March 31, 2010

Mr. Steve Thomas
Section Leader
In Situ Oil Sands
Energy Resources Conservation Board
640 – 5th, Avenue SW
Calgary, AB T2P 3G4

Mr. Pat Marriott
Acting District Approvals Manager
Northern Region
Alberta Environment
#111, 4999-98 Avenue
Edmonton, AB TB6 2X3

Dear Sirs:

Re: Applications for the Sunshine Oilsands Ltd.
West Ells SAGD Project

Sunshine Oilsands, Ltd. ("Sunshine") is a Calgary-based oil sands exploration, development and production company having as its principal asset a 100% interest in approximately 400,000 ha of oil sands leases located on crown-owned land in the Western Athabasca area. A portion of these leases are located approximately 60 km west of Fort McKay, Alberta in the West Ells area. Sunshine applies to the Alberta Energy Resources Conservation Board (the "ERCB") and Alberta Environment ("AENV") in this integrated application (the "Application"), for regulatory approval for this project (the "Project") which, if approved, will use Steam Assisted Gravity Drainage ("SAGD") technology to extract bitumen resources from its Oil Sands Leases in West Ells. It is anticipated that the Project will ultimately be capable of producing 1600 m3/day (10,000 bpd) of bitumen for more than 25 years. Planned facilities include a number of wells, well pads and associated infrastructure and a central processing facility, where the bitumen will be cleaned and diluted with condensate before being sent to market.

If approved, construction of the Project will occur in two phases. The Project's first phase will create a 5,000 bpd bitumen production and equivalent steaming capacity, estimated to produce up to 5,000 bpd depending on well performance. The Project's second phase will involve expansion of the facility by construction of a second train, to support a total production of 10,000 bpd of bitumen.

Sunshine applies to the ERCB for the following approvals:

1. Approval to construct and operate the Project pursuant to sections 10 and 11 of the *Oil Sands Conservation Act* and sections 3 and 33 of the *Oil Sands Conservation Regulation*, as set out in the Application; and

2. Approval to construct and operate a distribution and gathering pipeline system within the Project development area, pursuant to Part 4 of the *Pipeline Act*.

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Sunshine also applies to the AENV for the following approvals:

1. Approval pursuant to Part 2, Division 2 and section 66 of the Alberta *Environmental Protection and Enhancement Act,* to construct and operate the Project and related facilities, as set out in the Application;

2. Conservation and reclamation approval, as required under the *Conservation and Reclamation Regulation*, to develop, operate and reclaim the various components of the Project; and

3. Approval and a license to divert water for the Project, pursuant to Part 4 and section 49 of the *Water Act*.

Sunshine will file separate applications to those agencies having jurisdiction for those parts of the Project that are legislated under various other statutes.

This Application combines all information required under the above-mentioned legislation in order to facilitate and expedite regulatory approval for the Project. The Application complies with the information requirements of ERCB Directive 023 – *Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project* and with AENV's *Guide to Content of Industrial Approval Applications*. Sunshine has made all reasonable efforts to comply with privacy requirements. All materials in support of Sunshine's requests are set out in the Application. An executive summary appears at the beginning of the Application, which includes a Table of Concordance for ERCB Directive 023 requirements.

Correspondence with respect to the Application should be directed to:

Sunshine Oilsands Ltd.
Name: Jason Hancheruk, RPFT
Phone: 403-984-5144
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E-Mail: jhancheruk@sunshineoilsands.com

Respectfully submitted on March 31st, 2010.

Sincerely,

Sunshine Oilsands Ltd.

Jason Hancheruk
VP Regulatory, Environment and Stakeholder Affairs

TABLE OF CONTENTS

List of Tables

List of Figures

Acronyms

AAAQOs	Alberta Ambient Air Quality Objectives
AENV	Alberta Environment
API	American Petroleum Institute
ATC	Athabasca Tribal Council
AVI	Alberta Vegetation Inventory
bbls/day	Barrels per day, usually of Oil unless explicitly stated otherwise
BFW	Boiler Feed Water
bpd	Barrels per day, usually oil implied unless explicitly stated otherwise
BS&W	Basic Sediments and Water
C&R	Conservation and Reclamation
CDWQG	Canadian Drinking Water Quality Guidelines
CEMA	Cumulative Effects Management Association
CPF	Central Processing Facility
CPP	Caribou Protection Plan
CSOR	Cumulative Steam to Oil Ratio – an economic indicator used to monitor unit volumes of steam injected per unit volume of oil produced (no units as it is a ratio). This ratio can be calculated per well or over a group of wells.
CTL	Coniferous Timber Licence
CWE	Cold Water Equivalent
CWS	Canada Wide Standards
DBA	Decibel weighted on A scale
DOW	Dangerous Oilfield Waste
Drld & ABD	Drilled and Abandoned wells
EC	Environment Canada
EPEA	Environment Protection and Enhancement Act
ERCB	Energy Resources Conservation Board
ERP	Emergency Response Plan
EUB	Energy and Utilities Board, former name for ERCB
FMA	Forest Management Agreement
FMIS	Fisheries Management Information System
FWKO	Free Water Knock Out
HRIA	Historical Resources Impact Assessment
HSE	Health Safety and Environment
IGF	Induced Gas Flotation
IRC	Industry Relations Corporation
ISOR OR iSOR	Instantaneous Steam to Oil Ratio – similar to CSOR except that it is calculated over a finite period of time - usually a month e.g. amount of steam injected in a month divided by the amount of oil produced in a month. This ratio can be calculated per well or over a group of wells.
kPaa	Kilopascals(absolute), unit for pressure measurement
kPag	Kilopascals(gauge), unit for pressure measurement
LEL	Lower Explosive Limit

LOC	Licence of Occupation
LSA	Local Study Area
m3/day	Cubic m per day, usually of oil unless explicitly stated otherwise
MEMS	Millennium EMS Consultants Ltd.
MMBBLS	Million barrels, usually for Oil unless explicitly stated otherwise
MSL	Mineral Surface Lease
MWD	Measurement while Drilling
NCG	Non-condensable Gas, in Sunshine's case it will be the flue gas from Steam Generation Facilities
OBIP	Original Bitumen in place, usually expressed in thousands of barrels or millions of barrels
ORF	Oil Removal Filter
OSE	Oil Sands Exploration Program
OTSG	Once Through Steam Generator
PA	Project Area which sustains 10,000 barrels per day of Oil for 25 years
PDA	Project Development Area - the initial area for the first phase
PETREL	Schlumberger software for geological, geophysical, and reservoir characterization work
PDF	Process Flow Diagram
PLA	Pipeline Right of Way
PSL	Permissible Sound Levels
RSA	Regional Study Area
SAC	Strong Acid Cation
SAGD	Steam Assisted Gravity Drainage
SOR	Steam to Oil Ratio, see CSOR and ISOR
SRD	Alberta Sustainable Resource Development
Sunshine	Sunshine Oilsands Ltd.
UPS	Uninterrupted Power System
UTM	Universal Transverse Mercator - coordinate system
WBEA	Wood Buffalo Environmental Association
WSC	Water Survey of Canada

EXECUTIVE SUMMARY

Purpose of the Application

Sunshine Oilsands, Ltd ("Sunshine") is applying to the Alberta Energy Resources Conservation Board ("ERCB") and Alberta Environment ("AENV") in this integrated application (the "Application") for regulatory approval for the construction, operation, reclamation and related water use for the West Ells Steam Assisted Gravity Drainage ("SAGD") in-situ bitumen recovery project (the "Project"). Although the Project will proceed in two phases (discussed in more detail below), approval is being sought for the entire Project (up to 10,000 bpd). This integrated Application contains information required in accordance with the *Oil Sands Conservation Act*, the *Environmental Protection and Enhancement Act* the *Pipeline Act* and the *Water Act*.

Scope of the Project

Sunshine has a 100% working interest in approximately 400,000 ha (1,000,000 acres) of Oil Sands leases in the Athabasca Oil Sands region. The Project, located in Township 94, Ranges 17 and 18, W4 Meridian, will ultimately be capable of producing up to 1,600 m3/day (10,000 bpd) of bitumen from the Wabiskaw Member over a period of 25 years. Multiple well pairs will be drilled from individual well pads to reduce surface disturbance. Pipelines and access roads will connect pads to the Central Processing Facility ("CPF"). The CPF will include bitumen, water and gas separation, water de-oiling, water recycling and treatment, steam generation and a pipeline transportation system. Other systems such as flue gas, flare and drain, heating and cooling and power distribution will also be integrated into the CPF. Sunshine anticipates that over the course of the Project, approximately 80 well pairs will be drilled from 9 well pads.

Construction of the Project will proceed in two phases. The first phase, illustrated in Figure 1.1-3, anticipated to be completed by 2012, will result in a bitumen production capacity (and equivalent steaming capacity) of up to 5,000 bpd depending on well performance. The second phase, set out in Figure 1.1-4, anticipated to be completed by 2013, will involve the expansion of the facility by construction of a second train to support a total bitumen production capacity of 10,000 bpd.

Sunshine is committed to proceeding commercially through a phased approach, using steam injection at 400 – 600 kPaa for the Project's first phase, ensuring balanced injection to the overlaying lean zone pressures. During operations, Sunshine intends to test the impact, if any, of thief zone losses in the overlying lean zone. Sunshine will steam over balanced for periods, at pressures up to 2,000 kPaa. If thief zone effects are not observed, Sunshine intends to steam continuously at these higher pressures for sustained periods while observing performance. Sunshine has conducted extensive geostatistical and numerical modeling, integrated with advanced wellbore logging information, to determine that the use of SAGD technology at the

400 kPaa injection pressure will be highly effective and will result in substantial bitumen recovery, having regard to the parametric and petrophysical quality of the West Ells reservoir. It has further determined that at the balanced injection to lean zone pressure approach (400-600 kPaa), no steam will be lost to any overlying thief zones. Reservoir porosity, permeability, saturation, and grain-stone uniformity, among other things, are all within acceptable limits for the successful commercial application of the SAGD extraction technology using steam injection at this pressure.

The phased approach will allow for future flexibility and optimization such that the use of these and other potential alternate technologies mentioned in Section 2 may be considered for future use. Sunshine intends to monitor and assess the technology employed in the Project's first phase on an ongoing basis. Anything of benefit learned will be assessed and, if appropriate, considered for incorporation into the Project's operations so that the bitumen recovery may be further enhanced on an ongoing basis.

While detailed work has been conducted in respect of the first phase, the entire Project and Project Area have been assessed to confirm that neither the expansion of the facility in the Project's second phase nor any of the alternate technologies will impact or otherwise necessitate further consultation or any subsequent application for approvals.

Board Decision 2009-061

On October 15, 2009, this Board issued Decision 2009-061, granting the applications by Sunshine and others for the interim shut-in of gas production from the intervals requested, as well as from 51 additional intervals identified by the Board. An Order requiring the shut-in of the gas production was subsequently issued (the "Shut-In Order"). This Application seeks approval for the extraction of the bitumen resources in communication with some of these shut-in intervals.

A hearing Order has been issued. Sunshine intends to participate at the final shut-in hearing. While it is Sunshine's position that this Application and the final shut-in hearing can proceed simultaneously, Sunshine recognizes that a decision in connection with this Application will have to await the determination of the final shut-in hearing. If, following that hearing, the interim Shut-In Order is set aside, Sunshine intends to re-assess the application and the potential for bitumen extraction.

Sunshine is optimistic that following shut-in, pressure rebound will occur (which may be enhanced by the injection of non-condensable gas) thereby allowing for SAGD extraction technology to be utilized at increased pressures with no risk of steam loss. Although re-pressurization as an option has been incorporated into the Project design, Sunshine's modelling and other assessment substantiates that it is able to operate commercially at balanced pressure in the absence of re-pressurization.

Project Benefits

The Project is in the public interest. During its construction, operation, monitoring and reclamation phases, it will result in significant benefits accruing regionally, provincially and federally. Over the course of its 25 year life, it is expected that the Project will employ an average full time work force of approximately 40 people. During construction, the average work force is expected to be approximately 150 people, with the maximum work force peaking at 250. In addition, the Project will contribute directly to government revenues by means of property taxes, corporate taxes, payroll taxes, land use and municipal taxes and royalties.

The utilization of SAGD technology will result in a consistent and continuous supply of bitumen over a 25 year period. The material and energy balance is expected to be highly positive, with an energy produced to energy consumed ratio of over five.

Subject to steaming at up to 2,000 kPaa to assess the effects of any thief zones, Sunshine intends to operate commercially at balanced pressure (400 – 600 kPaa) for the first phase. Low pressure reservoir management is of significant benefit to the Province's consolidated resource base and constitutes safe, efficient thermal extraction technology.

Schedule

Sunshine estimates that the application approval process will take approximately 12-18 months. Assuming the Project receives the requested approvals, it is anticipated that procurement and civil work for the first phase of the Project will commence in 2011. Major facility construction is planned to begin in 2011 and will continue until the plant is commissioned by 2012. Well site drilling operations will be completed in 2012 and first oil is expected prior to the end of 2012. The Project's second phase, set out in Figure 1.1-4, is anticipated to be completed by 2013. The subsequent production is expected to ramp up to the design capacity of 10,000 bpd within six months of the first steam date in the Project's second phase.

Environmental Assessment

Sunshine is committed to environmental stewardship. While an Environmental Impact Assessment is not required for the Project pursuant to the *Environmental Assessment (Mandatory and Exempted Activities) Regulation* (AR 111/93), Sunshine has nonetheless undertaken a detailed assessment of environmental aspects associated with the first phase of development and a baseline environmental study for the Project Area., including an assessment of air, noise, water, terrestrial, aquatic, historical resource and wildlife impacts. Section 4 of the Application details Sunshine's review of the potential for material environmental impacts and the use of associated resources in the SAGD process. Notable aspects of the Project include minimizing surface disturbances in the Project Area, extensive water recycling to reduce freshwater requirements, incorporation of energy efficient technology to reduce emissions and commitment to progressive

reclamation and conservation during the Project's 25 year lifespan. The Project's environmental impacts will be minimal.

Public Consultation

Sunshine is committed to comprehensive consultation with stakeholders. It has established clear consultation objectives, identified potential stakeholders, provided notice of the proposed Project and has undertaken public consultation including community open houses and First Nations chief and council meetings.

APPLICATION GUIDE AND DESCRIPTION

For the convenience of readers who wish to read only specific portions of the Application, there is some repetition.

The Application has been integrated in accordance with ERCB and AENV guidelines to facilitate an efficient review by the regulatory review agencies and the public. It is presented in one volume consisting of the following components:

Section 1 – Project Introduction
Section 2 – Project Description
Section 3 – Public and Aboriginal Consultation
Section 4 – Environmental Information
Section 5 – EPEA Approvals
Section 6 – Water Act Application
Appendix 1 – Project Consultant
Appendix 2 – Glossary and Acronyms
Appendix 3 – References
Appendix 4 – Public Consultation Logs and Newsletter
Appendix 5 – Measurement Principles
Appendix 6 – Injectivity Test Results
Appendix 7 – Ground Water Monitoring and Testing Report
Consultant Report #1 – Air Quality
Consultant Report #2 – Conservation & Reclamation Plan
Consultant Report #3 – Aquatic Resources
Consultant Report #4 – Hydrogeology
Consultant Report #5 – Historical Resources[1]
Consultant Report #6 – Hydrology
Consultant Report #7 – Noise
Consultant Report #8 – Soils
Consultant Report #9 – Vegetation and Wetlands
Consultant Report #10 – Wildlife

EPEA application requirements as set out in the *Activities Designation Regulation* (AR 276/03) are discussed in Section 5.0 of this Application.

A concordance table attached in this section sets out *EPEA* approval information.

[1] In accordance with Alberta Culture and Community Spirit, clearance requirements, this report was submitted separately under a cover letter from FMA Heritage Inc.

ERCB Directive 023 Information Requirements (EUB 1991)

Directive 023 Section	Requirement	Location
1.0 GENERAL INFORMATION		
1.5	**Project description**	
1.5.1	Applicable Acts and Sections under which the application is made	1.5.1, 1.5.2
1.5.2	Name and address of the applicant and any partners involved and the details of company incorporation	1.2, 1.3
1.5.3	Statement of need and project timing	1.4, 1.7.1, Figure 1.7-1
1.5.4	Overall project description and discussion of schedule Including: location, size and scope, schedule of preconstruction, construction, start up, duration of operations, and a discussion of the reasons for selecting the proposed schedule.	1.1, 1.3, 1.7.1, 1.7.2, Figure 1.1-1, Figure 1.1-2, Figure 1.1-3, Figure 1.1-4, Figure 1.3-1, Figure 1.7-1, Figure 2.1-1, 2.0 (all)
1.5.5	Regional setting and reference to existing and proposed land use	1.6, 4.11
1.5.6	(a) Maps showing freehold, leasehold, mineral and surface rights of the proposed scheme and surrounding area. (b) Maps with legal descriptions showing the locations of landowners and their dwellings in relation to the proposed oil sands site	Figure 4.11-1, Figure 4.11-2 N/A
1.5.7	Maps showing topography, existing areas of habitation, industry, the proposed site and any development in the project area	Figures 1.1-1, 1.1-2, 1.1-3, 1.1-4, 1.3-1, 2.1-1

1.5.8	Aerial photomosiac at an appropriate scale to illustrate the locations of the project components including the mine area, wells, extraction plant, upgrader unit, tanks, discard storage sites including tailing ponds, access roads, railways, pipelines and utility corridors	1.3-1
1.5.9	Description of storage and transportation facilities of the final hydrocarbon product, including detail of size and ownership of any pipeline which may be utilized	2.1.1.3, 2.6.1, 2.6.2.4
1.5.10	Proposed rate of production over the life of the Project	2.3.3.3
1.5.11	Description of subject oil sands	1.1, Figure 1.1-1, Figures 1.1-2, 1.1-3, 1.1-4, 1.3-1, Section 4.11.2.1, Figure 4.11-1
1.5.12	Status of negotiations held or to be held with the freehold, leasehold, mineral surface rights owners	1.7.3, 3.3 (all), Table 3.3-1, App 4
1.5.13	Proposed energy source, comparison to alternative sources, resource use, description of sources and supply	2.7.2
1.5.14	Description and results of public information program planned or initiated	3 (all); App. 4
1.515	The term of the approval sought, including expected project start and completion dates	1.3, 1.7.1, Figure 1.7-1, 2.3.3.3
1.5.16	Name of responsible person to contact	1.3

Directive 023 Section	Requirement	Location
2.1	Surface mining operations	N/A
2.2	Underground access and development	N/A
2.3	**In situ operations**	
	Provide the following:	
2.3.1	A geological description of the zone(s) of interest in the project area including: (a) land surface topography maps (b) maps of evaluation wells, indicating cored or logged wells (c) log and core evaluation techniques (d) isopach maps (e) cross-sections (f) tabulations of reservoir rock parameters, fluid properties and log interpretation cutoffs (g) structure and position of fluid interfaces (h) maps showing gas caps and bottom water	Sections 2.2 and 2.3; Figures 2.2-2, 2.2-22, 2.2-1, 2.2-4, 2.2-5, 2.2-12 to 2.2-18
	(i) description of geological data modeling techniques	

Directive 023 Section	Requirement	Location
2.3.2	An identification by name and depth of the target zone including any crude bitumen zone or water zone immediately above or below the zone of interest	2.2.2; 2.2.2.4
2.3.3	The criteria used in selecting the oil sands zone	2.2, 2.3
2.3.4	A description of the cutoff bitumen grade and thickness criteria used to establish the inplace resource potential of the project area supported by reserve estimates and trends.	2.2.4.1; Table 2.2-1
2.3.5	A geological, engineering and economic evaluation of the bitumen reserves recoverable by the proposed scheme, and description of and rationale for the criteria employed	2.2.4.2; 2.3.3; 2.3.3.1; 2.3.3.2
2.3.6	A geological, engineering and economic evaluation of the bitumen reserves not recoverable by the proposed scheme	2.2.4.2; 2.3.3; 2.3.3.1; 2.3.3.2
2.3.7	A discussion of the potential and requirements for any followup recovery of reserves from the zone of interest or other bitumen bearing zones within the scheme area	2.3.2
2.3.8	An evaluation of gas reserves associated with or in the area of the oil sands to be developed including a description of: (a) the effect the proposed operations would have upon recovery of reserves (b) the effect the gas reserves would have on the recovery of crude bitumen	2.3.3, 2.4 (all)

Directive 023 Section	Requirement	Location
2.3.9	An evaluation of sand or fines production and the effects on hydrocarbon production and recovery, as well as anticipated disposal methods	
2.3.10	A description of the recovery process to be used including:	
	(a) objectives, intended course of operation and applicability of process	2.3; 2.3.1; 2.3.2; 2.4 (all), 2.5.2.1
	(b) comparison of this process with others considered, stating the technical, economic, environmental and cost reasons for selection	2.3.1; 2.3.2
	(c) potential for follow-up processes for improved recovery	2.3.2, 1.1
	(d) results of computer modeling or simulation studies	2.3.2; 2.5.2.1
	(e) economic and production criteria used to abandon an oil sands zone	2.3.3.1
2.3.11	The recovery efficiency of the process selected including:	
	(a) effects of reservoir well spacing and interwell communication	2.3.2; 2.3.3; 2.3.3.1; 2.3.3.2; 2.4 (all)
	(b) areal, vertical and displacement efficiencies	
	(c) effects of reservoir properties.	
2.3.12	A description of the project layout with emphasis on equipment spacing and surface disturbance including:	
	(a) sequence of development	2.3.3.3
	(b) wellpad configurations and spacing, wellsite and satellite layout and fluid treatment and handling facilities	2.1.1 (all); 2.1.3

Directive 023 Section	Requirement	Location
	(c) future pad configuration and surface facilities	2.3.3.3
2.3.13	A description of efforts to minimize land disturbance and the collection, conservation or other disposition of produced gas (reference IL 85-12 Oil Sands Primary Production)	2.1.1.2; 2.1.3; 2.3.2
2.3.14	A diagram and description of proposed well drilling and completion methods including: (a) wellhead design (b) casing and tubing with specifications and setting depths (c) cementing details	2.5.2 (all); Figure 2.5-4
2.3.15	A description of the proposed well-performance monitoring program including: (a) routine production testing (b) temperature and production logging (c) surface-fluid sampling (d) field and laboratory analyses programs	2.3.4; 2.3.5; 2.5.2.3; 2.5.4; 2.5.5
2.3.16	A description of geotechnical factors and techniques of monitoring that may affect operations including: (a) casing monitoring program (b) method of reporting failures, ghost holes and other drilling anomalies	2.3.4; 2.3.5; 2.5.2.3; 2.5.4; 2.5.5

Directive 023 Section	Requirement	Location
2.3.17	The volume of fluids and solids produced and the proposed disposition of each	2.5.3
2.3.18	The material balance for hydrocarbon, sulphur and water in the central plant facility	2.7.1.2; 2.7.2.2; 2.7.1.1, Figures 2.7-1 and 2.7-2
2.3.19	A process flow diagram for the central plant facility, indicating major equipment and stream composition with the proposed measurement devices and locations	Figure 2.1-3
2.3.20	A sample set of production accounting reports for the central plant facility with each entry explained using the flows from the process flow diagram or the calculated flows based on sound engineering techniques	
2.4	Processing Plant	N/A
2.4.1	A separate description of the bitumen extraction, upgrading, utilities, refining and sulphur recovery facilities, including: (a) a discussion of the process (b) process flow diagrams indicating major equipment, stream rates and composition, and the proposed production measurement devices, characteristics and locations (c) chemical and physical characteristics and properties of feeds and product materials	2 (all), 2.1 (all), 2.6 (all), Figure 2.1-3
2.4.2	Overall material and energy balances, including information with respect to hydrocarbon and sulphur recoveries, water use and energy efficiency	2.7, Figure 2.7-1, Figure 2-7-2
2.4.3	Quantity of products, by-products and waste and their disposition	2.10.2.4, Table 2.10-1
2.4.4	Surface drainage within the areas of the processing plant, product storage and waste treatment and disposal	2.10.2.5

Directive 023 Section	Requirement	Location
2.4.5	Comparison of proposed process to alternatives considered on the basis of overall recovery, energy efficiency, cost, commercial availability and environmental considerations and the reasons for selecting the proposed process	1.1
2.4.6	This number has been omitted from Directive 023	N/A
2.4.7	Example of production accounting reports	
2.5	Electrical Utilities and External Energy Sources	
2.5.1	A description of any facilities to be provided for the generation of electricity to be used by the project.	2.6.11.1 and 2.6.11.2
2.5.2	Identification of the source, quantity and quality of any fuel, electricity or steam to be obtained from sources beyond the project site	2.7.2.1
2.5.3	Where energy sources from outside the project boundaries are to be supplied to the project, a detailed appraisal of the options available to eliminate the need for such resources, with consideration for overall recovery, energy balance, costs, technical limitations and environmental implications	2.7.2.1
2.6	Environmental Control	
2.6.1	A description of air and water pollution control and monitoring facilities, as well as a liquid spill contingency plan	2.10.2.3, 2.10.2.7, 4.1.4, 4.3.4, 4.4.4

Directive 023 Section	Requirement	Location
2.6.2	A description of the water management program, including: (a) the proposed water source and expected withdrawal (b) the source-water quality control (c) the waste-water disposal program (d) water balance for the proposed scheme (e) the produced-water clean-up/recycle program	2.8, 2.2.5, 2.7.1.1, Tables 2.7-1 and 2.7-2, 2.8.2, 2.8.3, 2.8.5, 2.7.1.1, 2.6.3, 2.6.3.1, 2.6.3.2, 2.6.3.3
2.6.3	The manner in which surface water drainage within the Project area would be collected, treated and disposed	2.10.2.5
2.6.4	A description of the air and water pollution control and monitoring facilities	2.10.2.3, 2.10.2.7, 4.1.4, 4.3.4, 4.4.4

Directive 023 Section	Requirement	Location
2.6.5	A description of the emission control system, including: (a) stack design criteria and process data (b) any additions of residue gas or natural gas to the flare system to ensure combustion of hydrogen sulphide for both normal operating conditions and maximum emission conditions (c) methods proposed for the control of all air pollutants from all potential or actual emission sources at the operation (including all vents, stacks, flares, product storage tanks, sulphur handling areas, ponds, wells and other fugitive emission sources) during normal, emergency and maximum operating conditions (d) monitoring program for hydrogen sulphide, sulphur dioxide, total sulphation, hydrogen sulphide sulphation, soil pH, nitrogen oxides and hydrocarbons in the surrounding area	2.6.1, 2.6.8, 2.10, 2.10.2.3, 2.10.2.7, 2.10.2.8, 4.1.4
3.1	Commercial Viability	
3.1.1	An appraisal and projections, on an annual basis of revenues, capital and operating costs (including a breakdown of fuel costs and non-fuel operating costs), project financing, royalties and taxes, net cash flow, marketing arrangements, fuel and electric power requirements and supply arrangements	
3.1.2	A description of project costs which include capital and operating cost, including: (a) a breakdown of capital and operating costs for each component of the project including site preparation, well drilling and completion, central processing facilities (including steam generation, water treatment and recycling), satellite and surface facilities, production/injection distribution system, upgrading, utilities and off-sites, depreciation	

Directive 023 Section	Requirement	Location
3.2	Benefit-Cost Analysis	
3.2.1	A summary of quantifiable public benefits and costs incurred during the construction and operation of the Project	1.4
3.2.2	A summary of non-quantifiable public benefits and costs incurred each year during construction and operation of the Project	1.4
3.3	Economic Impact	
3.3.1	An appraisal of the economic impact of the Project on the region, province and nation	1.4
3.3.2	A discussion of any initiatives undertaken to accommodate regional economic priorities and interests	3.0
3.3.3	An assessment of direct and indirect employment opportunities for all groups associated with the Project including: (a) projected max and min workforce demand by skill categories in the construction and operating phases and an analysis of how these demands shall be met (b) an analysis of the indirect and induced employment generated by the project due to employment multiplier effects (c) a discussion of the employment and training arrangements by applicant that would enable residents of the region to participate in meeting the workforce demands	1.4
4.0	Environmental Impact Assessment	N/A

Directive 023 Section	Requirement	Location
5.0	Biophysical Impact Assessment	N/A
6.0	Social Impact Assessment	N/A
7.0	Describe the environmental protection plan including mitigation measures, environmental monitoring and research	4.14, 4.2.4, 4.3.4, 4.4.4, 4.5.4, 4.6.4, 4.7.4, 4.8.4, 4.9.4, 4.10.4, CR#1 through #10
8.0	Conceptual Development and Reclamation Plan	4.2, CR# 2
9.0	Solid Waste Management Plan	2.10.2.

1 PROJECT INFORMATION

1.1 Project Background

Since 2007, Sunshine has been actively conducting exploration programs to delineate bitumen resources under its Oil Sands Leases No. 7407060175, 7407020023 and 7407070311 from Crown-owned land located in the West Ells area approximately 60 km west of Fort McKay in north-eastern Alberta (Figures 1.1-1 and 1.1-2). Sunshine's bitumen resources are located in Townships 94 and 95, Ranges 17 and 18 W4M. The Project Area is located Sections 30, 31, 32, and 33 Township 94, Range 17; and Sections 25 and 36, Township 94, Range 18, W4M. Within Sunshine's lease area, bitumen charged marginal marine sandstones have been found.

Sunshine has developed a program utilizing SAGD technologies to extract the bitumen resources from this area. The Project is relatively small in scale and is expected to produce bitumen over a 25 year period, with a maximum production level of 1,600 m^3/day (10,000 bpd).

Construction of the Project will proceed in two phases. The first phase, illustrated in Figure 1.1-3, anticipated to be completed by 2012, will result in a bitumen production capacity (and equivalent steaming capacity) of 5,000 bpd, and is estimated to produce between 2,000 and 5,000 bpd depending on well performance. The second phase, set out in Figure 1.1-4, anticipated to be completed by 2014, will involve the expansion of the facility by the construction of a second train to support a total bitumen production capacity of 10,000 bpd. Each train is designed to provide 5,000 bpd of bitumen processing capacity at an SOR of 3.3.

The SAGD recovery process has been selected as the bitumen recovery method for the Project. The use of SAGD technology will maximize the economic recovery of this resource. Alternative recovery methods were evaluated and rejected for various reasons. Mining of the bitumen is not feasible due to the depth of the resource. Even if these technical issues could be resolved, environmental impacts would be substantial due to the considerable surface land area that would have to be disturbed. By way of contrast, the SAGD process optimizes resource exploitation by creating a small surface footprint that supports pads of horizontal wells.

1.2 Project Proponent

Sunshine is a Calgary-based oil sands exploration, development and production company. Its principal asset is a 100 percent interest in approximately 400,000 ha (1,000,000 acres) of Oil Sands Leases in the Athabasca Oil Sands region. Sunshine has been conducting Oil Sands exploratory drilling programs since 2007. In the winter of 2007, 58 core wells were drilled. Sunshine's corporate philosophy is based on maximizing the value of its Oil Sands resources while becoming a valued partner in the communities in which it operates. Sunshine fully

supports sustainable long term development while building mutually beneficial relationships with its key stakeholders.

The orderly and economic development of Sunshine's Athabasca Oil Sands resources though this Project is a significant component of the company's growth plan. The vastness of the resource, demonstrated extraction technology and proven economics provide an attractive long-term opportunity for sustained production. In addition to holding significant Oil Sands resources, Sunshine has the financial resources to undertake a project of this magnitude. This Project has devoted to it a current staff of over 22 full time employees who are supported by key consultants, retained specifically for the Project.

Sunshine is committed to responsible corporate behaviour and the elevation of operating standards for industrial performance, minimization of environmental impacts and the protection of shared values in the areas it operates. This commitment is realized through an open and consistent dialogue with regulatory bodies and stakeholder groups. Transparency of operations and open consultation, reporting and accountability are key result areas that Sunshine focuses on in order to maximize the value of its operations and minimize the impact in the areas in which it operates.

Sunshine is committed to accurate process measurement, monitoring and recording. It is also committed to the use of best practices for environmental monitoring, impact mitigation, and remediation and reclamation. Sunshine intends to use progressive reclamation techniques wherever possible to minimize active surface disturbance throughout the Project life. It is committed to the use of programs that promote the development of a diversity of self-sustaining vegetation communities to support watershed protection, traditional land uses, wildlife habitat and commercial forest production.

1.3 Project Overview

The Project will use proven SAGD technology to recover bitumen from bitumen reserves located approximately 250 m below the earth's surface. Planned facilities for the Project include a number of wells, well pads and associated infrastructure (e.g., roads, pipeline) and a central processing facility ("CPF"). At the CPF, the bitumen will be cleaned and diluted with condensate before it is transported by trucks to market.

To ensure maximum long term capital efficiency, the Project will be developed in two phases. The first phase will have a processing capacity of 5,000 bpd of bitumen and equivalent steaming capacity. This will require 13 well pairs to be drilled that will produce 2,000 to 5,000 bpd of bitumen depending on well performance. The second phase will expand the facility capacity with the addition of a second train, resulting in a total capacity of 10,000 bpd. Additional well

pairs will be required, the number of which will depend on well performance during the Project's first phase.

During the first phase, steam will be injected at what Sunshine expects to be the balanced reservoir pressure of 400 - 600 kPaa based on current field data and following pressure rebound. In Sunshine's view, a shut-in of the producing wells in the region will result in significant pressure rebound such that it expects to be able to operate at least at the 400 kPaa balanced pressure once this has occurred. Sunshine intends to occasionally operate at 2,000 kPaa injection pressure and thereby over balance the thief zone to test the continuous nature, if any, of thief zone losses. If losses are not experienced, Sunshine intends to operate at this higher pressure for sustained periods.

The Project is expected to produce bitumen over a 25 year period, with a maximum production level of 1,600 m^3/day (10,000 bpd). Over the life of the project, it is anticipated that approximately 80 well pairs will be required to maintain the 10,000 bpd production level. Those well pairs will be drilled from 9 well pads and will recover bitumen in excess of 14 million m^3 (88 MMbbls).

