td>CCBco</td>
<td>60 (2)</td>
<td>80 (1)</td>
<td>95 (1)</td>
<td>2 H</td>
</tr>
<tr>
<td>GSP</td>
<td>60 (2)</td>
<td>0 (7)</td>
<td>N/A</td>
<td>7 W</td>
</tr>
<tr>
<td>HLW</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>41 (4)</td>
<td>4 M</td>
</tr>
<tr>
<td>MDR</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>46 (3)</td>
<td>3 M</td>
</tr>
<tr>
<td>MNTaa</td>
<td>60 (2)</td>
<td>2 (7)</td>
<td>N/A</td>
<td>7 W</td>
</tr>
<tr>
<td>PHS</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>65 (2)</td>
<td>2 MH</td>
</tr>
<tr>
<td>PHS</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>54 (3)</td>
<td>3 M</td>
</tr>
<tr>
<td>ZGWco</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>62 (2)</td>
<td>4 W</td>
</tr>
<tr>
<td>ZGWfi</td>
<td>60 (2)</td>
<td>95 (1)</td>
<td>62 (2)</td>
<td>3 W</td>
</tr>
<tr>
<td>ZDL</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Values represent the degree of limitation index; number in parenthesis represents the suitability class.
2. Number refers to the most limiting class; letters refer to the subclass(es) that provide the limitation.

### Table 5-13  Distribution of Agricultural Land Suitability Classes in the PDA

<table>
<thead>
<tr>
<th>Agricultural Land Suitability Rating</th>
<th>Soil Map Unit(s)</th>
<th>Area (ha)</th>
<th>Extent of Study Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>PHS-2, PHS-3</td>
<td>63.0</td>
<td>12.0</td>
</tr>
<tr>
<td>3</td>
<td>CCBco, MDR-1, MDR-2</td>
<td>325.3</td>
<td>61.9</td>
</tr>
<tr>
<td>4</td>
<td>HLW, ZGWco-1, ZGWco-2, ZGWfi-1, ZGWfi-2</td>
<td>88.5</td>
<td>16.8</td>
</tr>
<tr>
<td>5</td>
<td>N/P</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6</td>
<td>N/P</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>7</td>
<td>GSP, MNT-1, MNT-2</td>
<td>30.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Not Rated (N/R)</td>
<td>Disturbed Land (ZDL)</td>
<td>18.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>525.7</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTE:**
1. N/P – Not present.
Agricultural Suitability Class Distribution in the SASOL GTL Project Disturbance Area

Acknowledgements: Original Drawing by Stantec. Basedata: National Road Network, Altalis

Prepared for
Prepared by

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Metres
5.5.2.6 Vegetation and Wetlands

Historical baseline survey data was obtained from Total for the 2007 and 2008 field seasons. These included: spring and late summer rare plant surveys, a spring rare plant survey for vascular plants and bryophytes (2008 only) and a late summer rare plant survey for vascular plants and lichens (2008 only). Vegetation and wetlands were characterized at all sites surveyed in both 2007 and 2008.

Additional field surveys were undertaken in 2012 to:

- gather information about the condition of vegetation and wetland communities and assist with mapping of these units within the LSA (i.e., ground truthing and filling gaps)
- confirm the presence of previously reported rare plant occurrences
- look for additional species of particular management concern (e.g., rare plants and weeds)

The vegetation and wetland community characterization survey assessed dominant plant species cover by vegetation layer (canopy, subcanopy, tall shrub, low shrub, graminoid, bryophyte and lichen) and general site conditions (e.g., slope, aspect, slope position, soil moisture regime, land use, etc.). Rare plant survey methods followed Alberta Native Plant Council (ANPC) guidelines for qualitative and quantitative rare plant surveys (Lancaster 2000).

Native vegetation is represented by upland and wetland areas, which occupy about 34% of the area, primarily in the northwest corner and along the western side (although wetlands are scattered throughout the PDA). Cultivated and pasture lands occupy southern and central areas, respectively, and together account for about 60% of the PDA. The remaining area is made up of various other activities.

For the distribution of ecosites and wetlands (land units) identified in the PDA, see Table 5-14 and Figure 5-6.

Rare Plants

Review of the federal government databases did not indicate the presence of any federally listed (Species at Risk Act [SARA]) species in the PDA (Government of Canada 2012).

A search of the Alberta Conservation Information Management System (ACIMS) database conducted in June 2012 revealed a single historic occurrence of a rare plant (*Hedyotis longifolia*) in the northwest corner of the PDA. This occurrence at this general location was not confirmed in any of the 2007, 2008 or 2012 field surveys; however, a new occurrence was found approximately 130 m away on the western side of the sand borrow pit during 2012 field surveys (plot RB1209). This is in the same polygon as the original historic occurrence (see Table 5-15). This species was also reported in the PDA after the late-summer rare plant survey in 2007 (at plot LH739) in the west-central portion of the PDA. It was subsequently re-confirmed during the 2012 rare plant survey (plot RB1213). All of these occurrences are in perennial pasture land units with sandy soils.
Ecosite and Wetland Distribution in the SASOL GTL Project Disturbance Area


Uplands
- Aspen Poplar Woodland Alliance
- Balsam Poplar Woodland Alliance
- Mixed Deciduous and Evergreen Woodland Alliance
- White Spruce Woodland Alliance
- Tall Shrubland Alliance
- Short Shrubland Alliance

Wetlands
- Treed Swamp
- Shubby Willow Swamp
- Ephemeral to Seasonal Marsh
- Semi-Permanent Marsh
- Permanent Marsh

Agricultural Lands
- Farmstead
- Dugout
- Cultivated Land
- Perennial Pasture

Industrial Lands
- Transportation
- Gravel and Borrow Pit
- Industrial Development
- Project Disturbance Area
  - Paved Access - Divided
  - Paved Access
  - Unpaved Access
  - Railway
  - Watercourse
  - Waterbody
  - Urban Area

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### Table 5-14 Distribution of Ecosites and Wetlands in the PDA

<table>
<thead>
<tr>
<th>Land Unit</th>
<th>Area (ha)</th>
<th>Area (% of PDA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uplands</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspen Poplar Woodland Alliance</td>
<td>20.9</td>
<td>4</td>
</tr>
<tr>
<td>Balsam Poplar Woodland Alliance</td>
<td>5.7</td>
<td>1.1</td>
</tr>
<tr>
<td>White Spruce Woodland Alliance</td>
<td>8.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Mixed Deciduous and Evergreen Woodland Alliance</td>
<td>34.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Short Shrubland Alliance</td>
<td>11.6</td>
<td>2.2</td>
</tr>
<tr>
<td>Tall Shrubland Alliance</td>
<td>19.3</td>
<td>3.7</td>
</tr>
<tr>
<td>Upland Subtotal</td>
<td>100.3</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Wetlands</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ephemeral to Seasonal Marsh</td>
<td>44.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Semi-permanent Marsh</td>
<td>13.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Shrubby Willow Swamp</td>
<td>19.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Dugout</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Wetland Subtotal</td>
<td>78.4</td>
<td>14.9</td>
</tr>
<tr>
<td><strong>Agricultural Land</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmsteads</td>
<td>14.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Cultivated Land</td>
<td>106.6</td>
<td>20.3</td>
</tr>
<tr>
<td>Perennial Pasture</td>
<td>207.7</td>
<td>39.5</td>
</tr>
<tr>
<td>Agricultural Land Subtotal</td>
<td>329.3</td>
<td>62.6</td>
</tr>
<tr>
<td><strong>Industrial Land</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>8.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Industrial Development</td>
<td>5.2</td>
<td>1</td>
</tr>
<tr>
<td>Gravel and Borrow Pits</td>
<td>3.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Disturbed Land Subtotal</td>
<td>17.8</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>525.7</td>
<td>100</td>
</tr>
</tbody>
</table>

**NOTE:**
Areas and proportions might not add up to totals because of rounding.

Other findings from the 2012 field surveys include what appears to be a rare brachythecium moss (*Brachythecium rutabulum*) at plot RB1206 in a shrubby willow swamp community (see Table 5-15); however its identification is currently uncertain as a positive identification could not be made based on the samples collected from the site. Additional field surveys might be required to confirm its presence at this particular location, but for now it is treated as a potential rare plant find.
Table 5-15 Rare Plant Occurrences in the PDA

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Last Observed</th>
<th>Plot Number</th>
<th>Easting</th>
<th>Northing</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Hedyotis longifolia</em></td>
<td>Long-leaved bluets</td>
<td>2006</td>
<td>ACIMS Element ID # 17324</td>
<td>360417</td>
<td>5960415</td>
<td>12U</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2007</td>
<td>LH739</td>
<td>360642</td>
<td>5959082</td>
<td>12U</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>RB1209</td>
<td>360289</td>
<td>5960401</td>
<td>12U</td>
</tr>
<tr>
<td><em>Brachythecium rutabulum</em></td>
<td>Brachythecium moss</td>
<td>2012</td>
<td>RB1206</td>
<td>360433</td>
<td>5959789</td>
<td>12U</td>
</tr>
</tbody>
</table>

NOTES:
*Hedyotis longifolia* is ranked S2 provincially and G4G5 globally (ACIMS 2012).
*Brachythecium rutabulum* is ranked S2 provincially and G5 globally (ACIMS 2012).
Both species are currently on the ACIMS tracking list (ACIMS 2012). See Appendix 11A for additional information.

**WEEDS**

No prohibited noxious weeds were identified in the PDA, although several noxious species were identified during vegetation field surveys (Government of Alberta 2010c). Species observed included:

- a single occurrence of scentless chamomile (*Matricaria perforata*)
- 31 occurrences of perennial sow-thistle (*Sonchus arvensis*)
- 93 occurrences of Canada/creeping thistle (*Cirsium arvense*)
- six occurrences of common/yellow toadflax (*Linaria vulgaris*)

**5.5.2.7 Hydrology**

The PDA is located in the North Saskatchewan River tablelands on the south side of the river. The terrain is low relief and predominantly drains westward to the North Saskatchewan River and, to a lesser extent, eastward to lower Astatin Creek, a tributary to the North Saskatchewan River.

Ditches associated with the surrounding public road network intercept and control much of the surface drainage. (Highway 15 runs next to the southeast side of the site, Range Road 214 on the east side and Township Road 554 along the immediate north boundary of the PDA.).

Surface drainage patterns in the PDA are poorly defined and runoff from the site largely percolates into the coarse-textured soils and drains through shallow groundwater flow. There are no lakes in the PDA and ponded water is limited to ephemeral wetlands located in lower-lying parts of the landscape. The natural drainage pattern conveys runoff from eastern areas to Astatin Creek, from western areas to the North Saskatchewan River via a small, unnamed watercourse and from northern areas to the North Saskatchewan River via roadside ditches.
5.5.3 Conservation and Reclamation during Construction and Operations

5.5.3.1 Pipeline Right-of-Way Management

A number of rights-of-way for third-party pipelines that pass through the PDA (see Figure 5-7). Measures will be instituted to ensure there is mutual consent with pipeline operators and owners to manage safety risks during Project construction and operations. Sasol is developing strategies to relocate some pipelines in conjunction with pipeline operators.

The following elements will be incorporated in Project design and construction:

- a minimum setback of 30 m will be maintained between the GTL facility and the rights-of-way
- Sasol will obtain crossing agreements for both the construction and operations phases of the Project
- right-of-way crossings will be minimized
- fencing and signage will be provided around pipeline rights-of-way, where appropriate
- single-crossing areas will be used, where possible, for transporting materials during construction
- right-of-way crossings will be designed, built and maintained with approval of pipeline owners
- during any construction within the setback, an approved pipeline right-of-way inspector will be on site and pipeline owners will be afforded the opportunity to have representatives present

Sasol plans to have ongoing communication with the pipeline owners before construction begins and during operations.

5.5.3.2 Clubroot Management

Clubroot is a soil-borne disease that affects canola, mustard and other crops species in the cabbage family. It is of particular concern because it adversely affects the yield and quality (oil content) of canola and mustard. Clubroot was added as a declared pest to Alberta’s Agricultural Pest Act in April 2007 with control and management delegated to Alberta Agriculture and Rural Development. Enforcement of these measures is the responsibility of the provincial municipalities, specifically the Agricultural Fieldmen (Government of Alberta 2010a).

Strathcona County does not disclose which fields are infected but when the Agricultural Fieldman reviews the application for a development permit he will require a management plan if a project crosses or is located on affected lands (Gould pers. comm. 2012). Any management plan should follow the Canadian Association of Petroleum Producers Best Management Practices: Clubroot Disease Management (CAPP 2008).

For an overview Alberta’s clubroot management program, specific control and mitigation and contact information specific to Strathcona County, see Appendix 5A.
Pipelines Crossing the SASOL GTL Project Disturbance Area

Acknowledgements: Original Drawing by Stantec Basedata: National Road Network, Altalis.

Pipeline Corridors
- Corridor 1
- Corridor 2
- Corridor 3
- Corridor 4
- Project Disturbance Area
- Paved Access - Divided
- Paved Access
- Unpaved Access
- Railway
- Urban Area

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Pipelines Crossing the SASOL GTL Project Disturbance Area
5.5.3.3 Rare Plant Mitigation

Two rare plant species were noted (see Table 5-15). Sasol proposes the following measures to mitigate potential effects of the Project on these species:

- complete a follow up survey before construction to confirm the identity of the brachythecium moss (thought to be *Brachythecium rutabulum*) at plot RB1206 and provide mitigation plans to ESRD, if positively identified
- consult with ESRD concerning potential mitigation, for *Hedyotis longifolia*, including the potential for transplanting

5.5.3.4 Brush Removal and Disposal

About 100 ha of upland land units fall in the woodland and shrubland categories (see Table 5-14). Sasol will salvage and stockpile any merchantable timber, then determine appropriate means of disposal in consultation with ESRD. Non-merchantable timber (i.e., coarse woody debris, slash) will be retained and used as surface cover for erosion control on the soil stockpiles. Material that remains will be disposed of after consulting with Strathcona County and ESRD.

5.5.3.5 Topsoil Salvage

Topsoil salvage will take place in all areas where Project activities are expected to occur except:

- Third-party pipeline rights-of-way where the active pipelines will remain in place with a 30-m setback (99.4 ha).
- internal areas where no development or soil salvage activities are currently proposed, including the area beneath the topsoil stockpile (86.2 ha).
- areas around the perimeter of the PDA where no developments are proposed (16.7 ha).

Topsoil will be salvaged and stored in a way that will reduce soil loss and degradation through erosion, compaction, rutting and loss of viable plant material, and will reduce admixing with subsoil. To ensure proper salvage and compliance with regulatory requirements, a qualified environmental monitor (i.e., preferably a soil scientist with experience in this geographical area) will be present during soil salvage operations to provide direction to the Construction Supervisor.

Typical terms and conditions of approval for similar industrial developments require that all topsoil be conserved for reclamation purposes (e.g., AENV 2006, 2007). Baseline data, including topsoil and subsoil reclamation suitability ratings, topsoil depths and land suitability for agriculture ratings were reviewed to determine which materials would provide the most viable reclamation resources.

Sasol’s proposed topsoil salvage prescriptions are outlined (see Table 5-16 and Figure 5-8). The total area from which topsoil will be salvaged is 323.7 ha, which will generate 1,255,605 m$^3$ of reclamation materials. The salvaged topsoil stockpile will measure about 415 m by 580 m by 6 m high.
Topsoil and subsoil reclamation suitability ratings are similar across the PDA. It is recommended that the topsoil be over-stripped slightly in many instances to allow relatively large contiguous salvage units of uniform depth. No adverse effects on the quality of the salvaged materials are anticipated for site reclamation because the topsoils and upper subsoils have essentially the same characteristics.

Organic deposits (GSP, MNT 1 and MNT 2, and inclusions in ZGW) will be excavated to depth so grading and levelling can provide a geotechnically stable base for construction. Sasol proposes to incorporate these materials with the lesser-quality salvaged mineral topsoils instead of stockpiling them separately. Adding organic content will improve the moisture and nutrient-holding capacity of the coarse mineral material and contribute some nutrients during decomposition.

### 5.5.3.6 Topsoil Storage

Salvaged topsoil will be stockpiled within the PDA. All topsoil stockpiles will:

- be placed where they do not interfere with other activities
- be on level ground, to the degree possible
- be placed on stable foundations
- be situated on undisturbed or reclaimed topsoil
- be designed to have maximum 3:1 sideslopes (3 horizontal: 1 vertical) for safety and stability reasons
- have setbacks to ensure materials are not inadvertently displaced outside designated areas and to allow for adequate workspace around the stockpiles
- be situated as shown on Figure 5-8—the final location and dimensions will be accurately recorded on as-built drawings

### 5.5.3.7 Subsoil Salvage

In general, the coarse texture, lack of organic and nutrient content and overall poor reclamation suitability ratings do not support salvaging subsoil given the limitations within the site for stockpiling the additional materials. A further complicating factor is the absence of a distinct colour separation between the subsoil and underlying parent material, which could introduce the potential for incorporating less desirable materials during subsoil salvage.

A no-subsoil-salvage approach is consistent with the prescriptions approved for Shell’s Scotford Upgrader Expansion 1 (Shell 2005a, 2005b; AENV 2006, Section 3.3 of EPEA Approval 49587-01-01, as amended). Once topsoil has been salvaged and removed to the stockpiles, the subsoil will be contoured to provide a stable surface for construction activities.
### Table 5-16  Topsoil Salvage Prescriptions for the PDA

<table>
<thead>
<tr>
<th>Soil Series</th>
<th>Laydown and Construction Area 1</th>
<th>Project Facilities Area</th>
<th>Laydown and Construction Area 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Salvage Depth (cm)</td>
<td>Salvage Area (ha)</td>
<td>Volume (m$^3$)</td>
</tr>
<tr>
<td>CCBco</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>GSP$^1$</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>HLW</td>
<td>25</td>
<td>5.2</td>
<td>13,000</td>
</tr>
<tr>
<td>MDR-1</td>
<td>25</td>
<td>50.9</td>
<td>127,250</td>
</tr>
<tr>
<td>MDR-2</td>
<td>20</td>
<td>17.1</td>
<td>34,200</td>
</tr>
<tr>
<td>MNT-1$^1$</td>
<td>110</td>
<td>5.1</td>
<td>56,100</td>
</tr>
<tr>
<td>MNT-2$^1$</td>
<td>90</td>
<td>9.9</td>
<td>89,100</td>
</tr>
<tr>
<td>PHS-2</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>PHS-3</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>ZGWco-1$^2$</td>
<td>40</td>
<td>2.6</td>
<td>10,400</td>
</tr>
<tr>
<td>ZGWco-2$^2$</td>
<td>40</td>
<td>12.8</td>
<td>51,200</td>
</tr>
<tr>
<td>ZGWfi-1$^2$</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>ZGWfi-2$^2$</td>
<td>N/P</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>DL</td>
<td>35</td>
<td>6.8</td>
<td>23,800</td>
</tr>
<tr>
<td>Total</td>
<td>N/A</td>
<td>110.4</td>
<td>405,050</td>
</tr>
</tbody>
</table>

**NOTES.**

N/A – Not applicable.

N/P – Soil series is not present.

$^1$Assumes full depth salvage of peat.

$^2$Assumes full depth salvage of peat–mineral topsoil.
5.5.3.8 Reclamation Materials Balance

The total area from which topsoil will be salvaged is 323.7 ha (see Table 5-16). This will generate approximately 1,255,605 m$^3$ of reclamation materials. All salvaged topsoil will be returned to these disturbed areas at the time of closure to allow site reclamation to proceed.

For material balance purposes it has been assumed that a uniform replacement depth will be followed, this would result in a replaced topsoil depth of 37.8 cm. Alternatives to uniform replacement depths are discussed further in Section 5.5.6.3.

5.5.3.9 Erosion Prevention

Based on their professional judgment, the environmental inspector and construction supervisor will determine appropriate erosion-prevention measures for each situation. Measures to reduce wind and water erosion could include:

- spraying risk areas with water (short-term or in an emergency)
- applying tackifying agents (short- to medium-term)
- applying coarse woody debris or slash (medium-term)
- installing erosion-control matting (long-term)
- crimping risk areas with certified weed-free straw (long-term)
- installing silt fences (short- to medium-term) or containment berms (long-term) around the base of the stockpile

Salvaged topsoil will be seeded to ensure long-term stability of the piles and reduce possible losses in quality. The goal is to minimize degradation and losses of topsoil to erosion to retain it for use in reclamation, either during operations or at closure.

Seed will be double-sampled for weed analysis and sourced in Alberta to avoid possible introduction of nuisance or noxious weeds. Incorporating a fast-growing annual cover crop in the seed mix will allow for rapid revegetation in the short-term and allow grasses to achieve a good catch. Since the stockpiles will be in place for the life of the Project, agronomic species or native species might be used to stabilize and maintain the materials.

An example of a commercial pasture mix suited to Parkland soils and western Canadian weather conditions is described (see Table 5-17).

A site-specific native reclamation seed mix, or mixes, could be developed for use in the Project area. For a description of a commercially available seed mix, see Table 5-18. Consultation with the seed mix provider is recommended to determine seeding and fertilizer rates.
Table 5-17  Drylands Pasture Mix*  

<table>
<thead>
<tr>
<th>Species Common Name</th>
<th>Proportion of Mix (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet meadow bromegrass</td>
<td>40</td>
</tr>
<tr>
<td>Kirk crested wheatgrass</td>
<td>20</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>20</td>
</tr>
<tr>
<td>Dahurian wild ryegrass</td>
<td>10</td>
</tr>
<tr>
<td>Pickseed 3006 alfalfa</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

NOTES:  
Can be grown in Brown, Dark Brown and Dry Black soil zones.  
Seed at a depth of 0.6 to 2.0 cm (¼ to ¾ inch) into a well-prepared, firm seedbed.  
Seed at 6.3 to 7.2 kg/0.4 ha (14 to 16 pounds/acre).  

Table 5-18  Central Parkland Natural Sub-region Reclamation Seed Mix1  

<table>
<thead>
<tr>
<th>Species2 Common Name (Latin Name)</th>
<th>Proportion of Mix (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green needlegrass (<em>Stipa viridula</em>)</td>
<td>20</td>
</tr>
<tr>
<td>Awned wheatgrass (<em>Agropyron trachycaulum</em>)</td>
<td>15</td>
</tr>
<tr>
<td>Slender wheatgrass (<em>Elymus trachycaulus</em>)</td>
<td>15</td>
</tr>
<tr>
<td>Western wheatgrass (<em>Agropyron smithii</em>)</td>
<td>15</td>
</tr>
<tr>
<td>Rocky Mountain fescue (<em>Festuca saximontana</em>)</td>
<td>10</td>
</tr>
<tr>
<td>Sloughgrass (<em>Beckmannia syzigachne</em>)</td>
<td>5</td>
</tr>
<tr>
<td>Idaho fescue (<em>Festuca idahoensis</em>)</td>
<td>5</td>
</tr>
<tr>
<td>Alkali bluegrass (<em>Poa secunda</em>)</td>
<td>5</td>
</tr>
<tr>
<td>Junegrass (<em>Koeleria macrantha</em>)</td>
<td>5</td>
</tr>
<tr>
<td>Sandberg bluegrass (<em>Poa sandbergii</em>)</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

NOTES:  
1 Pickseed Western Canada Reclamation Guide (2012).  
2 Reclamation mixes are often underseeded to a non-persistent, quickly establishing cover crop such as Dahurian Wildrye (*Elymus dahuricus*) to stabilize the ground surface and allow the native species to catch.

5.5.4 Reclamation during Operations

Over the life of the Project, it might be possible to return topsoil to certain areas for landscaping around office buildings and parking lots, shoulders and ditches along access roads, and other infrastructure that will be removed during decommissioning, to allow reclamation to the approved end land uses for these disturbed areas. Vegetation plantings in these areas would likely consist of agronomic species, or other domestic species and shrubs typically used in landscaping, that are compatible with safe operation of the GTL facility.
5.5.4.1 Weed Management

Weed management will begin concurrently with site preparation and will continue throughout operations until reclamation certification.

The weed management program will be developed to ensure regulatory compliance by instituting measures to control weeds of concern to the province and the county, as well as agronomic invasive species. As required under Alberta’s Weed Control Act (Government of Alberta 2010b), species defined as prohibited noxious or noxious in the Weed Regulation (Government of Alberta 2010c) will be destroyed or controlled, throughout all phases of the Project.

Key elements of the weed management program include:

- ensuring equipment arrives onsite clear and free of dirt and vegetative material
- ensuring only weed-free straw bales are used for erosion control
- controlling weed infestations
- ensuring harvested weeds are not deposited in a place where they might grow and spread. Preferably, they will be burned or disposed of at a landfill site.

Methods of weed control will be revised, as required, to remain current with regulations, and will be carried out according to location, species and quantity through spot spraying, mowing and hand weeding (AENV 2010a).

5.5.5 Surface Runoff and Drainage Management

For a detailed discussion of Sasol’s approach to water management for the Project, see Section 5.6.

5.5.6 Conceptual Closure Plan

5.5.6.1 Introduction

The Project lands are in the Scotford Heavy Industrial Policy Area as outlined in the Strathcona County Municipal Development Plan (Strathcona 2001) and the Alberta Industrial Heartland Area Structure Plan (AIHA 2002). It is reasonable to assume that land use priorities will remain industrial at the time of decommissioning. If this is not the case, a Conceptual Closure Plan has been developed that is designed to return the site to equivalent land capability.

It is anticipated that decommissioning and reclamation could extend for up to five years from the termination of operations. The duration of reclamation activities is contingent on the amount of time required for infrastructure removal, remediation of any contaminated areas and determination of end land uses, among other factors.

Reclamation is a sequenced approach to returning lands that were disturbed during construction and operations to a land capability equivalent with their pre-disturbed state. Although the proposed end land uses might not be identical to present day, careful conservation and reclamation practices will aim to restore potential for the lands to support those uses.
The objective for the Conceptual Closure Plan is to enable the closure landscape to support a mix of agricultural production and natural vegetation on dune-like landforms, similar to existing conditions. End land use goals and closure planning have been incorporated in Project design and development, including selection of emission-control technologies, water management, spill contingency planning and soil-handling and salvage techniques to minimize effects on land capability.

### 5.5.6.2 Decommissioning

At the end of operations, all infrastructure such as buildings, foundations, paved areas and subsurface utilities will be removed from the site. Concrete pads will be broken up and trucked to an approved landfill for disposal. Gravel pads used to cap parts of the disturbance area will be assessed for contaminants and sorted into clean or contaminated material. Clean gravel will be made available for third party reuse (e.g., for surfacing county roads). Contaminated material will be remediated or disposed of at an approved facility, as required.

Closure operations will be scheduled to limit potential impacts on surface water. Storm water ponds and isolation ditches and berms will be operational throughout decommissioning to allow retention, testing and treatment of surface runoff for potential contaminants or excessive sediment loading before release offsite.

Runoff collected in the ponds will be tested for compliance with EPEA discharge standards before release. Released water will be conveyed to the North Saskatchewan River via creeks near the PDA. At the appropriate time during reclamation, the ponds will be drained, the liners pulled and disposed of at an approved facility and the excavations backfilled to restore the grade contours.

Once infrastructure has been removed, the site will be assessed, where necessary, for potential contamination. Remediation will follow the applicable regulatory standards of the day.

Contaminated areas will be reassessed following remediation to ensure that specified objectives (i.e., applicable regulatory criteria or endpoints that are approved and in effect at the time) have been met.

### 5.5.6.3 Surface Recontouring and Drainage Establishment

Following successful completion of site decommissioning, any ponds and berms will be removed and the site will be rough contoured. At this time, any cuts and fills would be returned to their original elevations or to be consistent with the final closure land uses (these may change over the life of the Project).

Recontouring will involve grading the subsoil to blend with the surrounding terrain and establish interconnectivity with surrounding landscapes. It is proposed that those lands currently under woodland and shrub cover in the northwestern portion of the PDA would be reclaimed to conditions that will support similar vegetation communities. The more southerly lands are proposed for return to agricultural uses much like those found in these areas at present (pasture or annual cropping).

Surface and near-surface drainage patterns developed during the recontouring process will be integrated with the surrounding terrain to establish sustainable drainage patterns that reflect the original diffuse drainage and regimes in the area.
**SOIL RECONSTRUCTION**

Once grading is complete, the grade material will be ripped, if necessary, to alleviate compaction. Before topsoil replacement starts, an environmental monitor will determine whether additional cultivation, such as double-discing, is required to break down large subsoil aggregates. Stockpiled topsoil will be redistributed across the site as dictated by the final Revegetation Plan requirements. A uniform depth was assumed for material balance calculations; however, depending on the available volume of materials salvaged, it may be possible to vary the depths to suit the different types of end land uses. In the northern parts of the PDA where forest vegetation communities are proposed it might be possible to vary the depth of topsoil as compared to the central and southern areas where agriculture is the projected use to provide a variety of growing conditions and enhance potential biodiversity.

Topsoil replacement will occur during suitably dry, trafficable conditions and will be suspended if wet conditions or high winds lead to degradation or loss of topsoil (AEP 1998). Once the topsoil has been replaced, the area will be assessed to determine any need for further cultivation to ensure a suitable seed bed.

**AGRICULTURAL LAND SUITABILITY**

The pre-disturbance land suitability ratings (see Section 5.5.2.5) are based on soil profile and site characteristics, including:

- soil physical properties
- soil chemical properties
- depth to water table
- topography and landform position

Similar data is required to accurately calculate the potential distribution of suitability ratings across the closure landscape. These data are not available at this time, so a quantitative comparison of pre-disturbance and post-reclamation distributions of this index is not possible.

All of the salvaged top soil will be replaced on the recontoured areas from which it was removed. It is likely that a similar level of agricultural productivity could be expected post-closure. Differences would arise; however, because of potential differences in:

- overall site topography compared to pre-disturbance conditions
- subsurface hydrology and surface drainage patterns compared to pre-disturbance conditions
- the reclamation soil cover characteristics as a result of mixing the salvaged materials in the common stockpile

The distribution of suitability classes would be more uniform and, likely, fall predominantly in Classes 2 and 4.
**REVEGETATION**

The approved end-land-use objectives, to be developed by Sasol in consultation with ESRD, will dictate revegetation requirements for the disturbance area. Agriculture is the proposed end-land-use for the majority of the area based on the goals of the Strathcona County Municipal Development Plan (Strathcona 2001) and Alberta Industrial Heartland Area Structure Plan (AIHA 2002) and current land uses.

For this Conceptual Closure Plan, it was assumed that annual crops or perennial forages will be the principle target species for revegetation of much of the central and southern areas of the site. Seeding to cereal crops will promote rapid growth of surface cover to help reduce potential soil erosion and inhibit weed infestations. Underseeding to agronomic species (e.g., pasture mixes) will promote establishment of a more permanent surface cover until alternative uses might be determined.

The northern parts of the PDA will be planted to upland forested vegetation cover at closure. It is assumed that site conditions will be relatively similar to the present so the revegetation target is a similar assemblage of woodland and shrubland alliances. Planting prescriptions have been adapted from those outlined in AENV 2010b (see Table 5-19).

**Table 5-19 Conceptual Revegetation Prescriptions for Woodland Areas**

<table>
<thead>
<tr>
<th>Tree Species* (total density of 1200 to 2200 stems/ha)</th>
<th>Shrub Species* (total density of 500 to 700 stems/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aspen (60%)</td>
<td>• Saskatoon</td>
</tr>
<tr>
<td>• White spruce (20%)</td>
<td>• Prickly rose</td>
</tr>
<tr>
<td>• Balsam poplar (20%)</td>
<td>• Raspberry</td>
</tr>
<tr>
<td></td>
<td>• Green alder</td>
</tr>
<tr>
<td></td>
<td>• Low-bush cranberry</td>
</tr>
</tbody>
</table>

*Species are listed in order of planting dominance, balsam poplar are more likely to occur in wetter locations.

A brief outline of the approach used to adapt the oil sands reclamation guidelines to the Central Parkland is provided for context:

- A crown closure of class A/B, 6-50%, was selected as the default for wildlife habitat, recreation and traditional uses versus commercial forestry.
- The species selection was based on a dry-site type, with aspen leading white spruce.
- For detailed discussions around the application of the oil sands reclamation guidelines, see Section 4 and Appendices D, G, I and J in AENV (2010b).

**5.5.6.4 Weed Management**

Weed-control measures will be a direct function of the specific end land uses for the reclaimed areas. Areas returned to agricultural production will have suitable weed-control programs developed for and integrated with the specified uses (e.g., annual cereal crops, hayland or permanent pasture).
The weed management program will be developed to ensure regulatory compliance by instituting measures to control weeds of concern to the province and the county, as well as agronomic invasive species. As required under Alberta’s Weed Control Act (Government of Alberta 2010a), species defined as prohibited noxious or noxious in the Weed Regulation (Government of Alberta 2010b) will be destroyed or controlled throughout all Project phases.

Weed management will begin once site preparation begins and continue throughout operations until reclamation certification has been obtained. Methods of weed control will be revised, as required, to remain up-to-date with periodic regulatory input and will be carried out according to location, species and quantity.

5.5.7 Reclamation Monitoring

The characteristics of the reclaimed conceptual landscape will not interfere with normal land use or result in negative effects onsite or offsite. Reclaimed lands will be integrated in the surrounding landscape to provide interconnectivity and drainage patterns will be monitored to ensure that runoff patterns are consistent with original patterns and directions.

Soil and vegetation assessments on reclaimed lands are typically combined to allow correlation between vegetation and soil properties. Reclaimed soils will be assessed using approved criteria that are in effect at the time the assessment program is initiated.

The following vegetation characteristics will be assessed in areas that have been seeded (or planted if forest cover is a goal):

- percent vegetation cover
- vigour (e.g., colour, crop or seedling height, tug test for root health)
- evidence of disease
- species composition (including the presence of weeds)

A detailed monitoring program will be developed to comply with the requirements of the terms and conditions of the approval and will be used in carrying out the vegetation assessment.

If plant mortality is widespread, the soil should be analyzed to determine possible causes and fertilizer additions or organic amendments applied.

5.5.8 Implications of Climate Change

Assessing climate change effects on the conceptual closure goals for the Project is challenging. This is because implications are not precisely understood. Key points from the climate change evaluation include:

- direct effects include the influences of change over time in climate parameters such as temperature and precipitation regimes
indirect effects include other influences that could be affected by climate change, such as changes in groundwater or streamflow availability

success of site reclamation and revegetation activities will depend on prevailing climate conditions at the time of closure

Climate change research that is relevant to the PDA (Barrow and Yu 2005; Gray et al 2011; Khandekar 2002; Lemmen and Warran 2004) outlined a range of potential climate change effects that include:

- air temperatures will be warmer on average, and peak temperatures might be higher than historic averages
- warmer temperatures might lead to increased evaporation, decreased soil moisture and potential lowering of the water table

Should either, or both, of these trends occur, a general decrease in plant-available moisture would result, thereby imposing further limitations on land capabilities. Combined with higher temperatures, this could produce conditions that cause a shift from the present central parkland vegetation to a drier mixed grassland community.

The efficacy of including certain species, such as white spruce, that are on the geographic edge of their range might require reassessment of the suggested planting prescriptions. Native species mixes would have to be adjusted accordingly, as would agricultural practices (e.g., perhaps from annual cereal grains to permanent pasture with drought-tolerant agronomic species).

5.6 Water Management

5.6.1 Raw Water and Process Water

Water efficiency is practiced by reducing raw water intake, which Sasol will do by recovering and reusing water. In addition, the new plant design aims at minimizing the raw water intake, effective use and re-use of water and minimizing effluent generation based on location-specific circumstances.

The water, steam and power systems are tightly integrated with the GTL facility. This enables reuse of water and effective management of water in the Project. The integrated water treatment system (see Sections 3.5, 3.7.2 and 3.15.2) address these key issues:

- water balance
- raw water supply and treatment (see also Section 4.5.3)
- potable water
- cooling water system
- water effluent treatment and the collection of surface water
- process water treatment and the reuse
- drainage systems
- sanitary effluent treatment
Through water management, at least 70% of the remaining water (after being used in cooling towers and in the process) will be recovered in the reverse osmosis systems. The remainder is brine water. For more information, see Section 3.15.2.

5.6.2 Surface Water Management Plan

Sasol will develop a Surface Water Management Plan (SWMP) before construction, which will address management of storm water across the PDA. The GTL facility will be designed and operated to minimize the effects on the environment through use of third-party water infrastructure, minimizing water withdrawal requirements, and limiting release of water to the environment. This includes:

- use of a third-party water intake structure on the North Saskatchewan River
- re-use and recycling of process and collected storm water
- closed-loop water collection system across the process area of the GTL facility during operations to limit contaminated water from leaving the site

5.6.2.1 Construction

During construction, disturbed areas in the GTL facility will be closed circuited by diversion berms or ditches—to prevent runoff from leaving the site and offsite water from flowing into the site.

Storm water ponds will be established during initial construction, as required. Once commissioned, they will be used for construction surface water management. Water in these ponds will be tested for compliance with EPEA discharge standards and treated before release. Water will be treated onsite, where feasible. Offsite disposal options will be sought, if necessary. Storm water that meets discharge standards will be released to adjacent surface water bodies.

Foundations for aboveground structures, utilities and ponds will be constructed by excavating into shallow subsoil. A temporary dewatering system will be required for excavation extending below the water table and to allow for facility installations during construction. Temporary holding tanks or ponds will be used for groundwater collection and storage before discharging to surface water.

5.6.2.2 Operations

Sasol is planning to use a third-party water intake structure on the North Saskatchewan River to meet its requirements of 938 m$^3$/h.

Storm water will be collected and temporarily retained on site through a network of drains, sewers and ponds. All storm water ponds will be lined with high-density polyethylene (HDPE). Surficial ditches will be designed with a liner, such as concrete or HDPE, to prevent infiltration and leaking of potentially contaminated water.

Clean storm water from the developed areas of the GTL facility will be captured and reused as raw water. Storm water from undeveloped areas will go through natural drainage courses to the North Saskatchewan River. Developed areas will be grouped with each area, draining to a localized sump from where it will be pumped to the main storm water ponds.
For areas of potential contamination, a first-flush approach will be used for storm water management. The storm water pond will be designed to capture a 24-hour, 1:100-year rainfall event. The design will allow storm water to be collected in the first-flush basin and overflow in a second-flush basin. The overflows from each basin include weirs designed to remove free oil from being carried over. The first- and second-flush basins will be designed to contain rainfall from the furthest point. This water will be treated before reusing.

A closed-loop water collection system will be used across the process area during operations to limit the amount of contaminated water leaving the site. There will be no planned release of storm water from the process area.

Potentially oil contaminated (POC) water from paved and bunded areas, where there is a low possibility of mixing with oil and hydrocarbon (e.g., tank bund areas) is routed to the effluent treatment plant where it is treated and reused.

Oil contaminated (OC) water from areas of high probability of mixing with hydrocarbons and drainage of water containing hydrocarbons water (e.g., pump bases) are collected separately, treated in the effluent treatment system for reuse.

Storm water in the flare stack area will be allowed to infiltrate naturally into the ground surface or reach the natural drainage system as surface runoff, since liquid contaminants are not expected from the flare stack system.

Storm water in the site laydown areas will be allowed to infiltrate naturally into the soil or reach the natural drainage system as surface runoff, since these areas will remain undeveloped.

Storm water in the rail loading yard will be collected and sent to the storm water ponds in the process area. The collected storm water will be treated in the wastewater treatment unit and then reused in the process facilities.

Storm water in the areas outside of the rail loading yard will be allowed to infiltrate naturally into the soil or reach the natural drainage system as surface runoff, since liquid contaminants are not expected in the remainder of this area and the soil stockpile area.