The Project will employ an operating workforce of approximately 30-40 people for each of the Project's first and second phases. Sunshine proposes to fly its operational employees into the Fort McMurray Airport, where passenger vans will transport them to the Project site. Upon arrival, they will be housed in a camp constructed for the Project. Details of the development plan are provided in Section 2 - Project Description.

The development of the Project's first phase will result in a total surface disturbance of approximately 60.7 ha (150 acres) (Table 1.3-1 and Figure 1.3-1).

Table 1.3-1 Phase 1 Project Components

Area	Dimensions	Area (ha)
Plant Site	765 m by 415 m (irregular shape)	29.3
North Pad	330 m x 150 m	4.9
South Pad	300 m x 150 m	4.4
Construction Camp	269 m x 180 m	4.9
Operator's Camp	200 m x 125 m (Access 146 m x 30 m)	2.9
Supervisor's Camp	100 m x 100 m (Access 67 m x 30 m)	1.2
Borrow Pit # 1	368 m x 306 m (irregular shape)	8.9
Utility Corridor	0.88 km x 50 m	4.2
Total		**60.7**

The Project is located approximately 60 km west of Highway 63 and will require supporting infrastructure, including an access road and associated borrow pits. This supporting infrastructure is anticipated to disturb an additional 67.8 ha of land (Table 1.3-2, Figure 1.1-2). Sunshine has worked closely with other potential SAGD developers in the vicinity of the Project to develop a common access corridor that not only suits the needs of each of the companies, but is consistent with the current draft access management plan administered by Alberta Sustainable Resource Development. The main proposed access is illustrated in Figure 1.1-1. From there, Sunshine intends to construct an extension to the road, northward to the Project's CPF located in Section 31-94-17-W4M. The access road will be shared by other companies having interests in the area (e.g. Grizzly, Total E&P, ALPAC and AOSC).

Table 1.3-2 Access Road Components

Area	Dimensions	Area (ha)
Access Road	9,060 km x 50 m	45.3
Borrow Pit 2	295 m x 179 m (irregular shape) (Access 148 m x 30 m)	5.6
Borrow Pit 3	291 m x 225 m) (irregular shape)	4.5
Borrow Pit 4	300 m x 196 m (irregular shape) (Access 176 m x 30 m)	6.4
Borrow Pit 5	250 m x 245 m (irregular shape) (Access 58 m x 30 m)	6.0
Total		**67.8**

The name of the applicant for the Project is:

Sunshine Oilsands Ltd.

The address of the applicant is:

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1.4 Project Need and Benefits

The Project is in the public interest.

Sunshine is applying for regulatory approval of the Project following a thorough investigation of technical feasibility and economic analyses. Sunshine has confirmed the existence of bitumen resources in quantities sufficient to justify development. The economic benefit of developing the bitumen resource is attractive. Market conditions are expected to remain positive for bitumen SAGD developments for the foreseeable future. Bitumen development will help offset declining conventional oil resources. The utilization of SAGD technology will result in a consistent and continuous supply of the bitumen over a period of 25 years. The material and energy balance associated with the extraction of bitumen utilizing SAGD technology is highly positive, with an expected energy produced to energy consumed ratio of over five.

Subject to steaming at up to 2,000 kPaa to assess the effects of any thief zones, Sunshine intends to operate commercially at a balanced pressure (400 - 600 kPaa) for the Project's first phase. Low pressure reservoir management is of significant benefit to the Province's consolidated resource base and constitutes safe, efficient thermal extraction technology. To the extent that recoveries may be improved through enhancements learned during the Project's first phase of operation, consideration will be given to incorporating these into the Project's second phase. During its construction, operation, monitoring and reclamation phases, the Project will result in significant benefits accruing regionally, provincially and federally. A significant amount of new employment will be created and the Project will contribute directly to government revenues by means of property taxes, corporate taxes, payroll taxes, land use and municipal taxes and royalties.

Specific benefits of the Project will include the following:

- over the life of the Project, the revenues accruing to all levels of government are expected to approach $1.8B;
- during construction, the Project is expected to employ an average work force of approximately 150 people, peaking at 250 people;
- during operations for both phases, the Project is expected to employ an average work force of approximately 30 to 40 people; and
- for 25 years, there will be sustained on-site activity in the West Ells area.

Investment in the Athabasca Oil Sands is in the public interest. This Project will offset declines in conventional oil production and help secure North America's energy resources for many years to come. The Project's phased approach will provide level growth in the local economy for a sustained period and better cost control for the Project.

The Project is economically viable. While design engineering is continuing, to date, Sunshine has invested significant funds in the Project, including lease acquisition,

engineering, resource evaluation, environmental assessment and regulatory application. The total Project capital cost, when complete, is estimated at $480MM. Sunshine expects that the proposed phased development will facilitate effective Project management and level-load labour and material requirements over a sustained period.

Sunshine has designed a project that captures economies of scale and synergies between its components. When fully operational, Sunshine expects the Project's operating costs, including sustaining capital to be in the range of $70MM per year. Sunshine believes that at this operating cost level, the Project will not be vulnerable to oil price volatility.

1.5 Project Regulatory Approval Process

1.5.1 Application Approvals

This Application seeks approval for the construction, operation and reclamation of the Project. An Environmental Impact Assessment is not required for this Application.

The Project is fully described in this Application and consists of the following facilities and systems: bitumen/water/gas separation; well pads; steam generation facility; production treating facility; water de-oiling system; water supply recycling facility; water disposal system; access roads and associated buildings and facilities for utilities. The utility systems include fuel gas, flare and drain, instrument air and power distribution as well as office, camp and warehouse infrastructure, potable water, a sanitary system and solid waste disposal.

Sunshine is requesting the following approvals from the ERCB for implementation of the Project, an in-situ thermal recovery project using SAGD technologies, to produce bitumen at a peak rate of 1,600 m3/day (10,000 bpd) within the defined Project Development Area:

ERCB

- Approval to construct and operate the Project pursuant to Sections 10 and 11 of the *Oil Sands Conservation Act* and Sections 3 and 33 of the *Oil Sands Conservation Regulation*, as set out in this Application; and

- Approval to construct and operate a distribution and gathering pipeline system within the Project Development Area pursuant to Part 4 of the *Pipeline Act*.

Sunshine also seeks the following approvals from AENV for the construction, operation and reclamation of the Project:

AENV

- Approvals and registrations pursuant to Part 2, Division 2 and Section 66 of the Alberta Environmental Protection and Enhancement Act, to construct and operate the Project, as set out in this Application;

- Conservation and reclamation approval, as required under the Conservation and Reclamation Regulation, to develop, operate and reclaim the various components of the Project; and

- Approval to divert water for the Project pursuant to Part 4 and Section 49 of the *Water Act*.

1.5.2 Additional Approvals Associated with the Application

There are other related applications under provincial and federal statutes that are required for the Project. These supplemental applications will be submitted under separate cover to each of the agencies having corresponding jurisdiction, which will include but not necessarily be limited to the following:

- Surface rights requirements pursuant to the *Public Lands Act*;

- Site surface disturbance clearance pursuant to the *Historical Resources Act*;

- Production and injection well drilling licenses issued pursuant to the *Oil and Gas Conservation Act*;

- Development Permit issued pursuant to the *Municipal Government Act*, from the Regional Municipality of Wood Buffalo for the construction and operation of the Project and related infrastructure;

- Department of Fisheries and Oceans water body crossing and navigable waters approval pursuant to subsection 35(1) of the *Fisheries Act* and *Navigable Waters Protection Act;*

- Cogeneration facility approval pursuant to Part 2 Section 11 of the *Hydro and Electric Energy Act* to be filed with the Alberta Utilities Commission; and

- Electrical power interconnections issued pursuant to the *Electric Utilities Act.*

1.6 Regional Setting

The Project is located approximately 60 km west of the Athabasca River valley and 88 km north-west of the Fort McMurray urban service area. The nearest residence to the proposed development is located in the community of Fort McKay, which is 60 km southeast of the Project. According to the Regional Municipality of Wood Buffalo 2007 census, 737 people reside in the community of Fort McKay.

The Project is located in the Central Mixedwood Natural Subregion of the Boreal Forest Natural Region. Tree species consist of black spruce, aspen and white spruce, with small amounts of balsam poplar, paper birch, jack pine, and tamarack. The majority of the area is covered by lowland vegetation, predominantly bog and fen wetlands. Several lakes and ponds are located near the Project Area with Namur Lake located 16 km north of the Project Area. Several ephemeral draws transport water through the Project Area into the lakes and ponds.

1.7 Development Plan

1.7.1 Development Schedule

In this Application, Sunshine is proposing a cost-effective and technically prudent commercial development over two phases. During the Project's first phase, Sunshine expects to be able to operate at a balanced steam pressure of 400 - 600 kPaa based on current field data and following pressure rebound. The Project is commercially viable at this pressure as discussed in Section 2.3. During the Project's first phase of operations, subject to steaming at up to 2,000 kPaa to assess the effects of any thief zones, Sunshine expects to be able to enhance its understanding of how to most effectively operate at this relatively low pressure. Anything learned will be incorporated into the Project's future operations so that the efficiency of the bitumen recovery will be further improved.

Figure 1.7-1 is a development schedule for Phase 1 of the Project. Sunshine estimates that the application approval will take approximately 12-18 months. Following approval, it is anticipated that procurement and civil work for the Project will commence in 2011. Major facility construction is planned to begin in 2011 and will continue until the plant is commissioned by 2012. Well site drilling operations will be completed in 2012 and first oil is expected in 2012.

The Project's second phase will commence operation following one to two years of operations of the Project's first phase, at which time Sunshine will have a good understanding of the production performance that can help to optimize the design of the Project's second phase.

1.7.2 Development Areas

Sunshine conducted a detailed resource evaluation of the West Ells Area. Based on this regional study, Sunshine has identified a Project Area and a Project Development Area ("PDA") for the purpose of this Application. A detailed analysis of the bitumen resource in the Project Area is presented in Section 2.2.4.2. The analysis and study indicates that the Project Area contains more than enough resources required to support the Project development at a 10,000 bpd production level for the entire 25 year life of the Project. The PDA is the resource area required for the plant and initial development of the Project in the Project's first phase. These areas are outlined in Figure 1.1-2 and are identified as follows:

- Project Area:
    - Sec. 30, 31, 32 & 33, Twp. 94, Rge. 17W4M; and
    - Sec. 25 & 36, Twp. 94, Rge. 18, W4M.

- Project Development Area:
    - LSD 10 to 15, Sec. 30, Twp. 94, Rge. 17W4M;
    - LSD 2 & 7, SW, NE & NW Sec. 31, Twp. 94 Rge. 7W4M;
    - NE Sec. 25, Twp. 94, Rge. 18W4M; and
    - NW & SW Sec. 36, Twp. 94, Rge. 18W4M.

Sunshine has provided technical and environmental details for the entire 10,000 bpd Project surface facility development as well as the well pad development for the first phase, as there is a very high confidence level that the Project will be developed in this manner. The conceptual subsequent well pad development in the Project Area required to sustain the 10,000 bpd production level is shown in Figure 2.1-1.

The environmental regional study presented in Section 4 covers the entire Project Area, which provides the environmental baseline for the Project Area and detailed assessment of environmental aspects associated with the first phase of development. Future facilities including seven well pads, three borrow pits and utility corridors will be developed within the Project Area and will be operated and reclaimed using similar mitigation measures as proposed for the initial facilities (Section 4).

1.7.3 Summary of Public Consultation

Sunshine is committed to continuous, open and transparent dialogue with communities, residents and other stakeholders associated with the Project. Sunshine believes that consultation works

best when proactive community and stakeholder engagement occurs. The consultation program will continue throughout the course of the applications and approvals process and will provide the foundation for effective community relations over the life of the Project. Sunshine's community investment activities will be conducted with local communities in a manner that is socially, environmentally and economically responsible and sustainable.

Sunshine's key objectives, consistent with ERCB Guidelines and industry consultation best practices, include:

- seeking input into the design of the consultation process at the outset to ensure that communication and consultation needs are met;
- facilitating and maintaining open and effective communication with all stakeholders, including but not limited to members of the public, regulatory bodies and industry who are or may be directly related to the proposed exploration and development activities;
- providing aboriginal communities and stakeholders with clear and timely information;
- ensuring that a transparent, respectful relationship is built and maintained with stakeholders throughout the Project Area;
- developing and maintaining long-term relationships with key stakeholders;
- enhancing public understanding and knowledge of the Project;
- identifying and understanding the perspectives and concerns of various stakeholders and communities of interest;
- addressing stakeholder interests related to the Project;
- establishing processes to allow local stakeholders to benefit from economic and employment opportunities;
- welcoming and supporting participation from interested individuals or groups; and
- using input from the public to assist in decision-making related to Project planning, design and operations.

Sunshine has undertaken a comprehensive stakeholder communication effort, as detailed in Section 3 of this Application. A public consultation and community relations program pertaining to the Project was formally initiated in February of 2008. Consistent with its commitment to establishing long-term stakeholder relationships throughout the life of the

Project, Sunshine has been consistently working and communicating with stakeholders. A designated senior professional has been hired for the comprehensive public consultation effort for the entire Project Area. The detailed consultation activities with the stakeholder groups and the PNG right holders are summarized in Appendix 4.

To date, Sunshine has focused Project consultation activities on the access road and all activities outlined in the Project's first phase of development. The future phase 2 and additional facilities including well pads, borrow pits and utility corridors will require further consultation during the regulatory review period. Sunshine will continue consultation activities in regards to the entire West Ells Project and will provide consultation updates as required.

1.8 Environmental Assessment

The Project will have an insignificant impact on land and resource use. Section 4 of the Application details Sunshine's review of the potential for material impacts on the environment and highlights Sunshine's commitment to proper environmental stewardship. In summary:

- There are no events under standard or upset operating conditions that are expected to put air quality at risk.
- The effects of the Project and access road on surface aquatic resources within the Aquatics Local Study Area are expected to be insignificant after the application of suitable mitigation measures.
- Groundwater production from the Grand Rapids Formation is expected to have no significant effects on the quantity of water in other formations, the surface water resources or vegetation. Since there are no other Grand Rapids water users within the Project Area, interference effects will not occur.
- Extensive produced water recycling on steady state is expected to be equal to or greater than 97%.
- Potential spills or leaks of bitumen, produced water or process-related chemicals are expected to have no adverse effects on the quality of the groundwater resources. The operation of the SAGD production and injection wells are expected to have no adverse effects on the chemical quality of the potable aquifers. The operation of wastewater disposal wells is expected to have no adverse effects on the quality of groundwater.
- There are no potential impacts on Historical Resources.
- The hydrologic impacts caused by Project surface disturbances are expected to be insignificant.

- Detailed noise modeling indicated projected noise levels below the permissible levels identified in ERCB Directive 038.

- The Project contains adequate soil resources for reclamation. By utilizing acceptable soil salvage, soil handling and reclamation practices, the impact upon the soil resources will be minimal throughout the life of the Project.

- The overall impact of the Project on vegetation resources is low. Proper reclamation and re-vegetation techniques will reduce any long-term impacts that may occur.

- The Project and access road were designed to minimize potential effects of the Project on wildlife. In addition, several mitigation and monitoring measures will be implemented.

Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further environmental data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

2 PROJECT DESCRIPTION

2.1 Project Overview

Each of the key components of the Project is described in further detail below.

2.1.1 Overview - Bitumen Extraction and Processing Components

Proposed facilities for the Project include a number of well pads and associated infrastructure (e.g., well pairs, roads, power-line, pipeline) so that the bitumen can be extracted from the Oil Sands reservoir and transferred to a CPF. At the CPF, the bitumen is subjected to a number of processes before it is sent off site, via trucks initially, to a custody transfer point.

2.1.1.1 Well Pairs

The SAGD process involves drilling a pair of horizontal wells to extract bitumen from the Oil Sands reservoir (Figure 2.1-2). Steam is circulated in both wells until fluid connection between the two wells is achieved. Once connectivity has been established, steam is then injected continuously into the top horizontal well, the steam "injection" well, to create a steam chamber. Within the chamber boundary, bitumen is mobilized by steam, permitting the mobile fluids to drain to the bottom horizontal well by gravity. The bottom horizontal well, the "production" well, then collects fluids at the bottom of the steam chamber which are pumped to the surface CPF where bitumen, steam condensate, produced gases and water are separated and treated.

For the first phase of the Project, the steam injecting and producing sections of each horizontal well pair have been designed to be 800-1,000 m in length within the bitumen formation. The average sub-surface inter-well spacing (distance between wells) will be 70-100 m, with the wellheads spaced at 15 m. The vertical separation between horizontal sections of the injection well and production well will be approximately 5 m. Based on the simulation for production at conservative 400 kPaa steam injection pressure (Section 2.4), approximately 80 well pairs will be drilled throughout the life of the Project. The well pair design is described in greater detail in Section 2.5.

2.1.1.2 Well Pads

To minimize the amount of surface disturbance and to reduce infrastructure development costs, multiple well pairs will be drilled from each well pad. During the 25 year Project life, it is anticipated that 9 well pads will be used to access the bitumen reservoir. The well pads will have 6 to 10 well pairs per pad as determined by the evaluation of geological, environmental, technical and economic considerations.

Facilities located on each well pad will include wellheads, testing facilities, a manifold building, a casing vent gas compression system with flare relief and a utilities building.

Bitumen production from the well pads will flow through interconnecting above-ground piping to the CPF. The injection steam will flow from the CPF through the same interconnecting above-ground piping system to the well pads. The well pads are described in greater detail in Section 2.5.

2.1.1.3 Central Processing Facility

The Project CPF will be located in NE 31, Twp 94, Rge 17, W4M (Figure 2.1-1). For the Project, Sunshine intends to use well-established SAGD bitumen processing technologies (Figure 2.1-3).

The heated bitumen, produced gases, steam condensate and water (collectively referred to as "production fluids", "emulsion", or "reservoir fluid") are extracted from the production wells. The emulsion is then transported at high temperatures and pressures to the CPF via the insulated above ground pipeline system. At the CPF, the emulsion undergoes a number of processes.

Once the emulsion enters the CPF, the produced gases bound in the emulsion are separated and recovered as a fuel source for subsequent use in the SAGD process. The emulsion is then injected with "diluent", a hydrocarbon fluid that is added to dilute the emulsion so that it becomes less viscous. The diluent serves two purposes; by making the bitumen more fluid, it assists in making the product flow easier and it aids in separating the oil from the water.

The diluted emulsion is then sent through an oil/water separation process. During this separation process, oil having less than 0.5% impurities (i.e. water, sand and silica) is transferred to a holding tank, monitored for quality control, and then sent to market. . Oil with greater than 0.5% impurities is further treated through a series of gravity separation and filtration vessels such that the sand/silica and water is allowed to settle, and oil is skimmed off the surface. Oil that now meets purity specifications is sent to the holding tank. Oil that does not meet these specifications is either gradually blended in with the oil already having less than 0.5% impurities, or is treated as waste material.

The produced water is sent to an evaporator. The evaporator produces a pure distillate steam for use in steam generation. Brine from the evaporator will initially be trucked to an offsite facility until a suitable permeable formation is identified for disposal. The top potential choices for disposal are in the fractured Devonian carbonates. The Leduc formation has a thick porous reef buildup suitable for disposal west of Sunshine's acreage. Although no suitable deep disposal zones were identified on Sunshine's acreage during the 2007 winter drilling program, Sunshine will continue to evaluate the availability of deep disposal zones in its 2010/2011 program.

Vapour from the well pads flows to the facility in a dedicated emulsion vapour line. Emulsion vapour will be cooled in heat exchangers and the condensed liquids will be separated in a vessel. Gas from the separator vessel will flow to a sour fuel gas system and liquids from the separator vessel will be level controlled to the slop tank.

The Sunshine West Ells CPF is described in greater detail in Section 2.6.

2.1.2 Overview - Utility and Transportation Components

The utility corridor included in the Project footprint (Figure 1.3-1) will be used as an access road, pipeline and power line right of way. These are discussed in detail in Sections 2.6 and 2.9.

2.1.3 Overview - Site Selection Project Facilities

In order to determine the most suitable location for the Project facilities, Sunshine engaged in a constraints mapping process which involves an evaluation of the various economic, environmental and social sensitivities associated with the proposed development. This process is further explained in Section 4.12.

For locating the facilities, numerous site selection criteria were considered including the following:

- that the CPF be centrally located to the SAGD bitumen reservoir;
- that the CPF be located in close proximity to existing utilities;
- that the well pads be located to minimize operating distance between the pad site and the CPF, yet still optimize resource recovery;
- that the location of Project facilities and infrastructure be kept away from sensitive environmental features such as rare plants or rare plant communities; and
- that the location of Project facilities and infrastructure be optimized by incorporating key design and environmental features, which encourage maximum resource utilization and minimize environmental impacts.

2.2 Geology and Resource Recovery

This section evaluates the geology of the Project Area and PDA, and provides an estimate of the Wabiskaw Member bitumen resource. Sunshine evaluated the regional geology for the Project, which included Townships 94 to 96 and Ranges 17 to 18 W4M.

2.2.1 Geological Data and Control

The Project Area includes Sunshine OSL No. 7407060175, which covers 768 ha (1898 acres) of land located in Sections 30-32, Twp 94, Rge 17, W4M; OSL No. 07407020023, which covers 512 ha (1265 acres) of land located in Sections 25 and 36, Twp, 94, Rge 18, W4M; and OSL No. 07407070311, which covers 256 ha (633 acres) of land located in Section 33, Twp 94, Rge 17 W4M (Figure 1.1-2).

Sunshine had completed 11 core holes within the Project Area during the winter drilling program in 2008. There are 8 drilled wells in the Phase 1 development area located in the west half of Section 31-94-17-W4 (Figure 1.1-3). The program delineated a bitumen rich Wabiskaw Member shoreline sand that has consistent reservoir characteristics over the PDA. Sunshine is also planning to drill more exploratory/delineation wells within the PDA during the 2010/2011 winter drilling season. Figure 2.2-1 illustrates the locations of exploratory wells drilled in 2008 along with future proposed locations. Sunshine is evaluating the requirement for future resource delineation which may include a combination of coreholes, and 3D and 4D seismic programs.

2.2.1.1 Exploration Core Hole Program Information

There are 2 pre-existing wells in the West Ells Project Area which were drilled for gas targets. Sunshine drilled 22 oil sands core holes in 2008 within the West Ells Lease resource evaluation area (11 of the 22 wells that were drilled in 2008 are located within the Project Area). An additional 9 wells are to be drilled within and adjacent to the PDA during future drilling programs (Figure 2.2-1). These wells will be a combination of observation wells and core holes bringing the density of drilling within and adjacent to the PDA to one well every 65 acres. Given the consistent, predictable geology within the PDA, and the relatively flat structure of the top and base of the Wabiskaw pay zone, this density of drilling is appropriate. Continuous Wabiskaw/McMurray core was taken in all 22 of Sunshine's wells drilled in 2008 on the West Ells Lease. It is Sunshine's intention to take continuous Wabiskaw/McMurray core in most of these additional wells, thereby exceeding the requirement of one core per quarter section.

Core samples have been analyzed for bitumen saturation, porosity and permeability and a detailed facies description has been recorded for each core. Effective porosity is calculated using the density log which is corrected for shale volume. The oil saturation calculation from the log data is calibrated to Dean-Stark analysis data from the cores. All log and core data are combined into Petrel, a resource model capable of characterizing bitumen distribution and reserves.

2.2.2 Regional Geology

The three major geologic time intervals represented in the Lease Area, described from youngest to oldest are:

- Quaternary – 10,000 years before present (BP) to 1.6 million years BP;
- Tertiary – 1.6 million years to 66 million years BP; and
- Cretaceous – 66 million years to 144 million years BP.

At the base of the Quaternary, Tertiary and Cretaceous are major unconformity surfaces, representing long periods of non-deposition and erosion. These unconformity surfaces provide continuous subsurface markers that can be recognized and correlated over a large area, providing a high degree of confidence in the mapping.

Figure 2.2-2 shows the general stratigraphy in the West Ells area. In northeastern Alberta, the Mannville Group is composed primarily of unconsolidated sedimentary rocks that are divided into three formations. From oldest to youngest, these formations are the McMurray, the Clearwater and the Grand Rapids Formations. The bitumen resource at West Ells is within the Wabiskaw Member of the Clearwater Formation. The Wabiskaw overlies the McMurray Formation which in turn overlies the Pre-Cretaceous Unconformity. Devonian aged shales and carbonates underlie the unconformity in this area and were erosionally sculpted resulting in local topographic highs separated by erosional valleys.

2.2.2.1 Woodbend Group

Underlying the Pre-Cretaceous Unconformity, the Devonian Ireton and the Cooking Lake Formations of the Woodbend Group consist of dolomitized fossiliferous limestones and argillaceous limey muds. Figure 2.2-3 shows the structure of the Woodbend Group in regional context. The Pre-Cretaceous erosion is thinning these units from west to east towards a zero edge east of the Project Area.

In addition to the regional influences of the Beaverhill Lake Spur and the Grosmont High in forming the Northern Subbasin, the Pre-Cretaceous Unconformity has impacted the depositional thickness of the Wabiskaw and the underlying McMurray. The Devonian structure rises west and northwest toward the Grosmont High from the Northern Subbasin, (Figure 2.2-3). A high structural trend on the Sub-Cretaceous unconformity extends eastward from the Grosmont High to the West Ells area. The McMurray thins westward to zero thickness as it onlaps the rising Devonian structure. The Wabiskaw also thins westward as it onlaps the rising structure of the Sub-Cretaceous Unconformity. The thinning of the Wabiskaw onlap is prominent during deposition of the Wabiskaw D unit. Exposed Devonian during much of the Wabiskaw D time frame likely acted as a locus for shoreline sand deposition and resulted in the clean Wabiskaw D sand accumulation at West Ells.

2.2.2.2 McMurray Formation

In the Project Area, the basal sediments of the McMurray Formation were deposited in incised valleys. The early deposition consists of fluvial sediments deposited in high-energy, sand dominated environments. The later deposits were formed more in marine/estuarine environments resulting in coarsening upward sequences of sand and mud. The McMurray deposits overlie the Sub-Cretaceous Unconformity and thin to zero thickness against the west flank of the Grosmont Devonian High.

2.2.2.3 Clearwater Formation

Dipping regionally to the southwest, the Clearwater Formation contains a regional aquifer, regional marine mudstones which act as aquitards, and the Wabiskaw Member (including the Wabiskaw Shale, a mudstone unit (the reservoir cap rock), and the Wabiskaw sands (the bitumen reservoir)).

In the Project Area, the Clearwater Formation lacks the thick regional aquifers found to the south. Laterally extensive marine mudstones, 3 to 15 m thick, are present throughout the area separating thin (1-2 m) silts and argillaceous sandstones. These mudstones are regional aquitards and ideal, competent cap rock for SAGD operations in the Wabiskaw sands.

The Clearwater Formation overlies the McMurray Formation and is generally 80 m thick within the regional area. The structure and isopach maps of the Wabiskaw Member of the Clearwater Formation are included as Figures 2.2-8 and 2.2-9, respectively.

2.2.2.4 Wabiskaw Member

The West Ells area is located approximately 64 km west of the erosional limit of Cretaceous deposits along the Athabasca River valley. It is located within a northwest trending, Sub-Cretaceous valley defined by two erosion-resistant Devonian features on the Sub-Cretaceous Unconformity: the Grosmont High on the West flank and the Beaverhill Lake Spur on the East flank. The northward opening Sub-Cretaceous valley forms a depocentre designated as the Northern Subbasin. The McMurray Formation underlies the Wabiskaw and pinches out where it onlaps the Grosmont High. Wabiskaw time erosion of the McMurray resulted in an embayment shaped low in the Northern Subbasin which is interpreted to be the seaward opening of an incised valley. The Wabiskaw in the Ells area is deposited in the Northern Subbasin embayment above the erosional top of the McMurray and ranges from 25 m to 40 m thick, including up to 25 m of bitumen saturated sand.

The Wabiskaw Member can be subdivided into a series of sand-rich prograding shoreline units capped by a regional marine mudstone called the Wabiskaw Shale or the Clearwater B marker (Figure 2.2-11). The Wabiskaw sands were deposited in a marine shoreface setting. This

upward-coarsening succession consists of mudstones at the base that grade upward to medium grained sands at the top. Each of the Wabiskaw shoreface sand units onlap the Grosmont High and thin to the west. The three shoreface sand units are all laterally continuous, unconsolidated, fine-medium grained quartzose to lithic sands. There are no lithological barriers separating the three Wabiskaw shoreface sand units as they are in direct sand on sand contact.

The Wabiskaw D represents deposition during a transgressive event and is the lowermost and thickest reservoir unit directly overlying the McMurray. It is deposited in the highest energy environment and incises into underlying McMurray stratigraphy. The thin mudstones within it are a distinctive blue-grey colour and the sand has a blocky or cleaning upward gamma ray profile typical of shoreface deposition. The Wabiskaw C sand lies above the Wabiskaw D and is distinguished by a slight increase in gamma signature due to a higher K-feldspar content. The Wabiskaw A sand is the thinnest unit and typically includes gamma ray values ranging from 30^{o} – 45^{o} API units. Figures 2.2-6 and 2.2-7 illustrate the Wabiskaw Bitumen Pay.

2.2.2.5 Grand Rapids Formation

The Grand Rapids Formation dips to the west and its thickness averages 50 m. The Grand Rapids Formation is further divided into the Upper Grand Rapids and the Lower Grand Rapids Formations. The Lower Grand Rapids consists of coarsening upward sand, silt and mud intervals and porous intervals are generally wet with occasional thin gas zones (<1m) in the Project Area. The lower 5-15 m of the Grand Rapids is a regional mudstone aquitard. The Upper Grand Rapids Member consists of stacked coarsening upward cycles separated by impermeable thin marine shales. The structure of the Upper Grand Rapids Formation is shown in Figure 2.2-10.

2.2.2.6 Joli Fou Formation

The Joli Fou is a 3-10 m regional marine mudstone that acts a regional aquitard, however locally it may be cut by a Quaternary channel in section 31-94-17W4.

2.2.2.7 Viking Formation

The Viking (also known as the Pelican Formation locally) is a regionally extensive marine silt and sandstone shelf that reaches 45 m in thickness. The unit dips gently to the west and subcrops at the Pre-Quaternary Unconformity to the east and 5 miles south of the Project Area. The Viking is also cut locally by a narrow Quaternary channel in section 31-94-17W4. The fine sand cleans upwards has high permeability (1- 2 Darcies) and porosity (34%) and contains large volumes of water. Tests are rare, however a water recovery during Sunshine's 2007/2008 program indicated a water salinity in the range of 933tds. This zone is being considered as a possible water source for the Project and will be dealt with more detail in the hydrogeology

section. The structure and isopach for the Viking Formation are shown in Figures 2.2-23 and 2.2-24.

2.2.2.8 Quaternary

The glacial section overlies the La Biche Formation, separated from bedrock by the Pre-Quaternary Unconformity. Sand, till and gravel deposits are found within the Quaternary interval, representing at least five major ice ages and associated global warming episodes. In the Lease Area, five till sheets represent these ages and collectively, the deposits are approximately 100 m thick in this area. The till sheets are sediments that resulted from the buildup of continental ice sheets more than 1 km thick and their associated interglacial deposits (glaciofluvial meltwater deposits produced during global warming episodes at the end of each ice age). Quaternary channel deposits, formed by catastrophic glacial meltwater events and interglacial fluvial drainage systems, can contain sand and gravel intervals that have the potential to act as localized fresh water aquifers. Sunshine is currently mapping these aquifers and will have a report completed in 2010.

The known Quaternary channels in this area, such as the Birch Channel, can erode into bedrock as deep as the Grand Rapids cutting through potential source water formations such as the Viking and Upper Grand Rapids. At Ells there is one known channel approximately 400 m wide and 2 miles long that cuts as deep as the Joli Fou Formation, removing the Viking formation. Sunshine will include this channel in its 2010 report.

2.2.3 Project Area Reservoir Characterisation

2.2.3.1 Site Stratigraphy

Figure 2.2-11 shows the well log for drill hole 1AA/04-31-094-17W4/00 which typifies the Wabiskaw site stratigraphy for the Project Area. Measurements of bitumen, water saturation and porosity were made on the core from this drill hole. There was agreement between the log and the core data.

Six cross sections showing the stratigraphy through the Project Area have been developed. The locations of these cross sections are shown on Figure 2.2-12 and the cross sections are included as Figures 2.2-13 to 2.2-18.

2.2.3.2 Wabiskaw Member -Local Reservoir Characterization

In the Project Area, the Wabiskaw is represented as a local thick reaching 24 m (Wabiskaw Member structure and isopach Figures 2.2-4 and 2.2-5). Structurally, the top of the Wabiskaw Member is a flat high that gently dips off to the east and will allow a flat roof to the SAGD chamber.

Sunshine uses a Wabiskaw stratigraphic framework modeled after AOSTRA publication #10. The Wabiskaw in the Northern Sub-basin is comprised of three units: A, C, and D. The Wabiskaw B sand is not present in the Project Area. The A and C units are marine shoreline sands deposited on the east side of the Grosmont High. The bases of the A and C sands are transgressive surfaces of erosion and the overlying A and C sands are generally more argillaceous than the underlying sediments. The D sand in the broad low of the Northern Subbasin embayment (ranges 14-18W4), is comprised of clean marine shoreline sands derived from the estuarine incised valley fill D sands in the southeast portion of the northern subbasin (ranges 11-13w4).