Brine will be injected into an onsite deep disposal well.

### 5.6.3 Groundwater Management

Groundwater use is not anticipated at Sasol’s GTL facility. However, temporary groundwater dewatering will be required during construction for excavations that extend below the water table.

Engineered measures will be incorporated in the GTL facility’s design to prevent effects on groundwater during GTL facility operations, including:

- building secondary containment around storage tanks in the process area. Containment will be built according to the Energy Resources Conservation Board (ERCB) Directive 55: Storage requirements for the Upstream Petroleum Industry. Secondary containment will comprise a synthetic, impervious HDPE liner that will be keyed into the dike walls.
• installing a leak detection and collection system under each storage tank. A porous layer, consisting of sand or gravel (or a combination), will be placed over the HDPE liner and under the storage tanks to protect the liner and permit leaks to flow to a collection point in the diked area.

• inspecting diked areas, storage tanks and visible liners for signs of leaks or spills. Inspections will be done monthly. Spilled materials will be cleaned up immediately on discovery and reported to ESRD if the spill volume exceeds thresholds outlined in ESRD’s Release Reporting Guideline.

• constructing facility process areas on paved ground that slopes away from buildings, equipment and pipe ways, and drains to suitable drainage systems. Curbed areas will be provided where potential contaminant spills could occur during normal operating conditions.

• using closed pipes for construction of oily water sewers to prevent leaks to soil and groundwater. Where required, surficial ditches will be designed with a liner—such as concrete or HDPE—to prevent infiltration and leaking of potentially contaminated water.

• building loading and unloading facilities for liquids and chemicals on bermed concrete pads. These facilities will slope to a catch basin. Liquid spills will be contained and cleaned up immediately after loading and unloading operations are completed.

• implementing a Spill Response Plan. The plan would provide processes and guidelines to effectively and efficiently mitigate the effects of an incident involving products inside the GTL facility, during transportation, handling and storage.

• lining storm water ponds with HDPE to ensure containment of runoff water

• designing a groundwater monitoring network to allow early detection of effects on shallow groundwater. A Groundwater Management Plan, including a response plan, will be developed for the GTL facility to allow for early assessment, control and mitigation of potential effects.

• excavating into shallow subsoil when constructing foundations for aboveground structures, installing utilities and constructing ponds. A temporary dewatering system will be required for excavation extending below the water table and to allow for facility installations during construction. Temporary holding tanks or ponds will be used for groundwater collection and storage before discharging to surface water.

5.7 Waste Management

Sasol will perform waste-minimization reviews during each engineering stage. Waste minimization reviews incorporate the following principles:

• prevent or minimize waste generation

• reuse wastesthat can be reprocessed

• recycle waste

• recover energy from waste-containing calorific values

• dispose of residual waste safely
5.7.1 Waste Management Plan

A Project-specific Waste Management Plan (WMP) will be developed before construction and operations, when the most pertinent information is available. The WMP will be developed according to laws, regulations and guidelines. The WMP will be used to manage hazardous and nonhazardous waste material that is generated during construction and operations, according to the following regulations:

- Alberta *Environmental Protection and Enhancement Act* (EPEA)
- Alberta *Waste Control Regulation* (ESRD 1996a)

By applying waste-management principles, Sasol's goal is to reduce the quantity of waste form the GTL facility. The following planned management methods will be applied:

- segregate hazardous and nonhazardous material and mark bins and areas
- segregate and recycle domestic (office) waste (e.g., paper, cardboard, glass and pop cans)
- segregate and recycle maintenance waste (e.g., metal, halogen lights and oil)
- recover precious metal from spent catalyst
- regenerate catalyst for reuse, where practical
- recover and reprocess lubrication oils
- use environmentally friendly chemicals, where practical
- inform contractors and employees of their role and accountabilities with regards to managing wastes
- identify third parties that are able to increase the effectiveness of the waste handling

The goals of the WMP are to identify, classify, segregate and ensure safe storage of waste materials. Furthermore, suitable safety equipment will be provided to handle emergency situations and ensure safe disposal and record keeping of waste materials. For an outline of disposal routes for wastes, see Table 5-20. Sasol will work closely with potential third parties during the next stage of engineering to quantify final destinations and transportation requirements.

### Table 5-20 Typical Waste Streams

<table>
<thead>
<tr>
<th>Waste Category</th>
<th>Management Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction waste</td>
<td>Sent to an approved contractor for reuse and disposal</td>
</tr>
<tr>
<td>Solid waste from sanitary waste</td>
<td>Sent to an approved third party for treatment and disposal</td>
</tr>
<tr>
<td>Brine water</td>
<td>Sent to a disposal well on site</td>
</tr>
<tr>
<td>Ash from thermal oxidizer</td>
<td>Drummed and sent to an approved third party for disposal (hazardous)</td>
</tr>
<tr>
<td>Scrap metal</td>
<td>Sent to an approved third party for reuse</td>
</tr>
<tr>
<td>Spent catalyst</td>
<td>Catalyst containing precious metals will be sent to metal reclaiming companies for reuse (hazardous)</td>
</tr>
<tr>
<td>Pallets</td>
<td>Sent to contractor for reuse</td>
</tr>
<tr>
<td>Office waste (e.g., pop cans, plastic bottles, paper and cardboard)</td>
<td>Sent to an approved third party for recycling</td>
</tr>
</tbody>
</table>
Table 5-20  Typical Waste Streams (cont’d)

<table>
<thead>
<tr>
<th>Waste Category</th>
<th>Management Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used oil</td>
<td>Collected in drums and sent to an approved third party for recycling (hazardous)</td>
</tr>
<tr>
<td>Insulation</td>
<td>Sent to the approved insulation company for reuse, if not contaminated with hydrocarbons</td>
</tr>
<tr>
<td>Hydrocarbon-contaminated insulation</td>
<td>Drummed and sent to an approved third party for disposal (hazardous)</td>
</tr>
<tr>
<td>Laboratory waste</td>
<td>Wastes that cannot be treated in the GTL facility will be collected in drums and sent to an approved laboratory waste contractor (hazardous)</td>
</tr>
<tr>
<td>Domestic garbage</td>
<td>Collected in local containers and sent to municipal landfill</td>
</tr>
<tr>
<td>Catalyst and chemical drums</td>
<td>Sent to original supplier for reconditioning and reuse</td>
</tr>
<tr>
<td>Dewatered waste from water treatment sludge</td>
<td>Routed to the thermal oxidizer for heat recovery.</td>
</tr>
<tr>
<td>Wax remelt waste</td>
<td>Solid wax will be collected and sent to the thermal oxidizer for heat recovery</td>
</tr>
<tr>
<td>Waste water</td>
<td>Waste water streams will be collected, treated and reused. For more information, see Section 3.5.</td>
</tr>
</tbody>
</table>

### 5.8 Substance Release

#### 5.8.1 Introduction

To manage potential substance releases, Sasol will develop a Project-specific Spill Response Plan. The Spill Response Plan outlines a process for effectively and efficiently managing the effects of a substance-release incident involving Sasol products inside the PDA during transport, handling and storage. The purpose of the Spill Response Plan is to:

- ensure the safety of people
- protect property
- protect the environment
- return the incident site to normal conditions as soon as is safely possible
- report on significant incidents involving the transport, handling and storage of Sasol products

Sasol will design, construct, operate and maintain the GTL facility to prevent or limit, as far as practical, the potential for substance releases that might adversely affect health, safety or the environment. If incidents do occur, they will be reported according to applicable regulatory requirements and corporate standards.

#### 5.8.2 Spill Prevention and Response Plan

A Spill Response Plan will be developed before the start of construction and will be submitted to ESRD for review. The plan will define the responsibilities, roles and procedures applicable to a substance-release incident. The following risks were identified:

- major transport incidents
• damage to consignment (e.g., to a product container or to packaging)
• spills on site

The Spill Response Plan will provide guidelines for personnel who are involved in mitigating incidents that involved Sasol’s products. It will be part of the Project’s WMP and will also be incorporated into, and supported by, the Project’s Emergency Response Plan.

All personnel directly involved with the Project, including contract personnel, will receive spill prevention and reporting training, be knowledgeable on the Spill Response Plan and will know and understand their duties, roles and responsibilities in the event of an incident. The Spill Response Plan will include the provision of spill kits in process areas.

The Spill Response Plan will include the following sample table of contents, which addresses general information (specific content will be developed in discussion with ESRD before construction begins):

• purpose of the Spill Response Plan
• expectations of employees
• expectations of contractors
• relevant legislation
• accountabilities and obligations
• classification of spills
• getting help
• responding to spills
• initial response procedures
• immediate reporting
• follow-up reporting
• appendices
• checklist: What to do if a Spill is Discovered
• contact list (organizations and individuals)

5.8.3 Communication during an Incident

If a substance-release incident occurs and support is required, Sasol’s Call Centre will provide support and advice (for incidents outside the Project boundary), log the initial call and activate the Sasol emergency protocol, which informs the Sasol responsible person of the incident. For all incidents, the Sasol responsible person will inform key persons in Sasol’s business unit and will:

• inform the Sasol business unit managing director
• inform the communication department if there is the possibility of media or public communication
• gather relevant information on the situation
• ensure reporting is done to key community, government and industrial contacts, as defined in the Emergency Response Plan
• compile and distribute the initial incident report (as required) within 24 hours of the incident
• monitor the clean-up, ensuring the rehabilitation is done according to government regulation(s)
• obtain approval from regulatory bodies, if required
• ensure incident investigation and analysis is conducted, and distribute the report to relevant persons and implement corrective actions

5.8.4 Communication with Affected Parties

Sasol communications will coordinate communication with affected parties. Notification decisions will be based on potential effects and the information available at the time of the substance release. Notifications will include:

• nearby residents and businesses
• ESRD
• ERCB
• Strathcona County Fire and Emergency Response
• Strathcona County – Heartland Hall
• Northeast Region Community Awareness and Emergency Response (NR CAER)
• third-party facility owners
• Royal Canadian Mounted Police (RCMP)
• Sasol corporate management

5.9 Emergency Response

Sasol believes that being prepared for situations that pose immediate risk to workers, the public, the environment or property is a responsibility that cannot be compromised.

Sasol’s approach to emergency preparedness is designed to achieve the following objectives:

• prevent emergency situations
• ensure immediate and effective response and handling of emergencies
• minimize danger and consequences to individuals, the public, the environment and property
• establish and maintain timely and effective communications with parties affected by the emergency
• mobilize the required resources, both internally and externally if required, to address emergency situations with a view to restoring control in the shortest possible time and avoid escalation
• resume operational activity when safe to do so
• comply with all regulatory and regional requirements
• reflect and adhere to Sasol Limited’s corporate policies and procedures, which reflect its global experience and expertise in operating GTL facilities, emergency preparedness, and protecting the safety and health of individuals and the environment

Sasol’s emergency preparedness and planning includes:

• first aid, firefighting and emergency equipment
• mutual aid
• training, implementation planning and risk assessment (incorporating hazard and operability analysis (HAZOP))
• emergency shutdown systems (ESD)
• emergency reporting and follow-up
• loss of containment protocols and procedures
• communication protocols and procedures, including compliance with regulatory requirements for public and news media notification and communication with government and regulatory agencies and law enforcement authorities
• emergency evacuation for all facilities and offices
• corporate emergency response plans to address a range of situations, including:
  • accidents
  • injuries
  • medical emergencies
  • transportation incidents
  • operational upsets
  • malfunctions or incidents
  • emergencies created elsewhere but affecting the Canada GTL Project
  • non-routine emergencies
• incident investigation
• post incident monitoring and assessment, as applicable

The Project is at the early stage of planning, engineering design and regulatory review. Sasol is committed to having ERPs in place to address the construction and operational phases of the Project. Sasol will submit a conceptual ERP plan to ESRD, which will integrate Sasol Limited’s internal approaches and protocols for emergency response with the requirements of ESRD. The conceptual ERP will also address regulatory requirements of other government ministries and agencies, if applicable to the Project. It will also identify and address supplementary regional requirements.
Before beginning construction, Sasol—through the main engineering contractor overseeing Project construction—will submit an ERP to ESRD covering the construction phase (see Section 4.3.6 for additional details).

An ERP for the Project’s operational phase will be submitted to ESRD. An approved ERP will be in place before operations begin. The approved ERP will be developed through ongoing consultation with:

- ESRD to ensure compliance with ministry requirements
- Strathcona Industrial Association (SIA) through the Community Awareness Emergency Response (CAER) Program to ensure integration with the county’s requirements and expectations for external support and mutual aid

The approved operational ERP will incorporate the following major elements:

- objectives, approaches and reporting
- corporate emergency management program responsibility
- hazard identification/risk assessment/prevention and mitigation strategies
- planning process
- incident classification and management
- internal and external communication protocols
- crisis communication/media relations
- training/ frequency of training
- plan/program distribution
- updating cycle and approval
- prevention

5.10 References


Pickseed 2012. Accessed October 1, 2012 at:


Strathcona County. 2012. Accessed October 1, 2012, at:
http://www.strathcona.ca/departments/Planning_and_Development_Services/Zoning_planning_policies/area-structure-plans.aspx (reference is Strathcona 2001 as amended)

### 5.10.1 Personal Communications

6 EIA SUMMARY

6.1 Air

INTRODUCTION

The operation of the Project will result in air emissions from the following sources:

- heater, furnace and boiler stacks (21 stacks)
- waste to energy thermal oxidizer stacks (2 stacks)
- vent stacks (8 stacks)
- flare stacks (4 stacks)
- storage tanks (18 stacks)
- process areas
- cooling towers (one 20-cell tower and one 3-cell tower)

The Project stacks will produce oxides of nitrogen (NO$_X$), sulphur dioxide (SO$_2$), primary fine particulate matter (PM$_{2.5}$), carbon monoxide (CO), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The Project will also produce VOC emissions from fugitive storage tank and process area sources. The NO$_X$ and SO$_2$ emissions lead to the secondary formation of PM$_{2.5}$ in the atmosphere, and NO$_X$ and VOC emissions lead to the secondary formation of O$_3$ in the atmosphere. Water vapour emissions also result from Project combustion and cooling tower sources.

This section summarizes the results of the comprehensive air quality assessment provided in the EIA (Volume 2, Section 3). The objective of the assessment was to determine Project-related and cumulative air quality changes associated with the expected Project emission in combination with other existing and planned industry emissions and non-industry emissions.

KEY ISSUES

ESRD has ambient air quality objectives for a number of chemicals and deposition target loading criteria for acid-forming NO$_X$ and SO$_2$ emissions. The Capitol Region Air Quality Management Framework defines trigger levels for NO$_2$, SO$_2$, PM$_{2.5}$, and O$_3$. From a visibility perspective, PM$_{2.5}$ can lead to haze, and water vapour emissions from the combustion and cooling tower sources can lead to the formation of visible plumes. In addition, Alberta Health and Wellness requires assurance that resident health will not be compromised by exposures to criteria and non-criteria air emissions. There is also a continuing provincial, national, and international interest in documenting greenhouse gas (GHG) emissions.
**BASELINE OVERVIEW**

Baseline conditions are discussed in terms of meteorological and ambient air quality monitoring conducted in the region. While the focus is on the local data collected by the Fort Air Partnership (FAP), more distant data from the Edmonton area are included in the review.

Meteorology plays a major role in determining air quality changes downwind of industrial and non-industrial emission sources. The 5-year period used for the assessment includes cool, normal and warm years; and dry and normal years. The meteorological data represent the wide range of weather conditions that can occur in the area.

Ambient air quality data for the five year period 2007 to 2011 are examined to obtain an indication of existing conditions. Ambient air quality levels in the LSA and RSA vary considerably, as high concentrations are associated with monitoring sites near emission sources. A review of ambient air quality measurements indicates isolated areas where measured concentrations can exceed an ambient criterion. For the most part, the high values were measured at monitoring stations that are adjacent to a third-party industrial facility.

**EFFECTS MANAGEMENT**

An air management program has been designed to control air emissions from the GTL facility. The principals guiding air quality management for the GTL facility include:

- adopting plant-wide energy integration to maximize energy conservation
- using low-NOₓ (oxides of nitrogen) burners to reduce these emissions
- providing vapour recovery for storage tanks containing volatile hydrocarbons
- providing plot space and tie-in points for possible future carbon dioxide (CO₂) capture

For detailed mitigation measures to manage emissions from the Project, see Volume 2, Section 3.8. These measures relate to the previously mentioned emissions as well as greenhouse gas (i.e., carbon dioxide) emissions.

**EFFECTS ASSESSMENT APPROACH**

A standard approach is used to determine air quality changes due to Project emissions; this approach comprises six main tasks:

1. Identify and quantify atmospheric emission sources for the Project and each assessment case (i.e., Base, Application and Planned Development cases). Because the Project is in an airshed shared by other facilities, it is important to identify and characterize other substantive emission sources. This task involves the identification and the characterization of industrial and non-industrial sources in the model domain. Emissions are defined for the Base, Application and Planned Development cases. The basis for the emissions associated with each case is described in Volume 2, Section 3, Appendix 3A.
2. Review ambient air quality measurements in the region to provide an indication of existing conditions. Continuous and passive ambient air quality data collected in the region were obtained and examined. Western Canada model predictions undertaken by ESRD were reviewed to determine existing deposition levels. The detailed review of this information is presented in Volume 2, Section 3, Appendix 3B.

3. Regional and local meteorology determine transport and dispersion patterns. Information about the topography which influences meteorology, and information about the land use which influences deposition are required. Digital terrain data and land surface cover properties were obtained for the CALMET Domain. The CALMET meteorological model was used to generate three-dimensional meteorological fields for a 5-year period (2002 to 2006) (see Volume 2, Section 3, Appendix 3C). The CALMET model used MM5 data from ESRD and concurrent surface meteorological data from locations in the model domain.

4. Select and evaluate a dispersion model for the assessment. The model selection and the associated assumptions about the model application are provided in Volume 2, Section 3, Appendix 3D. The CALPUFF model was selected and model predictions are compared with regional ambient air quality measurements to gauge model performance.

5. Apply the CALPUFF dispersion model to predict ambient concentration and deposition patterns for each assessment case. The model was used to predict the transport, dispersion, chemical transformation, and deposition using the emission sources identified in Task 1 and the topographical and meteorological data from Task 3. The model was used to predict 1 hour, 24-hour, and annual average concentration patterns (i.e., NO$_2$, SO$_2$ and PM$_{2.5}$), and 5-year average deposition patterns (nitrogen, sulphur, and PAI).

6. Compare the ambient monitoring measurements and air quality predictions to the ambient air quality and deposition criteria, and identify the incremental air quality changes caused by the Project. The predicted concentrations and depositions are compared with respective ambient criteria in Volume 2, Section 3.10.

This approach has been used for air quality assessments for similar projects in Alberta’s Industrial Heartland (AIH).

**PROJECT EMISSIONS**

Ambient concentrations increase with increasing emission rates, decrease with increasing distance from an emission source, and vary with prevailing meteorological conditions. Ambient concentrations, therefore, vary considerably with location and time. This assessment focuses on determining maximum values, which assumes worst-case meteorological conditions and worst-case locations. These locations tend to be at or near the PDA boundary, at or near other facility fencelines, or in urban areas.

Ambient concentrations due to Project emissions, in isolation, are predicted to about or less than 1% of the respective AAAQO for many substances. For ambient SO$_2$ concentrations, the Project values range from 3% to 5% of the respective AAAQO. For ambient PM$_{2.5}$ concentrations, the Project values range from 6% to 15% of the respective AAAQO/AAAQG/CWS. For ambient NO$_2$, the Project values range from
7% to 28% of the respective AAAQO. The maximum concentrations due to the Project are predicted along or near the PDA boundary and all are less than the ambient criteria.