The lowermost Wabiskaw D shoreface sand unit is laterally continuous, unconsolidated, clean quartzose sand ranging from 5 m to 15 m thick and averaging 12 m in the PDA. The D sand thins westward on the west flank of the Northern Subbasin as D shoreface sand deposition onlaps the Sub-Cretaceous Unconformity. A mudstone that is generally present at the base of the D sand is used to define the base of the Wabiskaw. The D sand has a blocky or cleaning upward gamma ray profile that typically includes gamma ray values ranging from 15º-35º api units, 30% to 34% density log porosity and horizontal permeability from 1 darcy to greater than 8 darcies.

The Wabiskaw C shoreface sand unit is laterally continuous, unconsolidated, lithic quartzose sand ranging from 2 m to 10 m thick averaging 4 m in the PDA. The C sand thickens to the south and east, infilling the increased accommodation space of the Northern Subbasin. The C sand unit generally overlies the D sand unit with direct “sand on sand” contact. A discontinuous mudstone at the base of the C sand is recognized at the southern margin of twp 93 rg18w4 and southward. The C sand has a cleaning upward gamma ray profile that typically includes gamma ray values ranging from 20º-35º api units, 28% to 33% density log porosity and horizontal permeability from 300 millidarcies to greater than 5 darcies.

The uppermost Wabiskaw sand unit is the Wabiskaw A shoreface sand. The Wabiskaw A is a laterally continuous, unconsolidated, lithic quartzose sand ranging from 2 m to over 18 m thick regionally but averaging 3 m in the PDA. It is generally gas charged. The A sand unit overlies the C sand unit with a direct “sand on sand” contact. The A sand has a cleaning upward gamma ray profile that typically includes gamma ray values ranging from 30º-45º api units, 28% to 33% density log porosity and horizontal permeability from 200 millidarcies to greater than 800 millidarcies.

All core analysis porosity and oil saturation measurements made by Sunshine in its West Ells Project Area are posted against the LAS petrophysical curves (Figure 2.2-19). The Wabiskaw sand is overlain by approximately 15 m of a regional Wabiskaw marine mudstone which provides a competent cap rock for the bitumen resource (see Section 2.3.5).

2.2.4 Bitumen Reservoir Characterization

The Oil Sands pay zone has been identified and characterized by integrating log and core data. Figures 2.2-6 and 2.2-7 show Wabiskaw Bitumen Pay. A reservoir model has also been created for the West Ells area based on the available core and log data. Identifying and recovering hydrocarbons requires a high resolution geological model of the reservoir structure and stratigraphy. With the reservoir model in place, simulations have been used to reduce uncertainty and to assist in future well planning. Advanced up-scaling techniques have allowed the re-creation of geologically accurate models for full reservoir simulation.

2.2.4.1 Bitumen Reservoir Quality

Within the Project Area, the reservoir's net continuous Oil Sands pay zone thickness ranges between 13.5 m and 18.0 m. Table 2.2-1 lists the average reservoir parameters and fluid properties within the Project Area based on logs and core data derived from the exploration programs.

Table 2.2-1 Average Values of Key Wabiskaw Reservoir Parameters within the PDA

Reservoir Parameters	Value
Continuous Net Pay (m)	13.5-18
Porosities	32%
Ave. Bitumen Saturation over Net Cont. Pay	78%
Reservoir Temperature (C)	9.5
Bitumen Viscosity at TRes (cp)	>1,000,000
Horizontal Permeability (md)	500 - 8,000
Vertical Permeability (md)	400 - 6,000

Figures 2.2-20 and 2.2-21 show the reservoir oil saturations and effective porosities as modelled with PETREL. Output from this model confirms Sunshine's prognosis of the resource and the continuous uniform deposition, porosity and saturation, indicating SAGD as an appropriate applied technology for efficient extraction of the resource.

2.2.4.2 Bitumen Resource Evaluation

Sunshine conducted a detailed internal resource evaluation of the Project Area (3,870 Acres). The map of the Project Area is shown in Figure 2.2-22 including the estimated OBIP volume calculations. The OBIP volume in the Project Area is estimated to be 60,000,000 m^3 (377,800,000 bbl).

Based on computer simulations Sunshine estimates that 55% of the bitumen originally in place is recoverable by the SAGD process (33,000,000 m^3 / 207,000,000 stb). A discussion with respect to performance of the SAGD process and anticipated bitumen recovery estimates is provided in Section 2.3. The estimated OBIP within the Project Area represents more resource than required to sustain the 10,000 bpd production level for the entire 25 year life span.

2.2.5 Hydrogeology

Source water for the Project is proposed to be drawn from water wells drilled into the Viking and Grand Rapids Formations (Section 2.9.4 - Fresh Water Supply and Storage). In the winter of 2008/09 Sunshine drilled 3 water wells to investigate these potential aquifers. Further drilling is expected to test flow rates in the winter of 2010-2011. The evaluation will include a water well that will be drilled into the Viking with production tested for rates and drawdown. The potential impacts of the Project on hydrogeological resources is discussed further in Section 4.4, Consultant's Report #4 and the Ground Water Monitoring and Testing Report at Appendix 7 to this Application.

2.3 Reservoir Engineering

2.3.1 Recovery Process

Sunshine's application of SAGD technology is consistent with the parametric and petrophysical quality of the West Ells reservoir. Sunshine has conducted extensive geostatistical and numerical modeling, integrated with advanced wellbore logging information to determine the optimum application of thermal extraction technology. Reservoir porosity, permeability, saturation and grain-stone uniformity, among other reservoir performance indicators, are all within acceptable limits for the successful commercial application of SAGD.

The average reservoir parameters and fluid properties within the Project Area are listed in Table 2.2-1. Based on the high bitumen saturations and viscosities, reservoir depths greater than 250 m and adequate reservoir thickness, the most appropriate commercially viable process available to extract this resource while minimizing the environmental impacts is SAGD.

2.3.2 SAGD Recovery Process Description

Application of the SAGD technology requires the drilling of pairs of wells horizontally near the base of the reservoir with a vertical offset of approximately 5 m between the wells. The lower well is drilled 1-3 m above the base of the reservoir while the steam injection well is located 5 m directly above this producer. These wells are oriented and designed for high temperature steam injection and associated production of bitumen and water. After a warm up period, the lower well is set up for continuous production while the upper well continuously injects steam through

the upper wellbore into the reservoir and a steam chamber is formed, heating the formation and the bitumen. The heated bitumen drains into the lower horizontal well and flows or is pumped to the surface.

The use of SAGD technology provides many technological and environmental advantages. It uses less natural gas than other thermal processes, and it is a continuous process not having the rapid heating and cooling cycles that are very demanding on wellbore casings. For the Project, optimal application of this technology will preserve the integrity of the reservoir as steam will be injected below the fracture pressure (~4,200 kPaa at 250 m, detailed in Section 2.3.5) of the reservoir. This process will also limit land disturbance and environmental impacts, as several horizontal wells will be drilled from centralized pads.

For the first phase development, Sunshine expects to use 13 horizontal SAGD well pairs, 800 m to 1,000 m in length and spaced 70-100 m apart. Only two surface pads will be required in the first phase which limits surface land disturbance and environmental impact. The surface spacing between wells will be 15 m.

The well pairs will be operated in three steps:

The process starts with a 'Circulation Phase' in which the well pairs are preheated until there is relatively even heating along the entire horizontal length and thermal communication is eventually established between the injector and producer. This phase is expected to take 60 to 120 days.

Following the circulation phase, the 'SAGD-Phase' injects steam into the injection well to form a continuously growing steam chamber. Hot, produced fluid from the edges of this steam chamber drains into the lower producing well and is pumped to surface.

At some point in the operational lifecycle, as the steam chamber reaches the top of the pay zone and expands horizontally, productivity slows and ultimately it becomes uneconomical to continue injecting steam. This leads into the final 'Wind Down Phase', in which steam injection is continuously reduced until production is terminated, the wells are abandoned and the leases reclaimed. NCG injection can be utilized at this step for steam chamber support which could extend the life of the wells through SOR management.

At the second phase of the Project, more well pairs will be drilled to expand and sustain the production level at 10,000 bpd. A conceptual future well pad and well pair layout shown in Figure 2.1-1 have been designed based on the STAR simulation model with steam injection pressure of 400 kPaa. The simulation is discussed in more detail in Section 2.3.3. From the simulation results in Figure 2.3-1 the production rate will decline after 3 years of production. To sustain the production at 10,000 bpd, 2-4 infill well pairs will be required each year. These

future well pairs will be drilled from the conceptual well pad layout shown in Figure 2.1-1. Pad 3 and pad 4 will be drilled for Stage 2. Future in-fill well pairs will be drilled from pad 5 to pad 9. Pads 10 to 13 are identified for the future potential pad site placement. The infill drilling will be optimized depending on the production performance and the steam chamber development.

2.3.3 Bitumen Production Rate and Recovery Estimates for the Project

Sunshine employed computer simulation to estimate bitumen production rates, recoveries and steam to oil ratios (SOR) for the Project.

On October 15, 2009, this Board issued Decision 2009-061, granting the applications by Sunshine and others for the interim shut-in of gas production from intervals in communication with the bitumen sought to be extracted. Some of the wells ordered to be shut-in are identified in Table 2.4-1.

The field data from the 2007/2008 drilling operations identified the gas zone pressures to be 290 kPaa at 14-31-94-17W4. Further drilling in 2009/2010 acquired new data that showed the gas zone pressures to be 500-600 kPaa within the same region of influence at 9-8-96-17W4. 400 kPaa injection pressures, as presented in this application, should be conservative considering the current higher pressures found within the region of influence and complimentary pressure rebound effects taking place after the shut in of gas producing wells. Sunshine has installed peziometers in 9-8-96-17W4 which is within the region of influence and will monitor the pressures within the gas zones and the associated pressure changes over time.

As a conservative interpretation (290 kPaa gas zone pressure) Sunshine expects that after the producing gas wells have been shut-in, continuous gas dissolution from the bitumen combined with reservoir pressure equalization will increase the observed reservoir pressure. Sunshine estimates that as a result of the reservoir pressure rebound, the equilibrium reservoir pressures in 2013, when the first phase of the Project is expected to begin operation, will have increased from approximately 290 kPaa to at least 400 kPaa. The detailed simulation results below, which are based on the conservative pressures of 400 kPaa, confirm that Sunshine will be able to operate commercially with steam injection at that pressure.

2.3.3.1 Multi-Well Simulation Forecasts

Sunshine employed a Multi-well SAGD 3D numerical model utilizing discretized wellbore feature in CMG STARS to forecast the production for an average 800 m long well. This model simulates wellbore fluid dynamics and heat transfer between wellbore and reservoir/ overburden. The results of this multi-well simulation (five well pairs were simulated) can be seen in Figure 2.3-1.

Simulation input data incorporated known West Ells bitumen parameters. The reservoir characterizations are consistent with industry standards. The log and core analysis data from well 5-31-94-17-W4 was used to define the reservoir simulation gridblock parameters. Crossplots of porosity vs. horizontal and vertical permeability were applied to the model using the type well porosities representative of the West Ells Wabiskaw reservoir. The simulation grid porosities as well as horizontal and vertical permeabilities are shown in Figures 2.3-2, 2.3-3 and 2.3-4. The water and gas saturations were obtained from log data, corrected to core saturation. Water Saturation along the vertical blocks is shown in Figure 2.3-5. There is a lean bitumen zone encountered in the type well log at layer 10 of the simulation grid. Even though this lean zone is not present in all of the wells in the Project Area, Sunshine has conservatively simulated this lean bitumen zone as being continuous over the entire simulation grid. The gas saturations in the top two layers (two-meter gas zone on top of the bitumen) are 62% in layer 1 and 39% in layer 2. This zone has been conservatively modelled as an infinite gas zone. Oil viscosity is based on known Athabasca viscosity curves and calibrated by the core analysis for the West Ells area. The Viscosity curve used in the simulation is shown in Figure 2.3-6.

This simulation grid contains 81,060 cells and allowed for 5 wellpairs in half-symmetry to be incorporated into the simulation with 800 m lengths and 70 m spacing between wells. The rectangular simulation grid measured 10 x 386 x 21 with individual block dimensions of 100 m x 2 m x 1 m. Five discretized well pairs in half-symmetry were chosen as a scalable indicator of multi-wellpair performance. The 800 m injectors consisted of 8.625” slotted liner and 4.5” long tubing string extending to the toe. The 800 m producer consisted of 8.625” slotted liner and 4.5” long tubing string extending to the mid-point of the lateral section.

In order to simulate the effects of an extensive gas zone and lean zone, these were modelled as being infinite. In the gas zone, this was done by placing a constant-pressure gas well in the gas zone at the grid boundary. For the lean zone, possible outflow was expected during the early phases of SAGD before breakthrough to the gas zone, and possible inflow afterwards. A near-constant pressure condition was established within the lean zone with both a source and a sink well in the lean zone at the grid boundary. Both the water injector well and the water producer well were set to bottomhole pressures that straddled the initial gridblock pressure. These wells were incorporated to maintain a near-constant pressure at the boundary for both the lean and gas zones.

An effective pre-heat period is paramount in establishing proper SAGD performance, and this process was included in the simulations. Figure 2.3-7 shows the multi-well grid steam chamber with the 5 well pairs after 4 months of steam circulation. Upon completion of the circulation phase, SAGD commenced in which steam was injected into the injector well at a constant pressure of 1,100 kPaa. This pressure was maintained but gradually reduced in order to balance the steam chamber pressure with the 400 kPaa gas cap pressure at breakthrough. The maximum

steam injection pressure of 1,100kPaa is well below the formation and cap rock fracture pressures, therefore ensuring proper SAGD operations and steam chamber control and development. In the simulations, each well was restricted to maximum total fluid production rates of 650 m^3/day. The maximum steam rate is 5 m3/d/well and the steam quality is 98%.

The steam chamber development for in-balanced steam injection at 400 kPaa reservoir pressure is shown in Figures 2.3-8 to 2.3-10. The steam chamber development confirms that there is no steam loss to the top lean zone due to the pressure in-balanced steam injection. The average SOR is approximately 3.3.

Steam injection at 400 kPaa is a low pressure SAGD operation. Compared to high pressure steam injection, low pressure SAGD wells usually have lower production rates. A positive aspect of low pressure SAGD is that the life span of each well pair is longer. Table 2.3-1 shows the expected average 5 well production performance at 400 kPaa balanced steam injection pressures. Steam oil ratios, production rates and cumulative produced volumes are identified for the 5 simulated well pairs and are considered representative for the West Ells Project development.

Table 2.3-1 Average 5 Well Reservoir Performance (400kPaa)

Year	1	2	3	4	5	8	11	14	17	19	20
Annual Production (E3m3)	78	76	83	81	69	51	40	28	21	17	15
Oil Production (m3/d)	213	207	227	221	188	140	109	78	57	46	42
Cumulative Production (E3m3)	78	153	236	317	386	549	682	778	847	883	898
Steam Injection (m3/d)	757	788	683	600	530	393	339	307	278	261	254
Cumulative Steam (E3m3)	276	564	813	1,032	1,226	1,700	2,085	2,433	2,748	2,942	3,034
Average ISOR	3.6	3.8	3.0	2.7	2.8	2.8	3.1	3.9	4.9	5.6	6.0
Average CSOR	3.6	3.7	3.4	3.3	3.2	3.1	3.1	3.1	3.2	3.3	3.4

Future phases of simulation will focus on well management issues during operations, through the longer Project run period where history matching and model validation will be possible. Current modeling indicates that production rates of 45 m^3/day (283 bpd) can be achieved by well pairs in this SAGD development with a CSOR of ~3.3 at 400 kPaa injection. Each well pair is anticipated to produce 179,000 m^3 of bitumen with 55% recovery of initial bitumen in place (at an assumed economic cutoff of ISOR = 6 which is dependent upon the future cost of generating steam).

2.3.3.2 Recovery Estimates

Due to the existence of continuous and predictable shoreline sands in the Wabiskaw reservoir as described in the Geology Section 2.2, all of the six sections in the Project Area can be developed.

Evaluation of the six sections in the Project Area and the calculated OBIP volumes (evaluation was described in Section 2.2.4) of 60,000,000 m^3 (377,800,000 stb) indicates that far more resource is present in the Project Area than can be recovered in a reasonable time frame from the proposed 10,000 bpd 25 year development (recovery of 14 million m^3 (88 MMbbls) of oil).

Based on computer simulations, Sunshine estimates 55% of the bitumen originally in place is recoverable by the SAGD process (33,000,000 m^3 / 207,000,000 stb). Table 2.3-2 shows the simulation results and recoveries from the simulated 5 well pairs.

Table 2.3-2 5 Well Pair Simulation Recoveries

Injection Pressure	Proj Life (years)	OOIP (MMstb)	Cum Stm (MMstb)	Cum Oil (MMstb)	CSOR	RF
400 kPakPaa	19	10.2	18.86	5.61	3.36	55.0%

2.3.3.3 Development Plans and Schedules

The first phase of the West Ells SAGD Project development will proceed in Sections 31 and 30, with 13 well pairs drilled from two well pads (Figure 2.1-1). More well pairs will be drilled in the Project's second phase depending on the well performance during the first phase. During the 25 year life span of the Project, approximately 80 well pairs will be required to sustain the 1,600 m^3/day (10,000 bpd) production level. The Project will allow for full development of the Project Area. The well pad and expansion development plans are shown in Figure 2.1-1. Over the life of the Project, approximately 80 well pairs will be drilled from 9 well pads recovering in excess of 14 million m^3 (88 MMbbls) of oil. The production life for each individual well pair is estimated to be approximately 18-20 years. After three or four years, as individual well pair production starts to decline, additional well pairs will be required and drilled in order to maintain the 10,000 bpd production levels.

2.3.4 Reservoir Performance Monitoring

Sunshine will monitor reservoir performance through the measurement of individual well fluid volumes (injection & production) as well as down-hole and wellhead temperature and pressure

readings. Each well pair will be equipped with down-hole instrumentation such as thermocouple or fibre optic string in order to measure and monitor temperature along the horizontal length of the well. In addition, Sunshine will monitor vertical observation wells to observe the cap rock, pressurization of the upper lean bitumen zone and the progress of the steam flood/steam chamber development in selected areas. Observation wells will be utilized as discussed in Section 2.5.2.3.

Production and injection volumes will be measured in accordance with the Sunshine Measurement Principles set out in Appendix 5. A final Measurement and Reporting Plan (MARP) document will be submitted to the ERCB prior to site construction.

Operations staff responsible for monitoring well performance at the production pad will monitor casing integrity. Surface stations will measure any surface heave caused by steam injection in the PDA. Any operational pressure or temperature changes will be monitored and proper actions will be taken in order to protect the cap rock integrity.

2.3.5 Cap Rock Evaluation

The cap rock for the SAGD chamber is the Wabiskaw Shale Member of the Clearwater Formation. Thickness of the cap rock in the Project Development Area is 12 m to 16 m. Figure 2.3-11 shows the isopach map of the cap rock and cross sections showing the cap rock are included as Figures 2.2-13 to 2.2-18.

Sunshine performed cap rock testing in the PDA in order to ensure cap rock integrity for this SAGD development. Cap rock and Wabiskaw sands injectivity tests were completed on wells 7-36-94-18-W4M and 14-31-94-17-W4M in the PDA. There were two perforation intervals at each well; one of cap rock and the other for oil sands. The operation consisted of bull-head injection with a packer set between the two intervals in order to measure the in-situ minimum stress. Figure 2.3-12 shows the injectivity tests for 14-31-94-17W4 well and the full test analysis is presented in Appendix 6. Based on the injectivity tests completed in the Oil Sands, the in-situ minimum stress gradient for the Wabiskaw pay zone was found to be ~17 kPaa/m. The in-situ minimum stress gradient in the cap rock (shales) was determined to be 22 kPaa/m. The West Ells SAGD first phase development has been designed for initial maximum continuous injection pressures of 1,100 kPaa and intermittent pressure up to 2,000 kPaa while testing thief zone effects, which is much lower than the fracture pressure of the formation (~4,200 kPaa at 250 m) or of the cap rock (~5,400 kPaa at 248 m).

The injectivity tests have shown that shales directly above the Wabiskaw sands and into the Clearwater Formation are a barrier to steam and form competent cap rock. In the unlikely event that the cap rock is breached, steam would enter the Clearwater Formation but further contamination is unlikely. The data from observation wells will allow Sunshine to identify any cap rock breach. If loss of steam is encountered during operations due to cap rock breach

(sudden pressure drop and/or injection rate increase will trigger an alarm) the steam injection into the affected and adjacent well pairs will be shut down in order to minimize any contamination of the Clearwater Formation. Due to the continuous cap rock interval in the area and the low steam injection pressures in comparison to the cap rock fracture pressure, the risk of breaching the cap rock is minimal and unlikely. Also, the facility design consists of a maximum steam header delivery pressure of 5,000 kPag with a pressure safety valve (PSV) design of 4,000 kPag. This maximum facility design cannot exceed the cap rock fracture pressure of 5,400 kPag. The observation well and SAGD well pair injection pressure and down-hole temperature monitoring will allow for continuous evaluation of the steam chamber development and cap rock integrity.

2.4 Alternate Application Technologies

In this Application, Sunshine is proposing a cost-effective and technically prudent commercial development over two phases. During the Project's first phase subject to steaming at up to 2,000 kPaa to assess the effects of any thief zones, Sunshine expects to be able to operate at a balanced steam pressure of at least 400 kPaa based on current field data and following pressure rebound. The Project is commercially viable at this pressure.

2.4.1 Pressure Rebound and Balanced Steam Injection

Where lean zones overlie bitumen, SAGD operations must be balanced to that lean bitumen zone pressure. This requires the SAGD steam injection pressures to not exceed the overlying lean zone pressure. The balanced steam injection prevents the upper lean bitumen zone from behaving as a thief zone, thereby preventing steam losses and possible SOR and operating cost increases.

From the drilling results and petrophysical interpretation of logs, Sunshine has identified a lean bitumen zone in the Project Area. A PETREL geo-statistical model has been developed to map this overlying lean zone (Figure 2.4-1). A list of all the flowing and suspended gas well completions in the vicinity of the Project Area is shown in Figure 2.4-2 and listed in Table 2.4-1. All of the wells identified as "Flowing GAS" under Well Status in Table 2.4-1 are being shut-in in accordance with ERCB Decision 2009-061.

Table 2.4-1 Producing and Abandoned Wells in the West Ells Area

Well ID	Well Status	Current Operator Name	Part of Sunshine Lease	Abandoned with Thermal Cement
1AA/07-19-094-17W4/00	Drld & ABD	Athabasca Oil Sands Corp	No	Yes
1AA/02-20-094-17W4/00	Drld & ABD	Athabasca Oil Sands Corp	No	Yes
100/09-20-094-17W4/02	Flowing GAS	Paramount Enrg Operating	No	Shut-In
100/05-29-094-17W4/00	ABD Whipstock	Paramount Enrg Operating	No	No
100/05-29-094-17W4/02	Flowing GAS	Paramount Enrg Operating	No	Shut-In
1AA/11-30-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
100/03-31-094-17W4/00	Flowing GAS	Paramount Enrg Operating	Yes	Shut-In
1AA/04-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/05-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/06-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/11-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/12-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/13-31-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
1AA/14-31-094-17W4/00	Drilled & Cased	Sunshine Oilsands Ltd	Yes	Yes
1AA/16-32-094-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
100/10-33-094-17W4/00	Flowing GAS	EnCana O&G Co Ltd	Yes	Shut-In
100/11-34-094-17W4/02	Flowing GAS	EnCana O&G Co Ltd	Yes	Shut-In
100/12-34-094-17W4/00	ABD Whipstock	EnCana O&G Co Ltd	Yes	No
100/04-23-094-18W4/00	Flowing GAS	Paramount Enrg Operating	No	Shut-In
100/05-24-094-18W4/00	Susp GAS	Paramount Enrg Operating	No	Yes
100/05-24-094-18W4/02	Flowing GAS	Paramount Enrg Operating	No	Shut-In
1AA/10-25-094-18W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
100/07-26-094-18W4/00	ABD GAS	Paramount Enrg Operating	No	Yes
1AA/08-26-094-18W4/00	Location	Athabasca Oil Sands Corp	No	Shut-In
1AA/16-26-094-18W4/00	Drld & ABD	Athabasca Oil Sands Corp	No	Yes
100/09-35-094-18W4/00	Flowing GAS	Paramount Enrg Operating	No	Shut-In
1AA/07-36-094-18W4/00	Drilled & Cased	Sunshine Oilsands Ltd	Yes	Yes
100/14-02-095-17W4/00	Drilled & Cased	EnCana O&G Co Ltd	No	Yes
1AA/11-03-095-17W4/00	Drld & ABD	Sunshine Oilsands Ltd	Yes	Yes
100/14-04-095-17W4/00	Flowing GAS	EnCana O&G Co Ltd	Yes	Shut-In
100/04-05-095-17W4/00	Flowing GAS	Paramount Enrg Operating	No	Shut-In

As a conservative approach, Sunshine is considering the current West Ells reservoir overlying lean zone pressure to be approximately 290 kPaa which, as of the first phase of steaming, is expected to have rebounded following shut-in to 400 kPaa.

Efficient production at this relatively low pressure is dependent on several factors, including the following:

- Efficient distribution of steam along the injection well;
- Minimization of pressure losses in the reservoir between the formation and the injection well, and between the formation and the production well;
- Prevention of steam breakthrough into the production well, or proper design and operation of steam trap control; and
- Balancing the steam trap control sub cool temperature with impacts on fluid viscosity, to promote production with minimum vapour breakout from the fluid while maintaining maximum fluid temperature to reduce viscosity.

Progressive cavity pumping systems have been demonstrated to operate successfully in low pressure, high temperature conditions. Metal on metal progressive cavity pumps are able to successfully lift complex, high viscosity fluid systems under a variety of conditions. Field data is available in the public domain to show that, provided the pump inlet is covered by the reservoir fluids being produced, metal on metal progressive cavity pumps will continue to perform at high levels of efficiency.

Field testing and commercial installations have operated at high temperatures with long run times. A variety of pump sizes are available for this service. With the development of appropriate heat resistant materials, the fundamental positive displacement design of the progressive cavity pump makes its application at a wide variety of inlet and differential pressures a reasonably simple process.

As set out in Section 2.3, Sunshine has simulated and forecasted low pressure SAGD well performance, has analyzed reservoir performance and has determined that the Project is commercially viable at a steam pressure of 400 kPaa. As mentioned, during operations, Sunshine intends to steam at up to 2,000 kPaa to assess the effects of any thief zones.

2.4.2 Alternate Technologies

During the Project's first phase of operations, Sunshine expects to be able to enhance its understanding as to how to most effectively operate at this relatively low pressure. Anything learned: 1) will be incorporated into the Project's future operations so that the efficiency of the

bitumen recovery will be further improved; and 2) will provide guidance for future large scale commercial developments.

Sunshine anticipates that increased efficiencies will result following the application and assessment of various technologies and natural developments. While not required for the Project to be commercially viable, Sunshine intends to undertake a number of initiatives for this purpose, including the following:

1. Confirming the extent of ongoing pressure rebound following shut-in and the resulting improvement in the well performance;

2. Confirming the extent of bitumen saturation in the gas zone and the resulting reduction in the negative gas zone effect;

3. Confirming the extent of natural thief zone mitigation against loss of chamber pressure through bitumen viscous plugging of pore throats in the gas/bitumen interface;

4. Assessing the potential for re-pressurizing the lean bitumen zone using non-condensable gases thereby allowing for higher SAGD steam injection pressures; and

5. Assessing the potential application of emerging SAGD hybrid technologies, including ES-SAGD and Vapor Extraction Process (VAPEX).

For the first phase of the Project, processing capacity will be at 5,000 bpd. Thirteen well pairs will be drilled which will result in production levels of 2,000 bpd to 5,000 bpd, depending on well performance. The first phase facility will have a high steam capacity that will provide the flexibility for the different operation scenarios mentioned.

2.5 Production Pads and Horizontal Wells

The SAGD process will use well pairs drilled from surface pads. The producing wells follow a trajectory 1-3 m above the top of the Devonian unconformity and the injector will follow a parallel trajectory 5 m above this producer. The horizontal section of each well will be 800-1,000 m within the bitumen formation.

2.5.1 Well Pad Layout

Well pads will support one row of well pairs. For the initial first phase development of the Project, two well pads will be required (with 6-7 well pairs on each pad).

Reservoir structure, surface features and slant-rig drilling technologies will influence the surface location of the pads. Figures 2.5-1 and 2.5-2 show the facility plot plan for the planned well

pads, which comprise above ground field pipelines that will connect the pads to the CPF. Facility design is shown in Figures 2.5-3. The main items in the pad design will include:

- steam distribution pipeline/header fuel gas supply pipeline/header;
- vapour collection pipeline/header;
- production fluids gathering pipelines;
- connections to the CPF by road access, power and communication cables (DCS);
- steam-injection meters and flow controllers at each well - the steam can be flow controlled to both the tubing (toe) and the casing (heel) of each injection well. During start-up phases, steam goes to each producing well and creates the communication between the injector and producer;
- test separator - production from each producing well will flow through a control valve into the group or test header. Wells are tested on a routine basis with the test separator. Liquid and vapour streams are metered and sent to the group separator;
- group separator - production from each group production header flows into the group separator where vapours and liquids are separated. The pad group separator pressure, built from the well heads, sends vapour to the CPF's produced vapour train;
- group pumps to transfer produced liquids from the group separator to the CPF Inlet Cooling Exchangers - pressure control at the CPF ensures the liquids line remains under pressure and limits the amount of flashing/vapour generation in the liquids line;
- pop tank to capture any emergency relieving conditions;
- utilities including instrument air, power and data gathering; and
- ditching, berms and contouring to manage surface water drainage collection and topsoil conservation stockpile area.

2.5.2 Drilling and Completion

The proposed horizontal wells for the Project will be constructed by drilling the surface hole utilizing a slant drilling rig and then continuing to build the angle subsequent to setting surface casing in order to achieve an angle of 90 degrees off vertical. The wells will intersect the pay zone at 90 degrees off vertical. Current plans call for an average true vertical depth of approximately 266 m from the surface and a horizontal length of 800-1,000 m. Total measured

well length will be 1,230 m to 1,325 m, depending on the well trajectory. Figure 2.5-4 shows a schematic of the injection and production wells.

The slant surface hole will be drilled, cased and cemented in place with thermal cement. The surface casing, 339.7 mm, 71.42 kg/m, H40, ST&C, will meet the requirements of ERCB Directive 8. The intermediate hole will be drilled using a directional bottom-hole assembly consisting of a positive displacement mud motor and measurement while drilling (MWD) tools. Once the horizontal section is reached, intermediate casing will be cemented to surface with thermal cement. All intermediate casing strings will be 244.5 mm outside diameter, 59.52 kg/m, L-80, QBII threads or equivalent. The casing will be a high-grade, high strength casing, recommended by the ERCB for sour service with an API strength of 80ks, and will have excellent resistance to hydrogen sulphide stress corrosion cracking. It will meet or exceed all engineering design criteria for SAGD application. It was selected for and is used commonly across industry in this type of application. The casing will be run with premium Hunting, WBII connections, one of the "standard" thermal connections that industry has accepted for SAGD and thermal applications.

The horizontal main hole will be drilled and a gamma ray log will be run in conjunction with the MWD package to determine whether any non-reservoir formation was encountered. A sand control wire-wrapped screen will then be run the length of the horizontal section and "hung" with a high-temperature packer.

The production well will be drilled first, followed by the injection well. A magnetic guidance system will maintain a constant vertical separation of 5 m between the producer and injector.

Drilling fluid will be stored and disposed in remote sump locations according to ERCB Directive 50. Total volume of drilling waste will be about 200 m^3 per horizontal well. It is Sunshine's intent, however, to reduce these volumes by reusing drilling fluids whenever practical.

2.5.2.1 Producing Well Completion

The production well will be completed using two tubing strings - long string landed at the toe of the well and a short string landed at the heel. Both tubing strings will be open for production and will be able to accommodate a small-diameter coiled tubing string for artificial lift.

During the start up phase, steam injected into both the injection and production wells will warm the reservoir. The heat will reduce the viscosity of the bitumen and make the oil between the injection and production well mobile. This steam circulation phase will last a few months, but once thermal communication is established, the lower well will be converted into a producer while the upper well will continue with steam injection.

The produced fluids from the production wells will flow to the surface using artificial lift. Metal to metal PCP pump lift system will be utilized for this low pressure SAGD development.

2.5.2.2 Injection Well Completion

The injection well will be completed in a similar manner as the producer. During normal production, the long tubing string will flow steam (near 100 percent quality) into the reservoir at a pressure below the formation's fracture pressure. The injection pressures will be monitored continuously. Each well pair will also be equipped with down-hole instrumentation such as thermocouple or fibre optic string in order to measure and monitor temperature along the horizontal length of the well.

2.5.2.3 Observation Wells

Observation wells will be required for the monitoring of reservoir performance. These wells will employ fibre optic or thermocouple strings and will be drilled to just below the base of the Wabiskaw Oil Sands using premium connections and thermal cement. Locations have been selected that will optimize the SAGD and reservoir performance monitoring. Cap rock as well as both the upper lean bitumen zone and bitumen intervals will be monitored in order to evaluate steam chamber development and the pressure/temperature distributions in the development area. Observation wells for the Project's Phase 1 are shown in Figure 2.5-5. The observation wells will monitor the progress of the steam development in the reservoir and the SAGD operations where the injection pressures will balance to the upper lean zone upon steam chamber contact. A Reservoir Performance Monitoring plan was discussed in Section 2.3.4.

2.5.3 Drilling Waste Management

Sunshine plans to use a water-based drilling fluid system. Notwithstanding potential hydrocarbon contamination from the formation, these mud systems generate waste material largely composed of bentonite clay.

Surface holes, employing a slant drilling rig, will be drilled and casing set into the competent formation and cemented full length with thermal cement. Total waste generated from this section of the hole will be contained in remote sump locations. Following ERCB Directive 50, these wastes will be disposed of using a mix-bury-cover method. Cement returns will be stored and buried at the remote sump locations.

Mechanical solids removal equipment will recycle fluids from the intermediate and horizontal sections of the hole. This technique reduces the volume of liquid requiring disposal. Disposal options for liquid waste include disposal at a licensed, third-party waste disposal facility, or pump-off following Directive 50. Waste-sampling analysis will determine the liquid waste disposal method.

Waste-reduction methods are expected to limit the volume of solid waste from the intermediate and horizontal sections of the hole. Waste solids from the drilling operations will be analyzed according to the requirements of Directive 50. Should the hydrocarbon levels remain below Alberta Tier I Soil and Water Quality Guidelines for Hydrocarbons, the waste will be disposed of using the mix-bury-cover method.

If the waste does not meet the requirements of Directive 50 for hydrocarbons, it will be disposed of at an approved waste disposal facility, or bioremediated within the parameters of Directive 50. Selection of the final drilling solids disposal option will be determined from waste sampling analysis.

The drilling mud sump will be located nearby and separated into cells to isolate the various phases of drill mud and cuttings. The locations of the sump sites will be selected and constructed after soil sampling ensures the base material meets the required permeability limits.

2.5.4 Casing Failure Monitoring Program

The SAGD operation is a continuous process operated below the formation fracture pressure. As a result, the down hole tubulars are not subjected to the same stresses that occur from the high temperature and pressure fluctuations inherent in cyclic steam processes.

Casing integrity will be monitored by the operations staff that monitors well performance at the production pad. Injection and production well pressures and temperatures will be monitored continuously, as will steam flow rates. Any unanticipated changes in these parameters will be investigated immediately to avoid breaches in casing integrity.

The intermediate casing string will provide hydraulic isolation between the oil sands, into which steam will be injected, and the overlying shale. As well, surface casing set below the Quaternary formations will help provide hydraulic isolation. Sunshine does not expect any intermediate casing failures at the Project, as good casing standards and cementing practices will be followed.

2.5.5 Well Performance Monitoring

Production wells will be tested at least twice monthly. Daily oil, gas and water production will be allocated to the wells, based on battery pro-rations and well test data. Bitumen, produced water and produced gas will be measured during well testing. Bitumen will be analyzed regularly to monitor quality from the reservoir. Produced gases will be analyzed regularly for composition. The volume and pressure of steam injected into each injection well as well as down-hole temperatures will be measured and recorded continuously. Fluid will be analyzed as frequently as necessary. Appendix 5 contains details about Sunshine's Measurement Principles.

2.6 Central Processing Facility (CPF)

This section outlines the technical components associated with the proposed Project's CPF. The processing facility consists of two processing trains. The first train will be constructed and used during the Project's first phase. The second train will be constructed and used during the Project's second phase. Figure 2.6-1 (Sheets 1 to 9) shows the process flow sheets for water and steam process and Figure 2.6-2 (Sheets 1 to 8) shows the process flow sheets for the oil treating process. Further optimization of the phased construction of the two phases will be developed during the detailed engineering phase. Details of the processes carried out in the CPF are provided below.

The CPF will be designed to treat the product to ensure that it consists of sales quality dilbit that contains less than 0.5% impurities. The produced water will be purified and 97% of it will be recycled. The maximum makeup water of the Project in this design will be less than 365,000 m^3/year, which is well below the 500,000 m3/year threshold rate, where brackish water use may be required. Sunshine will nonetheless actively search for brackish water sources and use it whenever possible to minimize the use of fresh water.

2.6.1 Central Processing Facility Layout

The CPF will be located in NE 31, Twp. 94, Rge. 17, W4M (Figure 1.3-1). The total disturbance footprint for the CPF will be approximately 29.3 ha. The site was selected based on the environmental constraints mapping (Section 4.12).

Figure 2.6-3 shows a plot plan for the CPF. Included on this drawing is the location of buildings, flare stack, and storage tanks. Table 2.6-1 and Table 2.6-2 respectively list the external emission sources and storage tanks associated with the CPF. Dispersion modeling associated with these emission points (without NCG injection) is discussed in detail in the Air Quality Report (Consultant Report #1). A summary of this report is provided in Section 4.1. NCG (Flue gas) injection (Section 2.6.12) will take a stream of flue gas from the steam generator that will reduce the steam generator exhaust emission, but the two NCG injection compressors will create certain amount of emission volume. Table 2.6-3 shows the emission changes calculated based on Consultant Report #1 and the engineering design of the NCG injection system. It can be seen from Table 2.6-3 that the NCG injection will have little or no impact on the emission concentration contours shown in Section 4.

Table 2.6-1 External Emission Sources Associated with Central Processing Facility

Name	Design		Function	Phase
	#	Height (m)		
Cogeneration Exhaust Stacks	1	20	Refer to Section 2.6.11.1	**Phase 1**
Steam Generator Exhaust Stack	1	30.5	Refer to Section 2.6.6	**Phase 1**
Flare Stack – CPF	1	39	Refer to Section 2.6.8.1	**Phase 1**
Glycol Heater Exhaust Stack	1	5.0	Refer to Section 2.6.9	**Phase 1**
NCG injection Compressor	1	9.25	Refer to Section 2.6.12	**Phase 1**
Utility Steam Generator Stack	1	13.2	Refer to Section 2.6.11.4	**Phase 1**
Cogeneration Exhaust Stacks	1	20	Refer to Section 2.6.11.1	**Phase 2**
Steam Generator Exhaust Stack	1	30.5	Refer to Section 2.6.6	**Phase 2**
NCG injection Compressor	1	9.25	Refer to Section 2.6.12	**Phase 2**

Table 2.6-2 Storage Tanks Associated with Central Processing Facility

Name	Product	Volume (m^3)	Number	Function (refer to)	Phase
Diluent Storage Tank	Diluent	1,590	1	2.6.2.2	**Phase 1**
De-sand tank	Sediment & Water	350	1	2.6.2.3	**Phase 1**
Produced Water Surge Tank	Produced Water	1,600	1	2.6.2.3 and 2.6.3.1	**Phase 1**
Sales Oil Storage Tank	Dil-Bit[1]	1,600	1	2.6.2.4	**Phase 1**
Production Oil Storage Tank	Dil-bit[1]	1,600	1	2.6.2.4	**Phase 1**
Produced Water Skim Tank	Oily water	1,280	1	2.6.3 and 2.6.3.1	**Phase 1**
Waste Oil Storage Tank (Slop Tank)	Oily Water	397	1	2.6.3.1 and 2.6.5 and 2.6.11.6	**Phase 1**
De-Oiled Water Storage Tank	De-oiled Water	1,590	1	2.6.3.3 and 2.6.5 and 2.6.6	**Phase 1**
Source Water Storage Tank	Water	1,280	1	2.6.5 and 2.8.2	**Phase 1**
Evaporator Feed Tank	De-Oiled Water & Raw makeup water	30	1	2.6.5	**Phase 1**
Off Spec Bitumen Storage Tank	Dil-Bit	1,600	1	2.6.4	**Phase 1**
Caustic Storage Tank	Sodium Hydroxide	30	1	2.6.5	**Phase 1**
Boiler Feed Water Tank	Treated Water	1,600	1	2.6.5 and 2.6.6	**Phase 1**
Waste Water Tank	Evaporator Waste	228	1	2.6.5.1	**Phase 1**

Table 2.6-2 Storage Tanks Associated with Central Processing Facility					
Name	**Product**	**Volume (m^3)**	**Number**	**Function (refer to)**	**Phase**
	Water				
Boiler Blow Down Tank	Water	320	1	2.6.6	**Phase 1**
Pop Tank	Oil and Water	80	1	2.6.8.2	**Phase 1**
Glycol Storage Tank	Glycol and Water	32	1	2.6.9	**Phase 1**
Diesel Storage Tank	Diesel	16	1	2.6.11.2	**Phase 1**
Floor Drain Tank	Oil and Water	80	1	2.6.11.6	**Phase 1**

1 Dil-Bit – refers to a blend of Diluent and Bitumen

Table 2.6-3 Emission change with NCG injection				
	Captured from Boiler (t/d)	Generated from Compressors (t/d)	Net Addition (t/d)	Net Addition (%)
NOx	0.036	0.082	0.046	5.9%
CO	0.112	0.097	-0.015	-0.8%
PM2.5	0.005	0.007	0.003	3.1%

2.6.2 Oil Production System

2.6.2.1 Well Pad Group Separator

Once the heated bitumen, produced gases, steam condensate and water (collectively referred to as either “production fluids”, “emulsion”, or “reservoir fluid”) have been extracted from the production wells, they will flow to a group separator at the well pad. The vapour from the group separator will be back pressure controlled and will flow to the CPF via an emulsion vapour pipeline. The liquid from the group separator will be pumped to the CPF via the emulsion pipeline. Using pumps to transport the emulsion will allow the CPF inlet vessels to operate at the optimal pressure. The group separator will reduce surging from the individual wells and will remove the bulk of the produced gas contained in the emulsion. The produced gas will be cooled and recovered for use as a fuel source (Section 2.6.7.2 - Produced Gas Recovery System).

2.6.2.2 Diluent Addition

The emulsion will flow to the CPF and be cooled by two sets of exchangers. The first exchanger will cross-exchange the inlet emulsion with boiler feedwater and the second exchanger will cross-exchange the inlet emulsion with cooling glycol. After the first stage of cooling, a light hydrocarbon diluent (ranging from 60° to 80°API Gravity, depending on the diluent available) will be added to the emulsion. The addition of diluent will reduce the viscosity and density of

the emulsion, which will allow conventional oil treating equipment to separate the oil from the water. The diluent will be pumped from the diluent tank upstream of the Free Water Knock Out (Section 2.6.2.3). The diluent will initially be trucked to the CPF from the source of purchase.

The diluent will flash to some degree, resulting in a density change for blending purposes. This change in density will have a minimal effect at the blend rates anticipated. Based on engineering calculations, the shrinkage difference will be in the range of 0.05%, which is not significant in the overall facility accounting.

The diluent compositions will change, depending on the source of the diluent. Sunshine will monitor shrinkage. Where the volumes are material to the plant accounting (>0.5%), appropriate adjustments will be made.

2.6.2.3 Free Water Knock Out

Once the diluent has been added to the emulsion, it will then flow through one of two Free-Water Knock Out (FWKO) separators. The FWKO will be a horizontal three phase separator used to separate oil, gas and free water (i.e., water not bound to any oil and gas). Most of the water in the emulsion will be removed in the FWKO. Water from the FWKO will be cooled by cross-exchange with glycol and level controlled to the skim tank (Section 2.6.3 - Produced Water De-Oiling System). Oil from the FWKO will be level controlled to the treater.

Small quantities of sediments, primarily consisting of sand and silica, will also be included in the emulsion. Most of these sediments will settle and accumulate in the bottom of the FWKO. High velocity water jets installed at the bottom of the FWKO vessels will be used to periodically flush the accumulated sand slurry into a de-sand tank. Inside the de-sand tank, the sediment will be allowed to settle. Water and oils in the de-sand tank will be subsequently recovered and recycled (Section 2.6.4 - Oil Recycle and Treatment System). Sediments in the de-sand tank will be removed from time to time, and hauled offsite to a licensed disposal site.

Gases released in the FWKO separator will be cooled and recovered (Section 2.6.7.2 - Produced Gas Recovery System).

2.6.2.4 Gravity Separation and Filtration Vessels

After passing through the FWKO, only a small amount of water and gas will remain bound with the oil. Additional diluent will then be injected into this mixture, which will predominantly be a diluent-bitumen mixture referred to as “dil-bit”. Diluent addition will improve the specific gravity ratio of the dil-bit, aiding in further oil-water-gas separation. The dil-bit will flow through a gravity separation vessel (Treater) whose function will be to produce sales quality dil-bit that will contain less than 0.5% impurities comprised of basic sediments (sand and silica) and water. After passing through the Treater, the cleaned dil-bit will be cooled by cross-exchange

with glycol and level controlled to the production oil tank. Dil-bit will then pass from the production oil tank to the sales oil tank.

Prior to the cleaned dil-bit being shipped offsite from the sales oil tank, it will be monitored to ensure that it complies with pre-determined market and shipping specifications. A basic sediment and water (BS&W) analyzer and diversion valves will be located on both the sales oil tank and production oil tank. The specifications of the analyzer will be:

- 0 to 4% water in oil range;
- accuracy ±1% of scale;
- repeatability ± 0.05% of scale; and
- minimum detectability of 400 ppm water in oil (0.04%).

If the sampled dil-bit meets shipping specifications, it will initially be trucked off site. In the event that the sampled dil-bit does not meet shipping specifications, it will be diverted to the off-specification dil-bit tank where it will be re-processed through the oil recycle and treatment system (Section 2.6.4). All tanks (i.e., sales oil tank, production oil tank and off-specification bitumen tank) will be equipped with a bottom recycle system to prevent a build up of BS&W in the bottom of the tanks. Any BS&W that has accumulated in these tanks will be re-processed through the oil recycle and treatment system (Section 2.6.4).

Water separated in the treater will be cooled and level controlled to the produced water skim tank (Section 2.6.3 - Produced Water De-Oiling System). Gas from the treater will be backpressure controlled to the Produced Gas Recovery System (Section 2.6.7.2).

2.6.2.5 Emulsion Chemical Treatment

Chemicals will be added at various points in the gas-oil-water separation process. Chemicals used will be demulsifiers, reverse emulsion breakers and polymers. The chemicals will help to separate the oil and water and will also help to mitigate corrosion of piping and vessels. A list of the chemicals which will be used in the CPF is provided in Section 2.6.11.9 - Chemical Use.

2.6.2.6 Water and Solid Composition

The test separators located at the pads will be equipped with meters to measure the water cut, and coriolis meters to measure the mass flow. The water cut meters will be full range models with an accuracy of +/- 0.5% for the oil phase and +/- 1.0% for the water phase. The range of the water cut units will be 0-100% water cut with a resolution of 0.1%.

The monitoring devices used at this facility will be designed for temperature ranges up to 204°C and 1,345 kPag. The actual operating conditions will be 170°C and 800 kPag.

The coriolis meter can also be used to determine water cuts and will be able to be used as a secondary device to confirm the readings obtained from the water cut monitors. The water cut monitors will be calibrated annually to the same frequency as the coriolis meters used for accounting measurement. The sales oil water cut determination will be done at the trucking receipt point.

The water cut determination of the diluent will be done by manual sampling and spinning the cuts of each load. As the diluent is a royalty paid product, only diluent actually injected into the process bitumen stream will affect the accounting calculations. Operators will monitor the diluent receipts and the diluent tank for water content. If water is found in the loads or accumulates in the tanks, the water will be removed and disposed of. As the diluent is a spec product, no water is expected in the diluent receipts.

2.6.3 Produced Water De-Oiling System

Steam condensate and water contained in the emulsion is called "produced water". The purpose of the produced water de-oiling system is to remove oil and sediment from the produced water before it is softened and reused to generate steam for bitumen recovery (Section 2.6.6 - Steam Generation System). Without proper oil and sediment removal, the water softening equipment will become inefficient and non-operational.

The produced water de-oiling system will consist of three operations. First, bulk oil will be removed using a skim tank and surge tank, followed by the removal of oil using an induced gas flotation (IGF) cell. Finally, fine oil and solids will be removed by an oil removal filter (ORF).

2.6.3.1 Bulk Oil Removal

Following separation in the FWKO, the free water (2,000 mg/L oil in water) will be cooled through a series of heat exchangers to 90°C to prevent the water from boiling when depressurized. The free water will then be stored in the produced water skim tank. The skim tank will allow the small amounts of dil-bit in the water to separate by gravity. Dil-bit will be skimmed off the top of the skim tank and will be pumped to the slop tank (Section 2.6.4 - Oil Recycle and Treatment System). Water from the skim tank will then flow by gravity to the surge tank.

The surge tank will serve two purposes; first it will act as a break between the oil processes and the water de-oiling equipment by taking up surges or swings in produced water volumes generated during the oil production process and second, the residence time of the produced water in the surge tank will allow for some of the oil to rise to the surface. A skim system in the surge

tank will recover the oil and transfer it to the slop oil storage tank for treatment (Section 2.6.4 - Oil Recycle and Treatment System).

Produced water from the produced water surge tank will flow by gravity to the IGF cell.

2.6.3.2 Induced Gas Floatation

From the surge tank, the produced water (200 mg/L oil in water) will flow by gravity to the IGF cell where approximately 90% of the remaining oil will be removed. Minute natural gas bubbles will be introduced into the bottom of the IGF cell using a dissolved gas flotation pump. As the gas bubbles rise in the water column, they will coalesce with the oil droplets in the water, bringing them to the top of the vessel. The coalesced oil will be removed as an oily froth. The recovered oil from the IGF cell will be sent to the oil recycle and treatment system for further treatment (Section 2.6.4). The gas will be recovered from the top of the IGF cell, and recycled back into the cell.

2.6.3.3 Oil Removal Filter

After the IGF cell, the produced water will contain approximately 20 mg/L of oil. Final clean-up to less than 5 mg/L of oil in water will be completed using dual oil removal filters (ORF). Water will be pumped from the IGF cell through the filters, which will have approximately 90% oil removal efficiency. Dual filters will be used to provide 100% spare capacity, allowing one unit to be operational while the other is being backwashed or on stand-by.

De-oiled water leaving the ORF will be ready for purification in the mechanical vapour compressor evaporation process (Section 2.6.5). The de-oiled water will be stored in a de-oiled water storage tank to provide surge capacity for the steam generation system.

Backwash from the ORF will flow to the oil recycle and treatment system for further treatment (Section 2.6.4)

2.6.4 Oil Recycle and Treatment System

The purpose of the oil recycle and treatment system will be to allow emulsions to be re-processed to further recover oil from oil-water mixture. The oil recycle and treatment system will be designed to handle:

- dil-bit containing greater than 0.5% impurities from the oil production system;
- water and oil from the produced water de-oiling system;
- a mixture of oil and BS&W collected from the bottom of the sales oil tank, production oil tank, off-specification bitumen tank and de-sand tank;
- oil from the top of the surge tank and skim tank;

- any waste (i.e. slop) oil that may have seeped onto the processing plant floor from any of the process systems within the CPF; and
- any liquids from the gas flaring system.

The FWKO will process slop volumes from the slop tank. Water from the FWKO will be cooled and level controlled to the skim tank. Oil from the FWKO will be level controlled to the treater.

2.6.5 Produced Water and Source Water Treatment System and Boiler Feed Water

After de-oiling (Section 2.6.3 - Produced Water De-Oiling System), the produced water will be combined with raw make up water from the source water storage tank (Section 2.8.2 - Source of Process Make Up Water) and treated for use as boiler feed water (BFW) to generate steam. The produced water treatment system will consist of pH control via caustic injection and evaporation-distillation process. The water treatment system will remove sediment, insoluble oil and grease, hardness, total organic carbon, and dissolved solids from the produced water. Scale inhibitor and antifoam-chemicals are also added in the water treatment system to ensure appropriate water properties (Section 2.6.11.9 - Chemical Use).

The produced water feed to the evaporation-distillation process will flow from the de-oiled water storage tank to the evaporator feed tank. Caustic will be pumped from the caustic storage tank and introduced into the feed tank and mixed with the produced water to adjust and control the pH. The water solution will then be pumped from the feed tank through a heat exchanger to raise its temperature to the boiling point. It will then flow to a de-aerator where non-condensable gases such as carbon dioxide and oxygen will be removed from the water solution. The hot de-aerated feed will then enter the evaporator sump, where it will combine with the re-circulating brine slurry. The hot slurry will be pumped into vertical tubes allowing a portion of the feed to evaporate and the rest to fall back into the sump to be re-circulated. The distillate will be collected and pumped directly to the BFW tank for use in the steam generation process (Section 2.6.6 - Steam Generation System).

The evaporation-distillation process will be based on 5,280 m^3/day cold water equivalent (CWE) of steam required. It will be designed to recover approximately 97% of the produced water as high quality distillate (i.e., <10 mg/L total non-volatile dissolved solids).

2.6.5.1 Evaporator Waste Brine Removal

During the evaporation-distillation process, the concentration of salts will be continuously increasing and, without removal, will result in the equipment becoming inefficient and non operational. This waste stream will be collected in the wastewater tank then disposed of via trucks to an approved site, or via disposal wells that will either be located on site or at an approved location off-site. When the Project is in full production in the first phase a disposal

volume of 174 m^3/day is anticipated. The first phase disposal volume will be approximately 90 m^3/day.

Vent losses from the evaporator will be calculated as the difference between the evaporator inlet (measured) and evaporator liquid outlet streams (distillate and brine - both measured).

2.6.6 Steam Generation System

In order to extract bitumen from the oil sand reservoir, the SAGD process involves injecting steam into the reservoir at the well pads. Steam generated in the CPF will be delivered to the well pads through an above ground interconnecting pipeline. Steam will be generated and distributed at a maximum pressure of 5,000 kPag and subsequently reduced through pressure let down valves such that the resulting steam injection pressure at the reservoir face does not exceed the fracture pressure of 4,000 kPag. Injection pressures are kept below the pressure at which the reservoir can fracture so that the integrity of the reservoir is kept intact, and maximum bitumen recovery is realized. These pressures are consistent with the Project being commercial at 400 kPaa during the Project's first phase.

The actual injection pressure can be reduced further depending on reservoir design. For generating steam in the CPF, the high quality distillate from the produced water treatment system (Section 2.6.5) enables steam to be generated using water tube boilers. Water tube boilers have the capability to generate high quality steam, leading to reduced boiler blowdown volumes (1 to 3%). Steam generator exhaust stack details are contained in Table 2.6-1.

Once the distillate has been collected in the BFW tank, it will be pumped into two steam generation boiler units. Oxygen scavenger, phosphate and filming amine chemicals will be added during the boiling process to ensure appropriate water quality. The water will then be heated to saturation temperature and finally boiled into steam. Each boiler unit will be nominally rated at 273 MMBtu/hr and will be capable of producing saturated steam at a maximum pressure of 5,000 kPag for distribution to the well pads. A list of chemicals which will be used in the CPF is presented in Section 2.6.11.9 - Chemical Use.

Flow from the BFW tank to the boilers will be regulated by a control valve located at the boiler. Excess volumes will be recycled back to the BFW tank. To avoid temperature build-up in the boiler feed water tank, heat exchange will be necessary on the return flow. The small blowdown volume from the boilers will be returned to the de-oiled water storage tank via the boiler blowdown tank.

The boilers are designed to burn natural gas.

2.6.7 Fuel Gas and Produced Gas Recovery System

2.6.7.1 Fuel Gas

The Project will use natural gas as the fuel source which will be supplied from a third-party. At this time, Sunshine is not contemplating any alternative fuel sources. Conversion to alternate fuel is not part of this Application. Should a technology eventually prove to be economically viable in the future, it would be subject to necessary regulatory approvals which would be submitted at that time.

The largest gas volume which will be consumed will be for fuelling the steam generators and cogeneration equipment. Fuel gas will also be used:

- for piloting flares;
- for heating various components of the Project infrastructure; and
- as blanket gas for tanks and vessels.

Fuel gas energy balances for the Project are provided in Section 2.7.2.1 - Energy Balance - Fuel Gas.

2.6.7.2 Produced Gas Recovery System - Central Processing Facility

All produced vapours at the CPF will be recovered. Produced vapour releases into the atmosphere will not be part of normal operating conditions.

Use of third-party fuel gas purchased for the Project will be supplemented by using the produced gases from the reservoir. Within the oil production system, produced gases in the emulsion will be recovered from the group separator (Section 2.6.2.1), the FWKO (Section 2.6.2.3) and Treater (Section 2.6.2.4). These vapours will be water saturated and will be first cooled to remove the water, leaving a combustible gas which will be directed to a gas mix drum. The produced gas will then be blended with fuel gas for subsequent use in the CPF. The recovered water will be sent to the skim tank for recycle and use in the SAGD process (Section 2.6.3 - Produced Water De-Oiling System).

The produced gas may contain some sulphur in the form of hydrogen sulphide (H_2S). Based on operating experience from industry SAGD developments and industry data from **ERCB** in situ progress reports such as Jacos (2009), Athabasca Statoil (2009), and Connacher (2008), a maximum sulphur content of two percent (2%) H_2S in the produced gas is anticipated. The maximum sulphur emissions will coincide with maximum production rates.

Expected sulphur dioxide (SO_2) emissions are 0.07 tonnes per day (t/d) SO_2 for each steam generator, for a total of 0.14 t/d based on a produced gas H_2S concentration of 0.4%. If the produced gas H_2S concentration rises to 2%, the SO_2 emissions will then be 0.35 t/d SO_2 for each steam generator, for a total of 0.7 t/d.

In addition to the produced gas recovery process, a vapour recovery unit (VRU) will be used to recover low pressure vapours from any storage tanks containing hydrocarbons.

Blanket gas is a gas that is placed above a liquid in a tank or vessel to protect the liquid against air contamination by reducing the risk of air getting into the tank. The gas source is located outside the tank or vessel.

Gas from the VRU will be recovered and compressed for use as fuel. Low pressure vapour sources will also be connected to the flare system (Section 2.6.8 - Gas Flaring System).

Produced gas energy balances for the Project are provided in Section 2.7.2.2 - Energy Balance - Produced Gas.

Produced gas will be calculated by using the mass balance equations shown in Appendix 5.

2.6.7.3 Produced Gas Recovery System - Well Pads

All produced vapours at the well pad will be recovered. Vapour releases into the atmosphere will not be part of normal operating conditions.

A metal to metal PCP pump lift system will be utilized for the emulsion to flow to the surface. Once at the surface, the emulsion will flow to a group separator where the water vapour and produced gas will be separated from the emulsion (water and bitumen). The vapours will free flow back to the CPF through a dedicated pipeline and the emulsion will be pumped to the CPF in a separate pipeline.

Each well will be able to be tested for two 24 hour periods per month using a two phase separator. The vapours and liquids from the test separators will be recombined into the respective group lines.

2.6.8 Gas Flaring System

Under normal operating conditions there will be no vapour release into the atmosphere. However, a small flow of purge gas will be used to prevent air from entering the flare system and a small flow of pilot gas will be burned to ensure combustion of vapours during an emergency release. In recognition that equipment malfunction could result in the event of an “over

pressurization or depressurization" situation, provisions will be made to safely flare vapours during an emergency.

Emergency releases of gases will be collected and burned in a flare system. Flaring, or the burning of combustible vapours, is a means of vapour disposal when there is no way to safely contain the gas or use it for another purpose. The basic design philosophy of the flare system is to gather hydrocarbon vapour and liquids, separate any liquids from the vapour and then ignite and burn the hydrocarbon vapour at a reliable maintained flame.

A flare system will be located at the CPF. The flare tip will include a wind guard and a continuously burning pilot flame equipped with an electronic ignition system. The flare system will continuously be purged with natural gas to prevent air entering the system.

The maximum flaring that could occur during the plant operations has been estimated for the following circumstances:

- normal plant operations - 0 e^3m^3/d;
- typical plant upset - 10 to 15 e^3m^3/d;
- typical shut-down - 10 to 15 e^3m^3/d; and
- typical start-up - 10 to 15 e^3m^3/d.

2.6.8.1 Flaring System - Central Processing Facility

The flare system for the CPF will consist of a 2.4 m diameter by 3.7 m long knockout drum to collect any liquids, and a 324 mm diameter by 39.0 m high stack. The liquids from the flare knockout will be recycled to the oil recycle and treatment system (Section 2.6.4) for subsequent use in the SAGD process. A separate 3 m diameter by 9.1 m long pop drum will also be connected to the knockout drum and flare stack. The pop drum will handle vapour only.

2.6.8.2 Pressure Relief System - Well Pad

A pop tank will be used, for safety reasons, as a destination for over pressuring and accidental release of production fluids. When necessary, liquids released to the pop tank will be removed by truck and sent to the CPF for processing. In the highly unlikely event of an over pressurization, any gases sent to the pop tank will be vented to the atmosphere. Process piping and vessels will be designed to full wellhead design pressure, thereby minimizing the chance of a mechanical pressure safety valve relieving to the pop tank.

2.6.9 Cooling and Heating Systems

To make operating systems within the CPF more efficient, a closed loop water-glycol system based on a 50% (wt.) ethylene glycol solution will be used to assist in cooling processes and to recover low grade heat which would otherwise be lost to the atmosphere. Sources within the CPF where cooling systems will be utilized include:

- heat exchangers downstream of the FWKO (Section 2.6.2.3 - Free Water Knock Out);
- heat exchangers downstream of the Treaters (Section 2.6.2.4 - Gravity Separation and Filtration Vessels);
- heat exchangers along the return flow line between the BFW tank and boilers (Section 2.6.6 - Steam Generation System); and
- condensed vapour cooling points within the produced gas recovery system (Section 2.6.7.2).

The recovered heat will be used to heat various process streams such as combustion air preheat for the boilers, the boiler feed water and building heaters. Any surplus heat will be rejected to the atmosphere via the glycol air cooler. Any minor amounts of glycol-water solution lost in the closed system loop will be topped up from the glycol storage tank. Glycol heater exhaust stack details are provided in Table 2.6-1.

2.6.10 Above Ground Interconnecting Pipeline System

Above ground interconnecting pipelines will run along the utility corridor and connect the well pad facilities to the CPF. The pipelines within these corridors will consist of:

- liquid emulsion from the well pads to the CPF;
- vapours with flow from the well pads to the CPF;
- high pressure steam with flow from the CPF to the well pads: and
- fuel gas supply with flow from the CPF to the well pads.

2.6.10.1 Emulsion Gathering System

Group separator emulsion pumps will provide the required pressure to transport the liquid emulsion to the CPF for processing.

2.6.10.2 Vapour Gathering System

Sub-surface reservoir pressure will provide the pressure required to free flow the vapour back to the CPF for processing.

2.6.10.3 Steam Distribution System

Steam will be delivered from the CPF (Section 2.6.6 - Steam Generation System) to the well pads via high pressure above ground steam lines and will be distributed at the pads to each well pair via a manifold building. A series of pressure letdown valves in the manifold building will be utilized to reduce the steam pressure to ensure that the maximum allowed reservoir injection pressure is not exceeded. Each well pad will be equipped with an automatic shut off valve to ensure that this pressure is not exceeded. Road crossing and wildlife crossings are included in the current design.

The steam generators are designed to deliver high quality (~ 98%) steam at the generator outlet. In order to ensure the steam condensate contained in the steam distribution system does not flow to only one injection well, appropriate flow splitters will be utilized within the distribution and manifold systems to provide an even distribution of the steam condensate throughout the injection wells.

Utility steam for miscellaneous heating uses, when required, will be supplied at each pad from a letdown station on the high pressure supply line. It will be used to preheat cold production lines by bleeding steam into the production lines.

The expected volumes of steam being bled off will be a maximum of 50 m^3/d (intermittent) and will be measured in the main header by steam flow meters.

2.6.10.4 Gas Distribution

A gas line to provide fuel gas to each of the well pads will be installed in the above ground pipeline corridor. This fuel gas is required to operate the possible sub-surface artificial lift system, and for utility services.

2.6.11 Central Processing Facility - Utilities

2.6.11.1 Electrical Power

The continuous power load for the Project will be approximately 9 MW. Sunshine will build a natural gas fuelled combustion turbine-generator and heat recovery steam generator plant to supply the power requirements of the CPF. In addition, heat recovered from the turbine exhaust will be used to make steam for SAGD operations. This Cogeneration facility will provide the SAGD facility with a reliable and cost effective source of thermal and electric energy. The Cogeneration facility will initially operate as island generation, however as infrastructure develops in the area, the possibility exists that the facility will be connected to the grid.

The turbine generator will have the capacity to produce a continuous load of 9 MW of power, along with approximately 18,591 kg/hr (447 m^3/d CWE) of steam at up to 5,000 kPag. Natural

gas will be supplied from the local pipeline. No produced gas will be supplied to the turbine generators. Boiler feedwater will be supplied from the main boiler feed water system. The overall Cogeneration thermal efficiency will be approximately 78%.

Distribution of power from the main facility to the various production pads and make-up water wells will use an overhead 25 kV power line. Power line routing will follow the access roads or gathering pipelines whenever feasible. If there are difficulties in the distribution of power from the main facility to the well pads, the well pads will be powered by local natural gas drive generators.

Energy balances for the first and second phase of the Project are provided in Table 2.7-3 and Table 2.7-4 - Energy Return on Energy Input.

Sunshine intends to file a separate application with the Alberta Utilities Commission (AUC) for the cogeneration unit.

2.6.11.2 Emergency Power

In the event of failure of cogen power, critical plant loads will derive electricity from an emergency power system. It will consist of a combination of a standby generator for critical 480 V loads plus battery-backed uninterrupted power supplies (UPSs) for critical 24 VDC and 120 VAC loads, such as the plant control systems and computer systems.

The diesel-fuelled standby generator will not be sized to support normal plant operation; it will have a maximum load capacity of approximately 1 MW. The diesel storage tank on site will supply fuel to the generator.

Critical 480 V loads will include key plant utility systems such as instrument air compressors and heat medium pumps as well as 480 V to 120/208 V transformers feeding critical lighting and electric heat tracing loads.

The plant control systems and associated computer loads will be UPS supplied as detailed above, with a standby time of eight hours.

2.6.11.3 Sanitary and Potable Water System

A supply of potable water will be required for the construction camp, operations camp, and the administration and control room offices at the CPF. Water for sanitary uses such as showers and toilets will also be required. Details of the sanitary and potable water system are provided in Section 2.8.3 - Sanitary and Potable Water Supply Requirements and Source.

2.6.11.4 Utility Steam

A small stand-alone steam generator will provide low-pressure steam for utility purposes. Utility steam generator exhaust stack details are shown in Table 2.6-1. Utility steam will be used for wash-down stations in each building and supplemental process heat in oil and water processing.