**CUMULATIVE EFFECTS**

Three primary assessment cases (i.e., Base, Application and Planned Development) are characterized to determine cumulative effects of the Project on ambient air quality. The predicted concentration and deposition patterns indicate that industrial and non-industrial (i.e., urban heating and traffic) have a strong influence on the magnitude and the shape of these patterns. Some substances are strongly influenced by industrial sources (e.g., SO$_2$) while other substances (e.g., NO$_2$ and PM$_{2.5}$) are influenced by industrial and non-industrial source types.

A review of ambient monitoring measurements and cumulative air quality model predictions indicate the presence of local “hot spots” in the study area that are defined by high concentrations associated with existing and base case emissions. Some of these high values approach or exceed ambient air quality criteria. Specific examples follow:

- **High ambient NO$_2$ concentrations** are predicted near an industrial facility in Redwater and in the Edmonton area. The ambient measurements indicate high values at a station north of the PDA. The Project contribution to these maxima is essentially 0%.

- **High ambient SO$_2$ concentrations** are predicted 5.5 km to the north, 7.7 km to the northeast and 11.5 km to the northeast of the PDA. The ambient measurements indicate a fertilizer facility might be the source of these high values. The Project contribution to these maxima ranges from 0% to 1.1%.

- **High ambient PM$_{2.5}$ concentrations due to anthropogenic combustion emissions** are predicted to occur in the Edmonton area. High ambient PM$_{2.5}$ concentrations due to forest fires also occur in the LSA. The Project contribution to these maxima is essentially 0%.

- **High ambient hydrogen fluoride (HF) concentrations** are predicted near a fertilizer facility. Ambient measurements confirm that high HF concentrations have occurred near this facility. The Project contribution to these maxima is essentially 0%.

- **High ambient benzene concentrations** are predicted near a chemicals facility that uses benzene as a feedstock. Ambient measurements near this facility confirm that high benzene concentrations have occurred. The Project contribution to these maxima is essentially 0%.

- **High ambient H$_2$S concentrations** are predicted near a gas processing facility in Redwater and near an upgrader. Ambient measurements confirm that high H$_2$S concentrations have occurred near the upgrader and near the refineries in Edmonton. The Project contribution to these maxima is essentially 0%.

- **High ambient nickel concentrations** are predicted near a metal processing facility in Fort Saskatchewan. There are no ambient measurements to confirm that high nickel concentration have occurred or are occurring. The Project contribution to these maxima is essentially 0%.
In addition to Project precursor emissions contributing to the secondary formation of PM$_{2.5}$, they can also contribute to the formation of ozone. While the Project precursor emissions are relatively small, they—along with all other NO$_X$ and VOC emission sources—can contribute to high ozone events that can exceed the AAAQO.

Project emissions can also contribute to the deposition of acid forming compounds and to PAI. Again, while the Project precursor emissions are relatively small; they, along with all other NO$_X$ and SO$_2$ emission sources, contribute to PAI deposition. The RSA average PAI deposition is less than the Target Loading for sensitive, moderately sensitive and low sensitivity grid cells.

While Project precursor emissions, in themselves, are not likely to result in a perceptible change in visibility due to regional haze; they, along with all other PM$_{2.5}$, NO$_X$ and SO$_2$ emission sources, contribute to the formation of regional haze given the appropriate meteorological conditions. The Project cooling tower water vapour emissions are predicted to result in reduced visibility along nearby roadways under low temperature conditions. Warning signage is recommended should the presence of fog due to these sources be confirmed.

The Project greenhouse gas (GHG) emissions are estimated to be 16,176 t/d (5,904 kt/a or 5.904 Mt/a) expressed on an carbon dioxide equivalent (CO2e) basis. The Project emissions account for 2.53% of the 2010 Alberta GHG emissions, and 2.07% of the projected 2020 Alberta GHG emissions. The Project CO$_{2e}$ emissions account for 0.85% of the 2010 national total GHG emissions, and 0.69% to 0.82% of the projected 2020 national GHG emissions.

**MONITORING**

The Sasol air quality monitoring program will be made up of two components: source monitoring and ambient monitoring.

The source monitoring component will be developed through discussions with ESRD; and the monitoring terms and conditions will form part of the Alberta Environmental Protection and Enhancement Act (EPEA) approval. Larger stacks will be properly equipped with a continuous monitoring according to the Continuous Emissions Monitoring Systems (CEMS) Code, and these will be supplemented by stack surveys conducted according to the Alberta Stack Sampling Code. The results of the continuous monitoring and stack surveys will be reported in accordance with the terms and conditions identified in the EPEA approval.

For the ambient monitoring component, Sasol understands that the ambient air quality monitoring can be undertaken to address a range of objectives, for example: local-scale monitoring to determine compliance with AAAQO/CWS, monitoring to provide representative community exposures, regional scale monitoring to evaluate long-term environmental changes, monitoring to determine relative source contribution (e.g., urban vs. industrial), and monitoring to determine background values.

Ambient air quality monitoring in the region is conducted by FAP to meet multistakeholder (i.e., public, regulatory and industry) needs. Sasol plans to work with ESRD and FAP to ensure their monitoring contribution complements the current program without leading to duplication of efforts. In addition, Sasol will actively participate in FAP’s regional monitoring initiatives.
ASSessment Conclusions

The cumulative assessments that include Project emissions indicate the addition of the Project in the area does not compromise local air quality relative to meeting the AAAQO. The Project has been designed to reduce NO\textsubscript{X}, SO\textsubscript{2}, PM\textsubscript{2.5}, VOC and GHG emissions. Ongoing source and ambient monitoring will provide indicators of environmental performance from an air quality perspective, and will allow feedback for continual improvement to increase operating efficiencies and reduce emissions.

6.2 Noise

Introduction

In Alberta, energy facility sound emissions are regulated by the Energy Resources Conservation Board (ERCB) through Directive 038 (Noise Control; ERCB 2007).

The acoustic environment in the region is influenced by existing noise-emitting facilities, including the Shell Scotford Complex, Dow Chemicals and Keyera Energy. Highway 15 is also a major source of sound. Agricultural lands with associated residences are present in the area. The key issue for environmental noise from the Project is the potential for cumulative effects from multiple projects at residential receptors.

Nine noise receptors were identified as being potentially affected. Three are within 1.5 km of the Project’s fenceline. The others are locations that might experience cumulative effects because of the presence of energy-related development in the region.

The GTL facility fenceline is the Project disturbance area (PDA) boundary. The local study area (LSA) includes the Directive 038 1.5-km boundary from the Project fenceline. The regional study area (RSA) includes an area up to 5 km from the Project fenceline, allowing for nearby facilities that might affect the predicted noise levels in the LSA to be considered.

Key Issues

The key issues for noise are related construction and operational noise, and whether noise control guidelines are likely to be exceeded at the nearest receptors.

Baseline Overview

Baseline sound measurements were conducted between June 21 and 23, 2012. The measured one-minute $L_{eq}$ and audio recordings were reviewed to exclude noise events occurring near the microphone, which artificially raises the assessed ambient noise levels. Events filtered include technician and resident activities, excessive wind, rain and vehicles close enough to the microphone to significantly affect the $L_{eq}$. In all cases, the exclusion of noise data reduced the calculated $L_{DAY}$ and $L_{NIGHT}$. 
Baseline noise levels measured at R50 are higher than the ERCB-mandated ambient noise levels for daytime and nighttime. Otherwise, noise levels at receptors are similar to the ERCB-mandated ambient levels.

The measured sound levels at each receptor were compared with NCIA-provided Comprehensive Sound Levels. The measured levels at receptors R3, R38 and R520 showed excellent agreement with the provided levels, with measured results within ± 3 dBA of the NCIA values. The measured level at R50 was higher than the NCIA CSL. This is likely because of truck traffic on the nearby Highway 15 and Secondary Highway 830. Other influences to the measured sound level included an on-site school, seagulls, and an existing pump near a pond on the property.

**Effects Management**

Sasol will use best management practices and reasonable measures to reduce the effects of construction noise, including:

- limiting construction activity to between 07:00 and 22:00 to the extent reasonably possible
- scheduling significant noise-causing activities to reduce disruption for nearby municipalities and residents
- advising nearby residents of significant noise-causing activities and of any construction activities outside normal construction hours
- locating staging areas for construction away from residents
- ensuring that all internal combustion engines are fitted with muffler systems
- taking advantage of acoustical screening from existing on-site buildings (e.g., trailers) to shield noise receptors from construction equipment noise
- responding to noise complaints and taking action to manage issues responsibly

During operations, Project design features will help limit sound propagation and mitigate noise effects. These features include:

- physical barriers (e.g., machine housing, enclosures and walls), except for relieving devices
- relief silencers designed to lower the noise of safety valve vents
- buildings or enclosures, including sound-insulating materials, installed on large compressor packages
- anti-surge valves and control valves (with special trim inside the valves), discharge silencers, flow straighteners, and specially designed valve casing

**Effects**

Noise from construction and decommissioning phases are of shorter duration and with fewer total noise sources than for operations. Therefore, noise levels during these stages is expected to be lower, and will vary based on the type of activity. Most product shipments will be conducted by rail and pipeline, so changes in sound levels from highway traffic are not expected.
Continuous sound levels from locomotive engines moving around on site were propagated out to R50, located nearest to the train yard, and found to be below 10 dBA. This is more than 25 dBA lower than expected sound contributions from other site sounds and, as such, is expected to be indistinguishable most of the time. Impulsive sound levels from shunting activities were also propagated out to R50 and found to be approximately 40 dBA. This would increase the sound level at the nearest receptor by approximately 2 dB, which is below the human perceptibility limit.

The Project contribution to LFN was also assessed. All receptors, with the exception of receptors R7, R8 and R520, show dBC–dBA values of less than 20 dB. Tonality, the second condition defining LFN potential, cannot be confirmed because of the theoretical nature of the assessment; however, the dBC contributions are all lower than 60 dBC, so LFN potential is low.

Predicted sound levels as a result of normal operations of the Project alone are below the applicable PSLs at the nearby residences. The highest predicted sound level is at R3, a residence located approximately 500 m to the south of the Project fenceline. Temporary activities (e.g., emergency flaring, construction and decommissioning) might result in occasional short- term increases in noise levels, or intermittent noise events, but the overall effects are considered less than the effects of continuous operations. The residual effects at all receptors are compliant with the requirements of Directive 038.

**Cumulative Effects**

The predicted application case sound levels are at, or below daytime PSLs for all receptors. Noise at R3 exceeds the nighttime PSL by 1 dB, which is below the human perception level. All other receptors are at, or below, the applicable nighttime PSLs. These results will be verified by detailed monitoring at the receptors and at the Project boundary after operation begins to determine whether there is an exceedance. If so, additional mitigation (e.g., enclosures with higher sound attenuation ratings and noise barriers) could be used to reduce sound levels at the receptors.

**Assessment Conclusions**

Baseline conditions and Project activities producing noise were assessed. In the base case, R50 exceeds mandated ambient noise levels primarily due to proximity to Highway 15. During Project operation, continuous sound from locomotive engines will be mostly indistinguishable compared with other site sounds with impulsive shunting noise level at the nearest receptor below the human perceptibility limit. The Project contribution to LFN is considered low. The nighttime PSL exceedance at R3 is primarily due to conservative conditions used in the modelling and requires verification after the GTL facility is built. Therefore, with continuous operation of the GTL facility and other approved energy-related facilities in the area, the Project is considered compliant, with the need to verify modelling results at receptors.
6.3 Light

**INTRODUCTION**

The local study area (LSA) extends 2 km from the boundary of the Project site. Light trespass and nuisance glare is considered in the LSA with Dow Chemicals, Aux Sable Chemicals, Gulf Chemical and Metallurgical and the Canadian National (CN) Scotford rail yard also contributing to existing light effects. BP Canada and Keyera also have facilities north of Highway 15 and west of the Project site. The Shell Scotford Upgrader is located north of the Project site. The light intensive process area is located on the central to southern portion of the property nearest to Highway 15. Private residences near the GTL facility are receptors potentially affected by Project light sources.

The regional study area (RSA) extends 50 km from the boundary of the Project site. The RSA puts skyglow at the receptors within the LSA in the context of the regional light environment and includes Fort Saskatchewan and a portion of Edmonton.

**KEY ISSUES**

The key issues for light are related to light levels at the closest receptors.

**BASELINE OVERVIEW**

The LSA is in a rural agricultural area interspersed with large industrial facilities. The landscape is generally level or undulating and receptors’ properties often have trees, which help block nuisance glare. Industrial, civic (e.g., highway) and residential lighting are sources of nuisance glare in the LSA.

Similar industrial developments have indicated potential light trespass of less than 0.63 lux at a distance of approximately 500 m (Total 2009). Existing industrial facilities are farther than 500 m from the receptors, so baseline light trespass levels from current facilities are less than the 1.1 lux criterion for areas of low ambient brightness, as stipulated by LEED. Receptors in the LSA are affected by skyglow resulting from the presence of large population centres and numerous industrial facilities in the RSA.

Mitigation focuses on the quality of lighting (i.e., glare, uniformity, brightness ratios, reflection and colour) rather than the quantity of lighting.

**EFFECTS**

For light trespass the closest receptor to the Project, Receptor Number 3, is 575 m from the Project fenceline. This distance is large enough such that light trespass from the Project will not exceed the 1.1 lux criteria established by LEED for areas of low ambient darkness at the receptor’s property boundary. All other receptors are further away from the Project and will similarly not be adversely affected by light trespass from the Project.
The potential for nuisance glare is mitigated by trees on all the receptor lots, which, to varying degrees, remove the direct lines of sight between the Project and the residences on the receptors' properties. Additionally, several receptors have other light sources between their locations and the Project. In these cases, the existing light sources might be greater sources of glare.

The effect of skyglow is difficult to quantify, but it is unlikely that the incremental increase in regional skyglow under clear sky conditions will be noticeable given the context of the existing skyglow conditions.

**Cumulative Effects**

When considering the potential for nuisance glare in combination with other existing and planned developments, the effect on the viewscape will be of low consequence because of shielding from trees on receptor lots and Sasol's use of fully shielded luminaires. The number of industrial, residential, commercial and civic facilities in the RSA is expected to continue to grow, and the associated increase in lighting will contribute to skyglow.

**Assessment Conclusions**

Project effects from light trespass will not exceed LEED criteria for areas of low ambient darkness and the potential for nuisance glare is considered to be of low consequence. The Project's contribution to skyglow will be reduced through the implementation of Project mitigation measures.

### 6.4 Groundwater

**Introduction**

The regional geology and hydrogeology in the Fort Saskatchewan area are characterized by Quaternary-age preglacial, glacial and post-glacial deposits overlying bedrock. The Beverly Channel is the major preglacial valley in the area and is roughly coincident with the present-day North Saskatchewan River Valley. The buried sand and gravel deposits of the Beverly Channel form an important regional aquifer.

Groundwater in the bedrock and Beverly Channel naturally discharges to the North Saskatchewan River (NSR). Water wells in the Fort Saskatchewan area are generally completed in the surficial sand deposits, the Beverly Channel aquifer and the bedrock.

The local study area (LSA) is defined as the land encompassing the Project disturbance area (PDA). The RSA includes the area within a 3.2-km radius of the LSA and covers approximately two sections of the land around the LSA. The radial extent of the study area is limited to the west because of the presence of the NSR, which acts as a regional discharge feature.

A larger study area was used when discussing the hydrogeological conditions of the Beverly Channel aquifer, which lies beneath the LSA. The area used to describe the geology and hydrogeology of the Beverly Channel aquifer is approximately 10 km by 20 km, stretching from the City of Fort Saskatchewan to near the Vinca Bridge over the NSR on Highway 38.
**KEY ISSUES**

For key potential issues related to groundwater, see Table 6-1.

**Table 6-1 Key Issues for Groundwater**

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Effects of dewatering activities on local groundwater levels, flow regimes, surface waterbody levels and vegetation</td>
<td>Section 3.2.2 [A] and [B]</td>
<td>Groundwater dewatering might be necessary in localized areas during construction of foundations and ponds, and installation of underground utilities. These activities might affect the local water table.</td>
</tr>
<tr>
<td></td>
<td>Effects of dewatering on local groundwater users</td>
<td></td>
<td>Groundwater dewatering could also affect groundwater use by owners of local water wells.</td>
</tr>
<tr>
<td>Operations</td>
<td>Effects of leaks, surface spills and pond seepage on shallow groundwater quality</td>
<td>Section 3.2.2 [B]</td>
<td>Shallow groundwater quality could be affected by accidental spills or leaks of liquids containing chemicals or hydrocarbons, or seepage from ponds, which could affect underlying surficial aquifers.</td>
</tr>
<tr>
<td></td>
<td>Effects of leaks, surface spills and pond seepage on the groundwater quality of the Beverly Channel aquifer</td>
<td></td>
<td>The quality of the groundwater in the Beverly Channel could be affected if the quality of the surficial aquifers are compromised and if the clay and clay till units, which provide natural protection, are thin or absent.</td>
</tr>
<tr>
<td></td>
<td>Effects of leaks, surface spills and pond seepage on local groundwater users</td>
<td></td>
<td>Groundwater contamination could affect the potability of the shallow groundwater used by local water well owners. It could also potentially affect the groundwater quality in the Beverly Channel in areas where natural protection might be limited.</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>Effects of dewatering activities on local groundwater levels, flow regimes, surface waterbody levels and vegetation</td>
<td>Section 3.2.2</td>
<td>Groundwater dewatering might be necessary in localized places to remove foundations or subsurface utilities. This activity could affect the water table.</td>
</tr>
</tbody>
</table>

**BASELINE OVERVIEW**

In the RSA, aquifers are generally found in the Belly River Formation and the Quaternary deposits (surficial sands and Beverly Channel sand and gravels). In the Beverly Channel aquifer, groundwater flow is to the north-northwest toward the NSR. Horizontal gradients were highest along the river and decreased away from the river. The groundwater can be characterized as a sodium–magnesium–calcium–bicarbonate–sulphate type.

Groundwater flow in the Beverly Channel is generally northwest across the LSA and RSA. Hydraulic gradients range from 0.00042 m/m to 0.0014 m/m, with an average of 0.00068 m/m beneath the LSA.

During April and May 2012, the vertical hydraulic gradients ranged from 0.14 m/m to 0.25 m/m in a downward direction across the clay and clay till units. In July 2012, the vertical hydraulic gradients, also in a downward direction, ranged from 0.11 m/m to 0.48 m/m.
The average linear groundwater velocity for the Beverly Channel beneath the LSA was estimated at about 70 m/a, based on a geometric mean hydraulic conductivity of $4.8 \times 10^{-4} \text{ m/s}$, an average hydraulic gradient of 0.00068 m/m beneath the LSA and an assumed effective porosity of 0.15.

Local and regional groundwater quality is generally similar. The closest water wells to the LSA, located 400 to 1,000 m from the LSA, include four water wells within the Aux Sable property used for non-potable, domestic purposes, six wells in NE17 and one well at NE07 used for livestock purposes. All other existing water wells are located more than 1,000 m from the LSA.

**Effects Management**

During construction, a temporary dewatering system will be required for excavation that extends below the water table to install facilities. Temporary holding tanks or ponds will be used to collect and store groundwater. Temporary fuel storage tanks for construction equipment will be provided with secondary containment and leak-detection system. A catch basin will be installed around the fuel pumps to prevent spilled product from reaching the soil.

Effects on groundwater during operations are commonly linked to tank leakages, seepage from ponds, damaged pipelines, and miscellaneous spills from plant operations (e.g., loading and transportation). Design measures to avoid or respond to groundwater effects are discussed in the Spill Response Plan. In addition, engineered measures will provide:

- secondary containment for storage tanks
- containment for:
  - process and storage facilities
  - loading and unloading areas
  - raw water and wastewater
  - storm water
  - spills

During decommissioning, potential effects on groundwater might be associated with:

- localized dewatering of shallow groundwater
- spills or releases of raw materials, products or chemicals still present in pipelines, process lines storage tanks or pads and sumps

To mitigate potential effects on groundwater during decommissioning, Sasol will develop a detailed decommissioning plan.
**EFFECTS**

**EFFECTS OF GROUNDWATER DEWATERING**

Drawdown effects from shallow groundwater dewatering are expected to extend up to about 680 m from the excavation boundary. Effects are not expected to extend beyond the LSA boundary to the north, east and south because the construction of the GTL facility will be limited to the southwest portion of the LSA allowing greater distance between dewatering activities and the LSA boundaries. However, depending on the location of the excavation in the GTL facility construction area, the drawdown effects have the potential to extend westwards beyond the LSA but it is expected that the effects will be negligible because the land is undeveloped and there are no water well users.