2.6.11.5 Domestic Sewage

Domestic sewage will be contained in a septic tank and trucked away for disposal at an approved site or sent to a septic field.

2.6.11.6 Drain System

The facility will have a floor drain collection system. All buildings will be equipped with floor drains and a sump. Water used to wash down the floors and equipment as part of routine maintenance will be collected in the sumps and transferred by pump to an above ground double wall "floor drain tank". Liquids from the tank will be transferred back to the waste oil storage tank and returned to the process (Section 2.6.4 - Oil Recycle and Treatment System).

2.6.11.7 Compressed Air System

Both the CPF and the well pads will have their own compressed air system. The system will be provided from a conventional instrument air compressor package that will provide air at nominally 862 kPag and a dew point of -40°C. The air compressors will be electric powered.

2.6.11.8 Fire and Gas Detection

Each building will be equipped with Lower Explosive Limit (LEL) and/or H_2S detection heads. In those areas where there is potential for fire, fire detection heads will also be installed.

2.6.11.9 Chemical Use

Table 2.6-4 lists the approximate annual quantities of chemicals that will be used for the Project when operating at 1,600 m3/day during the Project's second phase. During the Project's first phase, the chemical use volume will be about half of the volume listed in the Table 2.6-4.

Table 2.6-4 Chemical Use

Item	**Rate** Per	Function
Water Treatment:		
Caustic Soda (50% NaOH)	750 m^3	Refer to Section 2.6.5
Anti foam	28 m^3	Refer to Section 2.6.5
Scale Inhibitor	60 m^3	Refer to Section 2.6.5
Boiler Chemicals:		
Phosphate Dispersant	38.3 m^3	Refer to Section 2.6.6

Table 2.6-4 Chemical Use

Item	**Rate** Per	Function
Oxygen scavenger	1.6 m^3	Refer to Section 2.6.6
Filming Amine	15.4 m^3	Refer to Section 2.6.6
Primary Separation:		
De-emulsifier	279 m^3	Refer to Section 2.6.2.5
Reverse emulsifier	150 m^3	Refer to Section 2.6.2.5
Coagulant	22 m^3	
Polymer	41 m^3	Refer to Section 2.6.2.5

2.6.12 Flue Gas Injection

Sunshine will draw a slip stream of flue gas from the steam generators for use in a flue gas injection scheme at the later phase of the well production to reduce SOR or if required to pressurize the local upper lean bitumen zone above the SAGD operation (Section 2.4).

Injection pressure is not expected to be higher than 4,000 kPag. The maximum designed volume of wet flue gas capacity is 7.4 mmscfd and the total maximum volume of dry flue gas for injection is 6 mmscfd.

The flue gas will be drawn through a quench venturi system to cool the stream from 150°C to 60°C. The cooled water-saturated gas will flow to the suction side of a blower. The blower discharge will be cooled and supplied to one of two (2) four-stage reciprocating compressor packages. Each compressor package will be driven by a 1,000Hp natural gas driver. During the first phase of the Project, one of the two compressors will be implemented. The second compressor will be implemented in the Project's second phase.

Significant water (as a product of combustion) will be recovered in this process. This will reduce the need for makeup water. It is expected that the water produced will be acidic because of contact with carbon dioxide. However, one of the steam generators will be dedicated to pipeline quality natural gas and there will be no sulfur species acids created from this boiler that will provide the flue gas for injection.

2.7 Material and Energy Balance

2.7.1 Material Balance

2.7.1.1 Water

Tables 2.7-1 and 2.7-2 provide a listing of the water sources and users for the Project's first and second phases respectively, assuming reservoir losses of 5% and 10%. Water losses to the reservoir are initially expected to be high in the warm up phase with little water returning. Long term average is estimated at 5%. Figure 2.7-1 shows the steady state scheme material balance for 5% water loss for the first phase of the Project. Figure 2.7-2 shows the steady state scheme material balance for 5% water loss for the Project's second phase. In summary, a produced water recycle rate of approximately 97% is expected for the long term average 5% loss case, using an average of 509 m^3/d of fresh water, with the 10% loss case using an average of 773 m^3/d. A 25% contingency has been added to both these scenarios. The first phase will have a much lower make up water rate of 325 m^3/d and 490 m^3/d for the case of 5% and 10% reservoir water loss respectively.

Makeup water volumes and source requirements are respectively discussed in Section 2.8.1 - Volume of Process Makeup Water and Section 2.8.2 - Source of Process Makeup Water.

Table 2.7-1 Estimated Water Balance for the first phase of the Project

Description	5% Water Loss Case Rate (m^3/d)	10% Water Loss Case Rate (m^3/d)
Reservoir:		
100% quality steam to field	2,640	2,640
Total water to SAGD Wells	2,640	2,640
Water losses to reservoir	132	264
Produced water from wells	2,508	2,376
Production Treating:		
Produced water from field	2,508	2,376
Water in sales oil & recycle	5	5
De-oiled water to evaporator	2,503	2,371
Water Treating:		
De-oiled water into evaporator	2,503	2,371
Makeup water	260	392
Brine off evaporator	90	90
Evaporator vent losses	26	26
Utility water	7	7
Treated water to steam boilers	2,724	2,724
Steam Generation:		
Treated water from evaporators	2,806	2,806
Boiler Blowdown	84	84
Steam generated	2,722	2,722
Overall:		
Water losses to reservoir	132	264
Water in sales oil & recycle	5	5
Brine off evaporator	90	90
Evaporator vent losses	26	26
Utility water	7	7
Fresh make up water	260	392
Contingency 25%	65	98
Total Makeup Water Required	325	490

Table 2.7-2 Estimated Water Balance for the second phase of the Project

Description	5% Water Loss Case Rate (m^3/d) (Figure 2.7-1)	10% Water Loss Case Rate (m^3/d) (Figure 2.7-2)
Reservoir:		
100% quality steam to field	5,280	5,280
Total water to SAGD Wells	5,280	5,280
Water losses to reservoir	264	528
Produced water from wells	5,016	4,752
Production Treating:		
Produced water from field	5,016	4,752
Water in sales oil & recycle	10	10
De-oiled water to evaporator	5,006	4,742
Water Treating:		
De-oiled water into evaporator	5,006	4,742
Makeup water	509	773
Brine off evaporator	174	174
Evaporator vent losses	51	51
Utility water	10	10
Treated water to steam boilers	5,443	5,443
Steam Generation:		
Treated water from evaporators	5,443	5,443
Boiler Blowdown	163	163
Steam generated	5,280	5,280
Overall:		
Water losses to reservoir	264	528
Water in sales oil & recycle	10	10
Brine off evaporator	174	174
Evaporator vent losses	51	51
Utility water	10	10
Fresh make up water	509	773
Contingency 25%	127	193
Total Makeup Water Required	636	966

2.7.1.2 Hydrocarbon Liquids

During peak operation, 6510 m^3/d of production fluids will be delivered from the well pads to the inlet group separator at the plant. Of the total volume, approximately 1,600 m^3/d will be bitumen and 4910 m^3/d will be water. The bitumen will be blended with 533 m^3/d of diluent in order to treat it to meet the 0.5% BS&W sales pipeline specification. A total volume of 2133 m^3/d of dil-bit will be shipped from the CPF gate. All vapours within the process will be cooled to condense water and hydrocarbons, which will be separated and returned to the bitumen extraction process. The remaining hydrocarbon gas will be combined into the fuel gas stream and consumed in the SAGD process.

2.7.2 Energy Balance

2.7.2.1 Fuel Gas

The major users of fuel gas in the plant will be the steam generators, glycol heater, and blanket gas to the storage tanks. The majority of this fuel gas will be supplied from a third party pipeline system. Initial agreement has been developed between TransCanada Pipelines Ltd. and Sunshine for TransCanada to supply natural gas for the Project. Annual fuel gas consumed compared to the amount of energy produced for the first and second phases are presented in Table 2.7-3 and Table 2.7-4.

2.7.2.2 Produced Gas

Minor volumes of production gas (mostly methane) will be released as the SAGD process heats the bitumen in the reservoir. High temperatures associated with steam operations can also lead to the presence of non-condensable carbon dioxide and hydrogen sulphide through the aquathermolysis process. These gases will be a small component of the total vapour processed in the CPF. Publicly available industry data from ERCB In Situ Progress Reports and laboratory research shows that the volume of produced solution gas varies widely from 4 to 12 m^3 of gas per m^3 of produced bitumen. The composition of this gas is expected to be 50 to 60% methane, 40 to 45% carbon dioxide and a maximum of up to 1.5% to 2% hydrogen sulphide.

At the full bitumen production rate of 1,600 m^3/d, the produced solution and non-condensable gas rate is estimated at 12,720 m^3/d based on 8 m^3 of gas per m^3 of produced bitumen. The maximum produced gas volume in the first phase will be only 6,360 m^3/d. This gas stream will be cooled to remove any water vapour and then combined with the main fuel gas to be burned in the steam generator. The production gas will make up approximately 3% of the total fuel gas requirement.

There is a depleted gas layer on the top of the bitumen formation. Sunshine has completed a sophisticated gas volumetric balance calculation for the gas zone around the Project Area. The

results indicate that the gas zone has been over produced by the gas producers and that the gas that will be produced together with the bitumen will be 100% solution gas.

Annual production gas consumed compared to the amount of energy produced for the Project in the first and second phases are presented in Tables 2.7-3 and 2.7-4.

Table 2.7-3 Energy Return on Energy Input (EROEI) for the first phase of the Project

Item	Flow Rate (m^3/d)	Flow Rate (GJ/d)
Fuel Gas for Steam Gen	167,744	6,290
Natural Gas for Co-Gen	34,909	1,309
Produced Gas	6,360	239
Net Natural Gas Use	196,293	7,361
Bitumen	795	34,595
Energy Return to Energy Input		5

Table 2.7-4 Energy Return on Energy Input (EROEI) for the second phase of the Project

Item	Flow Rate (m^3/d)	Flow Rate (GJ/d)
Fuel Gas for Steam Gen	341,247	12,797
Natural Gas for Co-Gen	59,345	2,225
Produced Gas	12,720	477
Net Natural Gas Use	387,873	14,545
Bitumen	1,590	69,190
Energy Return to Energy Input		5

Assumptions:

- 60% of the production gas is methane, the remainder is non combustible
- Fuel gas and production gas both have an average heat value of 0.0375 GJ/m^3
- The HHV (higher heating value) of the bitumen is assumed to be 0.043 GJ/kg at a density of 1012 kg/m^3

2.7.2.3 Electricity

The main power consumption in the CPF will be by the vapour compressors associated with the produced water treatment system and boiler feed water (Section 2.6.5). At peak operations, the total power load from the CPF of the Project is estimated at approximately 9 MW. Co-gen driven by natural gas (shown in Table 2.7-4) is designed to provide the electricity.

2.8 Water Management

Regulatory guidelines for process water recycle are included in the following main guides:

- ERCB Guide IL89-05 "Water Recycle Guidelines and Water Use Information";
- ERCB-AENV Guide 89-AA "Water Recycle Guidelines and Reporting of Water Use Information for In-Situ Oil Sands Facilities in Alberta";
- EUB Bulletin 2006-11 March 28, 2006, "Water Recycle, Reporting, and Balancing Information for In Situ Thermal Schemes"; and
- ERCB Draft Directive Feb 2009 – "Requirements for Water Measurement, Reporting, and Use for Thermal In Situ Oil Sands Schemes".

These guidelines have a goal of maximizing water recycling to reduce the freshwater requirements and wastewater disposal volumes associated with Oil Sands developments. All in-situ operators with freshwater requirements exceeding approximately 500,000 m^3/year (500 dam^3/year) are required to recycle produced water.

Despite being below this threshold, the water management plan proposed by Sunshine will follow the ERCB Draft Directive and Sunshine will re-cycle, as much as possible, the steam condensate and water used in the SAGD process. As set out in the produced water treatment system section (Section 2.6.5), a produced water re-cycle rate of 97% is expected.

2.8.1 Volume of Process Makeup Water

Table 2.7-2 lists the water material balance for the CPF and reservoir during normal full capacity operations. The source makeup water requirements are predicted to range from 636 m^3/d to 966 m^3/d. This range is due mainly to the volume of water expected to be retained by the reservoir (estimated at 5% and 10%). Water losses will be comprised of:

- losses in the reservoir;
- brine off the evaporator;
- vent losses off the evaporator
- utility water losses; and
- water entrained in sales oil.

As the individual SAGD well pairs progress through their productive life cycle, the balance of water injected to the water produced varies. During initial circulation of the well pairs, up to 20% of the water injected is expected to be retained in the reservoir. The amount of retained water will decrease from 10% to about 5% of the water injected during normal SAGD well pair

production operations. As each well pair nears the end of its productive life, the injection volume will be decreased and stopped. During this period, the well will remain in production resulting in a surplus volume in the water injected to water produced balance.

The volume of water required for steady-state operations (assuming a 10% reservoir water loss and a 25% contingency) is 490 m^3/d for the Project first phase, and is 966 m^3/d after the Project second phase expansion. It is expected that start-up of each phase will take approximately 90 days and start-up of the second phase of development will occur a year after start- up of the first phase. An additional 1,075 m^3/d, or approximately 96,750 m^3/y is required for two years for start up of both phases.

The makeup water, steam and produced water will be measured in accordance with ERCB Draft Directive Feb 2009, "Requirements for Water Measurement, Reporting, and Use for Thermal In Situ Oil Sands Schemes". The measurement and report will follow Sunshine Measurement Principles set out in Appendix 5. A final Measurement and Reporting Plan (MARP) document will be submitted to the ERCB prior to site construction.

2.8.2 Source of Process Makeup Water

Source water for the Project will come from water wells drilled into the Viking or Grand Rapids Formations. Source water will be pumped from water wells to a 1280 m^3 source water storage tank via fresh water transfer pumps. The source water storage tank will be utilized to service and provide surge capacity for the CPF.

In the Project Area, water has been encountered in the Viking and Grand Rapids Formations. This water varies in salinity from 900tds to 1300tds. Sunshine will be testing the Viking formation in the winter of 2011 to determine its suitability as process makeup water by testing its salinity, chemistry and deliverability. Sunshine will be exploring for brackish water in the 2011 core hole program and is planning to drill a well into the Devonian to explore for a potential saline water source.

Sunshine will make use of the excess water collected in the storm water runoff pond. Its capacity will be approximately 11,300 m^3. The volume of precipitation is not stable and is difficult to predict. The median annual storm runoff water that could be available for use in the process is 79,800 m^3. Sunshine will make use of the maximum amount of runoff water for makeup water usage.

2.8.3 Sanitary and Potable Water Supply Requirements and Source

A supply of sanitary and potable water will be required for the construction camp, operations camp and the administration and control room offices at the CPF. Drinking and cooking water

will be trucked in from an offsite source. Water for sanitary uses such as showers and toilets will come from the source water supply for the Project.

The planned 250 man construction camp for the Project will require an estimated 25 m^3/d and 4 m^3/d, for the sanitary and potable water supplies, respectively, when the camp is at full capacity. This camp will be in operation for approximately 18 months for the Project's first phase, and approximately 12 months for the second phase. During operations a 40 man operations camp will be required. The estimated daily sanitary and potable water usage is 3 m^3 and 1 m^3, respectively. Potable water will be trucked in from an approved water treatment facility. The water for showers and toilets will come from the water treatment in the plant which will be suitable for this use. The washrooms will be posted with a sign that states "water is not potable, do not drink".

2.8.4 Drainage Management

The main focus of the drainage management plan is to maintain natural drainage patterns by directing water around Project facilities and to control water potentially impacted by the Project from entering the surrounding landscape.

Site preparation will result in adequate drainage away from storage tanks, equipment, skids, buildings and pipe racks, directing it towards designated storm water retention ponds. Site preparation will include the following:

- clearing the site by removing trees and plant roots;
- stripping and stockpiling topsoil and subsoil;
- removing unsuitable or excess material including muskeg;
- contouring the site to ensure proper site drainage;
- constructing storm water retention pond(s);
- applying (where necessary) appropriate sub-base material and compact bases for facilities, complete with geo-textile and asphalt spray as required; and
- ensuring appropriate (where necessary) secondary containment around facilities complete with geo-textile and asphalt spray as required.

2.8.4.1 Central Processing Facility

All storage tanks, except boiler feed water and source water tanks, will be equipped with secondary containment and leak detection to minimize the occurrence of product leaks and subsequent contamination to the environment.

Surface water run-off from the plant site will be directed to a storm water retention pond constructed to take advantage of the natural elevation gradient. The retention pond will be constructed in accordance with ERCB Directive 55 requirements. All surface runoff will be collected in the settling pond and returned to the CPF for use as plant makeup water. However, it is anticipated that periodically, depending upon site and operating conditions, the surface runoff collected in the settling pond will be released into the surrounding watershed receiving waters. Prior to discharge, the water will be tested and released in accordance with the terms and conditions of the operating approval.

The CPF storm water retention pond design will be based on "Environmental Protection and Enhancement Act Approvals and Registrations Procedures Regulations. Applications for Sour Gas Processing Plants and Heavy Oil Processing Plants: A Guide to Content - Appendix B" (AENV, 1999).

It is intended that excess water collected in the storm water runoff pond will be used to supply a portion of the makeup water volume to the plant. The capacity of the storm water runoff pond will be approximately 11,300 m^3. This volume of water will supply approximately 16 days of makeup water for the CPF. It is difficult to predict the volume of precipitation and runoff that will be collected in the storm runoff pond. The median annual storm runoff water that could be available for use in the process is 79,800 m^3.

If there are heavy rain events and the runoff water pump return to the process does not have adequate capacity to keep the level in the runoff pond safely below overflow, the water will be tested to ensure that it meets surface discharge water quality requirements before discharge to the environment. The actual yearly amount of water returned to the CPF will depend on weather conditions encountered.

2.8.4.2 Well Pads and Roads

All well pads and roads will be constructed in a manner in which erosion from surface water runoff will be minimized. This will be achieved utilizing appropriate collection areas and flow barriers where necessary. Ditches will be designed to avoid pooling of water along the road surface. Surface drainage will be directed around the well pads (particularly the North Pad) using drainage ditches. The intent is to ensure that surface flows do not get interrupted or impacted by the Project components.

Culverts will be installed along the utility corridor as required. These culverts will be installed in accordance with the AENV *Code of Practice for Watercourse Crossings*.

2.8.5 Waste Water Disposal

2.8.5.1 Processed Water Disposal

A waste stream of concentrated brine from the evaporation-distillation process will be trucked to remote approved sites or pipelined to approved disposal wells located in proximity to the CPF. The first phase disposal volume is anticipated to be approximately 90 m^3/day. The second phase disposal volume is anticipated to be 174 m^3/day.

As stated in Section 2.6.11.5, sewage waste water will be contained in a septic tank and trucked away for disposal at an approved site or sent to a septic field. The system will meet all provincial and local codes. If on site water treatment is to be installed, Sunshine will hire a qualified professional company to design and install the treatment system, which will meet all Alberta and Municipal requirements.

2.9 Offsite Connections

2.9.1 Transportation

The Project will be located approximately 60 km west of Fort McKay. All staff and equipment will be transported to the Project using a newly constructed shared access road. As stated in Section 2.9.5, bitumen and diluent will also be initially hauled by truck along the access road to support the Project.

2.9.1.1 Construction

During construction, contractors will be housed onsite in a camp. Transit bussing will be provided by Sunshine for the transportation from Fort McMurray airport to the site to reduce the traffic on the local highways. Sunshine will also explore options for scheduling construction worker shift changes to avoid overlap with particularly busy periods along local highways.

With regard to the movement of large loads, Sunshine will consult with Alberta Transportation to ensure traffic safety. Sunshine will also attempt to schedule the truck delivery of goods and services during off-peak times on Highway 63.

2.9.1.2 Operations

The operating workforce required to develop the Project is forecast to be 40 people, working on a 7 days-in/7 days-out rotation. Sunshine proposes to fly its employees into the Fort McMurray Airport and transport them to the site. Once on site, the workforce will be housed in a camp constructed for the Project.

2.9.1.3 Road Construction Requirements

The main access is shown at Figure 1.1-1. The access road will continue from Section 6-94-17-W4M and extend northward to the Project's CPF located in Section 31-94-17-W4M. Sunshine has been working closely with other potential SAGD developers in the vicinity of the Project to develop a common access corridor that will suit the needs of each company and reduce the disturbance area.

Within the Project boundary, the road rights of way (which will include associated infrastructure) between the CPF and well pads are planned to be approximately 50 m wide, allowing the electric power lines and surface pipelines to be constructed adjacent to the roads to minimize surface disturbance.

The development of future well pads will also require road access. Where practical, these roads will follow existing site clearings and disturbances such as exploration lines.

2.9.2 Electrical Supply

As stated in Section 2.6.11.1, Sunshine plans to construct a cogeneration facility on site to provide power for the Project. Initially the cogeneration unit will operate as island generation, however as infrastructure develops in the area the possibility exists that the facility will be connected to the grid.

2.9.3 Fuel Gas Supply

Natural gas is the primary fuel source for the Project and will be supplied from a third-party. A 15 cm (6 inch) fuel gas line will be built from the main plant site and will tie into the existing main distribution pipeline operated by TransCanada Pipelines Ltd., which is located near the Project. A meter station will be required, which will be installed and operated by TransCanada.

2.9.4 Fresh Water Supply and Storage

Sunshine is investigating potential brackish water sources to supply the Project. Until a brackish water source is identified (see Section 2.8.2), the source water for the Project is proposed to come from fresh water wells drilled into the Viking and Grand Rapids Formations. Source water will be pumped from water wells located in the vicinity of the CPF to a 1280 m^3 source water storage tank via fresh water transfer pumps.

2.9.5 Diluent and Oil Sales Pipelines

Sunshine is currently reviewing the dil-bit and diluent market and diluent providers. Several diluent pipeline projects are either being proposed or are already underway. They include the Gateway Pipeline and Southern Lights Pipeline by Enbridge. Enbridge is also actively

discussing with potential anchor shippers a new industry diluent pipeline from Edmonton to Cheecham terminal. Canadian National Railway Co. has developed a transformative strategy it calls the "Pipeline on Rail" that can move Oil Sands production quickly and cheaply to markets in North America, which also provides a flexible way of delivering diluent to the CN Fort McMurray Terminal. By 2012 more diluent supply is predicted. Sunshine will contract with the providers to secure diluent supply.

Diluent will be supplied to the Project, initially by truck, and ultimately by a supply pipeline. Dil-bit (diluted bitumen) produced during operations will be trucked away initially, and then shipped to market via pipeline. The diluent and dil-bit marketing arrangements are intrinsically related to the discussions regarding routing and terms with the stakeholders mentioned above. Sunshine is currently working on marketing and transportation arrangements.

2.10 Health, Safety and Environmental Management

2.10.1 Policies

Sunshine is not a member of the Canadian Association of Petroleum Producers (CAPP), but is committed to CAPP's stewardship program. Sunshine is in the process of implementing an upgraded Corporate HSE Management system and is working further to update the emergency response plan to be site specific. These programs will be in place prior to the commencement of construction of the Project.

Sunshine believes in the commitment to responsible resource development and continuous improvement. By leveraging an integrated approach to sound planning and operating practices, Sunshine will practice continuous improvement in environmental, health and safety and social performance. Sunshine believes in promoting mutually beneficial relationships and open and honest reporting of its performance in those areas.

Sunshine will provide responsible management for the Project by ensuring that health, safety, and environmental policies and procedures are established and implemented. All management staff will be familiar with all policies and procedures and employees, contractors and consultants under their direction will receive proper instruction through on-site training programs. By following this approach, the Project will be developed and operated in a professional, safe and responsible manner.

Fundamental to Sunshine's long-term growth and success are two important elements: socially responsible operations and environmental stewardship. The company's vision in areas of environment, health and safety and community is clearly defined:

- Sunshine conducts all operations in a manner that protects the health and safety of employees, contractors, the public and the environment;

- Sunshine works cooperatively with communities, government agencies and interested stakeholders to reduce potential impacts of its operations and maximize opportunities for economic participation;

- Sunshine commits to a long-term presence in the community where it operates. The company's significant business activities contribute to economics and quality of life;

- Sunshine works together with the community and industry groups to ensure a better, sustainable energy industry; and

- Sunshine integrates environmental and community planning with project design and implementation.

2.10.1.1 The Environment

Protection and preservation of the environment is a fundamental operating principle of Sunshine. Comprehensive measures will be reviewed and implemented to mitigate the occurrence of environmental issues in the design and operation of the Project.

Employees, contractors and consultants will be expected to operate equipment according to manufacturers' specifications. Workers will be trained to manage and respond to operating situations that may impact the environment by expeditiously determining the cause and remedying the problem.

Preparation and adherence to environmental Standard Operating Procedures and Practices (SOPs) will form part of the guiding operating principles throughout the life of the Project. All employees, contractors and consultants will be advised of these environmental work procedures and practices with daily and routine activities being managed according to same.

Appropriate signage, markings and other designations will be implemented to guide and inform personnel with respect to environmental considerations. With knowledge, training and understanding of the situation, these directions, along with applied procedures and practices will minimize the risk of occurrence of an undesirable incident.

Continuous learning, training and improvement will be ongoing throughout the life of the Project to ensure operating staff remain current with respect to knowledge and information on regulatory issues and environmental considerations associated with the development and operation of the Project.

Environmental monitoring will be reviewed by designated company personnel to ensure compliance with environmental approval requirements. Ongoing assessments and audits will be carried out on a regular basis throughout the life of the Project to ensure the company's objectives have been met with respect to environmental stewardship.

Sunshine's environmental management plan and operating guidelines focus on minimizing the impact of field operations while meeting regulatory requirements and corporate standards. Sunshine's pro-active program includes the following elements:

- regular audits and inspection programs;
- reclamation and decommissioning standards;
- effective surface reclamation programs;
- due diligence programs related to ground water monitoring; and
- programs related to preventing and reclaiming spill sites

Sunshine plans to participate in programs of greenhouse gas reduction whenever the available technologies are adaptable to the Project.

2.10.1.2 Health and Safety

Sunshine is committed to conducting its operations in a safe and environmentally sound manner. In support of this commitment, Sunshine has developed a policy on Health, Safety and the Environment and a Safety Program to ensure that its operations comply with this Policy. The Program includes a Management Plan dealing with the implementation of the Program and will provide management, employees and contractors with the tools, information and references they need to carry out that Management Plan.

It will be Sunshine's practice to provide each of its operators, supervisors and contractors with training in the use its Safety Program manual. This training will be included in the orientation of new personnel to the company's operations.

Complementary documents, tools and training will include Sunshine's Health, Safety & Environment Handbook and Emergency Response Plan. Sunshine is compliant with ERCB Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry, which sets out emergency preparation requirements.

The Safety Program, together with the supporting training, will ensure that all Sunshine staff, contractors and supervisors make maximum use of the combined resources of Sunshine, government agencies, and other outside services to:

- assist with orienting, informing, guiding and motivating Sunshine employees and contractors;

- implement policies, procedures, practices and standards relating to Sunshine's operations;
- provide and maintain a safe working environment including the safe use of tools, machines and equipment;
- maintain effective communication;
- ensure immediate, competent responses when handling an emergency; and
- control work site hazards, thereby minimizing the risk to Sunshine employees, its contractors and the public.

All personnel directly involved with Sunshine operations, including both employees and contract personnel, will be responsible for ensuring their activities are consistent with this manual.

2.10.2 Integrated Environmental Health and Safety Management Plan

Sunshine will integrate environmental health and safety aspects into all facets of the Project. The objective of the Management Plan will be to ensure compliance with Sunshine's environmental and health and safety stewardship objectives. The program will be implemented through the following mechanisms:

- Progressive Project Management - Continual Improvement Process;
- Loss Control and Environmental Compliance Program;
- Emergency Response Plan;
- Waste Management Plan;
- Substance Release Controls and Monitoring;
- Wildfire Response Plan; and
- Stakeholder Consultation.

2.10.2.1 Progressive Project Management - Continual Improvement Process

The Progressive Project Management approach adopted by Sunshine will be applied in three stages.

The first stage will be carried out prior to development. Baseline conditions will be evaluated and potential environmental and safety considerations identified. Where deemed appropriate, facility design and control requirements will be modified so as to minimize any potential negative operating incidents.

The second stage will involve monitoring and mitigating the potential environmental and safety incidents during operations. This program will include making any necessary changes to the environmental and safety programs to best achieve this objective.

The third stage will occur at abandonment to ensure that all environmental and safety liabilities have been removed from the site's remaining footprint, and to ensure that the site has been fully reclaimed and pre-disturbance capabilities have been returned.

2.10.2.2 Loss Control and Environmental Compliance Program

Designated Sunshine personnel will act as the site custodians to ensure that environmental and safety operating procedures are regularly evaluated and, if necessary, altered to address any adverse effects that are occurring. The Progressive Project Management - Continual Improvement Process, is an integral part of the Loss Control and Environmental Compliance Program.

2.10.2.3 Emergency Response Plan

Sunshine's Emergency Response Plan (ERP), which is compliant with ERCB Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry, has been developed to facilitate an effective response by Sunshine operations, management and support personnel to an emergency occurrence. To ensure a state of emergency preparedness throughout the company, Sunshine has developed these emergency procedures to protect the public, employees, contract employees, property and the environment.

With the development of the ERP, Sunshine is prepared to:

- ensure immediate competent responses to, and handling of, an emergency occurrence;
- minimize danger to the public, employees, contractors and the environment;
- establish and maintain effective communications with all parties in an emergency; and
- make maximum use of the combined resources of Sunshine, government agencies and other services.

The plan will specifically address alert levels, evacuation requirements, call-down procedures and external emergency agency involvement.

Response equipment will be documented, kept current and made readily available as a part of the ERP.

The ERP will address incidents such as:

- serious onsite injury to facility personnel, contractors, consultants or members of the public;
- CPF shutdown;

- major equipment or instrumentation failure;
- major spills or releases to the environment;
- fire in or near facilities;
- security issues such as criminal acts, threats or acts of terrorism;
- loss of well control; and
- pipeline rupture.

The primary objectives of the ERP will be to limit the danger to facility personnel, the public, the environment and operating equipment.

2.10.2.4 Waste Management Plan

A waste management plan for the Project will be designed to effectively control waste by minimizing waste generation and waste disposal. The over-riding principles of the plan will be to reduce, reuse and recycle. The waste management plan will designed to regularly receive feedback as to its effectiveness and identify opportunities for continual improvement.

Waste management at the site will comply with all waste management processes, procedures and guidelines, including the EPEA Waste Control Regulation (AEP 1996). Practices will include:

- classifying, measuring and controlling waste generation, handling, storage, treatment and disposal;
- tracking and reporting;
- off-site disposal of dangerous oilfield waste (DOW) and non-DOW waste as appropriate; and
- recycling as appropriate.

Waste management practices will be in compliance with all ERCB requirements including those outlined in the following Directives:

- Directive 58 (Oilfield Waste Management Requirements for the Upstream Petroleum Industry) (EUB 1996a); and
- Directive 50 (Drilling Waste Management) (EUB 1990).

All wastes will be disposed of in a responsible manner, in compliance with all appropriate regulations and guidelines, and in accordance with the waste handling requirements set out in any EPEA Approval granted for the Project. Detailed waste disposal practices and procedures will be developed prior to the start of construction and operations and will be continuously reviewed throughout the life of the Project. Sewage waste water will be contained in a septic tank and trucked away for disposal at an approved site or sent to a septic field.

Wastes will be generated during two phases of the proposed development; initially during construction, and following that during the Project's on-going operation for the life of the Project. The construction phase will include the construction and operation of a camp, roads, the plantsite and wellpads, and the steam distribution lines and liquid transfer lines from the well pads to the CPF. The construction phase will extend over a period of approximately one year and the operational life of the Project is estimated to be 25 years.

Summaries of the wastes generated for each phase are shown in Table 2.10-1, including proposed storage locations, disposal sites and disposal method.

Quantities of waste generated during operations (brine off evaporator) have been estimated in the Table 2.7-1 and Table 2.7-2 for Phase 1 and Phase 2 respectively by using process flow diagrams and material balance calculations, but the quantities of construction waste and camp waste have not been determined. These will be disposed of in approved disposal facilities on an as-generated basis.