**SHALLOW GROUNDWATER QUALITY**

The surficial sand deposits underlying the majority of the LSA are susceptible to potential groundwater contamination should a spill, leak or seepage occur directly to the ground surface. However, containment measures for process and storage areas will be a fundamental part of the design that will limit the potential effects on the shallow groundwater quality. Shallow groundwater contamination outside the LSA is considered unlikely given the planned mitigation measures and spill-response procedures for the Project.

**GROUNDWATER QUALITY**

Given the combined thickness of the clay and clay till unit and the low vertical hydraulic conductivity, these units provide an effective barrier that would hinder downward migration of contaminants to the Beverly Channel aquifer.

**EFFECTS ON WELL USERS**

If a spill, leak or seepage reaches the ground or subsurface, measures will be taken to recover the spilled product and delineate its effects. As well, a program will be implemented to remediate the soil and groundwater to acceptable levels. If a spill or leak occurs outside protected process areas, the relatively slow groundwater flow velocity will provide sufficient time to detect and remediate the affected groundwater before it reaches the site boundaries and offsite users.

The Project’s planned engineered mitigation and operational measures are considered adequate to protect groundwater from adverse effects. During decommissioning, mitigation measures are also considered to provide adequate protection to groundwater and no effects are expected.
**CUMULATIVE EFFECTS**

**WATER LEVEL**

There is no information about planned dewatering activities at the neighbouring facilities, but it is unlikely that dewatering in the LSA and at one or more of the neighbouring facility would occur simultaneously. In addition, there is a buffer zone of 750 m to the north and 1,000 m to the east of the process area. To the south of the process area, surficial sands are not present. Therefore, no cumulative effects are expected.

**GROUNDWATER QUALITY**

Based on the planned design engineering, mitigation and operations measures, and Sasol’s spill response plan, it is unlikely that spills, leaks or seepage from ponds in the LSA would contribute to cumulative contamination of shallow groundwater. A groundwater monitoring program will be implemented in the LSA to provide early warning of potential effects on the groundwater and to allow immediate assessment, control and mitigation of groundwater effects.

**ASSESSMENT CONCLUSIONS**

The groundwater assessment examined the potential effects of dewatering on the water table and water well users, and the potential effects of surface spills, leaks or seepage from ponds on groundwater quality. Based on Project design, operation and mitigation measures, no cumulative effects are expected.

### 6.5 Hydrology

**INTRODUCTION**

The Project site is located in the North Saskatchewan River (NSR) tablelands on the south side of the river, approximately 20 km downstream from Edmonton, and 4 km northeast from Fort Saskatchewan. The northwest corner of the Project disturbance area (PDA) is located approximately 1.3 km from the NSR. It is centered on a local topographic high, where natural swales and constructed ditches convey runoff from eastern areas to Astotin Creek; from western areas to the NSR by a small, unnamed watercourse; and from northern areas to the NSR by roadside ditches.

The local study area (LSA) includes land areas in the PDA, downstream and upstream watercourses that convey natural site drainage to Astotin Creek and Beaverhill Creek and local watercourses west and northwest of the PDA that drain to the NSR. The regional study area (RSA) encompasses the LSA and a reach of the NSR within which cumulative effects of the Project are assessed. The downstream limit of the RSA is Pakan Bridge, which is consistent with the aquatic resources and surface water quality disciplines. The upstream limit of the RSA is the Town of Devon, which is approximately the existing limit of urban development upstream of Edmonton.
**KEY ISSUES**

For key potential issues related to hydrology, see Table 6-2.

**Table 6-2 Key Issues for Hydrology**

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Effects on surface and near-surface water resources, including changes in surface and near-surface flow conditions, potential flow impediment, changes in open-water surface areas and local erosion</td>
<td>Section 3.3.2 [A] and Section 3.2.2 [B]</td>
<td>Closed-circuiting and storm water management at the PDA could affect runoff conditions to local receiving streams, including timing, rate and quantity of flow, with associated effects on water levels and erosion.</td>
</tr>
<tr>
<td></td>
<td>Effects on navigable waterways</td>
<td>Section 2.7.2 [A]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Effects on sedimentation in receiving waters</td>
<td>Section 3.3.2 [C]</td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Effects on surface and near-surface water resources, including changes in surface and near-surface flow conditions, potential flow impediment, changes in open-water surface areas and local erosion</td>
<td>Section 3.3.2 [A] and Section 3.3.2 [B]</td>
<td>Closed-circuiting and storm water management at PDA could affect runoff conditions to local receiving streams, including timing, rate and quantity of flow, with associated effects on water levels and erosion.</td>
</tr>
<tr>
<td></td>
<td>Effects on navigable waterways</td>
<td>Section 3.3.2 [E]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Effects on other water users</td>
<td>Section 3.3.2 [D]</td>
<td>Net withdrawals of water could affect flows and water levels on the NSR.</td>
</tr>
<tr>
<td></td>
<td>Effects of low-flow conditions and IFN on water supply and water and waste water management strategies</td>
<td>Section 3.3.2 [F]</td>
<td></td>
</tr>
<tr>
<td>Decommissioning</td>
<td>Effects on surface and near-surface water resources, including changes in surface and near-surface flow conditions, potential flow impediment, changes in open-water surface areas and local erosion</td>
<td>Section 3.3.2 [A]</td>
<td>Decommissioning water supply pipeline could cause local effects in the NSR. As these effects will be similar to but reduced in magnitude relative to those anticipated for construction, this issue is not assessed further.</td>
</tr>
</tbody>
</table>

**BASELINE OVERVIEW**

The surface hydrology baseline investigation included watershed delineation to identify drainage patterns and waterbodies in the LSA, characterization of climate (precipitation) and characterization of stream flow in the LSA and the NSR, which included the RSA, relying heavily on data published by Environment Canada and Alberta Environment and Sustainable Resource Development.
LSA

Flood flows for return periods of 2, 10 and 100 years were derived for Astotin Creek. The hydrometric station on Beaverhill Creek reported low flows or discharges of zero in each of the 12 years of its period of record (Environment Canada 2012). Astotin Creek, a tributary of Beaverhill Creek, is expected to have low flow or zero discharge. Flow records from the Sturgeon and Redwater rivers fall to zero often enough that the calculated 7Q10 value is zero.

Mean annual water yields, defined as mean annual stream discharge volume divided by gross drainage area, vary from 7 mm for Beaverhill Creek to 49 mm for Flat Creek. A mean annual water yield of approximately 35 mm is expected for Astotin Creek. Surface flow patterns away from the site are strongly influenced by ditches associated with existing public roadways.

NSR

Flow in the NSR is regulated at two locations: the Brazeau Dam on the Brazeau River (since 1961) and the Bighorn Dam on the NSR (since 1972). Mean flows from November through March (winter) are substantially higher in the post-dam period, and mean flows in the adjacent months of October and April are also marginally greater. Mean flows during the open-water months of May through September are currently smaller than if the dams had not been constructed. Annual flows are only slightly affected by the dams. Calculated values of consumptive use as a percentage of 7Q10 and mean annual flow are based on the post-dam (1973-2009) 7Q10 value of 61.4 m$^3$/s and post-dam mean annual flow of 210 m$^3$/s. Existing and future licensed consumptive use in the study area are 15.90% of post-dam 7Q10 and 4.65% of post-dam mean annual flow.

There are about 140 licensed water withdrawals on the NSR between the downstream limit of the study area and the Saskatchewan border. The total licensed withdrawal is 50.2 Mm$^3$/a, and the total licensed consumptive use is 26.4 Mm$^3$/a. The total licensed consumptive use is equal to 1.36% of the post-dam 7Q10 and 0.4% of the post-dam mean annual flow.

Effects Management

Quantities of water from dewatering activities during construction are expected to be small, and they will be conveyed to the storm water management pond. Perimeter ditches will be constructed to prevent water from a small drainage area south of the site from naturally flowing into the site. The water will be directed to downstream watercourses. During construction, disturbed areas will be closed-circuited by constructing diversion berms, as they are stripped or developed to allow water to be managed and to prevent offsite water from flowing into the site.

During operations, storm water will be collected. Clean storm water will be used in the process instead of raw water and contaminated storm water will be treated in the waste-water treatment units and reused as a source of process water. River water withdrawals for process water supply will be sourced from the existing water abstraction sites.
**Effects**

Onsite storage volumes are small relative to NSR flows, and water will not be discharged to smaller tributaries. Therefore, changes in the timing of flow will be negligible. The assessment, therefore, focuses on changes in volume and rate of flow.

The PDA has a drainage area of 5.25 km$^2$, and it will be closed-circuited during construction and operations. Because the PDA is located mainly on a topographic high, site development will remove headwater areas from small tributaries to the NSR and Astotin Creek. Drainage from a small area south of the PDA, which would normally drain through the PDA to downstream watercourses, will be redirected by perimeter ditch to an Astotin Creek tributary.

The effect on hydrologic isolation was estimated: approximately 2.3 km$^2$ of the Astotin Creek watershed is occupied by the PDA. This is 1.1% of the gross drainage area of Astotin Creek and 0.04% of the gross drainage area of Beaverhill Creek. Changes in Astotin Creek will be less than 0.9% and changes in Beaverhill Creek will be 0.4% or less.

The Project will apply for a license to divert a design water withdrawal requirement from the NSR of 938 m$^3$/h. Change in 7Q10 will be 0.4% and change in mean annual flow will be 0.1% due to the Project. Changes will be immeasurable however there is the potential for cumulative effects from all licensed withdrawals.

**Cumulative Effects**

When considering the planned development case, the drainage area that is closed-circuited causing hydrologic isolation in the Astotin Creek watershed will be 14.88 km$^2$, which is 7.15% of the gross drainage area of Astotin Creek. The drainage area that is closed-circuited in the Beaverhill Creek watershed is 17.02 km$^2$, which is 0.58% of the gross drainage area of Beaverhill Creek. For the planned development case, changes in flow into Astotin Creek will be approximately 6.6% and changes in flow into Beaverhill Creek will be approximately 2.2%. These changes will not be measureable, and changes in water level of this magnitude will similarly not be measureable.

Licensed net water withdrawal from the NSR under the planned development case will be 202,300 dam$^3$/a, equivalent to a mean annual withdrawal of 6.48 m$^3$/s. This amount will reduce mean annual flow by 3.34% and the 7Q10 by 10.55%.

**Assessment Conclusions**

Closed-circuiting and storm water management at the PDA have the potential to affect runoff conditions to local receiving streams. Only one drainage area south of the PDA will require re-directing to allow for construction and operation. The changes in flow due to hydrologic isolation will be immeasurable for Astotin Creek and Beaverhill Creek and the water withdrawal requirements from the NSR for the Project will have an effect of less than one percent on low flows and mean annual flows. By using a third-party water intake facility, the Project will eliminate the potential to affect navigability on the NSR and effects on regional hydrology.
6.6 Surface Water Quality

INTRODUCTION

The Project will be relying on the North Saskatchewan River as the source for process water supply. Although the Project will not be releasing any effluent back into the NSR, there are many other industrial and municipal sources withdrawing and discharging to the NSR. These include three municipal wastewater treatment plants (WWTPs) located downstream on the NSR between the Town of Devon and the Town of Pakan, several storm sewer and combined sewer outfalls within Edmonton city limits and several industrial developments that discharge to the NSR downstream of Edmonton.

These combined discharges have resulted in elevated total suspended solids (TSS), nutrient concentrations, carbonaceous biochemical oxygen demand (CBOD), coliform bacteria and reduced dissolved oxygen (DO) levels in the river. Dissolved oxygen regimes are considered the most limiting adverse effect of nutrient and CBOD loading on aquatic life in the NSR.

The local study area (LSA) includes the lower section of the Astotin Creek drainage basin, which extends from the PDA to the confluence of Astotin Creek and the NSR. The regional study area (RSA) includes the NSR from upstream of the Project at Fort Saskatchewan to downstream at Pakan, and also includes the surface water quality LSA. Both the LSA and RSA for surface water quality are identical to those defined for the hydrology and aquatic resources assessments. In addition to the surface water quality RSA, the air quality RSA was used to assess acidification and eutrophication of regional lakes.

KEY ISSUES

For key potential issues related to surface water quality, see Table 6-3.

Table 6-3 Key Issues for Surface Water Quality

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
</table>
| Construction and decommissioning | Increased sediment release | Section 3.4.2 [B] (e) | • Land clearing, road construction and plant construction could increase sediment in runoff to local waterbodies and watercourses.  
• During construction, storm water ponds will be used for water collection and storage. See Volume 1, Section 5.6 for the Surface Water Management Plan.  
• Disturbances associated with decommissioning are expected to be similar to those associated with land clearing, road construction and plant construction. |
## Table 6-3  Key Issues for Surface Water Quality (cont’d)

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
</table>
| Operations    | Changes in surface water quality from dewatering | Section 3.4.2 [B] (e) | • Lowering of shallow groundwater tables during dewatering could change the water quality of local waterbodies.  
• Release of dewatering water could lead to changes in the water quality of local waterbodies and watercourses.  
• Dewatering water will be collected in temporary ponds and tested for compliance with Environmental Protection and Enhancement Act (EPEA) approval requirements before it is discharged. See Volume 1, Section 5.6 for Surface Water Management Plan. |
|               | Changes in quality of runoff and sedimentation | Section 3.4.2 [B] (e) | • During operations, the quality of runoff from the PDA can change, which can result in water quality changes associated with increased suspended solids. |
|               | Changes in surface water quality from release of treated process water | Section 3.4.2 [B] | • Process effluent will be injected into a disposal well. Because effluent will not be discharged to surface water bodies, there is no potential for changes in surface water quality associated with effluent. Consequently, it was not included in the assessment. See Volume 1, Section 5.6 for the Surface Water Management Plan. |
|               | Increased acidification of lakes and streams from air emissions | Section 3.4.2 [B] (d) | • Increased acidifying air emissions from the Project could result in acidification of regional lakes and streams and result in toxic effects on fish and other aquatic life. Increased deposition could also contribute to episodic acidification in streams.  
• Acidifying emissions contain nitrogen compounds that could contribute to eutrophication of lakes. |
|               | Changes in quality of runoff and sedimentation | Section 3.4.2 [B] (e) | • The PDA will be a closed-circuit system during operations with storm water used for process water. Because no water will be discharged to the environment during operations, runoff and sedimentation during operations were not included in the assessment. See Volume 1, Section 5.6 for the Surface Water Management Plan. |
Table 6-3  Key Issues for Surface Water Quality (cont’d)

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations (cont’d)</td>
<td>Changes in surface water quality from spills</td>
<td>Section 3.4.2 [B]</td>
<td>• Spills have potential to cause contamination of ground and surface water.</td>
</tr>
<tr>
<td></td>
<td>Changes in surface water quality from release of treated domestic wastewater</td>
<td>Section 3.4.2 [B]</td>
<td>• Sanitary sewage will be disposed offsite through the Rural Municipality of Strathcona.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Sanitary sewage will not be released to surface water; therefore, there is no potential for changes in surface water quality associated with domestic wastewater and it was not included in the assessment.</td>
</tr>
<tr>
<td></td>
<td>Changes in surface water quality due to water withdrawals from the NSR</td>
<td>Section 3.4.2 [B]</td>
<td>• The Project requires water withdrawals at a rate of 938 m3/h from the NSR using third-party pump infrastructure. Water withdrawals can affect downstream water quality by reducing assimilative capacity.</td>
</tr>
</tbody>
</table>

**BASELINE OVERVIEW**

**LSA**

Water in Astotin Creek was characterized as very hard (i.e., >180 mg/L CaCO₃) and slightly saline, with high levels of total dissolved solids (TDS) and conductivity. Historical data (2006 and 2007) and current data (2012) showed concentrations of total nitrogen (TN), phosphorus and metal to be above chronic aquatic life guidelines. Chloride and total phenolic concentration were also above guidelines in 2007.

**RSA**

In the RSA, the NSR was usually well oxygenated and slightly alkaline, with pH values often above the chronic aquatic life guideline range. The NSR has nutrient concentrations above chronic aquatic life guidelines, which is typical of surface water quality downstream of municipal wastewater treatment outfalls. Water quality in the NSR varies seasonally and longitudinally. Concentrations of TSS and associated parameters (nutrients and metals) as well as levels of TDS were elevated during periods of high flow and were lower during periods of low flow.

Acid sensitivity of regional lakes was characterized based on data available for 20 lakes located in a 100 x 100 km area centered on the PDA. Field-measured water quality parameters were generally within ranges typical of surface waters in central Alberta. As with the NSR, pH values of lakes in the RSA were often above the chronic aquatic life guideline range, indicating that the lakes are highly buffered and not sensitive to acidification. These lakes had moderate to high alkalinity values and concentrations of major ions, dissolved organic carbon (DOC) and nutrients. Based on alkalinity values, these lakes can be classified as least sensitive to acid deposition.
**EFFECTS MANAGEMENT**

Sediment and erosion control measures will be implemented to decrease the risk of sediment release into surface water during construction and decommissioning activities. Dewatering water will be collected in the storm water ponds and tested for compliance before discharging to surface waterbodies. During operations, no water will be discharged to the environment due to the closed-circuiting of the PDA. Measures to reduce changes in surface water quality will include collecting, treating and reusing site storm water as makeup process water, designing the storm water system to accommodate a 24 hour, 1:100 year rainfall event, injecting process effluent into an onsite disposal well, trucking sanitary sewage offsite for treatment, using third-party water withdrawal infrastructure and developing a spill contingency plan.

**EFFECTS**

The use of control measures during construction and operation are expected to mitigate the potential effects of runoff and sediment release to local waterbodies. A sediment and erosion control plan will be developed therefore indirect effects of increased sedimentation in Astotin Creek to the NSR are not anticipated. Groundwater from dewatering activities is expected to be small and will be conveyed to the stormwater management pond where it will be tested for compliance with EPEA approval requirements before release; no effect on water quality in Astotin Creek is expected. Management practices that will reduce or prevent the volume and likelihood of spills reaching surface water will be implemented. Because Project-related water withdrawals are small scale compared with the total river flow, residual effects on assimilative capacity and surface water quality are not anticipated.

**CUMULATIVE EFFECTS**

Lakes in the air quality RSA have high pH and alkalinity values and are considered least at risk for acidification according to the classification systems presented by Saffran and Trew (1996). Lake PAI calculated for the PDC is below calculated critical loads. Therefore, Project emissions of sulphur and nitrogen for the PDC would be expected to have negligible effects on water quality and aquatic life in the 20 lakes examined in this assessment. Similarly, in the air quality RSA, streams were found to be unaffected by episodic stream acidification (i.e., they were not sensitive to this acidification).

Predicted eutrophication effects as a result of air emissions from the Project were very small (i.e., generally less than 2%). Of the 20 lakes studied, no noticeable eutrophication effects are expected for the PDC compared with the base case. Nitrogen deposition was predicted to increase TN concentrations in the 20 lakes of this assessment by less than 6.4% over the base case.

**ASSESSMENT CONCLUSIONS**

Only during construction and decommissioning will any water be released from the PDA through dewatering activities. Before release, dewatering water will be collected and tested to be compliant with EPEA approval limits. During operations, no water will be discharged to the environment because the PDA will be a closed-circuiting system. Air emissions from the Project are expected to have negligible effects on lake and stream acidification. Similarly, predicted air emission effects from the Project on lake eutrophication were small (generally less than 2%).
6.7 Aquatics

**INTRODUCTION**

The Project disturbance area (PDA) is in the Beaverhill sub-basin of the North Saskatchewan River (NSR) watershed tablelands on the south side of the river, about 20 km downstream of Edmonton. The northwest corner of the PDA is 1.3 km from the North Saskatchewan River (NSR) and the eastern edge of the PDA is about 800 m from Astatin Creek. There are no watercourses in the PDA and natural watercourses and constructed ditches convey runoff from eastern areas of the PDA to Astatin Creek and from western areas to the NSR.

Sasol plans to obtain water required for the Project from the North Saskatchewan River through a third-party water intake structure. No effluent outfall is planned for the Project and process effluent will be injected into a deep disposal well.

The local study area (LSA) for aquatic resources was selected to include areas where surface water and aquatic habitat might be directly affected by the Project. The LSA includes the lower section of the Astatin Creek drainage basin, which extends from the PDA to the confluence of Astatin and Beaverhill creeks with the NSR. The regional study area (RSA) for aquatic resources was selected to include areas where surface water and aquatic habitat might be directly or indirectly affected by the Project. The RSA includes the NSR from Fort Saskatchewan, upstream of the Project, to the Pakan Bridge downstream of the Project, and includes the LSA.

**KEY ISSUES**

For key potential issues related to aquatics, see Table 6-4.

### Table 6-4 Key Issues for Aquatics

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Changes in aquatic habitat in Astatin Creek</td>
<td>Section 3.5.2 [A]</td>
<td>Project construction will alter the drainage area.</td>
</tr>
<tr>
<td></td>
<td>Alteration or loss of fish and aquatic and riparian habitat in the NSR</td>
<td>Section 3.5.2 [A]</td>
<td>No water intake is being constructed for the Project, so there will be no disturbance to the bed and banks of the NSR. Therefore, this key issue was not assessed.</td>
</tr>
<tr>
<td>Operations</td>
<td>Increased fish mortality in the NSR caused by fish entrainment</td>
<td>Section 3.5.2 [B]</td>
<td>No water intake is being constructed for the Project, so there will be no disturbance to the bed and banks of the NSR. Therefore, this key issue was not assessed.</td>
</tr>
<tr>
<td></td>
<td>Changes in tributary water levels and flow</td>
<td>Section 3.5.2 [A]</td>
<td>Alteration of the flow volume could affect fish habitat in tributaries to the NSR.</td>
</tr>
</tbody>
</table>
### Table 6-4  Key Issues for Aquatics (cont’d)

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations (cont’d)</td>
<td>Increase in water demands on the NSR, leading to changes in flow and effects on aquatic resources and habitat</td>
<td>Section 3.5.2 [D]</td>
<td>A reduction in flow has the potential to reduce aquatic habitat downstream of the water intake location. Withdrawals for the Project’s water supply will increase the total withdrawal from all developments on the NSR.</td>
</tr>
<tr>
<td></td>
<td>Key Issue</td>
<td>TOR</td>
<td>Relevance to the Project</td>
</tr>
<tr>
<td></td>
<td>Effects of effluent on NSR fish and fish habitat</td>
<td>Section 3.5.2 <a href="a">A</a></td>
<td>Process effluent will be injected into a deep disposal well, not discharged to the NSR or other surface waters. There is no potential for changes in surface water quality associated with effluent; therefore, it was not included in the assessment.</td>
</tr>
<tr>
<td></td>
<td>Effects on fish and fish health</td>
<td>Section 3.5.2 <a href="a">A</a></td>
<td>Process effluent will be injected into a disposal well, not discharged to the NSR or other surface waters. There is no potential for changes in surface water quality associated with effluent; therefore, it was not included in the assessment.</td>
</tr>
<tr>
<td></td>
<td>Effects of acidification and other air emissions on aquatic resources</td>
<td>Sections 3.1.2 <a href="f">A</a> and 3.5.2 <a href="a">A</a></td>
<td>Acidifying air emissions from the Project might alter the pH balance of waterbodies in the LSA and RSA (see Section 8).</td>
</tr>
<tr>
<td></td>
<td>Effects on biodiversity and habitat fragmentation</td>
<td>Section 3.5.2 <a href="d">A</a></td>
<td>Changes in flow volume might alter existing species richness or species composition because of habitat effects.</td>
</tr>
<tr>
<td></td>
<td>Effects on resource use</td>
<td>Section 3.5.2 <a href="a">A</a> and (c)</td>
<td>Process effluent will be injected into a deep disposal well—not discharged to the NSR or other surface waters. Because there is no potential for changes in surface water quality associated with effluent, it was not included in the assessment. An increase in fishing pressure because of the Project could decrease sportfish abundance.</td>
</tr>
</tbody>
</table>

**Baseline Overview**

A review was conducted of historical fisheries data and field assessments on the NSR and Astotin Creek to evaluate baseline conditions for fish habitat and fish community structure. Site inspections of Astotin Creek during May 2012 qualitatively assessed whether habitat conditions had changed from previous assessments.

**Astotin Creek**

Astotin Creek flows northwest from Astotin Lake until it reaches Highway 15, at which point it begins to flow northeast, 800 m east of the Project site, through agricultural and industrial lands until joining with Beaverhill Creek about 6 km upstream of the NSR.

The channel is characterized by numerous beaver impoundments dominated by fine substrate (organics and silt) bed and banks. Overall, habitat within the watercourse was rated as poor to nil for sportfish or
large-bodied coarse fish, with habitat use likely restricted to species able to tolerate low DO levels (NLP 2006; NAOSC 2007). Field surveys conducted between 1997 and 2010 in Astotin Creek show the presence of brook stickleback (Culaea inconstans), fathead minnow (Pimephales promelas), and white sucker (Catostomus commersoni) (NLP 2006; NAOSC 2007). Given the beaver impoundments in Astotin Creek and lack of migration and overwintering potential, other fish species are not expected to establish resident populations in Astotin Creek.

NSR

Within the LSA, the NSR exhibits primarily deep-run habitat (R1) with isolated riffle sections and occasional shallow runs. The flow of the NSR is regulated by upstream hydroelectric generating facilities. Load peaking from energy demands mean the river experiences daily water level fluctuations. Daily river fluctuations likely affect the use, productivity and habitat values of nearshore and shallow habitats.

The NSR provides some rearing and summer foraging habitat to all recorded species and is likely a migration corridor for seasonal spawning species (Allan 1984; FHELP 2006; NLP 2006; NWU 2006; NAOSC 2007; TOTAL 2007; SRD 2008). Minnow species are abundant in the LSA. Longnose dace (Rhinichthys cataractae) and white sucker (Catostomus commersoni) are the most abundant coarse fish, and goldeye (Hiodon alosoides) and walleye are the most abundant sportfish species (FHELP 2006, NLP 2006, NWU 2006, NAOSC 2007, TOTAL 2007, ESRD 2012b). Invertebrate communities have variable abundance and species composition in the LSA of the NSR (FHELP 2006; NLP 2006; NWU 2006; NAOSC 2007; TOTAL 2007).

Species of concern in the RSA include lake sturgeon, northern redbelly dace (Phoxinus eos), pearl dace (Margariscus margarita), quillback (Carpiodes cyprinus), river shiner (Notropis blennius), sauger, and silver redhorse (Moxostoma anisurum). No fish species currently listed under the Species at Risk Act (SARA) occur in the RSA.

No flowing watercourses were identified in the PDA and no effluent will be discharged into the NSR therefore no fish habitat will be directly affected. Any water pumped from the North Saskatchewan River through the third-party water intake structure will adhere to the Freshwater Intake End-of Pipe Fish Screen Guideline (DFO 1995).

A Surface Water Management Plan (SWMP) (see Volume 1, Section 5.6) will be implemented for construction and operation phases. During construction, mitigations will be in place to control sediment from the PDA that has the greatest potential to affect aquatic resources in the Astotin Creek drainage.

**Effects**

Development of the PDA will increase the amount of impermeable surface area because of infrastructure. The surface water drainage system that will collect storm water to be treated and used in the GTL facility, will also reduce the drainage area of Astotin Creek. The reduction in flow to Astotin Creek because of the Project alone will be less than 0.9% of the mean annual flow (0.231 m³/s). These changes in flow will be negligible. Changes in water level in Astotin Creek will also be negligible.
Seasonally dry channel conditions in Astotin Creek are related to beaver impoundments and low seasonal flows from surrounding drainages. Given that most fish habitat is in beaver-impounded areas where water is stored, Astotin Creek is somewhat buffered from low flows. Changes in aquatic habitat in the local drainages will similarly be negligible.

Species diversity for fish is not expected to be affected by the Project as there is no construction occurring in either the NSR or Astotin Creek, and no effluent is being released into these waterbodies. Project effects on habitat fragmentation will be negligible because the Project is not located in watercourses and will not create barriers to fish movement.

**Cumulative Effects**

The reduction of flow in the NSR, as a result of water withdrawal by the Project, is predicted to be less than 0.4% of 7Q10 and 0.1% of mean annual flow and are predicted to increase the mean annual demand from 4.37 m$^3$/s (base case) to 4.57 m$^3$/s (application case); the Project’s contributions to water withdrawals are therefore expected to have low magnitude effects with low environmental consequence.

Emission of acidifying substances from the Project is predicted to have a negligible effect on aquatic resources under the application case. Baseline conditions for lakes in the RSA had pH values above the chronic guideline range for the protection of aquatic life and streams surrounding the Project have a high capacity to buffer against changes in pH.

The application case is predicted to increase total nitrogen concentration in lakes surrounding the Project site by less than 3% relative to the base case. The increase in lake productivity as a result of nitrogen deposition was predicted to be negligible; therefore, the effect on aquatic resources is predicted to be negligible.

Because of the proximity of the Project to the NSR, it is anticipated that fishing pressure from workers and their families will increase on the river and surrounding tributaries and lakes. An increase in fishing pressure can lead to a reduction in the abundance of sportfish in surrounding waterbodies.

Assuming the additional workforce moving into the region as a result of Project construction primarily uses the NSR for recreational fishing, the effects are expected to be low in magnitude, but short in duration. The additional fisheries use related to the operation of the Project is expected to be small relative to existing estimates in the Parkland Prairie Zone 2 (Zwickel 2012); therefore, a low increase in angling pressure with low environmental consequence is expected during operations. The Project is also not expected to increase access to fisheries resources.

**Assessment Conclusions**

Although the Project will alter the drainage area for Astotin Creek, there are no watercourses within the PDA therefore direct effects on aquatic habitat will be negligible. Water required for the Project will be taken from the NSR through a third-party water intake structure and there will be no effluent outfall back into the NSR therefore there is no potential for change in water quality and consequently aquatic habitat. Sasol will have a Surface Water Management Plan in place to mitigate the dispersal of sediment into nearby drainage areas during construction.
6.8 Terrain and Soils

**INTRODUCTION**

The Project is located in Soil Correlation Area (SCA) 10 (Alberta Soil Information Centre 2001). SCA 10 is described as the Thick Black/Dark Grey-Grey Soil Zone of Central Alberta (Brierley et al. 2006), which is in the Central Parkland Natural Subregion of the Parkland Natural Region (NRC 2006).

The local study area (LSA) occupies the interface between the Redwater Plain to the northwest and Lake Edmonton Plain to the southeast. The Redwater Plain is characterized by undulating to hummocky glaciofluvial deposits composed of gravelly sand; the Lake Edmonton Plain typically comprises glaciolacustrine deposits of bedded clay and silt (Shetsen 1990). The Agricultural Region of Alberta Soil Inventory Database (AGRASID 3.0) indicates that the topography is undulating, with slope values typically 4% or less (Alberta Soil Information Centre 2001).

The RSA is 100 km x 100 km (total area of approximately 1 million ha). The RSA encompasses the predicted extent of the potential acid input (PAI) monitoring load isopleth (0.17 keq H+/ha/a) for sensitive soils for the planned development case (PDC) (CASA 1999; AENV 2008; CEMA 2004).

**KEY ISSUES**

For key potential issues related to terrain and soils, see Table 6-5.

**Table 6-5 Key Issues for Terrain and Soils**

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Changes in soil quality from site preparation activities</td>
<td>Section 3.9.2.A and Section 3.9.2.B</td>
<td>Site preparation will involve removing and stockpiling topsoil from the disturbed portions of the LSA for future use in reclamation. These activities could alter the morphological and physical properties of salvaged soils in the LSA and could result in compaction, admixing or soil contamination, which could lead to soil deterioration. Potential for topsoil stripping and stockpiling activities to alter the suitability of salvaged soils and the associated land capability at decommissioning was assessed.</td>
</tr>
<tr>
<td></td>
<td>Changes in soil quantity from site preparation activities</td>
<td>Section 3.9.2.A and Section 3.9.2.B</td>
<td>Construction activities could increase the potential for wind and water erosion, and topsoil loss during salvage. Potential for topsoil stripping and stockpiling activities to alter soil quantities and land capability at decommissioning was assessed.</td>
</tr>
<tr>
<td></td>
<td>Changes in soil moisture and drainage patterns from site preparation activities</td>
<td>Section 3.9.2.A</td>
<td>Site preparation will involve dewatering of shallow aquifers to facilitate foundation preparation. Dewatering could temporarily affect soil moisture regimes and soil suitability in and immediately next to the LSA. Potential for dewatering to alter soil suitability and land capability was assessed.</td>
</tr>
</tbody>
</table>
Table 6-5  Key Issues for Terrain and Soils (cont’d)

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>Changes in soil chemical properties from acidifying emissions produced during operations</td>
<td>Section 3.9.2.B</td>
<td>The Project will increase levels of acidifying emissions in the airshed, which might alter chemical properties of soil, leading to soil acidification. Potential for acidifying emissions to alter soil suitability and land capability was assessed.</td>
</tr>
<tr>
<td></td>
<td>Potential changes in soil chemical properties due to contamination from spills during operations</td>
<td>Section 3.9.2.B</td>
<td>Spills could occur during operations, which might alter the chemical properties of soils resulting in changes to land capability. The potential for spills and their effects on land capability was assessed.</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>Changes in soil quality and quantity from site reclamation activities</td>
<td>Section 3.9.2.A and Section 3.9.2.B</td>
<td>Replacement and reconstruction of salvaged soils during reclamation activities might lead to changes in the physical or chemical conditions of salvaged soils. Potential for replacement and reconstruction activities to alter soil suitability and land capability at decommissioning was assessed.</td>
</tr>
</tbody>
</table>

**Baseline Overview**

The baseline conditions of terrain and soils are summarized as follows:

- The LSA is dominated by very coarse to coarse textured eolian and glaciofluvial parent materials along with glaciolacustrine sediments in the southern and eastern regions. Pockets of organic materials are present. Topography is generally undulating; however, there are low-relief eolian dunes in the northwestern part of the LSA.

- The LSA has soils of Chernozemic, Gleysolic and Organic orders. About three quarters of the LSA is covered by map units dominated by Black and Dark Grey Chernozems. Gleysols and Organic soils occur in isolated wetland depressions.

- Soils in the LSA are rated poor to fair for reclamation suitability. Poor suitability ratings are mainly related to the very coarse-textured nature of the soils, or to pH.

- Soils in the LSA range in agricultural land suitability from slightly limited (Class 2) to unsuitable (Class 7) for small crop production. Excess water and coarse texture, along with temperature regime, are the main limitations of land suitability for agricultural crop production in the LSA.

- Overall post-reclamation agricultural land suitability is expected to improve as a result of combining topsoil materials.

- Soils show significant variation in stripping depth and material type in the LSA. This results from differences in parent material, peat deposits, site history and slope position.

- Soils mapped in the LSA typically have very low water erosion ratings at the slope values found in the LSA. The risk of wind erosion is generally high on a local scale because of the coarse textures of topsoil material.
• Compaction and rutting risk is generally low, except for wetter map units, which include Gleysols and Organics.

• Acid sensitivity for soil series falling within the predicted PAI monitoring load isopleth for sensitive soils is typically low; however, several series are rated as medium and a single unit is rated as high.

**Effects Management**

Design features, construction procedures and industry best practices will be used to minimize long-term effects of the Project on terrain and soil resources. When the Project is decommissioned, the goal is to return the site to equivalent land capability.

**Soil Salvage and Storage**

All topsoil materials in the LSA with value for future reclamation will be stripped and stockpiled for future use. A soil specialist will supervise soil salvage activities and provide direction for site-specific stripping depths and procedures. Salvage activities will be carried out during non-frozen conditions and will be restricted during periods when sensitive soils are at higher risk of compaction, rutting or erosion (i.e., spring wet period, periods of high precipitation). The addition of peat to very coarse-textured topsoil increases both organic carbon content and water-holding capacity of the soils, which should result in higher agricultural suitability ratings.

Subsoil will not be salvaged from the LSA because of low subsoil reclamation suitability values and limited space within the Project area for stockpiling material.

Sasol has not determined a final topsoil storage site in the LSA, but has chosen a general area for placement. Guidelines will be followed to minimize effects on stored materials.

**Erosion Control**

During construction, erosion prevention measures will be determined after considering local site conditions. Measures to reduce soil erosion by wind and water typically include: spraying water to reduce soil erodibility, applying tackifying agents, applying coarse woody debris or slash, installing erosion-control matting, crimping risk areas with certified weed-free straw and installing silt fences or containment berms around the base of the stockpile. Salvaged topsoil will be seeded as soon as possible to ensure long-term stability of the pile and to reduce losses in quantity and quality.

During operation, the Project will contribute acidifying emissions, potentially altering soil chemical properties in the airshed. Several design features will reduce acidifying emissions.

Although the LSA is zoned for heavy industrial development, the conservation and reclamation plan provides a conceptual closure plan for the re-establishment of equivalent land capability following decommissioning.
**EFFECTS**

Project effects on soils arising from direct physical disturbance and dewatering activities will not reduce land capability or associated land use options after decommissioning, relative to pre-disturbance conditions. Therefore, in the long term, the Project is not contributing to cumulative losses in land capability (see Table 6-6).

### Table 6-6  Project Residual Effects on Soils

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Issue or Measurable Parameter</th>
<th>Magnitude/Extent</th>
<th>Duration</th>
<th>Seasonality</th>
<th>Frequency</th>
<th>Reversibility</th>
<th>Environmental Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Changes in soil quality from site preparation</td>
<td>Low</td>
<td>Long term</td>
<td>Year-round</td>
<td>Once</td>
<td>Reversible</td>
<td>Low</td>
</tr>
<tr>
<td>Operations</td>
<td>Changes in soil chemical properties from acidifying emissions and spills (see Section 10.9.1)</td>
<td>Low</td>
<td>Long term</td>
<td>Year-round</td>
<td>Continuous</td>
<td>Reversible in Agricultural areas, non-reversible in non-agricultural areas</td>
<td>Low in agricultural areas, possibly moderate in non-agricultural areas</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>Changes in soil quality and quantity from site reclamation</td>
<td>Low</td>
<td>Long term</td>
<td>Year-round</td>
<td>Once</td>
<td>Reversible</td>
<td>Low</td>
</tr>
</tbody>
</table>

**CUMULATIVE EFFECTS**

Project effects on terrain and soils are generally confined to areas where soil is disturbed. Only acid deposition is considered to have potential regional effects. The GTL facility will produce emissions that will contribute to regional acid deposition. Therefore, the effects on soils from the cumulative acid deposition of all existing, approved and planned developments are assessed.

Given the buffering capacity of agricultural soils and the typical fertilization practices on these soils, it is unlikely that Project contributions to cumulative acidifying emissions will change agricultural suitability. The effect on agricultural land is low in magnitude, long-term, reversible and of low environmental consequence.

The potential effects of current and future rates of acidification on the properties of mineral soils currently not used for agricultural production, and on peatlands, are poorly understood. Monitoring initiatives in the region to assess soil properties under critical and non-critical loadings are required to support effects assessments and management plans. Acidification effects are expected to be low in magnitude, long-term, nonreversible and of low environmental consequence. It is not expected that these soils will decline in terms of agricultural suitability or reclamation suitability.
**ASSESSMENT CONCLUSIONS**

The focus of the terrain and soils assessment for the LSA focused on construction effects on soil quality and quantity that might lead to changes in soil suitability for native vegetation, reclamation, agriculture and changes in soil moisture regimes near the LSA. In the RSA, the focus was on assessing acidification of soils arising from the Project’s contributions to acidifying air emissions during operations. The Project is not predicted to contribute to cumulative losses in land capability. It is unlikely that Project contributions to cumulative acidifying emissions will change agricultural suitability and it is not expected that these soils will decline in terms of agricultural suitability or reclamation suitability.