Table 2.10-1 Waste Management

Waste Description	ERCB Waste Code[1]	Storage Location	Disposal Responsibility	Disposal Method
Drilling				
Drilling mud/cuttings	Various	Tanks	Contractor	Recycle or Mix-Bury-Cover
Lubricants	LUBOIL	Drums	Contractor	Recycle
Mud additives	Various	Bins	Contractor	Return or Recycle
Scrap metal	SMATAL	Bins	Contractor	Recycle
Pallets	CONMAT	Bins	Contractor	Landfill/Recycle
Cement	CEMENT	Bins	Contractor	Class II Landfill
Solvents	Various	Drums	Contractor	Return or Recycle
Mud sacks	EMTCON	Bins	Contractor	Class II Landfill
Construction				
Packing Materials	DOMWST	Bins	Contractor	Incinerator/Recycle
Cardboard	DOMWST	Bins	Contractor	Incinerator/Recycle
Pallets	CONMAT	Bins	Contractor	Incinerator/Recycle
Wood	CONMAT	Bins	Contractor	Incinerator/Recycle
Scrap Metal	SMETAL	Bins	Contractor	Landfill/Recycle
Glass	CONMAT	Bins	Contractor	Landfill/Recycle
Paint	WPAINT	Bins	Contractor	Recycle
Sand Blast	CONMAT	Bins	Contractor	Class II Landfill
Insulation	CONMAT	Bins	Contractor	Class II Landfill
Welding Rods	CONMAT	Bins	Contractor	Class II Landfill
Lubricants	LIBOIL	Drums	Contractor	Recycle
Oil Filters	FILLUB	Drums	Contractor	Recycle
Cable cut-offs	SMETAL	Bins	Contractor	Landfill/Recycle
Construction – Camp				
Kitchen Waste	DOMWST	Bins	Contractor	Landfill
Cardboard	DOMWST	Bins	Contractor	Landfill/Recycle

Table 2.10-1 Waste Management

Waste Description	ERCB Waste Code[1]	Storage Location	Disposal Responsibility	Disposal Method
Containers	EMTCON	Bins	Contractor	Incinerator
Septic Fluids	WSTMIS	Septic	Contractor	Off Site Disposal
Operations - Plant				
Filter: Glycol	FILGY	Bins	Contractor	Swan Hills
Filter: Raw Water	FILFWT	Bins	Owner	Class II Landfill
Filter: Pressure	FILOTH	Bins	Contractor	Swan Hills
Filter: Oil removal	FILOTH	Bins	Contractor	Swan Hills
Ion exchange resins	IEXRES	Bins	Owner	Class II Landfill
Filter backwash Sludge/Liquid	WESTMIS	Tank	Owner	Recycle
Boiler Blow down Water	WSTMIS	Vessel	Owner	Recycle
Process Blow down Water	WSTMIS	Tank	Owner	Recycle
Septic Fluids	WSTMIS	Septic Tank	Owner	Off Site Disposal
Caustic	CAUS	Tank	Owner	Recovery
Acid	ACID	Truck in as needed	Third Party	Return or Recycle
Batteries	BATT	Bin	Owner	Recycle
Containers: Drums/barrels	EMTCON	Bins	Owner	Return or Recycle
Containers: Herbicide	PSTCON	Bins	Owner	Return or Recycle
Containers: pesticide	PSTCON	Bins	Owner	Return or Recycle
Containers: biocide	EMTCON	Bins	Owner	Return or Recycle
Filters: lube oil	LUBOIL	Bins	Third Party	Recycle
Filters: produced oil	FILWWT	Bins	Contractor	Swan Hills
Garbage: office paper	DOMWST	Bins	Owner	Landfill/Recycle
Packing materials	DOMWST	Bins	Contractor	Landfill/Recycle
Pallets	DOMWST	Bin	Owner	Landfill/Recycle
Hydrotest fluids: methanol	METHNL	Tank	Contractor	Recycle
Lab. Chemicals	INOCHM/OR	Bin	Owner	Recycle
Insulation	CONMAT	Bin	Contractor	Class II Landfill
Sludge: oil slop	SLGHYD	Tank	Owner	Recover
Sludge: Separators	SLGPRO	Tank	Owner	Recycle
Well Workover fluids	WNOFLD	Tank	Contractor	Bioremediation
Operations – Camp				
Kitchen waste	DONWST	Bins	Contractor	Landfill
Cardboard	DOMWST	Bins	Contractor	Landfill/Recycle
Containers	EMTCON	Bins	Contractor	Landfill/Recycle
Septic Fluids	WSTMIS	Septic Tank	Contractor	Digestor
Incinerator Ash	INCASH	Bins	Contractor	Class II Landfill

[1] ERCB Waste Codes are provided in Appendix 7 of Waste Listings of ERCB Directive 58 – Oilfield Waste Management Requirements for the Upstream Petroleum (EUB, 1996)

2.10.2.5 Water Management

Surface water run-off from the plant site will be directed to a storm water retention pond which will be located to take advantage of the natural elevation gradient. The retention pond will be designed, constructed and operated in accordance with ERCB Directive 55 requirements and operated as per conditions in the AENV Project operating approval.

Surface runoff collected in the storm water retention pond will be used in the process as much as possible and the excess water will be released into the surrounding watershed. Prior to discharge, the water will be tested and released in accordance with the terms and conditions of the operating approval.

2.10.2.6 Fire Control Plan

The fire control plan for the Project will address:

- the Project as a source of fire; and
- wildfire impact on the Project.

Potential sources of fire resulting from the Project include operations within the CPF and the flare system. Fire detection will be provided at the CPF and the well pads.

Sensors capable of detecting open flame will be installed in critical areas of the facilities. The sensors will be tied to the plant's control room. Smoke detection will be located in the control room/administration building. A combination of wall mounted and wheeled fire extinguishers will be located around the plant and the well pads. Fire blankets, eyewash stations and safety showers will be strategically located around the plant for personnel safety. In addition, operators' trucks will be outfitted with portable fire extinguishers.

Other fire reduction measures which will be incorporated will include:

- use of non-combustible building materials;
- where deemed appropriate, absence of combustible ground cover;
- adequate setback of facilities from the surrounding forest;
- adequate building separation; and
- placement of fire blankets in strategic locations within the PDA.

A wildfire control plan will be developed jointly with the Forest Protection Division of Alberta Sustainable Resource Development. It will set out the equipment and level of readiness required at the Project to assist in wildfire control. It will also include maps of roads and access to the West Ells Lease area providing valuable information for the local forest protection division.

Forest fire awareness training will also be added to the suite of training programs for Sunshine employees.

2.10.2.7 Substance Release Monitoring

The two primary emission destinations that emission sources from the Project can affect are air and water. Substance release monitoring will be carried out under the supervision of the on-site Project Manager. The types and volumes of Project emission sources will be tracked and recorded in accordance with the applicable regulations and operating approval conditions. The maintenance of pollution abatement and monitoring equipment will be an integral component of normal maintenance and operation of the facility.

2.10.2.8 Site Management

Site preparation will provide adequate drainage away from storage tanks, equipment, skids, buildings and pipe racks and direct it towards the designated storm water retention pond.

Site preparation activities will include the following:

- clearing the site by removing trees and plant roots;
- stripping and stockpiling topsoil;
- constructing a storm water retention pond;
- contouring the site to ensure proper site drainage;
- where required and deemed appropriate, removing unsuitable or excess material including muskeg;
- applying (where necessary) appropriate sub-base material and compact bases for facilities complete with geotextile as required; and
- ensuring appropriate (where necessary) secondary containment around facilities complete with geotextile as required.

All storage tanks, except boiler feed water and source water tanks, will be equipped with secondary containment and leak detection to minimize the occurrence of product leaks and subsequent contamination to the environment.

All well pads and roads will be constructed in a manner in which erosion from surface water runoff will be minimized. This will be achieved utilizing appropriate collection areas and flow barriers where necessary. Ditches will be designed to avoid ponding of water along the road surface.

3 PUBLIC AND ABORIGINAL CONSULTATION

Sunshine is committed to developing an ongoing stakeholder and aboriginal community engagement program prior to and throughout the life of the Project. Since the winter of 2007, Sunshine has been actively engaged in meetings with local stakeholders and aboriginal communities regarding the proposed Project and ongoing exploration activities throughout the West Ells area. To date, Sunshine has focused Project consultation activities on the access road and all activities outlined in the Project's first phase of development. The future phase 2 and additional facilities including well pads, borrow pits and utility corridors will require further consultation during the regulatory review period. Sunshine will continue consultation activities in regards to the entire West Ells Project and will provide consultation updates as required.

Key consultation activities have included the following:

a. *Stakeholder Identification* - The identification process is complete and engagement is ongoing;

b. *Notifications* - These have included plain language Project updates provided to stakeholders via "Light on the Horizon" newsletter, person to person meetings, open house forums and telephone and e-mail correspondence throughout 2008-2009 including all overlapping and offset PNG and Oil Sands lease holders. Formal project notifications will occur once the Project application has been submitted to the ERCB and AENV for regulatory review;

c. *Community Open Houses* – Sunshine hosted a community open house in Fort McKay on October 14, 2008 which was attended by 59 elders. Valuable feedback was gathered and will form the basis for ongoing discussions with the community. Additionally, Sunshine is planning a community open house in Fort McMurray and throughout other aboriginal communities as requested;

d. *Trapper Consultation* – Two Fort McKay trappers have been engaged and have reviewed the Project surface footprint via map sessions and a helicopter tour which occurred during the fall of 2008. Consultation is ongoing and updates will be provided as discussions progress; and

e. *Access* – Discussions have occurred with Alberta Sustainable Resource Development ("ASRD"), potential industry users and affected stakeholders regarding the use of one common corridor into the Project Area. Sunshine is currently working with an industry partner to ensure access development aligns with ASRD's draft Moose Lake Access Management Plan. Sunshine is also a member of the Traffic Impact Assessment working group which is reviewing the

potential impact on Highway 63 as a result of the Project, which is working closely with Alberta Transportation to ensure that a mutually beneficial solution is derived.

Consultation has been ongoing and Sunshine will continue pursuing a thorough consultation process based on the objectives listed below.

3.1 Consultation Objectives and Process

Sunshine's consultation objectives are as follows:

- Facilitate open and effective communication with all stakeholders, including but not limited to, members of the public, regulatory bodies and industry who are, or may be, affected by the proposed exploration and development activities;
- Provide Aboriginal communities and stakeholders with clear and timely information;
- Ensure that a transparent, respectful relationship is built and maintained with neighbours and stakeholders throughout the Project Area;
- Seek input into the design of the consultation process at the outset to ensure that communication and consultation needs are met; and
- Establish a high level of inclusiveness when indentifying those who may have an interest or be potentially impacted by Sunshine's activities or proposed activities.

Sunshine believes that consultation works best when proactive community and stakeholder engagement occurs. It has adhered to these principles in conducting its consultation activities in connection with this Project.

3.1.1 Aboriginal Consultation

In accordance with the *Government of Alberta's First Nation Consultation Policy on Land Management and Resource Development*, when aboriginal and treaty rights (including rights to hunt, trap and fish for food in traditional territories) may be adversely affected by a government decision, the Crown's duty to consult is triggered. The Crown's duty to consult has been delegated to industry in the province of Alberta. Since 2007, Sunshine has been engaged in exploration and project specific consultation activities with the Fort McKay First Nation,

Mikisew Cree First Nation, Fort McMurray First Nation, Chipewyan Prairie D'ene First Nation and Athabasca Chipewyan Cree First Nation.

Sunshine will continue to engage all applicable Aboriginal communities and is committed to hosting further open houses throughout 2010 and 2011. Sunshine will make every effort to ensure that the consultation process is meaningful.

The first stage of Sunshine's consultation process is to inform and introduce the affected aboriginal communities to Sunshine, introduce the Project and review the need for joining Industry Relation Corporations.

The second stage of the process is to hold detailed meetings relating to the Project, document any specific concerns and discuss proposed mitigation strategies. These forums include one on one discussion, chief and council meetings and community open houses.

Key aboriginal communities have been identified and are listed below in Table 3.3.1. All of the affected aboriginal communities are mailed copies of Sunshine's informational newsletter "Light on the Horizon" biannually which summarizes the proposed Project details and associated infrastructure.

3.1.2 Public Consultation

ERCB Directives 023 and 056 and the EPEA set out the following public involvement statements and requirements:

- Directive 023 *"Applicants are encouraged to plan and carry out a suitable program to make the public aware of the proposed development, to obtain and incorporate, where feasible, the reaction of interested or affected persons, and to provide documentation to the ERCB and AENV as to the nature and extent of communication".*

- Directive 056 *"Industry is required to develop an effective participant involvement program that includes parties whose rights may be directly and adversely affected by the nature and extent of a proposed application."*

- EPEA *Public involvement is a key component of the approval process: sections 73 (1) and (2) of the EPEA provide that the public must be notified of all approval applications. Anyone directly affected by an application may submit a written statement to the Director outlining concerns, and may appeal a decision to issue an approval.*

As outlined in Table 3.3.1, key stakeholders in the Project Area include industry, landowners, land occupants, municipal governments, land use groups and environmental organizations. All of the affected stakeholders were mailed copies of Sunshine's informational newsletter "Light on the Horizon" which summarizes the proposed Project details and associated infrastructure.

3.1.3 Stakeholder Communication Process

The various consultation methods which Sunshine has employed include the following:

- Provision of plain language documentation, Project description letters and mapping which specifically references known landmarks;
- Community forums, open house presentations and in person one-on one meetings with appropriate Sunshine personnel;
- E-mail, website postings, library access, hand delivery and telephone calls;
- Timely media advertisements;
- First Nation Industry Relations Corporation communications; and
- First Nation Chief and Council communications.

These types of communications have and will continue to be utilized to communicate to all Project stakeholders.

3.1.4 Documentation Process

Sunshine is utilizing a communication tracking database that ensures that all consultation updates are accurately recorded. In accordance with the *First Nation Consultation Guidelines* and *ERCB Directive 023*, Sunshine will submit updated consultation logs to all applicable regulatory bodies, aboriginal communities and local stakeholders during the Project regulatory review process and life of the Project.

3.1.5 Stakeholder and Community Feedback Process

Sunshine will continually monitor and gather constructive feedback from and will provide meaningful consideration to all stakeholders and aboriginal communities throughout the consultation process. If and when mitigation strategies are required and subsequently agreed upon by all parties, Sunshine will advise the overseeing regulatory body as to the outcome of the mitigation discussions in a timely fashion.

3.2 Regional Association Membership

Sunshine is currently in the process of or is considering joining the following Oil Sands related multi-stakeholder groups:

- Athabasca Tribal Council All Parties Core Agreement;
- Cumulative Effects Management Association;
- Wood Buffalo Environmental Association; and
- Oil Sands Developers Group.

3.3 Public Stakeholder and Aboriginal Community Identification

The public consultation program has been designed to be as inclusive as possible. Sunshine is in the process of consulting with those participants, identified in Table 3.3-1, who have an interest in the land on or near the Project Area.

Table 3.3-1 West Ells Project Participant Listing

Stakeholder	Details
Fort McKay First Nation	Fort McKay, Fort McKay Industry Relations Corporation, and Fort McKay Group of Companies.
Chipewyan Prairie D'ene First Nation	Chipewyan Prairie D'ene First Nation Industry Relations Corporation
Athabasca Chipewyan First Nation	Athabasca Chipewyan Industry Relations Corporation and Industry Business Group.
Mikisew Cree Nation	Mikisew Cree Industry Relations Corporation and Group of Companies
Fort McMurray # 468 First Nation	Fort McMurray # 468 Industry Relations Corporation
Métis Organizations	Fort Chipewyan Métis Local 125, Fort McKay Métis Local 63 and Fort McMurray Métis Local 1935.
Fort McKay Trappers	Two individuals
Metallic /Mineral Permit Holder	Athabasca Minerals Inc and Grizzly Diamonds Ltd.

Table 3.3-1 West Ells Project Participant Listing	
Stakeholder	**Details**
Alberta Government	Alberta Sustainable Resource Development, Energy Resources Conservation Board, Alberta Environment, Historical Resources and Alberta Transportation.
Oilsands Lease Holders	Agadir Resources Inc., Bancroft Oil & Gas Ltd. and Canadian Coastal Resources Ltd.
Disposition Holders and Area Operators	Alberta Pacific Forest Industries, Athabasca Oil Sands Corp., ATCO Electric, Chevron Canada Ltd., EnCana Oil and Gas, Grizzly Oilsands, Paramount Energy Operating Corp., TransCanada Pipelines and Total E&P
Industry Association	Oilsands Developers Group
Regional Business Associations	Northeastern Alberta Aboriginal Business Association and Fort McMurray Chamber of Commerce.
PN&G Rights Holders	Paramount Energy Operating Corp and EnCana Oil and Gas.
Health Authorities	Northern Lights Regional Health Authority

3.4 Open House Activities

On October 14, 2008 approximately 59 elders attended a West Ells SAGD Project community open house in Fort McKay. During the open house, information related to the Project was presented, along with an update on Sunshine's area operations including this Project and the SAGD process. The open house was also attended by eight of Sunshine's representatives, including its environmental assessment consultant, all of whom collected and addressed questions and discussed observations regarding the information presented. All concerns which arose from the open house were noted and will be discussed during future Fort McKay community elder advisory meetings and subsequent discussions with the community of Fort McKay.

Sunshine is planning further open houses in the City of Fort McMurray and throughout aboriginal communities. The following table provides a general summary of the issues raised by

stakeholders and aboriginal communities to date and a proposed mitigation strategy as suggested by Sunshine:

Table 3.4-1 Key Themes

Issues Raised	Proposed Mitigation
Proximity to Namur and Moose Lakes (Fort McKay IR's 174 A 17B)	Establishment of security protocols around the West Ells Plant site location to help mitigate access to Fort McKay Indian Reserves 174 A and 174 B. Formation of a Fort McKay Elders advisory group.
Land Disturbance	Sunshine is minimizing the project disturbance footprint by proposing to drill multiple horizontal wells from 2 well pads. No site specific concerns have been raised to date.
Reclamation	The approved conservation and reclamation plan associated with the West Ells approval will ensure that Sunshine returns the landscape to an equivalent land capability upon abandonment.
Employment	Sunshine recognizes the need for local employment and will further review this issue throughout the consultation process.
Surface Water	No surface water will be used for steam generation at the plant site. Also, the central plant is designed to ensure that no water will be released offsite until tested to ensure provincial guidelines are met.
Groundwater	Liquid waste from the CPF will be trucked off site and disposed of at an approved facility until a suitable disposal zone has been identified.
Air Quality	Flaring on site will be minimized and shall only occur during plant start up, or shut down.

3.5 Regulatory Review Agencies

Regular communication will continue with the regulatory review agencies and other interested provincial agencies as Sunshine proceeds with the Application and subsequent development of the Project.

3.6 Future Consultation

Sunshine will maintain its open-door public consultation initiatives during the regulatory review period and throughout the life of the Project. Once the Project approvals have been received, Sunshine will provide information to stakeholders through its corporate website (www.sunshineoilsands.com) and through regularly scheduled meetings with stakeholder groups and Aboriginal communities.

4 ENVIRONMENTAL INFORMATION

This section of the Application constitutes the environmental impact statement for the Project and provides a summary of the attached Consultant Reports (CR #1 – CR #10) which deal with each of the technical disciplines covered in much greater detail. This section also summarizes the monitoring and mitigation measures Sunshine intends to implement so as to minimize any environmental impacts caused by the Project.

Each of the disciplines has completed the baseline data collection within the Project Area or larger. The components listed in Table 1.3-1 will be developed for the Project's first phase that has a small disturbance area and has been studied in a greater detail as provided in this section and in the Consultant Reports (CR #1 – CR #10).

Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further environmental data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.The Project related surface facilities that will comprise Phase 1 of the Project and that were considered in the environmental assessments include:

- Plant Site 29.3 ha
- North Pad 4.9 ha
- South Pad 4.4 ha
- Construction Camp 4.9 ha
- Operator's Camp 2.9 ha
- Supervisor's Camp 1.2 ha
- Borrow Pit #1 8.9 ha
- Utility Corridor 4.2 ha
- Total 60.7 ha

The environmental assessments also included an access road required to support the SAGD Project. The access road will include the following surface facilities:

- Access Road 45.3 ha
- Borrow Pit #2 5.6 ha
- Borrow Pit #3 4.5 ha
- Borrow Pit #4 6.5 ha
- Borrow Pit #5 6.0 ha
- Total 67.8 ha

In general, the environmental assessments considered a local study area for the Project and another study area for the access road. For most of the Project components or disciplines, the study areas (i.e. soils, C&R, vegetation, wildlife, historical resources, noise, land use and constraints) include the following areas:

- Project LSA
- Sections 3, 4, 5-95-17-W4M
- Sections 30, 31, 32, 33-94-17-W4M
- Sections 25, 36-94-18-W4M
- Access road LSA
- NE 24-94-18-W4M
- Pt. Sections 7, 18, 19-94-17-W4M
- W ½ 5, E ½ 6, W ½ 8-94-17-W4M

The aquatic and hydrology components have used local study areas, that are slightly different (typically drainage basins) and include the following areas:

- Aquatic Resources Local Study Area ("Aquatics LSA") - uppermost portion of the Dover River watershed, and a small section of the upper-Snipe Creek watershed. The Aquatics LSA extends to the north to include a reference station which could be used to provide baseline data for future aquatic monitoring activities.
- Surface water hydrology Local Study Area ("Hydrology LSA") - total drainage area of the local tributaries to the Dover and Dunkirk rivers which have portions of their watersheds lying within the Project Area and access road right-of-way.
- The surface water hydrology Regional Study Area ("Hydrology RSA") - composed of the watershed of the MacKay River.

Air quality used a study area that relates to the predicted dispersion of aerial project emissions. Hydrogeology considered a study area that reflects the reservoir delineation such as the Project Area and Project Development Area as described in Section 2.

4.1 Air Quality

4.1.1 Introduction

Millennium EMS Solutions Ltd. (MEMS) was retained by Sunshine to provide an Air Quality Assessment for the proposed Project. The following section is a summary of the Air Quality Assessment (without NCG injection) set out in more detail in Consultant Report #1. Table 2.6-3 shows the emission changes calculated based on Consultant Report #1 and engineering design of an NCG injection system. As set out in Table 2.6-3, the NCG injection will have little effect on the emission.

The objective of the assessment was to assess the air quality as a result of the Project emissions together with nearby emission sources using the CALMET meteorological model and the CALPUFF dispersion model. The operation of the Project will result in combustion products being vented to the atmosphere. Chemicals of concern in this assessment include NO_x, SO_2, $PM_{2.5}$ and CO. Ambient concentrations should not exceed Alberta ambient air quality objectives (AAAQOs) or Canada Wide Standards (CWS).

4.1.2 Background Concentrations

According to AENV Dispersion Modeling Guidance (AENV, 2003), appropriate compound concentrations due to natural sources, in addition to unidentified and possibly distant sources, are to be used as background, and added to predicted values from the facility and nearby sources. For the Project, background emissions due to distant industrial sources (approved and planned) as well as emissions from roadways and the Fort McMurray area were considered by adding concentrations predicted in the recent Deer Creek Joslyn North Mine Project Supplemental Information (DCEL, 2007) to the Sunshine CALPUFF predicted concentrations.

Predictions (future development case) from the DCEL 2007 model results at the receptor nearest the Project were obtained and applied uniformly throughout the model domain as a background concentration. A summary of the background values used in this assessment is provided in Table 4.1-1.

Table 4.1-1 Ambient Background Concentrations of Modelled Compounds[1]

CAC Compounds	Hourly (µg/m^3)	8-Hour (µg/m^3)	24-Hour (µg/m^3)	Annual (µg/m^3)
NO_x	125	N/A	48	3.0
SO_2	41	N/A	18	0.93
$PM_{2.5}$	38	N/A	9.9	0.52
CO	103	87	42	2.8

N/A: Not Applicable
1: from DCEL, 2007

4.1.3 Potential Impacts

The air quality assessment included modelling of emissions from expected Project operations as well as an assessment of upset conditions leading to flaring (CR #1, Section 7).

Tables 4.1-2 to 4.1-5 summarize the maximum predicted concentrations obtained by using the CALPUFF modeling program.

4.1.3.1 Predicted NO_2 Concentrations

Most NO_x emissions are in the form of NO and atmospheric reactions with ambient O_3 converting NO to NO_2. In this assessment, the background NO_x concentration was added to the predicted NO_x concentration and then the total was converted to NO_2 concentration using the ozone limiting method (OLM) recommended by AENV (2003). This method is considered to be a conservative screening approach, producing overestimations of actual concentrations. The results using the total conversion method have also been presented.

Table 4.1-2 summarizes the maximum predicted NO_2 concentrations. The key results are as follows:

- the predicted 99.9th percentile hourly, maximum 24-hour, and annual average NO_2 concentrations outside of the plant site boundary are 112 µg/m^3, 85 µg/m^3 and 24 µg/m^3, respectively;
- the maximum 99.9th percentile hourly concentration is predicted to occur approximately 100 m outside of the plant site boundary along the northeastern side (CR #1, Figure 6.1);
- 24-hour and annual maximum concentrations are predicted to occur on the southeastern edge of the plant site boundary (CR #1, Figures 6.2 and 6.3); and
- predicted NO_2 concentrations are well below AAAQOs for every averaging period.

Table 4.1-2 Summary of NO_2 Maximum Ground-Level Concentrations

	NO_2 Ozone Limiting Method (µg/m^3)	NO_2 Total Conversion Method (µg/m^3)	AAAQO (µg/m^3)
99.9th Percentile 1-hour Average	112	325	400
Maximum 24-hour Average	85	119	200
Annual Average	24	24	60

4.1.3.2 Predicted SO_2 Concentrations

Table 4.1-3 summarizes the maximum predicted SO_2 concentrations. The key results are as follows:

- the predicted 99.9th percentile hourly, maximum 24-hour, and annual average SO_2 concentrations outside of the plant site boundary are 207 µg/m^3, 58 µg/m^3, and 6.2 µg/m^3, respectively;
- the maximum 99.9th percentile hourly concentration is predicted to occur along the southeastern edge of the plant site boundary while the maximum 24-hour

concentration is predicted to occur approximately 150 m east of that location (CR #1, Figures 6.4 and 6.5, respectively);

- the predicted annual average concentration is predicted to occur at the northeastern corner of the plant site boundary (CR #1, Figure 6.6); and
- predicted concentrations are well below the AAAQOs in each averaging period.

Table 4.1-3 Summary of Predicted SO_2 Maximum Ground-Level Concentrations

	SO2 Predicted GLC (µg/m^3)	AAAQO (µg/m^3)
99.9th Percentile 1-hour	207	450
Maximum 24-hour average	58	150
Annual Average	6.2	30

4.1.3.3 Predicted CO Concentrations

Table 4.1-4 summarizes the maximum predicted CO concentrations. The key results are as follows:

- the maximum hourly and 8-hour average CO concentrations are 547 µg/m^3 and 358 µg/m^3, respectively. These maximums are predicted to occur approximately 75 m east of the eastern edge of the plant site boundary (CR #1, Figures 6.7 and 6.8); and
- both the hourly and 8-hour averages are well below the AAAQOs of 15,000 µg/m^3 and 6,000 µg/m^3, respectively.

Table 4.1-4 Summary of CO Maximum Ground-Level Concentrations

	CO Predicted GLC(µg/m^3)	AAAQO (µg/m^3)
99.9th Percentile 1-hour	547	15,000
Maximum 8-hour average	358	6,000

4.1.3.3 Predicted $PM_{2.5}$ Concentrations

Table 4.1-5 summarizes the predicted 24-hour (CR #1, Figure 6.9) and hourly (CR #1, Figure 6.10) $PM_{2.5}$ concentrations. The key results are as follows:

- the predicted maximum hourly $PM_{2.5}$ concentration outside of the plant boundary is 64 µg /m^3. There are no predicted exceedances of the 1-hour AAAQO over 80 µg /m^3; and
- the predicted maximum 24-hour average outside of the plant boundary is 15 µg /m3. There are no predicted exceedances of the 24-hour PM2.5 AAAQO of 30 µg /m3.

Table 4.1-5 Summary of $PM_{2.5}$ Maximum Ground-Level Concentrations		
	$PM_{2.5}$ Predicted GLC($\mu g/m^3$)	**AAAQO ($\mu g/m^3$)**
Maximum 1h-Average	64	80
Maximum 24-hour average	15	30

4.1.3.4 Upset Conditions

According to Alberta Environment (AENV (2003)), the impact due to emergency and upset releases must be considered in environmental assessments for air quality. It is the design intent that the Project flare stack be used as an emergency system only. All normal gas production will be consumed in the steam generators and emergency flaring will only occur if a static overpressure situation arises in the system for any of the following reasons:

- blocked flow;
- fire; or
- liquid expansion within the blocked-in side of heat exchangers.

The worst-case emergency flaring scenario would occur if there is a release from the pressure safety valve that protects the fuel gas delivery system to the steam generators. The stack and emission parameters for this scenario are shown set out in CR #1, Table 7.1. The maximum flow rate of 15 mmscfd would occur for a maximum duration of 30 seconds, which is equal to the estimated time for the emergency shut-down valve (ESDV) to activate, including a reasonable safety factor.

CALPUFF modelling was performed for this upset scenario. Background concentrations are included in model predictions. The predicted 99.9^{th} percentile hourly SO_2 prediction of this worst-case upset release scenario is 45 $\mu g/m^3$, which is 10% of the hourly AAAQO of 450 $\mu g/m^3$.

4.1.4 Mitigation and Monitoring

Sunshine will monitor air quality in accordance with all EPEA requirements, including annual stack sampling for oxides of nitrogen and monthly passive sampling for H2S, SO2 and NO2.

4.1.5 Summary

The CALMET meteorological model and the CALPUFF dispersion model were used to assess air quality impacts associated with the operation of the proposed Project facility. Background

concentrations due to future development and nearby plant operations were considered and added to Project predictions.

The total SO_2, NOx, $PM_{2.5}$, and CO emissions from the facility have been estimated to be 0.70, 0.77, 0.08, and 1.90 tonnes per day, respectively. The results of dispersion modelling showed that model predictions of NO_2, SO_2, $PM_{2.5}$ and CO are well below AENV's AAQOs for all averaging periods within the modeling domain.

4.2 C&R Plan

4.2.1 Introduction

Sunshine retained Millennium EMS Solutions Ltd. to develop a Conservation and Reclamation Plan ("C&R Plan") for the proposed Project. This section provides a summary of key information contained in Consultant Report #2 (CR #2).

The C&R Plan serves many purposes, including the following:

- it provides the regulatory review agencies with the information needed to assess whether, upon completion of the Project, the land can be reclaimed and returned to the equivalent land capability that was present prior to commencement of the Project;
- it provides information about the ongoing reclamation activities that the Project proponent will carry out during the life of the Project to ensure that environmental impacts are kept to a minimum and end land use objectives and goals are attained;
- it provides conceptual information about the ultimate closure and abandonment plans for the facilities once the Project has ceased operations; and
- after considering landforms, soils, vegetation and the hydrological regime, the C&R Plan identifies the reclamation practices and mechanisms that will be carried out to ensure that a sustainable post-Project landscape meets the equivalent land capability of the pre-Project landscape.

The Project footprint for Phase 1 will include the development of a central processing facility ("CPF"), utilities corridor (i.e. access roads, surface pipelines, powerlines), well pads and borrow areas which will disturb 60.7 ha (Table 4.2-1). An access road footprint will also be required to support the Project and will disturb an additional 67.8 ha over approximately 9 km (Table 4.2-2). The Project and access road footprints are shown in CR #2, Figure 1.0-1. Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further environmental data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

Table 4.2-1 Phase 1 Project Components	
Area	**Area (ha)**
Plant Site	29.3
North Pad	4.9
South Pad	4.4
Construction Camp	4.9
Operator's Camp	2.9
Supervisor's Camp	1.2
Borrow Pit #1	8.9
Utility Corridor	4.2
Total	**60.7**

Table 4.2-2 Access Road Components	
Area	**Area (ha)**
Borrow Pit #2	5.6
Borrow Pit #3	4.5
Borrow Pit #4	6.4
Borrow Pit #5	6.0
Access Road	45.3
Total	**67.8**

To supplement this C&R Plan, while the Project is operational, Sunshine will prepare an Annual C&R Report that will outline the development work that was completed in the previous year and activities that are planned for the following year. An abandonment and reclamation plan will be submitted to AENV six months before decommissioning of the surface facilities.

4.2.2 Reclamation Goals and Objectives

Developed lands will be reclaimed to achieve equivalent capability to pre-disturbance conditions resulting in reclaimed landscapes that are compatible with the surrounding landscape, including forested areas, wetlands and streams. The reclaimed lands will provide a range of end uses including forestry, wildlife habitat, traditional use and recreation.

The reclaimed landscape will be biologically self-sustaining and have a land capability at least equivalent to that of the pre-disturbance landscape to allow for:

- re-establishment of merchantable forests; and
- establishment of diverse upland and peatland wildlife habitats that are compatible with the surrounding ecosites.

Post-development land uses will be determined in consultation with stakeholders including aboriginal groups, local community representatives, regulators and other members of the public.

4.2.3 Conservation and Reclamation Plan

Sunshine will use the following objectives as the basis for operational and reclamation program design:

- facility development, well pads, roadways, pipelines, and other landscape alterations will be constructed to be geotechnically stable;
- all construction and operational activities will be designed with final reclamation objectives in mind to ensure that the necessary natural resources are conserved to allow for end land use objectives to be met;
- reclamation is designed to create a landscape that is self-sustaining and capable of supporting soils and vegetation processes similar to the adjacent undeveloped areas with no subsequent management input required;
- following soil placement or de-compaction, vegetation communities will be established and will be capable of ecological succession processes similar to those found within the region;
- on those localized sites that are sensitive to erosion (i.e. steeper erodable slopes, coarse textured soils (sands), or disturbances immediately adjacent to watercourses), watershed protection will take priority over other vegetation objectives;
- water discharges during development and following reclamation will be managed to ensure an acceptable level of input into the streams that flow into natural watershed; and
- reclaimed lands will meet the criteria for certification.

The areas disturbed by construction activities will be progressively reclaimed to minimize post-construction impacts such as soil erosion. Final reclamation will be undertaken when the Project is abandoned and all of the facilities removed.

4.2.3.1 Soil Salvage

Within the Project disturbance footprints, topsoil material will be salvaged from all upland soils, which are defined as soils having less than 40 cm of surface peat. Topsoil material will be salvaged with the overlying litter material in one lift. Total topsoil salvage depths will typically vary between 15 to 40 cm for mineral soils, depending on soil type and landscape position. This depth includes the litter/shallow surface peat layer and the A horizon. The detailed soil information including soil depths is provided in CR #8.

Sufficient soil volumes will be salvaged and replaced to ensure that the reclaimed areas will support revegetation activities, allow ecological succession and achieve land capability equivalent to the pre-development conditions. Details with respect to assessing baseline soil conditions, soil mapping, and determining suitable soil salvage depths for Phase 1 of the Project are provided in Section 4.8 and CR #8.