**6.9 Vegetation**

**INTRODUCTION**

The Project is in the Dry Mixedwood Natural Subregion of the Boreal Forest Natural Region and the Central Parkland Natural Subregion of the Parkland Natural Region of Alberta (Alberta Tourism Parks and Recreation 2012), which is the most densely-populated region in the province, and most of its native vegetation has been altered by human development.

The local study area (LSA) is the area where direct effects on vegetation and wetlands are anticipated, which involves the Project disturbance area (PDA). The air emissions regional study area (RSA) was defined as the furthest extent of area where measurable air emissions of the Project might directly affect vegetation and was based on the modeling domain for air dispersion modeling, equivalent to an area of approximately 100 km by 100 km centered on the PDA. The biodiversity RSA was selected because it provides a reasonable area to examine potential effects of the Project on regional biodiversity within AIH, south of the North Saskatchewan River, and within the Strathcona County.

Existing baseline survey data was obtained from Total E&P Canada Ltd. for the 2007 and 2008 field seasons (Total 2007). Additional field surveys were done in 2012.

**KEY ISSUES**

For key potential issues for Vegetation, see Table 6-7.
Table 6-7  Key Issues for Vegetation

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Potential direct effects on native community diversity and rare communities</td>
<td>Section 3.6.2 [A, B, C, D, G, H]</td>
<td>Site preparation will involve clearing existing vegetation, grading the surface and excavating. Direct effects on native vegetation communities were assessed, including changes in species diversity and rarity from clearing existing vegetation within the LSA. For an assessment of direct effects of the Project on crops, see Section 14.</td>
</tr>
<tr>
<td></td>
<td>Potential indirect effects on wetland communities and species</td>
<td>Section 3.6.2 [G]</td>
<td>Site preparation could involve changes in surface water catchments, siltation and temporary dewatering of surficial aquifers that might indirectly affect adjacent associated wetland communities. Potential effects of the Project on wetland communities beyond the LSA were assessed. For an assessment of potential water drawdown, see Section 6.</td>
</tr>
<tr>
<td></td>
<td>Fragmentation of large blocks of native vegetation and loss of landscape diversity</td>
<td>Section 3.6.2 [J]</td>
<td>Site preparation will involve clearing existing vegetation. Direct effects on habitat diversity from clearing were assessed in Section 13. Potential landscape diversity in terms of vegetation loss at the species and community levels is assessed in this section.</td>
</tr>
<tr>
<td>Construction</td>
<td>Project direct effects of weeds on native species diversity</td>
<td>Section 3.6.2 [I]</td>
<td>Exposure of soils through site preparation and movement of equipment during construction, operations and decommissioning could allow persistent weed establishment in and near disturbed areas. Potential effects of weed introduction and spread on communities and species were assessed.</td>
</tr>
<tr>
<td>Operations</td>
<td>Potential effects of air emissions on native vegetation health and diversity</td>
<td>Section 3.6.2 [C]</td>
<td>Project contributions to air emissions could affect native plant species health and diversity. Effects of Project-related air emissions on native vegetation were assessed.</td>
</tr>
<tr>
<td></td>
<td>Potential effects of air emissions on economic crops</td>
<td>-</td>
<td>Air emissions could affect health and yields on crops. Effects of Project-related air emissions on crops were assessed.</td>
</tr>
</tbody>
</table>

**Baseline Overview**

The LSA is largely perennial pasture and cultivated land and accounts for about 63%. Natural vegetated uplands comprise roughly 19%, and wetlands are nearly 15% of the LSA. Industrial land accounts for only 3% of the LSA.

The air emissions RSA is predominantly agricultural land (68%), with a mix of annual and hay crops and pasture land. Uplands account for 16%. Approximately 8% of this RSA is developed land, including roads, industrial development and urban areas. The remaining area is covered by wetlands and open water.

Agricultural land also dominates the biodiversity RSA (47%). Industrial land accounts for the next largest collective unit mapped (27% of this RSA). Together with settled land (e.g., rural residential), these
anthropogenic features account for roughly 75% of the biodiversity RSA landscape. The remaining natural area (25%) comprises uplands, wetlands, riparian areas and a small body of open water.

No old growth communities or rare ecological communities are present in the LSA.

There are no records of any species at risk (SARA) in the LSA. A search of the ACIMS database (ACIMS 2012a) in June 2012 revealed a single historic rare plant observation (ACIMS Element ID # 17324), long-leaved bluets (*Hedyotis longifolia*), in the northwest corner of the LSA. The rare plant was not observed at this location during a 2012 field visit; however, it was found approximately 130 m away on the western side of a borrow pit (plot RB1209) in the same perennial pasture as the original historic observation.

While no prohibited noxious weeds were identified in the LSA, several noxious species were identified during vegetation field surveys.

Based on known distributions and habitat characteristics, no federally-listed (SARA) species have been documented or have the potential to occur in the biodiversity RSA. Information available in the ACIMS database (ACIMS 2012a) revealed 14 previously recorded rare vascular plant species, 25 rare bryophytes and 10 rare lichens within the biodiversity RSA, including occurrences of the rare species long-leaved bluets identified in the LSA.

**EFFECTS MANAGEMENT**

Mitigation measures to further minimize Project effects on native vegetation diversity could include: installing siltation fences to prevent siltation effects on adjacent offsite wetlands, transplanting rare plants from the PDA to regionally protected areas, and implementing a weed management program. Project design features to reduce air emissions will be implemented.

**EFFECTS**

The Project will eliminate all of the native upland and wetland plant communities within the LSA; therefore, effects of the Project on community diversity will be moderate in magnitude, long-term and nonreversible. As the diversity of common and other valued communities in the biodiversity RSA will not be lost as a result of the Project, effects are considered to be of low environmental consequence.

Project effects on species diversity and rare plants are rated as locally high in magnitude, as the Project will result in a loss of one rare species (long-leaved bluets) within the LSA. Although transplanting rare species can be sometimes used as a mitigation measure to reduce effects, this measure is considered experimental. Therefore, localized effects are considered to be long-term and nonreversible and have the potential to contribute to cumulative effects.

If dewatering occurs during the spring when water levels in wetlands typically recharge, wetlands within 360 m of the LSA that are adjacent to the GTL facility might be affected. Two wetlands are in this potentially affected area outside of the LSA. One is a shrubby willow swamp wetland (0.4 ha), and one is a semi-permanent marsh (Class IV wetland; 1.9 ha). Because water levels in these wetlands are predicted to be outside the range of natural variability, residual Project effects are expected to be moderate in magnitude, short-term and reversible, particularly if drawdown occurs during the spring.
As no tracked species or communities will be affected by this temporary dewatering activity, indirect effects of the Project on wetland communities and species will have a low environmental consequence regionally. Dewatering for the Project is not expected to contribute to cumulative effects on the water table, because dewatering on adjacent sites (e.g., Shell Scotford) is unlikely to occur at the same time.

Project activities could introduce and spread weed species that might out-compete native vegetation, which would reduce species diversity but the effect is predicted to be negligible to low in magnitude, short-term and reversible and will have a low environmental consequence at the regional scale.

**Cumulative Effects**

Past and current activities and development in the region have substantially reduced and altered native vegetation. The Project will contribute to further reductions in the areal extent of native communities. However, no tracked communities will be affected by Project activities, and no loss of community diversity is anticipated at the regional level as a result of the Project.

The Project will produce NO\(_2\) and SO\(_2\) emissions that contribute to cumulative emissions in the region. Project-related emissions could affect sensitive species and the health of native vegetation, pasture lands and crops, so they were assessed at the regional level. Effects can occur directly, through fumigation (NO\(_2\) and SO\(_2\)), fertilization (nitrogen deposition) and smothering (dust). Effects can occur indirectly because of changes in soil chemistry from potential acid input (PAI) and dust.

Although NO\(_2\) emissions are predicted to affect vegetation resources, only parts of vegetation communities in the air emissions RSA are exposed to critical levels, and reduced community diversity is not expected. Therefore, the effects of the Project on cumulative NO\(_2\) emissions are expected to be of low environmental consequence. Similarly, effects from SO\(_2\) emissions are considered low in magnitude and reversible in the long term. Therefore, the effects of Project contributions to cumulative SO\(_2\) emissions are expected to be of low environmental consequence.

While one rare plant species (long-leaved bluets) will be locally affected, other occurrences of this species are known in the biodiversity RSA. As a result, rare species diversity will be regionally reduced but not lost and the cumulative effect to species diversity is considered to be of moderate environmental consequence.

The Project will result in a small, incremental increase to overall emissions effects in the air emissions RSA, but the magnitude of the effects will not change. While effects are considered long-term, they can generally be considered reversible as shown in other areas where nitrogen deposition has declined (Mitchell et al. 2004; Clark and Tilman 2008). Therefore, the effects of Project contributions to fertilization through nitrogen deposition are expected to be of low environmental consequence.

Project effects related to road dust will be localized and are, therefore, considered to be negligible and have no regional environmental consequence.

Predicted effects on crops from NO\(_2\) concentrations are considered moderate in magnitude as the area potentially affected by the Project is small, and the affected area is primarily urban. As most cultivated crops are annuals, effects are considered to be reversible and medium-term, as the Project’s contribution will extend less than one year past decommissioning. As climate effects have a much larger effect on
crop yields, the environmental consequence of NO$_2$ concentrations above critical levels is determined to be of low environmental consequence.

The annual average critical SO$_2$ deposition level for crops is 30 µg/m$^3$ (WHO 2000). Air emission modeling for the Project did not predict any areas within the air emissions RSA that exceeded the critical level for any of the assessment cases. As a result, any effects on cultivated crops from SO$_2$ emissions associated with the Project would be low and of no environmental consequence.

**ASSESSMENT CONCLUSIONS**

Development in the region has substantially reduced and altered native vegetation. The Project will contribute to further reductions however, no tracked communities will be affected by Project activities, and no loss of community diversity is anticipated at the regional level as a result of the Project. A reduction in rare plant species diversity is predicted for the RSA due to the reduction in known occurrences of long-leaved bluets. As there are other known occurrences of this species in the RSA regional species diversity will be maintained and the environmental consequence is ranked as moderate. However, due to the relatively small size of the LSA and that the majority has already been converted to perennial pasture and cultivated land, overall reduction of native vegetation in the LSA is minimal in a regional context. Although NO$_2$ emissions are predicted to affect vegetation resources, only parts of vegetation communities in the air emissions RSA are exposed to critical levels, therefore reduced community diversity is not expected.

6.10 Wildlife

**INTRODUCTION**

The Project is situated along the boundary of the Central Parkland Natural Subregion of the Parkland Natural Region and the Dry Mixedwood Natural Subregion of the Boreal Forest Natural Region (Alberta Tourism, Parks and Recreation 2012). Wildlife communities in the region include species associated with boreal forest habitat and parkland habitat as well as many known to be tolerant of human activity.

To focus the assessment, key indicators (species or species groups) were chosen to represent the environmental effects on wildlife because of their relative importance (i.e., legislatively protected) or sensitivity to Project activities. The key indicators selected are: white-tailed deer, great horned owl, least flycatcher, Sprague’s pipit and amphibians.

The 904-ha LSA consists of the Project disturbance area (PDA) and a distance 500 m from the boundary of the PDA. The 13,615-ha RSA includes lands:

- under the Strathcona County’s Municipal Development Plan (SCMDP) (Strathcona County 2012a)
- within the boundaries of the Strathcona County portion of Alberta’s Industrial Heartland Area Structure Plan (ASP) (Strathcona County 2012b)

**KEY ISSUES**

For key potential issues related to Wildlife, see Table 6-8.
Table 6-8  Key Issues for Wildlife

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction, operations, and decommissioning</td>
<td>Reduction of wildlife habitat availability and habitat quality</td>
<td>Section 3.7.2[B]</td>
<td>Site preparation will involve clearing existing vegetation, surface grading and excavation. Ongoing operations could reduce adjacent habitat quality through sensory disturbance from noise and light.</td>
</tr>
<tr>
<td>Loss of biodiversity</td>
<td></td>
<td>Section 3.8.2[B]</td>
<td>Loss of habitat availability and quality will alter the distribution and abundance of certain species in the local and regional study area. This could lead to localized reductions in biodiversity.</td>
</tr>
<tr>
<td>Increased habitat fragmentation and interference with regional wildlife movement patterns for indicator species</td>
<td></td>
<td>Section 3.7.2[B]; Section 3.8.2[B]</td>
<td>Potential barriers to wildlife movement through the area might occur because of native vegetation being removed during development, and ongoing operational activities.</td>
</tr>
</tbody>
</table>

**Baseline Overview**

Habitats influenced by anthropogenic land uses make up 66% of the LSA, while native vegetation makes up 34%. Wildlife baseline surveys (breeding bird, waterbird, amphibian, winter tracking and nocturnal owl) were conducted in the LSA in 2007, 2008 and 2012 and out of the 65 total wildlife species observed, eight are considered species of management concern federally or provincially.

Surveys were done on key indicator species. Of the 904 ha in the LSA, 190 ha are classified as mixedwood and treed or shrubby swamp habitat. These habitats are highly suitable for white-tailed deer relative to other habitat types in the LSA. Of the 904 ha of the LSA, 161 ha of mixedwood habitat is highly suitable for great horned owl. Approximately 197 ha of mixedwood and upland shrub habitat in the LSA is high suitability for least flycatcher. Sprague’s pipit was found in pasture habitat during the 2007 and 2012 breeding bird surveys in the LSA. Approximately 312 ha of pasture habitat provide moderate suitability habitat for Sprague’s pipit. Of the 904 ha in the LSA, only 44 ha of highly suitable amphibian habitat is available.

Land units altered by human activities, such as disturbed and agricultural land, occupy 75% of the total area in the RSA, with wildlife habitat consisting of native vegetation making up the remaining 25%.

The provincially significant North Saskatchewan River valley is an environmentally significant area (ESA) located 1 km northwest of the LSA. The river valley is also a key wintering area for ungulates and other mammals, contains historical peregrine falcon nest sites, and has high recreational value (Fiera Biological Consulting 2009; Infotech 1989).

The North of Bruderheim Natural Area and Northwest of Bruderheim Natural Area have been provincial natural areas since 1963 and form part of the Beaverhill Creek wildlife movement corridor (Infotech 1989) and are located approximately 8 km to the northeast of the LSA. Astotin Creek is identified as a locally significant area (Westworth and Knapik 1987). The creek supports valuable riparian habitat and may function as a wildlife movement corridor through the region.
Habitat fragmentation in the RSA is illustrated by landscape metrics such as the high number of habitat patches, small percentage of the RSA area, small mean and maximum patch size, and high edge:area ratio. There are 627 patches (4,044 ha; 25% of the RSA area) of land classified as native and 48 patches (12,257 ha; 75% of the RSA) of land classified as anthropogenic in the RSA. With an edge:area ratio for native habitat of 18.8 compared with 6.2 for anthropogenic, approximately 65% of the habitat patch will be greater than 200 m from the patch edge and can function as core habitat for a number of wildlife species.

Multiple potential wildlife movement corridors stemming from the North Saskatchewan River valley have been previously identified in the RSA but only one crosses the LSA.

**Effects Management**

The GTL facility will be built on private land currently zoned for heavy industrial development and already modified by current land uses, including agriculture and gravel extraction. There is little opportunity for Sasol to minimize the change to wildlife habitat further.

To reduce risk of mortality to wildlife, and in compliance with the applicable provisions of the *Migratory Birds Convention Act*, construction activities, particularly site clearing, will be planned to avoid the critical bird nesting periods, if possible. During operations, mitigation measures will be largely focused on reducing noise and light effects.

The conceptual Closure Plan will be implemented as part of decommissioning, which incorporates a mix of agricultural lands and native wildlife habitats, to provide equivalent land capability to current conditions.

**Effects**

Direct habitat change and loss will occur through removing and altering vegetation communities due to Project activities, such as site clearing. In the LSA, 59% of native habitat will be lost during construction. However, the small size and relative isolation of the woodland vegetation patches limit their value for many species. Due to the localized nature of clearing, measurable long-term changes in species distribution or biodiversity in the RSA are unlikely.

Sensory disturbance associated with construction will likely affect wildlife immediately adjacent to the PDA. However, the area of disturbance is relatively small and the PDA is located in a region with a number of existing disturbances and nearby sources of ambient noise. Typical noise levels in the LSA are expected to be between 40 and 50 dBA in most of the LSA with a small portion of the area experiencing sound levels up to 60 dBA but levels predicted for the Project are unlikely to affect wildlife behavior in the LSA.

Increased lighting during operations could potentially affect the distribution and behavior of wildlife, particularly nocturnal species such as bats, birds and amphibians. It is doubtful that the Project will have a measurable effect on bat distribution and abundance due to the lack of suitable roosting habitat in and around the LSA. Tadpoles experience later and lower rates of metamorphoses under constant light conditions than tadpoles under daylight and darkness conditions (Perry et al. 2008) however mitigation measures will help reduce light pollution and associated indirect effects.
For the application case, the effective habitat for white-tailed deer decreases by 183 ha, or 58%, by 130 ha (58%) for the great horned owl, by 123 ha (55%) for the least flycatcher, by 212 ha (68%) for Sprague’s pipit and by 187 ha (61%) for amphibians.

One wildlife corridor will be disrupted by the PDA and the effectiveness of other parts of the same corridor may be reduced due to sensory disturbance, although such influence would likely be restricted to 100 m or less. The remaining 300 to 400 m of upland woodland habitat corridor north of the PDA will remain available for wildlife movement. Overall, fragmentation of the RSA does not measurably increase for the application case.

The loss of wildlife habitat is localized and effects on wildlife habitat availability and habitat quality are not expected to extend outside of the LSA. The effect of the Project on wildlife habitat availability, habitat quality and biodiversity in the RSA is moderate in magnitude, long term, reversible and of low environmental consequence.

**Cumulative Effects**

Past and current activities and development in the region have resulted in substantial reduction and alteration of wildlife habitat in the RSA. The Project will contribute to further cumulative losses of habitat and carrying capacity. For the planned development case, a total of 561 ha (13.9%) of native habitats will be lost. Ultimately, the loss of native habitat may result in the RSA sustaining fewer individuals of a given species. While the total number of native vegetation patches will increase, this will result in a reduction in total native vegetation area by 391 ha. Overall contributions to regional fragmentation from the Project and other planned projects are minor due to the existing degree of fragmentation in the landscape.

**Assessment Conclusions**

The majority of the LSA has already been modified by anthropogenic land uses and is currently zoned for heavy industrial development. Currently, only portions of the LSA are considered suitable habitat for the key indicator species chosen. Although direct habitat change and loss will occur in the LSA, fragmentation is not expected to measurably increase in the RSA. Only one habitat corridor crosses the LSA and it is expected that the portion of the corridor outside the LSA will still be suitable for wildlife movement. Measurable long-term changes in species distribution or biodiversity in the RSA are unlikely. Upon decommissioning, the conceptual Closure Plan will be implemented to provide equivalent land capability to current conditions.

**6.11 Human Health**

The human health risk assessment (HHRA) examined both acute (short-term) and chronic (long-term) health risks associated with the Project in combination with existing and approved developments, as well as with planned future developments for the region. Health risks were evaluated in the HHRA by comparing predicted inhalation and multiple pathway exposures with health-based exposure limits considered protective even of sensitive sub-groups of the population. The approach used for the HHRA has been accepted in the past by provincial regulatory agencies such as Alberta Health, Alberta
Environment and Sustainable Resource Development (ESRD), and the Energy Resources Conservation Board (ERCB).