All landscapes within the footprints that have peat thicknesses greater than 0.4 m will have the peat material partially salvaged, padded over, or completely salvaged. Appropriate procedures will be based on site specific characteristics and best construction practices, which will be determined at the field level by a qualified site construction specialist. Each potential peat handling option is described below:

- Option A - partially salvage - the top 0.3 – 0.4 m of peat is salvaged and stored for use at reclamation, leaving the lower peat material intact such that geo-textile can be placed on top of the lower peat material, and fill material placed on the geotextile.
- Option B - no salvage - all peat material will be left intact, with geo-textile placed on top, and fill material placed on the geotextile. Fill material will be obtained from borrow pits, which will have all the soil salvaged, whether they are upland or Organic.
- Option C - complete salvage – in some instances areas of relatively shallow peat (40-100 cm) may be completely salvaged for construction of Project components, with the salvaged material been stockpiled for use at reclamation and fill material obtained from borrow pits.

Subsoil will be salvaged and replaced, from the central processing facility (CPF), to a maximum depth of 30 cm.

All topsoil and shallow peat (<40 cm) material salvaged will be stored in stockpiles for the duration of the Project life. Soil stockpiles will be constructed with maximum 3:1 slopes and stored in designated soil storage areas. Along access routes, salvaged soil material will be windrowed along the right-of-way and then replaced along the ditchlines once the roads have been constructed. All excess salvaged soil material will be left in a windrow on the edge of the right of way for use at reclamation.

Within the CPF a second-lift consisting of upper subsoil will be salvaged, stockpiled and replaced upon reclamation to ensure that the reclaimed rooting zone will be similar to that which existed prior to disturbance. A maximum depth of 30 cm of subsoil material will be salvaged for replacement upon reclamation of the CPF. All salvaged subsoil material will be stored separately from salvaged topsoil material.

4.2.3.2 Final Site Grading and Recontouring

Progressive reclamation will be undertaken where possible to minimize the amount of active surface disturbance. For example, well pads will be reclaimed as they are decommissioned over the life of the Project. Once a particular component of the site infrastructure is no longer required (e.g. well pads, borrow pits, sumps, construction camp) final site grading and re-contouring activities will take place.

The majority of the Project footprint is located in undulating to hummocky terrain with slopes ranging from 2-10%. The access road footprint is located in subdued gently undulating to level terrain with slopes ranging from 0-5%. Final contouring of the footprints will be carried out so that the reclaimed terrain blends into the natural landscape and proper site drainage is maintained. Where possible, final site preparation will be re-contoured to near natural drainage patterns and topography.

During final reclamation, side slopes of the borrow areas will be graded to a 3:1 slope. It is anticipated that wetlands will form within these areas.

Surfaces receiving gravel surface treatment, such as the working surface of access roads, central facilities and well pads, will all be subjected to significant load applications and traffic over their life. These areas will become relatively compacted compared to undisturbed soils.

Sunshine will ensure that compacted subgrades along the access roads are deep-ripped or "subsoiled" prior to replacement of soil. These activities will help ensure that densities of the formerly compacted soils are not significantly different from that of nearby undisturbed lands.

In areas where it is decided to remove all geo-textile and fill material that was used to pad over deep organic materials, the peat surface will be de-compacted to allow for vegetation and water flow throughout the peat landforms.

4.2.3.3 Soil Replacement Plan

For surface pipelines, powerlines and road ditches, following construction and installation, soil will be immediately replaced and revegetated on the rights of way to minimize impacts related to erosion.

With respect to other Project infrastructure, soil will be placed once final re-contouring and de-compaction of the surficial materials is complete. The goal of soil replacement is to establish a soil profile that permits the establishment of an initial vegetation cover, subsequent natural recovery of the plant community and initiation of natural soil processes such that land capability equivalent to that which existed prior to disturbance is achieved. The reclaimed soil profile will provide:

- adequate moisture supply;
- adequate nutrient supply;
- a native seed bank; and
- capability to support a self-sustaining vegetative cover similar to pre-disturbance conditions.

The reclamation material balance is provided in Tables 4.2-3 and Table 4.2-4 for Phase 1 of the Project and Table 4.2-5 for the access road footprint.

Within the Phase 1 development footprint (including the plant site) approximately 19.6 ha are covered by organic map units (> 40 cm of surface peat). The remaining 41.1 ha are covered by mineral soils, including peaty Gleysols which will be stripped and stockpiled for use at reclamation. The access road footprint contains 49.9 ha of mineral soils and 17.9 ha of organic map units. An estimated 37.5 ha of organics will be disturbed as a result of the Phase 1 development.

Various options are available with respect to the handling of deep peat deposits (> 40 cm) during construction of the Project. Final soil salvage and handling methods will likely be determined by way of field level decisions at the time of construction. With respect to reclamation of site disturbance on deep organic/peat soils (>0.4 m of peat material), different methods of reclamation may be used depending on the method of soil salvage at the time of construction, as discussed below:

- Option A - partial peat salvage will result in partial fill removal - portions of fill and geo-textile may remain in place, as sufficient soil material will be available for replacement over this material, after de-compaction and re-contouring has been completed. Portions of the fill material will likely be removed in this scenario as well, exposing the underlying organic soils;
- Option B – no peat salvage will result in full or complete fill removal - all fill and geo-textile material will be removed exposing the underlying peat surface will be de-compacted to allow for revegetation and water movement; and
- Option C – complete peat salvage will result in no fill removal - most of the fill material will remain in place, as sufficient soil material. which will be available for replacement over this material, after de-compaction and re-contouring has been completed.

The appropriate reclamation method will be based on site specific characteristics existing at the time of reclamation.

In general, the following reclamation practices will apply to all borrow pits proposed for the Project. All borrow pits will be sloped to 3:1 and soils replaced once all necessary borrow materials have been removed. Approximately one half of each borrow pit will contain a pit area that will likely fill with water and function as an open water wetland. The remainder of the area

will have soil spread near the tops of slopes, with mulch and woody debris spread over this to help prevent soil erosion.

Within the Project footprint for Phase 1, approximately 113,278 m^3 of salvaged soil will be replaced (Tables 4.2-3 and 4.2-4). A range of soil replacement is required to meet equivalent capability. Sunshine is committed to replacing sufficient soil materials to ensure that equivalent capability is returned on the reclaimed landscape. If deep organic materials are salvaged, as discussed in Options A, B and C, the reclamation will be conducted as described above. Approximately 56,425 m^3 of upper subsoil material will be replaced over the re-contoured CPF (Table 4.2-4).

Along the access road footprint and associated borrow pits, approximately 129,962 m^3 of soil material will be salvaged and replaced (Table 4.2-5). Soil material salvaged from surface pipelines, powerlines and road ditches will be immediately replaced and revegetated on the rights of way post-construction to minimize impacts related to erosion. Soil salvage and replacement activities for the borrow pits associated with the access road will be identical to the borrow pit located within the Phase 1 Project footprint.

Table 4.2-3 Reclamation Material Balance for the Phase 1 Footprint

Project Component	Total Area (ha)[1]	Area of Mineral Soil Salvage (ha)[2]	Topsoil Lift Materials Available		Typical Replacement Depth of Topsoil Lift Layer (m)	Total Volume of Topsoil Lift Replaced (m^3)
			Litter (m^3)	**Topsoil (m^3)**		
Borrow Pit 1	8.9	8.9	8,987	8,722	0.2	17,709
Construction Camp	4.9	3.6	3,581	3,765	0.2	7,346
North Pad	4.9	0.6	1,652	551	0.4	2,203
Operator's Camp	2.9	2.4	2,429	2,429	0.2	4,858
South Pad	4.4	2.9	2,522	3,835	0.2	6,357
Supervisor's Camp	1.2	1.2	1,200	1,200	0.2	2,400
Utility corridor	4.2	2.7	4,832	3,517	0.3	8,349
TOTALS[4]	**31.4**	**22.3**	**25,203**	**24,019**		**49,222**

[1] Includes total areas of disturbance including deep peat deposits.

[2] Areas include soil material that will be salvaged for replacement. Includes litter/surface peat, A horizon, and shallow organics (peat <40 cm).

[3] Typical estimated replacement depth for areas where soil materials were salvaged.

Table 4.2-4 Reclamation Material Balance for the Plant Site

Project Component	Total Area (ha)[1]	Area of Mineral Soil Salvage (ha)[2]	Topsoil Lift Materials Available		Typical Replacement Depth of Topsoil Lift Layer (m)[3]	Total Volume of Topsoil Lift Replaced (m^3)	Upper subsoil Materials Available **(m^3)**	Typical Replacement Depth of Upper subsoil (m)	Total Volume of Upper subsoil Replaced (m^3)
			Litter (m^3)	**Topsoil (m^3)**					
Plant Site	29.3	18.8	34,671	29,385	0.3	64,056	56,425	0.3	56,425

[1] Includes total areas of disturbance including deep peat deposits.

[2] Areas include soil material that will be salvaged for replacement. Includes litter/surface peat, A horizon, and shallow organics (peat <40 cm).

[3] Typical estimated replacement depth for areas where soil materials were salvaged..

Table 4.2-5 Reclamation Material Balance for the Access Road Footprint

Project Component	Total Area (ha)[1]	Area of Topsoil Lift Salvage (ha)[2]	Topsoil Lift Materials Available		Average Replacement Depth of Topsoil Lift Layer (m)[3]	Total Volume of Topsoil Lift Replaced (m^3)
			Litter (m^3)	**Topsoil (m^3)**		
Borrow Pit 2	5.6	5.6	5,583	5,583	0.2	11,166
Borrow Pit 3	4.5	4.5	4,897	6,259	0.3	11,156
Borrow Pit 4	6.5	4.3	4,313	4,313	0.2	8,626
Borrow Pit 5	6.0	6.0	8,922	5,948	0.3	14,869
Access Road	45.3	29.5	53,794	30,350	0.3	84,143
TOTAL[4]	**67.8**	**49.9**	**77,509**	**52,453**		**129,962**

[1] Includes total areas of disturbance including deep peat deposits.

[2] Areas include soil material that will be salvaged for replacement. Includes litter/surface peat, A horizon, and shallow organics (peat <40 cm).

[3] Typical estimated replacement depth for areas where soil materials were salvaged..

4.2.3.4 Reclaimed Land Capability

The post reclamation land capabilities will be similar to the ratings determined for the baseline soil map units, as listed in Table 4.2-6 and Table 4.2-7. In areas where the soil profile was disturbed as a result of the Project, appropriate reclamation activities will be undertaken as discussed in CR #2, Section 3.1.5 Soil Replacement Plan. Once the reclaimed soil profiles have been created and appropriately conditioned, the site can be revegetated to near original patterns.

Although the shape of the soil polygons will be altered as a result of the development, the reclaimed capability will be similar to pre-existing patterns. The forest soils land capability classification system (LCCS) ratings assigned to the baseline soil map units and reclaimed LCCS ratings are not meant to imply that the identical soil profiles and distribution of soils determined in the baseline case will exist upon completion of reclamation. The reclaimed LCCS values were calculated using the physical and chemical characteristics of representative soil series and variants recorded in the baseline conditions of each map unit, blended as appropriate, and based on the anticipated soil salvage, storage and eventual replacement. Examples of the LCCS calculations are provided in CR #8, Appendix F.

Table 4.2-6 Comparison of the Baseline and Reclaimed Forest Land Capability Ratings for the Phase 1 Footprint

Capability Class	Baseline Capabilities		Reclaimed Capabilities		Difference (%)
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
Class 1	--	--	--	--	**0.0**
Class 2	--	---	--	---	**0.0**
Class 3	32.6	53.7	30.0	49.4	**-4.3**
Class 4	8.5	14.0	8.5	14.0	**0.0**
Class 5	19.6	32.3	19.6	32.3	**0.0**
Wetland*	**-**	**-**	**2.6**	**4.3**	**4.3**
TOTAL	**60.7**	**100**	**60.7**	**100**	**0.0**

* Wetlands created as a result of the development of the borrow pits.

Table 4.2-7 Comparison of the Baseline and Reclaimed Forest Land Capability Ratings for the Access Road Footprint

Capability Class	Baseline Capabilities		Reclaimed Capabilities		Difference (%)
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
Class 1	--	--	--	--	**0.0**
Class 2	6.7	9.9	4.5	6.6	**-3.3**
Class 3	38.0	56.0	34.0	50.2	**-5.8**
Class 4	5.3	7.8	5.3	7.8	**0.0**
Class 5	17.8	26.3	17.3	25.5	**-0.8**
Wetland*			**6.7**	**9.9**	**9.9**
TOTAL	**67.8**	**100**	**67.8**	**100**	**0.0**

* Wetlands created as a result of the development of the borrow pits.

4.2.3.5 Revegetation

The primary objective of the revegetation program is to provide a range of site conditions suitable to support plant communities capable of developing into self-sustaining forest ecosites that will provide for watershed protection, traditional land uses, wildlife habitat and commercial forest production, with possibilities for recreation and other end uses.

To meet this objective, Sunshine is committed to a reclamation program that will promote the development of a diversity of self-sustaining vegetation communities throughout its reclaimed leases. The revegetation plan is intended to follow an ecosystem-based approach for the establishment of suitable reclaimed site conditions for the Project Area.

Natural recovery of the plant community can be a viable and effective revegetation strategy. The level of revegetation effort and the time required for natural recovery to adequately revegetate these sites is determined in large part by the degree of disturbance.

Revegetation practices to be employed as part of the reclamation program are discussed in terms of the degree of disturbance experienced:

- low degree of disturbance - seismic lines, power lines and road/corridor rights-of-way. On these sites, rollback will be completed (unless it is determined that access is to be maintained to meet other land use objectives). Natural recovery is expected to redevelop native plant communities that are similar in composition to those of adjacent undeveloped areas. No further revegetation activities will be conducted unless site-specific conditions warrant, e.g. a steeper, potentially erodable slope that needs runoff diversion work and/or revegetation;
- moderate degree of disturbance - pipelines and corridor soil stockpile sites. When the pipeline or soil stockpile is removed from these sites, the capability of the underlying native soil is expected to recover quickly. On these sites, rollback will be brought back (if available) and a short-lived nurse crop may be seeded. This nurse crop will provide short-term erosion control and leave a protective layer of organic matter that will help to encourage natural recovery of the vegetation communities. On those sites where erosion is not an issue, a nurse crop may not be necessary. Tree planting will be conducted on those upland reclaimed disturbances that had a tree cover prior to disturbance. On poorly drained sites, natural recovery will be relied upon for woody species re-establishment. Tree planting will reduce the time needed for these sites to regain a forest cover; otherwise, it is expected that a full range of herbaceous and shrub species will re-establish naturally; and
- highest degree of disturbance - well pads and the central processing facility. After the soil profile on these sites has been reclaimed, natural recovery will be encouraged through the application of a short-lived nurse crop of barley or other agronomic species and subsequent planting with tree seedlings. The nurse crop will provide short-term cover, a protective organic layer, and conditions that will encourage the natural ingress of locally native herbaceous plants, shrubs and trees.

Some areas located in the vicinity of streams or watercourses may be sensitive to soil erosion. In such areas, the value of watershed protection supersedes other vegetation objectives, and special measures are required to stabilize soils including the use of agronomic species that are effective due to their quick establishment. In consultation with the department of Sustainable Resource Development (SRD), Sunshine will select an approved seed mix that will be used in such areas.

Weed control, by picking or spraying, will be undertaken as required. Revegetation of disturbances will be phased to coincide with construction activities to limit the area of exposed soil at any one time.

As reclamation proceeds, monitoring of reclamation and revegetation performance over time allows land use objectives to be reviewed and adjustments made to site conditions according to natural revegetation processes. The intent of adaptive management is to facilitate and respond to the soil replacement and revegetation process to meet specific objectives.

Establishment of woody plants in reclamation areas is an important part of revegetation activities. Selection of species and the proportion of each species in the supplemental planting mix are based on:

- expected growth of woody-stemmed species from seeds and root fragments in the replaced soil;
- woody-stemmed species common to the ecosites;
- existing field conditions;
- vegetation type or types desired for development on the site, based on end land use objectives and landscape terrain features; and
- the ability to produce the species at a practical scale.

The planting prescription for establishing woody species on the Project's footprints will consider ecological site characteristics, land use objectives for the site, the degree of disturbance, and the likelihood that woody plants will recover naturally. Where feasible, the planting prescription will use those species that are present within the adjacent ecosite.

With the incorporation of the reclamation and revegetation practices previously discussed, Tables 4.2-8 and Table 4.2-9 provide the predicted post disturbance/reclaimed ecosites and wetland classes for the Project and the access road footprints. The post disturbance ecosites are also shown on CR #2, Figure 3.2.1a & b for the Project and access road footprints.

Table 4.2-8 Reclaimed Ecosites for the Phase 1 Footprint

Ecosite	Baseline		Reclaimed		Difference	
	Area (ha)	% of Footprint	Area (ha)	% of Footprint	Area (ha)	% of Footprint
d	26.8	44.2	27.4	45.1	0.6	0.9
h	4.9	8.1	3.8	6.3	-1.1.	-1.8
i	3.6	5.9	1.3	2.1	-2.5	-3.8
j	19.3	31.8	16.8	27.7	-2.5	-4.1
k	6.1	10.0	8.8	14.5	2.7	4.5
NWL	0	0.0	2.6	4.3	4.3	4.3
Total	**60.7**	**100**	**60.7**	**100.0**	**0**	**0**

Table 4.2-9 Reclaimed Ecosite for the Access Road

Ecosite	Baseline		Reclaimed		Difference	
	Area (ha)	% of Footprint	Area (ha)	% of Footprint	Area (ha)	% of Footprint
c	3.4	5.0	3.3	4.9	-0.1	-0.1
d	28.4	41.9	25.3	37.3	-3.1	-4.6
g	7.1	10.5	6.2	9.1	-0.9	-1.4
h	2	2.9	2.5	3.7	0.5	0.8
i	22.8	33.6	21.7	32.0	-1.1	-1.6
j	2.3	3.4	1.0	1.5	-1.3	-1.9
k	1.8	2.7	1.1	1.6	-0.7	-1.1
NWL	0	0.0	6.7	9.9	6.7	9.9
Total	**67.8**	**100**	**67.8**	**100.0**	**0.0**	**0.0**

4.2.4 Mitigation and Monitoring

4.2.4.1 Mitigation

The Project reclamation plan will include implementation of the following procedures to reclaim the sites to an equivalent capability:

- meet with local reclamation inspector, prior to the initiation of the reclamation programs, to confirm the land use and reclamation procedures that are planned;
- removal of facilities;
- remediate contaminated areas;
- recontour and re-establish natural drainage patterns;
- rip well pads, roadways, and facility pad areas, as required, to alleviate surface compaction;
- removal of fill and geotextile material in certain areas depending on site conditions, which will expose the original soil profile. The soil profile will be processed to create a suitable seed bed for vegetation to establish. This may include ripping, digging or cultivating to alleviate compaction;
- place subsoil over the disturbed area of the CPF prior to soil placement;
- place soil over the disturbed area; the replacement depths will generally be similar to what existed prior to development;
- promote natural recovery as the primary means of ground cover re-establishment. Where necessary, specific sites will be seeded with either a nurse crop or longer-lived, non-invasive vegetation cover and planted with tree species consistent with the revegetation plan;
- undertake regular monitoring and maintenance activities, following reclamation, to assess reclamation success and identify areas of concern and;
- undertake a post-reclamation site assessment to determine the status of the site prior to applying for a reclamation certificate.

4.2.4.2 Monitoring

Development of the Project will progress in a phased manner, allowing for sequential reclamation of well pads, roads and facilities over the operating period of the Project. This development schedule minimizes the active footprint within the Project Area at any one time and will allow for consistency in the reclamation measures to be used in all phases of the Project. Reclamation monitoring will be incorporated into an annual report to be used to document the success of reclamation efforts and, over time, to refine measures according to site-specific conditions.

The objectives of the reclamation monitoring program will be to evaluate the success of reclamation measures and to adjust or modify those measures where necessary to ensure:

- natural recovery of desired plant communities;
- erosion control and slope stability;
- self-sustaining vegetation cover on all disturbed areas;
- noxious weed control;
- establishment of the designated end land uses; and

- reclamation certification.

Sunshine will produce an Annual C&R Report. This report will summarize the year's activities in terms of development activities, assessments completed on facility areas to be constructed in the following year, reclamation activities, reclamation monitoring, and planned activities for the following year. This report will be submitted to "AENV".

Reclamation monitoring will be consistent with the Project development schedule to ensure that reclaimed sites are fully documented according to the types of reclamation measures employed in the area. Information on each reclamation site will include:

- a description of the type of development (e.g., central plant sites, well pads, roads);
- a description of the reclamation activity (e.g., recontouring, soil depths, seeding, tree planting);
- the date when the reclamation activities took place; and
- the end land use objectives that were established for each site.

Information collected from the monitoring program will allow further evaluation of the reclamation techniques and measures used for various sites. The data will be incorporated into the reclamation database for subsequent reference as to the status of all reclaimed sites. The monitoring program will include:

- inspection of each reclaimed area after the first growing season following site landscaping, soil replacement and revegetation. The inspections will be used to gauge the success of initial revegetation activities and to evaluate conditions designed to encourage natural recovery. The assessments will include information regarding soil stabilization, erosion control and the status of herbaceous vegetation growth, including dominant species composition;
- annual inspections to monitor the continued establishment of the vegetative cover, progress towards natural recovery of plant communities, as well as to identify requirements for follow-up activities. The annual program will include a routine maintenance component to address any required site erosion repair and control as well as any supplemental seeding and fertilizing needs for the reclaimed sites. Noxious weeds will also be identified and removed in consultation with the local reclamation inspector;
- assessment of older reclaimed areas will be conducted on a less frequent basis as determined necessary at the time. For example, stocking and growth measurements will be recorded for all commercial tree species, including planted stock and naturally established seedlings; and
- monitoring wildlife use of both natural and reclaimed areas. Initially, the wildlife monitoring program will largely be confined to observational recordings and incidental information on general wildlife use of the reclaimed areas. More

systematic approaches to monitoring the reclaimed sites for wildlife will be considered as the reclaimed areas mature.

4.2.5 Summary

At the end of the 25 year life of the Project, all Project facilities will be decommissioned. In compliance with EPEA requirement, an abandonment and reclamation plan will be submitted to AENV six months before decommissioning of the surface facilities.

4.3 Aquatic Resources

4.3.1 Introduction

Sunshine retained Hatfield Consultants to conduct an assessment on surface aquatic resources for the proposed Project and access road. The following section is a summary of the Surface Aquatic Resources Assessment included as Consultant Report #3 ("CR #3").

The Aquatic Resources Local Study Area ("Aquatics LSA") encompasses the uppermost portion of the Dover River watershed, and a small section of the upper-Snipe Creek watershed (CR #3, Figure 2). The Aquatics LSA was developed based on the locations of the proposed Project infrastructure components, with the objective of incorporating significant aquatic features in proximity to the Project footprint. The Aquatics LSA extends to the north to include a reference station which could be used to provide baseline data for future aquatic monitoring activities.

Data sources used in the Aquatic Resources Assessment included specific field studies undertaken in support of this Project and previous EIAs completed for oil sands projects in the Athabasca Oil Sands Region of northeastern Alberta. In addition, a review of existing data present in the Fisheries Management Information System ("FMIS") was completed for the Snipe, Dover, MacKay and Ells watersheds.

4.3.2 Baseline Conditions

4.3.2.1 Fisheries Resources

Fish inventories were undertaken at 15 survey sites (CR #3, Figure 2), and consisted of a combination of minnow trapping, gillnetting, back pack electrofishing and angling. A total of 4,124 fish from six species were captured (Table 4.3-1).

Table 4.3-1 Summary of Fish Species Collected During Aquatic Resources Baseline Field Studies

Common Name	Latin Name	Number Captured	% of Total Catch	Lakes	Streams
Brook Stickleback	*Culaea inconstans*	2,189	53.1	✓	✓
Fathead Minnow	*Pimephales promelas*	1,638	39.7	✓	
White Sucker	*Catostomus commersonii*	13	0.3		✓
Lake Chub	*Couesius plumbeus*	6	0.2		✓
Lake Trout	*Salvelinus namaycush*	2	< 0.1	✓	
Longnose Sucker	*Catostomus catostomus*	275	6.7	✓	
Total		4,124			

Brook stickleback was the most common fish species encountered during the inventory, comprising 53.1% of all fish captured. Although fathead minnow were captured at only one site, it was the second most common fish species, comprising 39.7% of all fish captured. Longnose sucker was the third most common species (6.7%). Based on both relative abundance (catch-per-unit-effort, or CPUE) and total capture numbers, fish were more common in streams than in lakes; this result was strongly influenced by the high numbers of fish captured in two streams.

4.3.2.2 Water Quality

Baseline fieldwork consisted of aquatic habitat surveys at 18 sampling locations (CR #3, Figure 2), and included surface water quality collections (17 locations) and fish inventories (15 locations). Surface water quality results obtained from the aquatic resources baseline field studies are presented in CR #3, Table 6.

The ionic composition of the sampled watercourses was dominated by bicarbonate, sulphate and calcium. Stream waters were generally characteristic of brown-water systems, with sampled true color above 100 TCU. Sampled watercourses were generally neutral to slightly acidic, while lakes were neutral to slightly alkaline. Both lakes and streams exhibited DOC near to or greater than 30 mg/L, with low levels of TSS, conductivity, TDS, and hardness. Naphthenic acids and recoverable hydrocarbons were consistently below detection limits.

Concentrations of total phosphorus, sulphide, and total nitrogen exceeded water quality guidelines for the protection of aquatic life at 8, 10 and 14 of the 17 sample locations, respectively. Concentrations of total aluminum, total chromium and total copper exceeded water quality guidelines for the protection of aquatic life at two locations, while concentrations of total iron and total mercury exceeded water quality guidelines at 10 and 1 location(s), respectively. Exceedances of dissolved metals, which are biologically available and therefore toxic to aquatic organisms, were much less frequent. Concentrations of both dissolved copper and dissolved

mercury exceeded guidelines at one location, and dissolved iron concentrations exceeded guidelines at nine locations. These results are similar to those observed in regional monitoring initiatives in the Athabasca Oil Sands Region (RAMP, 2007).

4.3.2.3 Habitat

Aquatic habitat surveys were conducted at 18 locations in June 2008 (CR #3, Figure 2).

Lakes

The lakes sampled (CR #3, Figure 2) have surface areas ranging from 13 to 335 hectares, with maximum depths between 0.9 m and 4.2 m. Littoral zone substrate at all sampling locations was comprised of fines, and shorelines were generally vertical with depths at the banks ranging from 0.5 to 0.7 m. Riparian areas were generally flat, with vegetation consisting of bands of grasses and cattails. Lake habitat summaries are provided in CR #3, Figures 4 to 12.

Streams

Stream reaches surveyed for this assessment (CR #3, Figure 2) were generally small to moderate in width and velocity, with riparian vegetation comprised of sedges, shrubs, and immature to established coniferous or mixed forest. Four of the sites (sites S2, S3, S7, S8 and S9) had sections within the sampling reach exhibiting characteristics representative of wetlands (diffuse borders with limited to no flow and extensive instream vegetation), while one site (S7) exhibited only an intermittent stream channel and an expected watercourse at another site (S6) did not exist. Stream cover was generally high, with most sites exhibiting greater than 70% total cover for small-bodied fish. Cover was dominated by deep pools and instream and overhanging vegetation. Bed material at all stations consisted of fines (silt and sand) while stream bank shape varied among sites, ranging from nearly flat wetland areas to steeply sloped banks. Water levels were moderate at the time of survey. Summaries of aquatic habitat at each stream sampling location are provided in CR #3, Figures 13 to Figure 20.

4.3.3 Potential Impacts

4.3.3.1 West Ells SAGD Project

The effects of the Project's first phase footprint, which includes the central processing facility, well pads and associated infrastructure, on the aquatic resources are discussed below.

Water Use

Sunshine is planning to use groundwater sources to make steam for injection into the bitumen reservoir. This withdrawal of water can have an effect on surface aquatic resources if there is a hydrologic connection between the groundwater being used as a source of water for the Project and surface waters. The final source of groundwater to be used for the Project will be

determined during the winter 2010 drilling program. Based on initial testing of sources of groundwater, the Project will use a source of groundwater that has no hydrologic connectivity with surface waters. Surface aquatic resources (water quality, fish, and aquatic habitat) are not expected to be influenced by groundwater withdrawals for the Project. There are no predicted effects of Project activities on surface aquatic resources from changes in groundwater quantity.

Water Quality

Project activities conducted near watercourses or waterbodies in the Aquatics LSA may increase sediment transport to surface waters, change the water quality of surface runoff to these aquatic systems, and may alter aquatic habitat through direct physical changes.

During normal operating conditions, accidental spills or releases may occur and the contents may enter the surficial groundwater or surface waters. Upset conditions may also result in accidental release of substances, which may affect water quality, fish habitat, and fish resources.

The residual effects of Phase 1 Project activities on water quality, fish, and aquatic habitat via surface run-off, sediment loadings, or direct physical alteration are expected to be negligible with the effective application of the mitigation measures, which will include appropriate sediment control, emergency response and complete capture and containment of all surface runoff on the central processing facility.

Stream Crossings

All watercourses to be crossed by the access road are designated as Class C watercourses under the Alberta *Code of Practice for Watercourse Crossings*. Sunshine will endeavour to undertake all necessary stream crossing assessments in 2010 and will use the results of these assessments to design and implement appropriate mitigation measures during construction to enable compliance with the Alberta *Code of Practice for Watercourse Crossings*. This approach will help achieve the objective of no-net-loss of productive fish habitat for Alberta (ASRD, 2006). Additionally, Sunshine will engage the Department of Fisheries and Oceans (DFO) once specific detailed proposed stream crossing methodology has been finalized.

Fishing Pressure

Sport-fish species were captured in one lake (L2) during the baseline fish inventories of the Aquatics LSA (CR #3, Table 4). The number of sport-fish captured during the inventory was low (one juvenile lake trout), indicating that this waterbody would not be considered productive enough to warrant recreational fishing. Additionally, no Project-related infrastructure is planned in the proximity of this site; therefore, it is expected that there will be a negligible effect on fish abundance in the Aquatics LSA as a result of increasing fishing pressure related to Project construction and operation.

4.3.3.2 Access Road

The residual local effects of the access road on water quality, fish, and aquatic habitat are predicted to be negligible with the application of mitigation measures.

4.3.3.3 Regional Effects

With the application of mitigation measures, the effects of the Project on surface aquatic resources (water quality, fish and aquatic habitat) are expected to be negligible. Therefore, the effects of the Project on these surface aquatic resources are also expected to be negligible or insignificant at a regional scale.

4.3.4 Mitigation and Monitoring

4.3.4.1 Mitigation

Sunshine will implement the following mitigation measures:

- project-related activities will not be conducted within 150 m of the high water mark of the lakes located within the Aquatics LSA;
- the central processing facility will be graded to direct surface water runoff to a containment pond. Containment pond water will be allowed to evaporate, and excess water will either be used for Project operations or tested for key chemical parameters and released to the environment if criteria are met;
- all water releases are compliant with application guide
- lines and the terms and conditions of the regulatory approvals;
- the storage and handling of hazardous materials for the Project will be conducted in compliance with CCME guidelines as well as the Transportation of Dangerous Goods Act, and other applicable environmental legislation, regulation, standards and codes;
- earthworks contractors will be required to submit a sediment control plan at the stream crossings using methods such as the use of cutoff trenches, silt fences, flow barriers, temporary and/or permanent sediment control ponds and/or traps, and ditches to minimize or eliminate sediment transport from exposed soil areas into receiving waterbodies and watercourses;
- minimization of the time interval between clearing/grubbing and subsequent earthworks, particularly at or in the vicinity of watercourses or in areas susceptible to erosion;
- disturbed areas will be revegetated to stabilize soils and minimize erosion;
- protect surface watercourses and waterbodies from concrete works such as discharging concrete wash water and containment and isolation of any concrete-affected water for either treatment; and
- implement the Alberta Code of Practice for Watercourse Crossings to mitigate any effects of stream crossings on water quality, fish and aquatic habitat.

4.3.4.2 Monitoring

- suspended sediments will be routinely monitored (upstream and downstream) during construction periods for all instream construction activities; and
- monitoring during operations will be carried out in accordance with the terms and conditions of Project approval.

4.3.5 Summary

All of the effects of Phase 1 of the Project and access road on surface aquatic resources (i.e. water quality, fish, and fish habitat) within the Aquatics LSA are expected to be negligible or insignificant after the application of suitable mitigation measures. Therefore, the effects of the Project on these surface aquatic resources within the Aquatics RSA are also expected to be negligible or insignificant. Sunshine will engage the ”DFO” once specific detailed proposed stream crossing methodology has been finalized.

4.4 Groundwater

4.4.1 Introduction

Sunshine retained Millennium EMS Solutions Ltd. (MEMS) to conduct a Hydrogeological Assessment for the proposed the Project. The following section is a summary of the Hydrogeological Baseline and Environmental Assessment included as Consultant Report #4 (CR #4).

The objectives of the environmental assessment report are to provide a collection and interpretation of baseline hydrogeological data for the Project and, from that assessment, predict changes to the environment. It is unlikely that the access road will impact the groundwater resource.

The baseline study was completed based on a literature review and field investigations. Key information sources for the baseline study included the following:

- report by Golder Associates (Golder) (2008) describing groundwater monitoring wells installed into the Grand Rapids Formation;
- site specific geological mapping provided by Sunshine;
- published regional geological and hydrogeological maps and reports from the Alberta Geological Survey and Alberta Research Council, and;
- water well drilling reports and groundwater chemical analyses from the Alberta Environment Groundwater Information Center.

Licenses for groundwater withdrawals under the *Water Act* from Alberta Environment will be applied for once groundwater source has been finalized.

The Project lies within Townships 94 and 95, Ranges 17 and 18, West of the 4th Meridian. Field investigations included the installation of wells at three locations in the Project Development Area in February 2008 (CR #4, Figure 2.1). Wells were installed to depths of 5.2 to 17.4 m below ground level (m bgl), with an additional 5 wells installed to similar depths within 5 km to the north and east. The wells were developed, tested (rising head hydraulic conductivity testing) and sampled in February, June and October 2008.