The Project alone, and in combination with other developments, is not expected to result in adverse human health effects. The changes between the base case and application case health risks are generally small, suggesting that the Project is not expected to contribute significantly to local or regional health risks. Similarly, the changes in health risks from the base case to Planned Development Case (PDC) are generally small.

Recognizing the influence of duration and pathway of exposure on toxicity, health risks were segregated into:

- acute inhalation
- chronic inhalation
- chronic multiple routes of exposure (or multi pathway)

Acute inhalation health risks, expressed as Risk Quotients (RQ values), were evaluated by comparing peak predicted short-term air concentrations for each of the assessment cases (i.e., base case, application case and PDC) with health-based exposure limits. With the exceptions of NO₂, SO₂, cadmium and nickel, predicted acute RQ values did not exceed 1.0. This demonstrates that, in most cases, predicted short-term air concentrations were less than their health-based exposure limits, and adverse health effects are therefore not expected to occur. When considering chemical mixtures, RQ values greater than 1.0 were predicted for the combined nasal irritants, respiratory irritants and immunotoxicants.

The interpretation of the exceedances considered the following:

- the contribution of the project and planned future developments to the predicted exceedances
- the likelihood of the exceedances occurring at the specified location(s)
- comparison of the predicted ground-level air concentrations with the exposure levels known to cause adverse health effects in people

Overall, the weight of evidence suggests that health risks associated with short-term exposure to these chemicals in isolation and as mixtures are low, and that adverse health effects are not predicted to occur.

Chronic inhalation health risks were evaluated by comparing predicted annual air concentrations for each of the assessment cases with health-based exposure limits. Separate assessments were completed for non-carcinogenic and carcinogenic exposures, reflecting the different approaches used in calculating and interpreting the risk estimates. The majority of the predicted chronic inhalation health risks for the non-carcinogens, expressed as RQ values, did not exceed 1.0. The exceptions include the aliphatic C₉-C₁₆ group and nickel. This demonstrates that, in most cases, the predicted annual air concentrations were less than their health-based exposure limits, and adverse health effects are therefore not expected to occur. For the chemical mixtures, RQ values greater than 1.0 were predicted for the combined nasal irritants, respiratory irritants and neurotoxicants.
Similar to the acute inhalation assessment, interpretation of the non-carcinogenic exceedances considered the following:

- the contribution of the Project and planned future developments to the predicted exceedances
- comparison of the predicted ground-level air concentrations with the exposure levels known to cause adverse health effects in people

Overall, the weight of evidence suggests that health risks associated with long-term inhalation of these chemicals in isolation and as mixtures are low, and that adverse health effects are not predicted to occur.

For the carcinogens, predicted risk estimates, expressed as Incremental Lifetime Cancer Risks (ILCR values), associated with the Project and other planned future developments in the area (i.e., PDC minus base case) are all less than one in 100,000, indicating that the incremental cancer risk from the Project and planned future developments are deemed to be negligible according to Health Canada protocol.

Health risks associated with multiple pathways of exposure, including those related to ingestion of (and/or dermal contact with) water, fish, livestock, poultry, dairy, eggs, wild game, fruit, garden vegetables and soil, were estimated. The risk estimates were based on a combination of measured data and predictive models. With few exceptions, the health risk estimates for the non-carcinogens, expressed as RQ values, did not exceed 1.0. Generally, base case exposure estimates are currently and will continue to be below health-based guidelines. The Project is not expected to adversely affect the quality of any of the foods consumed by local residents. Due to the conservative nature of the HHRA, the overall health risks to people living and working in the area are considered to be low.

For the carcinogens, predicted ILCR values associated with the Project and the planned future emission sources are all less than one in 100,000, indicating that the incremental cancer risks are negligible according to Health Canada protocol.

### 6.12 Land Use

**Introduction**

Land use refers to the human use of land and resources, both renewable and non-renewable on, in or below the land. This includes residential, agricultural, industrial and resource development land use, aggregate reserves, parks, protected and environmentally significant areas, and recreational land use. Land use also includes the non-consumptive use of water (e.g., recreational uses) and consumptive land uses of water (e.g., fishing), but does not include the diversion of water. The assessment considers direct (the Project’s direct effects on human land uses and resources) and indirect effects (the Project’s effects on the biophysical environment that the land use activity depends, e.g., effects on residential development).

Assessments are described for the Project disturbance area (PDA), which is located in Strathcona County in Alberta’s Industrial Heartland (AIH)—Canada’s largest hydrocarbon processing region. The PDA is congruent with the local study area (LSA) assessed for land use. The LSA covers 526 ha and is located in sections 17, 18, 19 and 20 of Township 55, Range 21, West of the Fourth Meridian. Assessment of the
LSA is to determine direct Project-related land use effects. The RSA encompasses Strathcona County’s portion of the AIH. This area was selected to identify existing land uses and planning parameters in and around the LSA.

**Key Issues**

For key potential issues related to Land Use, see Table 6-9.

### Table 6-9 Key Issues for Land Use

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Key Issue</th>
<th>TOR</th>
<th>Relevance to Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Compliance with local and regional land use management</td>
<td>Section 3.10.1 [D]</td>
<td>The Project must be consistent with all local and regional bylaws, development plans and area structure plans.</td>
</tr>
<tr>
<td></td>
<td>Changes in residential land use</td>
<td>Section 3.10.2 [A] (e)</td>
<td>Locally, construction will remove areas available for residential use. Regionally, air emissions, noise, night light, changes in aesthetics and altered hydrogeology have the potential to affect residential use. For details, see Section 3 through 6:</td>
</tr>
<tr>
<td>Construction, operations and decommissioning</td>
<td>Changes in agricultural land use</td>
<td>Section 3.10.2 [A] (e)</td>
<td>Construction will alter agricultural activities in the LSA for the life of the Project. Operations might increase levels of acidifying emissions in the airshed, which could alter soil chemistry, leading to changes in agricultural capability in the RSA. For details, see Section 10 and 11.</td>
</tr>
<tr>
<td></td>
<td>Changes in recreational land use (including wildlife habitat)</td>
<td>Section 3.10.2 [A] (e)</td>
<td>The Project is expected to have no local effects on recreational land use because there is no recreational use of the LSA. Regionally, operations have the potential to affect recreation land use in the area from noise, air emissions and altered aesthetics, as well as indirect effects (e.g., changes in the occurrence of vegetation, wildlife or fish). For details, see Section 3 through 5, Section 9 and Section 11 through 13.</td>
</tr>
<tr>
<td></td>
<td>Changes in access to aggregate reserves</td>
<td>Section 3.10.2 [A] (c)</td>
<td>Construction and operation could affect access to aggregate reserves (sand or gravel) located in the LSA.</td>
</tr>
<tr>
<td></td>
<td>Changes in industrial land use</td>
<td>Section 3.10.2 [A] (e)</td>
<td>Increased traffic from the Project and adjacent industrial developments might result in road congestion. For details, see Section 16.</td>
</tr>
<tr>
<td></td>
<td>Changes in natural land use (including protected areas)</td>
<td>Section 3.10.2 [A] (e)</td>
<td>The RSA has two protected natural areas; the LSA has none. Construction will avoid all areas protected under federal and provincial legislation. Operations have the potential to indirectly affect natural land use through air emissions on terrestrial and aquatic resources and water quality. For details, see Section 8 through 12.</td>
</tr>
</tbody>
</table>
**Baseline Overview**

The effects of the Project on land use are determined by whether or not the Project will meet the planning guidelines and bylaws of the land jurisdiction governing the Project area. Under the *Municipal Government Act*, Strathcona County regulates industrial development through:

- the Strathcona County MDP (Bylaw 1-2007), which guides policy planning
- the Strathcona County Land Use Bylaw (LUB) 8-2001, which controls implementation
- the Strathcona County Heartland ASP

The LSA and a large portion of the RSA are zoned for heavy industrial use under bylaw, which is the primary consideration of the land use assessment (Strathcona County 2012a).

Strathcona County identifies priority environmental management areas (PEMAs) as part of their environmental management and conservation policies. A portion of the LSA (specifically the north half of 19 and most of NW20) is identified as a High PEMA, with the remaining portion of the LSA identified as a Medium PEMA (Strathcona County 2012d).

**LSA**

Approximately 60% of the LSA is in agricultural production (cultivated or pasture). Native vegetation and wetlands occupy another 34% of the total area, with industrial and other related activities making up the remaining uses of the land. According to the land suitability rating system for agricultural crops developed by Agriculture and Agri-Food Canada (AAFC 1995), the land suitability for the majority of soil in the LSA is classified as moderately to severely limiting for the growth of specified crops. Excess water and coarse texture are the main limitations for agricultural crop production in the LSA.

Linear development in the LSA includes pipeline rights-of-way, transmission lines and roads. An inactive sand quarry is located in the north half of the LSA.

There are no national or provincial parks, protected areas or environmentally significant areas in the LSA and as it is largely private agricultural and heavy industrial land, recreational activities also do not occur in the LSA.

**RSA**

Urban population centers do not exist in the RSA; however, the City of Fort Saskatchewan is adjacent to the southwestern boundary of the RSA and the Town of Bruderheim is located at the eastern boundary of the RSA.

In the Strathcona County portion of the AIH, or the RSA, much of the land is privately owned and used for mixed agriculture and pasture (AIHA 2002).

There are two provincially designated protected natural areas in the RSA:

- Northwest of Bruderheim Natural Area
- North of Bruderheim Natural Area
The RSA also includes three Strathcona County-designated environmentally significant areas:

- North Saskatchewan River Valley
- Environmentally Significant Area 454
- Environmentally Significant Area 455

Environmentally significant areas are not protected by legislation unless they are also classified as provincial protected areas, as is the case with the Northwest of Bruderheim Natural Area and North Bruderheim Natural Area. The North Saskatchewan River Valley contains an interprovincially important watercourse. In the RSA, recreational land-use opportunities exist primarily in the two provincially protected natural areas—northwest of Bruderheim Natural Area and north of Bruderheim Natural Area—and in the North Saskatchewan River Valley. These areas are available for passive recreation activities such as hiking, biking, bird watching and wildlife viewing, and host a network of recreation trails.

**Effects**

Sasol intends to abide by all relevant municipal bylaws and regulations. Magnitude of Project effects on land use issues is considered.

In consideration of the limits put on intensification of residential development under Strathcona County’s Heartland ASP, Project development will not reduce existing levels of residential development in the RSA, but will reduce future opportunities for residential development. Therefore, effects are considered to be high magnitude. However, given the location of the GTL facility in an area zoned for industrial development, and the low residential use of these areas, the land use consequence of the GTL facility with respect to residential development is considered low.

The LSA is currently zoned for heavy industrial use, and therefore will reduce agricultural opportunities during the life of the Project and likely during subsequent uses of the LSA. However, conceptual closure measures outlined in the C&R Plan (see Volume 1, Section 5.5) are intended to restore the lands to pre-disturbance equivalency. Therefore, the land use consequence of the GTL facility with respect to agriculture is low.

Although the GTL facility will likely reduce recreational opportunities within and adjacent to the LSA (i.e., moderate magnitude effect), it is consistent with regional land and resource use plans and objectives. GTL facility construction and operations will not directly affect environmentally significant areas or protected areas but the use, quality and enjoyment of these areas might be indirectly affected through noise or air emissions effects on terrestrial and aquatic resources and water quality. Indirect emission-related effects would be of negligible magnitude to land use, and the land use consequence of the GTL facility with respect to recreational use of these areas would be negligible.

The Project site is unlikely to support nonindustrial uses after closure and with the increasing industrial development expected in the area, recreational activities in the RSA. However, the land use consequence of the GTL facility with respect to recreation over the life of the Project as well as after closure is considered low.

There will be no direct effects on other industrial facilities that occur outside the LSA. Indirect effects of the GTL facility would be its influence on the available workforce, as well as on accommodations,
services, transportation and infrastructure. Industrial land use effects will be negligible as the GTL facility will not reduce future industrial land use development in the region.

Sasol will work with Alberta Environment and Sustainable Resource Development (ESRD) to ensure appropriate management of any aggregate reserves located in the LSA.

**Cumulative Effects**

Although land use options in the LSA during GTL facility construction and operations will be reduced, this is to be logically expected on lands that are being transformed from agricultural and natural habitat conditions to lands zoned for heavy industrial development. Therefore, the Project’s contributions to cumulative losses of land use activities and opportunities were not assessed.

In the RSA, the GTL facility’s contribution to cumulative emissions has the potential to affect offsite agricultural production. According to 2011 census data (Statistics Canada 2011), 89,105 ha of land in Strathcona County are used for various agricultural purposes. The loss of 315 ha as a result of GTL facility construction represents a loss of less than 1% of agricultural land from the county therefore the cumulative effect on agricultural production in the region is low.

**Assessment Conclusions**

In summary, the PDA is within Alberta’s Industrial Heartland, an area zoned specifically for heavy industrial use. The Project will be in compliance with all municipal bylaws and regulations as well as with land use plans for the area. Considering the heavy industrial designation, effects on residential, agricultural, recreational, industrial and natural land use will be negligible.

### 6.13 Historical Resources

**Introduction**

Historical resources are the residues of past cultures or societies and fossil remains. They are non-renewable and, therefore, they are susceptible to alteration or removal by industrial development.

Historical resources include precontact archaeological sites, historic-period sites and palaeontological sites. Precontact archaeological sites result from the occupation in Alberta of Aboriginal people before contact with European traders in the late 1700s. Historic period sites can be Aboriginal and non-Aboriginal, and date from the time of European contact until approximately 1960. Palaeontological resources, or fossils, comprise evidence of past multicellular life.

Vegetation clearing and construction of Project components might affect historical resources by disrupting the sediments that contain archaeological, historic and palaeontological sites, which are discrete and immovable, thereby affecting the site contents and context. Therefore, the Project footprint is the relevant study area for historical resources because it is the entire area that will be subjected to surface disturbance, including vegetation clearing. Consequently, the Project footprint is the local study area.
KEY ISSUES

The parkland region around Fort Saskatchewan is rich in recorded archaeological and historic period sites. The heritage value of the Project area was assessed to determine the likelihood of disturbing historical resources.

BASELINE OVERVIEW

The high number of recorded sites in the parkland region around Fort Saskatchewan is a result of the large number of development-related studies that have been conducted in the region and cultivation of sandy soils in the area, which makes identification of near surface sites relatively easy. Projectile points from a variety of periods have been recovered from sites in this region, indicative of a long history of human occupation. However, undisturbed sites are relatively rare because of the high level of cultivation and development-related impacts to near surface sediments.

The area has low palaeontological potential and the nearest previously recorded fossil site is approximately 4 km distant, along the Sturgeon River (Alberta Culture 2012).

A large number of historical resources impact assessments (HRIAs) have been conducted near the Project site, including several within the Project’s footprint. In 2007, Golder Associates conducted a desktop review of the then-proposed Total Upgrader Project (Murphy 2007) because of the presence of known historical resources sites in the Project’s footprint and the lack of extensive HRIA studies conducted for much of the lands—an HRIA was warranted.

During the 2007 HRIA studies, 346 shovel tests were excavated in areas deemed to have potential for the identification of historical resources, or at known historical resources site locations (Murphy 2007). Three new archaeological sites were identified, and three previously recorded sites were revisited to update site status.

Five of the six sites investigated during the 2007 HRIA studies were determined to have limited heritage value and were not recommended for avoidance or further study. However, the sixth site (FkPg-150)—a buried precontact campsite identified in eight positive shovel tests—was determined to be of heritage value, and avoidance or further study (excavation) was recommended for the site. Alberta Culture issued requirements for mitigation studies at FkPg-150; Stage I excavation was conducted in 2008 under Archaeological Permit 08-179 (Murphy 2008) and, because of the perceived high value of the site, additional Stage II excavations were done in 2009 under Archaeological Permit 09-071 (Murphy 2009). Following completion of these studies, Alberta Culture issued a letter indicating that no further study was required for the Total Upgrader Project area (Alberta Culture Project File 4668-088).

The Project footprint is similar to the Total Upgrader Project area assessed in 2007, but contains some lands in the southern portion that were not included in the previous HRIA studies. A desktop review of the Project’s footprint was conducted and submitted to Alberta Culture as part of a statement of justification (SOJ; Porter 2012). The SOJ indicated that the Project’s footprint is completely disturbed by cultivation. Because of this disturbance, and the overall heavy use of this area, which has likely resulted in additional disturbance factors, it was determined that the potential for undisturbed historical resources was low. Seven historical resources sites lie in the Project’s footprint, including precontact isolated artifact finds,
artifact scatters and campsites. However, all of these sites have been issued historical resources values (HRVs) of 0, indicating that no further investigation is required for these sites relative to development-related impact. No lands included in the Project’s footprint were found on the Listing of Historic Resources (Alberta Culture 2012), indicating that no historical resources sites requiring avoidance or additional study are present.

Historical Resources Act clearance was granted for the Project in a letter signed November 19, 2012.

**ASSESSMENT CONCLUSIONS**

In summary, the Project footprint is the relevant study area for historical resources because it is the entire area that will be subjected to surface disturbance. Situated in an area with low palaeontological potential, the main concern was archaeological and historic-period sites. Five of the six sites investigated during the 2007 HRIA studies were determined to have limited heritage value whereas the sixth had further study and mitigations requested by Alberta Culture. More recent desktop reviews revealed that the Project’s footprint is completely disturbed by cultivation. Because of this disturbance, and the overall heavy use of this area, it was determined that the potential for undisturbed historical resources was low. Historical Resources Act clearance was granted for the Project in a letter signed November 19, 2012.

6.14 Socio-Economics

The capital cost of the Project is estimated at $11 billion to $16 billion (in 2012 Canadian dollars); for the purpose of this assessment, cost is estimated at $12.5 billion. From an economic perspective, the Project is a net economic driver. Project construction will create an estimated 33,510 person-years of direct, indirect and induced employment in Alberta from 2018 to 2024. The effect of construction on provincial gross domestic product and household income is estimated at $11.6 billion and $7.5 billion.

Project operations—beginning in 2021 and lasting to at least 2045—will create 890 fulltime permanent positions, and an additional 690 indirect and induced fulltime equivalent positions during each year of operation. The Project will incur approximately $585 million annually in expenditures, not including periodic maintenance turnarounds. The annual gross domestic product and household income effects of Project operations are estimated at $550 million and $150 million.

The Project is expected to have a number of local economic and employment benefits for residents in the greater Edmonton area. Approximately $2 billion (or 16%) of total construction spending is expected to accrue to workers, contractors and suppliers of goods and services in the regional study area. Roughly $225 million (38%) of annual operations spending is expected to accrue locally. Corporately, Sasol works at ensuring strong local participation in its projects, and the company will be exploring ways to maximize economic and social benefits for the region.

From a government fiscal perspective, the Project is a net contributor. Once operational, the Project will contribute $320 million to the provincial government and $480 million to the federal government in corporate taxes annually. At full buildout, the Project’s municipal property tax payments to Strathcona County are estimated to reach $49 million annually, assuming current mill rates. Project-related activities are expected to have minimal direct effect on municipal costs.
From a social perspective, the Project will have an effect on regional infrastructure and service providers, both through the temporary construction activity as well as increased population through operations. Project effects during construction include demand on the regional accommodation market, generation of additional traffic on regional roadways and some additional demand on health, emergency, protective and community services. The regional study area is accustomed to hosting industrial projects of this scope and nature, and has the capacity to accommodate the level of effects predicted for the Project. Sasol will continue to revise the Project’s implementation plan and mitigation to ensure that effects are minimized. Sasol will also continue to liaise with regional stakeholders to ensure lessons learned from past construction projects are incorporated.

The Project’s permanent population effect is estimated at 2,600 people, or 0.2% of the region’s predicted population in 2026, and will occur over a number of years. Project effects during operations include demand on the region’s housing, municipal and social infrastructure. Growth effects associated with the Project represent a continuation of growth similar to levels being experienced in the region, which responsible government departments have been planning for and managing. Sasol will work with stakeholders to establish ways to maximize the positive benefits of its operations.