4.4.2 Baseline Conditions

4.4.2.1 Field Investigations

The results of all field investigations completed in 2008 are summarized in Table 4.4-1.

Table 4.4-1 Summary of Groundwater Monitoring Well Information within and Adjacent to Project Area

Well Location	Unit	UTM Zone	Coordinates		Screened Interval	Measured Water Level				Hydraulic Conductivity
						Feb-08	Mar-08	Jun-08	Oct-08	
			Easting	Northing	(mbgl)	(mbgl)				(m/s)
Wells within Project Development Area										
11-30-94-17	Drift	12	395,539	6,339,218	4.3 to 6.3	Dry		Dry	Dry	
14-31-94-17		12	395,312	6,341,320	3.1 to 6.1	Dry		0.56	-	4.8×10^{-9}
07-36-94-18		12	394,152	6,340,527	2.1 to 5.2	Dry		Dry	Dry	
11-30-94-17	Grand Rapids				64 to 73		12.49			4.2×10^{-6}
14-31-94-17					99 to 108		35.18			9.5×10^{-7}
07-36-94-18					100.5 to 109.5		8.18			5.3×10^{-8}
Wells near Project Area										
09-36-94-17	Drift	12	404,291	6,340,426	5.2 to 8.2	0.74		***0.35***	***0.50***	3.0×10^{-7}
11-03-95-17		12	398,566	6,342,553	3.1 to 6.1	5.89		***1.81***	-	
14-04-95-17 Deep		12	397,273	6,342,994	13.4 to 16.5	Dry		Dry	Dry	
14-04-95-17 Shallow		12	397,272	6,342,994	3.5 to 6.5	5.47		4.26	3.24	4.1×10^{-8}
07-17-95-17		12	395,792	6,345,340	3.7 to 6.7	Dry		1.24	3.83	3.2×10^{-9}
10-15-95-17		12	399,153	6,345,766	3.7 to 6.7	Dry		Dry	Dry	
10-21-95-17		12	397,513	6,347,139	3.1 to 6.1	4.70		0.16	0.74	4.2×10^{-8}

'-' = Not measured

Bold & italicized water levels are frozen

Sources: Golder 2008

4.4.2.2 Physiography and Climate

The Project Area is located along the northern edge of the MacKay Plain physiographic region just south of the Birch Mountains (Andriashek, 2001). Ground elevation of the site is about 560 m above sea level ("m asl") along the north edge and generally slopping downwards to the southeast, dropping below 540 m asl (CR #4, Figure 1.1). The higher ground at the northern edge of the site separates the headwaters of the Dover River, where the site is located, from the headwaters of Snipe Creek to the north. Snipe Creek is a tributary to the Dunkirk River, which then flows into the MacKay River.

Mean monthly temperatures are below zero from November to March with a mean annual precipitation of 456 mm.

4.4.2.3 Geology

The geological setting consists of glacial drift overlying Cretaceous-age sediments which lie unconformably on Devonian-age carbonate sediments. The regional and site geological setting is summarized in Table 4.4-2.

Table 4.4-2 Stratigraphic Units at the Project Site

Period	Stratigraphic Unit	Description	Thickness (m)
Quaternary	Drift	Mainly till with minor sand	50 to 90
Cretaceous	Colorado Group	Predominantly marine shales	50
	Grand Rapids Formation	Fine grained sandstone, siltstone and shale of deltaic to marine origin	50
	Clearwater Formation	Marine shales and sands	80
	McMurray Formation	Interbedded shale and sand	10
Devonian	Woodbend Group	Limestone and shale	-

No regional Quaternary mapping is available for the study area. Drift generally consists of till with some intervals of sand and gravel, and thickness is estimated to be 45 to 70 m from regional mapping (Andriashek and Meeks, 2001), although limited well reports in the area indicate a thickness of drift deposits between 25 and greater than 90 m.

Borehole logs from both shallow monitoring and deep monitoring wells indicate organic deposits up to 5 m thick, with predominantly silty clay or clayey silts to depths of 20 to 60 m.

Local Cretaceous Formations include the Upper and Lower Cretaceous Colorado Group and Lower Cretaceous Mannville Group, which contains the Grand Rapids, Clearwater and McMurray Formations. Structure maps depicting the surface of the Grand Rapids and Wabiskaw Member and the Woodbend Group are included in CR #4, as Figures 3.1, 3.2, and 3.3, respectively.

4.4.2.4 Hydrogeology

The hydrostratigraphy for the Project Area is outlined in Table 4.4-3 based on regional information with local characteristics for the Quaternary drift and Grand Rapids Formation. Shallow groundwater (i.e. within Quaternary drift) may discharge into nearby surface water bodies within the Dover River watershed, but on a regional scale most groundwater above the pre-Cretaceous unconformity is expected to flow to the southeast then eastward towards the Athabasca River.

Table 4.4-3 Summary of Hydrostratigraphic Units and Aquifer Hydraulic Properties

Stratigraphic Unit	Hydrostratigraphic Unit	Hydraulic Head (masl)	Local Hydraulic Conductivities (m/s)	Average TDS (mg/L)
Quaternary Drift	Aquitard – Non saline water	~549 to 563	3×10^{-9} to 3×10^{-7}	<1,000
LaBiche Formation (Colorado shale)	Aquitard			
Viking Formation	Aquifer	-	-	900
Joli Fou Formation	Aquitard			
Grand Rapids Formation	Aquifer – Non saline water	~514 to 546	5×10^{-8} to 4×10^{-6}	1,100-1,400
Clearwater Formation	Aquitard and Aquifer			
McMurray Formation	Aquifer – Bitumen	NA	7×10^{-6} to 3×10^{-5}	NA

masl = m above sea level

Quaternary Drift Aquitard/Aquifer

The Birch Channel is identified about 15 km south of the Project Area running east-west across the southern half of Township 93, Range 18 and just into Range 17 (Andriashek and Meeks, 2001). Little information is available regarding this channel. One other short unnamed channel was encountered within the PDA during the 2007/08 drilling program. It trends north/south, is

less than 400 m wide and erodes down to the Joli Fou level (see Viking Isopach Figure 2.2-24). The channel is less than 1 mile long and is eroded out to the south of the PDA and appears to pinch out to the north of it. It is possibly a remnant of a tributary channel once connected to the Birch channel to the south. Limited information is available regarding Quaternary deposits in this area and thus, there is potential for Quaternary aquifers not currently identified. A detailed study of the Quaternary in the PDA will be complete in 2010.

In general, groundwater is expected to be close to surface, as indicated by the wet conditions and abundant surface water bodies present within the Project Area. Wells in and near the Project Area had shallow groundwater levels between 0.6 and 3.8 m below ground level (bgl) (Table 4.4-1). Shallow groundwater flow is expected to be towards the south or southeast, reflecting the local topography. Based on measured hydraulic conductivities and an estimated hydraulic gradient of 0.006 m/m, groundwater flow rates are expected to be slow (i.e. in the order of centim per year).

Viking Aquifer

Regional mapping indicates that the Viking Formation is locally present, having a thick and extensive aquifer. No wells in the region appear to be completed within this unit and consequently there is no information regarding pressures and flow rates. One water well drilled by Sunshine in 2008 indicated a salinity of 933 TDS. Further drilling and testing is necessary to determine the suitability of the Viking as an aquifer.

Grand Rapids Aquifer

The Grand Rapids Formation forms a regional aquifer, which is typically divided into upper and lower sand aquifers. Hydraulic conductivity of 6.7×10^{-6} m/s was calculated for the aquifer at the location of a water source well recently completed in the Lower Grand Rapids (1-23-93-17), approximately 13 km to the southeast of the Project Area.

Two wells completed in the Grand Rapids Formation within the Project Development Area had falling head permeability tests performed with calculated hydraulic conductivities ranging from 5.3×10^{-8} to 4.2×10^{-6} m/s (Table 4.4-1) (Golder, 2008).

The direction of groundwater flow was unable to be determined from available Project information, but is expected to be to the southeast. This direction is consistent with other mapping completed in the area (Matrix Solutions Inc., 2008). The Grand Rapids Formation outcrops and discharges within the Athabasca River valley.

Shallow drift and Grand Rapids monitoring wells installed together on the same drill pads enable a comparison of vertical gradient. Hydrostatic water levels at one location indicate a downward

gradient of 0.40 m/m. At two other locations, the shallow wells were dry and therefore the gradient could be lower or, in fact, reversed at these locations.

McMurray Aquifer

Regional and site specific information indicates that no water bearing McMurray aquifer is present in the immediate area of the Project. A basal McMurray aquifer has been mapped approximately 10 km away (Ozoray et al., 1980) and where present, is expected to be saline.

Devonian Aquifer(s)

Devonian units are generally identified as having very low hydraulic conductivity to the east and southeast of this location. Future water source investigations will include testing of Devonian units for potential saline water source and/or disposal zones.

4.4.2.5 Groundwater Chemistry

Available groundwater chemistry information from wells within and near the Project Area is summarized in CR #4, Tables 3.3 and 3.4.

Quaternary Drift Aquitard/Aquifer

Groundwater chemistry was determined in samples collected from five shallow drift monitoring wells (four outside the Project Area). Three samples from wells in the eastern area (14-4, 10-21 and 9-36) have calcium-bicarbonate type water and have fairly low total dissolved solids ("TDS") (279 – 474 mg/L). By contrast, samples from two wells in the western area had more significant concentrations of sodium, and one location (14-31) is a sodium-bicarbonate type water. Both the sodium and TDS concentrations measured in these samples are above the Canadian Drinking Water Quality Guidelines ("CDWQG"). One sample had a concentration of manganese that exceeded the CDWQG. No detections of benzene, toluene, ethlybenzene or zylene (BTEX) and (fraction) F1 (C6-C10) or F2 (>C10 – C16) hydrocarbons were found.

Grand Rapids Aquifer

Groundwater samples collected from the two groundwater monitoring wells installed in the Grand Rapids Formation indicate a sodium-bicarbonate type water. Concentrations of TDS and sodium consistently exceeded the CDWQG. Exceedances were also noted for pH, iron, aluminum and manganese for the CDWQG and nitrite, aluminum, copper, iron, lead and zinc for the Freshwater Aquatic Life criteria. There were no detections of BTEX, F1 or F2 hydrocarbons.

4.4.2.6 Local Groundwater Users

A summary of the available water well information for wells within 20 km of the Project is provided in Table 4.4-4. The location of the wells are shown on CR #4, Figure 3.4.

Table 4.4-4 Summary of Water Well Records within 20 km of the West Ells Project Site

AENV ID	Location	Owner	Well Completion Depth (m)	Lithology	Completion Date	Comments
150681	13-09-093-18	Petro-Canada	31.7 to 33.2	Sand	Feb- 1990	Surficial. Tested at 230 m^3/day. Licensed.
293907	12-31-094-18	Paramount Resources Ltd	26.8 to 28.4	Sandstone	Feb- 2000	Licensed for 33 m^3/day.
279598	NW-31-094-18		-			
	01-23-093-17	Athabasca Oil Sands Corp.	77.5 to 99.5	Sandstone (LGR)	Mar- 2008	Tested at 463 m^3/day.
1064983	SW-13-095-16	Chevron (West Ells Camp)	-	Gravel & Sand	Jan- 2007	Surficial. Abandoned.
0925655	01-23-095-17	Shell Canada	-			Chemistry data only.

'-' = Not Available
LGR = Lower Grand Rapids

4.4.3 Potential Impacts

The following are a list of potential project effects:

- effects of the water supply wells on groundwater quantity and levels;
- effects of the surface facilities on groundwater quality;
- effects of the production/injection wells on groundwater quality; and
- effects of the disposal wells on groundwater quality.

4.4.3.1 Potential Effects of Water Supply Wells on Groundwater Quantity

The water demands for the Project, including make-up water for steam generation, sanitary and potable water, are summarized in Table 4.4-5. Recycling will be incorporated into the process and is expected to result in a recycle rate of 97% produced water. Potable water for drinking and cooking will be trucked to the site, and all other water (i.e. make-up and sanitary) is expected to be sourced from a network of groundwater supply wells.

The volume of water required for steady-state operations (assuming a 10% reservoir water loss and a 25% contingency) is 490 m^3/d for the Project's first phase, and 966 m^3/d after the Project's second phase expansion. It is expected that the start-up of each phase will take approximately 90 days and that the second phase of development will occur one year after the start- up of the first phase. An additional 1,075 m^3/d, or approximately 96,750 m^3/y is required for two years for the start up of both phases.

Table 4.4-5 Water Volume Requirements of the West Ells Project			
Project Phase	**Water Demand (m^3/day)**		
	Steam Generation (Make-up)	**Sanitary**	**Potable**
Construction (Q3 2011-Q4 2012)	0	25	4
Start-Up (90 days)	2,041	25	4
Operations (2012 – 2037)	490(first phase) 966 (first and second phase)	3	1

It is anticipated that non saline groundwater from the Viking Aquifer will be used as a water source for the Project. Based on the regional and local information, individual well yields could equal 300 m^3/day. A groundwater investigation program is planned for the winter of 2009-2010 to evaluate the potential of the Viking Aquifer as a water source zone for the Project. Depending on the results of these investigations, it will be determined whether additional sources will be required to meet the estimated demand.

Under the Water Conservation and Allocation Guideline for Oilfield Injection (Alberta Environment, 2006) non-saline groundwater use for enhanced recovery is to be reduced or eliminated. Saline groundwater is typically considered the most feasible alternative to non saline groundwater use. For the Project, saline aquifers are not evident at this time. Future investigations will explore potential saline sources, such as Devonian units, in an effort to replace non saline water use with saline sources.

Considering the remoteness of the Project location relative to other groundwater users in the region, it is reasonable to conclude that the impacts to other groundwater users will be low.

A supply of water for sanitary and drinking purposes will be required for the construction camp, operations camp, and the administration and control room offices at the central processing facility. Drinking and cooking water will be trucked in from an offsite source. Water for sanitary uses such as showers and toilets may come from the source water supply for the Project.

4.4.3.2 Effects of the Surface Facilities on Groundwater Quality

Upset conditions, specifically spills or leaks of fluids, may allow small amounts of fluids to seep into the shallow groundwater. Possible groundwater contaminants include bitumen, produced water and minor amounts of various process-related organic chemicals such as glycol and lubricants. With appropriate mitigation the surface facilities should have no effects on groundwater quality under normal operating conditions.

The plant site is located over an area of 60 m or more of glacial drift composed predominantly of clay rich deposits. Groundwater flow rates have been estimated in the order of centim per year. This will act to retard any movement of spilled liquids and allow ample time for clean up and remediation.

The mitigation measures to be implemented should be effective in preventing or minimizing any fluids from adversely affecting the shallow groundwater. If a significant impact on groundwater quality is detected, a groundwater response plan will be implemented.

4.4.3.4 Effects of the Production/Injection Wells on Groundwater Quality

The SAGD injection wells will be operated at pressures below the hydraulic fracturing pressure of the cap rock (the Wabiskaw Shale Member of the Clearwater Formation) and the reservoir (Wabiskaw Member). Overlying the Wabiskaw shale cap rock is the Clearwater Formation, which is also expected to form a barrier to steam. There is little probability that fracturing could occur and result in fluids being transported into overlying non-saline aquifers, such as the Grand Rapids.

In addition, the production and injection wells will be completed with surface casing set below the base of the Quaternary deposits and the intermediate casing will be installed using standard casing and cementing practices. The intermediate casings will not be subjected to abnormal pressures because tubing is used to conduct fluids into or out of these wells. Consequently, casing failures followed by annular leakage into the overlying potable aquifers should not occur.

In view of these design and operational factors and the fact that no non-saline groundwater was identified in association with the Wabiskaw Member in the Project Area, the operation of the production and injection wells should not have any effect on the chemical quality of the groundwater in potable aquifers and therefore, an effects analysis is not warranted.

4.4.3.5 Effects of the Disposal Wells on Groundwater Quality

Produced water separated from the bitumen that is no longer able to be treated, as well as blow down water from the water conditioning process,will be initially trucked out to an approved disposal site. In the future it will be injected into deep subsurface formations. The disposal zone has not been determined at this time.

The disposal wells will be applied for under a separate application, likely after Project scheme approval is granted.

The probability of an adverse effect from injection is minimal for the following reasons:

- injection pressures are limited to below rock fracture pressure, therefore the probability of escape of liquids through this mechanism is very low;

- if the packer or tubing should fail, the injection pressures will be transferred into the casing annulus. Regular monitoring of the casing annulus pressure will observe this quickly, and if it occurs, the well will be shut in;
- since the main string casing above the tubing packer is not subject to internal injection pressures and contains rust inhibiting liquid, the probability of it having a leak is minimal; and
- an additional level of protection is the surface casing, which lies outside the main string casing, to the depth of groundwater protection. This provides additional protection against leaks into non-saline groundwater resources.

There is a low probability that wastewater injection will result in any impact on groundwater.

4.4.4 Mitigation and Monitoring

4.4.4.1 Mitigation

Mitigation of potential effects of water supply wells for the Project on groundwater quantity is unlikely to be necessary, but could include the adjustment of production rates or locating alternative water sources, if required.

Sunshine will develop a groundwater response plan which, in case of an upset condition, spills or leaks, will be effective at avoiding a significant effect on groundwater quality, preventing impacted groundwater from reaching surface water bodies and restoring groundwater quality. The plan will include industry-standard operating practices and preparedness for and appropriate management of upset conditions.

The mitigation measures (i.e. cemented surface and production casings) noted for potential effects of the production/injection wells on groundwater quality, are expect to be effective at preventing casing failures and annular leakage from occurring.

In addition, an appropriate monitoring program will be agreed upon with regulators if a leak or other incident occurs in order to mitigate the unlikely effects of the disposal wells on groundwater quality.

4.4.4.2 Monitoring

The groundwater monitoring program for the Project will be developed and implemented as required in any EPEA approval granted and will have the following two main purposes:

- to detect any impacts on the shallow groundwater quality resulting from spills or leaks from surface facilities at the plant site; and
- to evaluate the performance of the water supply well(s) in the Grand Rapids Formation.

The shallow groundwater monitoring network currently includes three monitoring wells within the Project Area. These and any additional wells are intended to be located down-gradient of the plant site or other Project facilities. Instrumentation will be used to detect a casing failure and can be set for an automatic shutdown of the well, and groundwater sampling will be instituted if a casing failure occurs. Monitoring parameters will include major ions, hydrocarbons, metals and selected organics.

A groundwater investigation is planned for the winter of 2010-2011 to evaluate potential yields from the Viking Aquifer. Future investigations will explore potential saline sources, such as Devonian units, in an effort to replace non saline water use with saline sources.

4.4.5 Summary

The West Ells SAGD Project is not expected to have any adverse effects on the groundwater resources within the region. The conclusions of the Project effects evaluations are summarized as follows:

- groundwater production from the Viking Formation should have no significant effects on the quantity of water in other formations, the surface water resources or on vegetation. As there are no other Viking water users within the Project Area, interference effects will not occur;
- potential spills or leaks of bitumen, produced water or process-related chemicals at the plant site should have no adverse effects on the chemical quality of the groundwater resources;
- the operation of the SAGD production and injection wells should have no adverse effects on the chemical quality of the potable aquifers; and
- the operation of wastewater disposal wells should have no adverse effects of the quality of groundwater.

4.5 Historical Resources

4.5.1 Introduction

FMA Heritage Incorporated was retained by Sunshine to conduct a Historical Resources Impact Assessment ("HRIA") for the proposed Project and access road. The following section is a summary of the HRIA included as Consultant Report #5 ("CR #5").

The objectives of the HRIA were to assess the potential for the occurrence of archaeological and historical sites within the Study Area and to design and implement an acceptable site specific mitigation program.

In order to meet those objectives, the following tasks were conducted:

- record review;
- ground reconnaissance;
- site evaluation; and
- impact assessment.

The Historical Resources LSA for the Project includes nine sections of land and the study area for the access road includes the road plus a 500 m buffer on either side (CR #5, Figure 3).

Since the Historical Resource field reconnaissance was completed the Project and access road footprints have been refined. Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further Historical Recources field reconnaissance for these facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed. Sunshine will apply for clearance for the development from Alberta Culture and Community Spirit once all applicable data has been collected.

4.5.2 Baseline Conditions

The proposed project lies within Borden Block HhPe. Currently, no archaeological sites are on record within this Borden Block.

The initial ground reconnaissance consisted of an aerial overflight followed by a pedestrian traverse and an intensive visual examination of the study area, especially those high potential landforms associated with bodies of water. All fortuitous exposures, such as seismic cut lines, vehicle tracks and disturbance from previous petroleum industry activities were examined for the presence of cultural materials. During the course of the assessment a total of 157 shovel tests were excavated within the study area (CR #5, Figure 4). All 157 shovel tests were negative for cultural material.

To determine the relative ranking of terrain features in terms of potential to identify precontact historical resources, a predictive model was developed using Geographic Information Systems ("GIS") technology. Archaeological sites previously recorded in the oil sands area have generally shown correlation with relatively flat, well-drained habitable landforms such as ridges and knolls. Often, sites have also been associated with water sources such as rivers, streams and lakes. Therefore, the predictive model developed for the historical resources assessment studies databases contained information on vegetation ecosite phases, soil complexes, aspect, slope and proximity to perennial waterbodies to reflect these archaeological associations.

The predicative model indicates that the areas of high and moderate archaeological potential occur in elevated areas adjacent to bodies of water, including lakes, creeks and bogs. Areas of highest archaeological potential include areas of highest relief and well-drained terrain (typically open spruce or aspen forest) adjacent to perennial creeks and lakes. Areas of moderate-high potential consist of areas of relatively significant relief within proximity of perennial lakes and creeks. Areas of low-moderate potential consist of those areas along wetland edges, including bog, lake and creek edges, that have minimal relief and exhibit moderately- to poorly-drained terrain; although the relief is not pronounced at these low-moderate areas, the edges of wetlands are anticipated to represent potential travel routes for precontact peoples during summer conditions. Areas of low potential are those areas located some distance from perennial waterbodies or ephemeral wetlands. The map of archaeological potential produced using the predictive model is shown in CR #5, Figure 3.

4.5.3 Potential Impacts

No archaeological sites have been previously recorded or found during the ground reconnaissance. Based on the results of the predictive model, the Study Area has some potential for archaeological materials to be present. This is particularly true of areas located on well-drained, high relief areas adjacent to perennial creeks, but moderate archaeological potential also exists along less well-defined margins of ephemeral creeks and bog edges. It is recommended that additional field studies be conducted under summer conditions, prior to construction, on those areas of moderate to high archaeological potential that will be impacted by the Project and access road.

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4.5.4 Mitigation and Monitoring

Sunshine will implement the following mitigation measures:

- further assessment on the Project footprint and access road; and
- application to Alberta Culture and Community Spirit for clearance to construct the Project and access road.

4.5.5 Summary

Initial field assessment was conducted within the Project Area. Since this time the Project footprint and access road locations have been refined therefore further assessment is recommended. Sunshine will conduct further surveys on the footprint and access road and apply for clearance from Alberta Culture and Community Spirit prior to construction.

4.6 Hydrology

4.6.1 Introduction

Sunshine retained Northwest Hydraulic Consultants Ltd. to conduct a hydrology assessment for the Project and access road. The following section is a summary of the Hydrology Assessment included as Consultants Report #6 ("CR #6").

The hydrology assessment included an evaluation of the regional meteorological and hydrologic characteristics, a brief description of the development plan, and an assessment of the impacts of the SAGD development and access road on both the hydrology and channel characteristics of the catchments both locally and regionally.

The surface water hydrology Local Study Area (Hydrology LSA) is defined as the total drainage area of the local tributaries to the Dover and Dunkirk rivers which have portions of their watersheds lying within the Project Area and access road right-of-way. The boundary of the Hydrology LSA is shown in CR #6, Figure 2.

The surface water hydrology Regional Study Area (Hydrology RSA) is defined as the area in which stream flows and water levels could be affected by development within the Project Area. The Hydrology RSA is composed of the watershed of the McKay River as shown in CR #6, Figure 1. The Hydrology RSA is limited to this watershed because potential impacts to the larger watershed downstream are expected to be negligible due to the much greater drainage area of the downstream watershed.

4.6.2 Baseline Conditions

Most of the Project is located in the watershed of the Dover River, which is a major tributary of the MacKay River.

4.6.2.1 Climatic Conditions

Climate is a major driver of the hydrologic regime. A long term climate station operated by Environment Canada is located at the Fort McMurray airport (3062693) about 110 km southeast of the Project. This station provides long term continuous climate record for the area, however, the elevation of this station is 911 m, which is much greater than the mean elevation of the lease area at 530 m.

SRD also operates two stations that provide summer climate data - the Legend LO station, which is about 30 km north of the Project, and the Livock LO station, which is 86 km southwest of the

Project. The Legend LO station is at an elevation of 579 m, which is similar to the mean elevation of the lease area, while the Livock LO is at an elevation of 369 m.

Air Temperature

The climate station at the Fort McMurray airport shows that the mean monthly temperature ranges from 17°C in July to -20°C in January while the extreme monthly temperatures range from a maximum of 23°C in July to a minimum of -25°C in January. The mean daily air temperature drops below freezing in November and rises above freezing in April.

Summer air temperatures at the Legend LO station are generally 2 to 3°C lower than those of Fort McMurray, with temperatures at Livock LO typically falling between the other two sites. The lower temperatures at Legend and Livock LO are likely due to the lower elevations of these sites.

Precipitation

The winter snowfall at Fort McMurray is relatively constant from month to month, averaging about 20 cm. Generally all the precipitation between November and March falls as snow due to the below freezing air temperatures during this period. This precipitation is stored on the ground until April and May, when the snow melts and snowmelt runoff is produced.

Summer precipitation records are also available for Legend LO and Livock LO. Both Legend LO and Livock LO have about 20% more precipitation than the Fort McMurray station in June and July but have precipitation similar to Fort McMurray in May and August. The greatest monthly precipitation occurs in July, averaging about 79 mm at Fort McMurray, 98 mm at Legend LO, and 92 mm at Livock LO.

Fort McMurray experienced a maximum winter snowfall of 297 mm in 1972 and a minimum winter snowfall of 46 mm in 1949. The maximum annual precipitation of 675 mm occurred in 1973, while the minimum annual precipitation of 242 mm occurred in 1998.

The extreme daily precipitation of 95 mm for Fort McMurray is similar to the value of 94 mm at Legend LO but much greater than the 61 mm reported for Livock LO. Rainfall intensity curves provided by Environment Canada for Fort McMurray indicate that the 10-year 24 hour rainfall is 64.1 mm.

Evaporation

Average annual lake evaporation for Fort McMurray from 1972 to 1980, as calculated by Bothe (1981) for this period, was 570 mm.

Evapotranspiration, the combination of evaporation and transpiration from vegetated land, tends to be lower than lake evaporation due to the limitation of soil moisture availability. The median annual evapotranspiration from the vegetated land in the lease area is estimated to be about 325 mm, which is based on the method of estimating evapotranspiration potential and lake evaporation from by Morton (1983).

4.6.2.2 Streamflow

The streamflow assessment includes a regional analysis of annual runoff and peak flows and an assessment of the local hydrography and channel characteristics.

Regional Flow Characteristics

Water survey of Canada ("WSC") maintains a number of streamflow gauges in the region. The gauges listed in Table 4.6.1 provide a record of discharges for streams with drainage areas ranging from 165 km^2 for the Beaver River above Syncrude (07DA018) to 5,570 km^2 for the MacKay River near Fort McKay (07DB001).

Table 4.6-1 Summary of WSC Gauges in the Region

Stream	Location	Gauge Number	Gauge Type	Period of Record	Drainage Area (km^2)	Median Annual Runoff Coefficient
Steepbank River	Fort McMurray	07DA006	Continuous Seasonal	1972-1986 1987-2007	1,320	0.25
Muskeg River	Fort McKay	07DA008	Continuous Seasonal	1974-1986 1987-2007	1,460	0.19
Hartley Creek	Fort McKay	07DA009	Continuous Seasonal	1975-1987 1988-1993	358	0.19
Unnamed Creek	Fort McKay	07DA011	Continuous Seasonal	1975-1981 1982-1993	274	0.10
Joslyn Creek	Fort McKay	07DA016	Continuous Seasonal	1975-1981 1982-1993	257	0.12
Ells River	Mouth	07DA017	Continuous	1975-1986	2,450	0.17
Beaver River	Syncrude	07DA018	Continuous Seasonal	1975-1987 1988-2007	165	0.18
MacKay River	Fort McKay	07DB001	Continuous Seasonal	1972-1987 1988-2007	5,570	0.15
Dover River	Mouth	07DB002	Continuous	1975-1977	963	n/a
Dunkirk River	Fort McKay	07DB003	Continuous	1975-1979	1,570	n/a

Table 4.6-1 Summary of WSC Gauges in the Region

Stream	Location	Gauge Number	Gauge Type	Period of Record	Drainage Area (km^2)	Median Annual Runoff Coefficient
MacKay River	Dunkirk River	07DB005	Seasonal	1983-1991	1,010	0.12

As presented above, annual precipitation records are available for Fort McMurray, while at Legend LO and Livock LO precipitation records are only available for May through August. For the runoff analysis, a composite precipitation was developed from the Fort McMurray record, averaged with the records from the other two sites when they were available. The annual runoff coefficients were calculated from the November to October annual precipitation to associate the accumulated winter snowfall with the runoff in the following spring and summer. The median annual precipitation of the Nov-Oct composite record was 454 mm.

The median annual runoff coefficients for the region range from 0.10 for an Unnamed Creek near Fort McKay to 0.25 for the Steepbank River near Fort McMurray, with an average of 0.16. There is no significant trend in the magnitude of the runoff coefficient with the drainage area. This average value for the region is expected to provide a reasonable estimate of local runoff in the West Ells area.

Mean annual flows were calculated for each of the nine WSC basins and are listed in Table 4.6.2. The mean annual flow ranged from 0.39 m^3/s for Unnamed Creek to 13.3 m^3/s for MacKay River near Fort McKay. The trend of mean annual flow with drainage area indicates that mean annual flow is directly proportional to drainage area.

Mean annual peak flows ranged from 5.8 m^3/s for Unnamed Creek to 122 m^3/s for the MacKay River near Fort McKay. The mean annual peak flows tend to increase log-linearly with drainage area (CR #6, Figure 6).

Table 4.6-2 Summary of Regional Flows

Stream	Location	Drainage Area (km^2)	Mean Annual Flow (m^3/s)	Mean Annual Peak Flow (m^3/s)	10-Year Peak Flow (m^3/s)	25-Year Peak Flow (m^3/s)	100-Year Peak Flow (m^3/s)	Average Minimum Monthly Flow[1] (m^3/s)
Steepbank River	Fort McMurray	1,320	4.60	37.0	68.4	91.0	129	0.37
Muskeg River	Fort McKay	1,460	3.74	26.3	48.2	63.7	89.9	0.36
Hartley Creek	Fort McKay	358	1.00	8.46	18.6	27.3	43.6	0.011

Table 4.6-2 Summary of Regional Flows

Stream	Location	Drainage Area (km^2)	Mean Annual Flow (m^3/s)	Mean Annual Peak Flow (m^3/s)	10-Year Peak Flow (m^3/s)	25-Year Peak Flow (m^3/s)	100-Year Peak Flow (m^3/s)	Average Minimum Monthly Flow[1] (m^3/s)
Unnamed Creek	Fort McKay	274	0.39	5.79	10.6	14.2	20.3	0.057
Joslyn Creek	Fort McKay	257	0.62	13.9	27.8	38.7	58.0	0.011
Ells River	Mouth	2,450	6.32	71.0	156	237	397	0.81
Beaver River	Syncrude	165	0.50	10.1	23.0	35.9	62.0	0.043
MacKay River	Fort McKay	5,570	13.3	122	260	381	608	0.47
MacKay River	Dunkirk River	1,010	2.46	21.0	47.9	72.5	121	0.038

[1]winter flow records incomplete

Local Hydrography

The Project lies within the watershed of MacKay River which has a drainage area of 5,570 km^2 (CR #6, Figure 8). Most of the Project Area lies within the watershed of the Dover River, a major tributary of the MacKay River, which has a drainage area of 963 km^2. A small portion of the Project Area lies within the watershed of another major tributary of the MacKay River, the Dunkirk River, which has a drainage area of 1570 km^2 (Table 4.6-3).

The watersheds of two small tributaries (Dov1 and Dov2) in the headwaters of the Dover River drain 95% of the Project Area and flow south-eastward into Lake L1 (CR #6, Figure 8). The Project Area occupies 595 ha of the watershed of tributary Dov1 and 917 ha of the watershed of tributary Dov2. A small portion of the western edge of the lease, 51 ha, drains into the watershed of Snipe Creek, which is a tributary of the Dunkirk River.

Lake L1, which has a surface area of 330 ha, is the largest lake in the vicinity of the Project (CR #6, Figure 8). Most of the Project Area lies within the drainage area of this lake. Watershed Dov1 contains a small lake, L2 with a surface area of 25 ha, while watershed Dov2 contains two larger lakes, L3 and L4, which have surface areas of 188 ha and 105 ha, respectively. Two other lakes, L5 and L6 with surface areas of 162 ha and 230 ha respectively, are located on Snipe Creek just to the northwest of the Project.

The mean annual flows for the local watersheds were estimated based on the relationship between discharge and drainage area (CR #6, Figure 6), and the log-normal distribution adopted from the analysis regional flow frequencies was used to estimate the expected flood peaks in the

local watersheds. Table 4.6-3 summarizes the flood peaks for various return periods for these watersheds.

Table 4.6-3 Summary of Drainage Areas and Estimated Flow Rates for Local Watersheds

Stream	Major Watershed	Drainage Area (km^2)	Mean Annual Flow (m^3/s)	Mean Annual Peak Flow (m^3/s)	10-Year Peak Flow (m^3/s)	25-Year Peak Flow (m^3/s)	100-Year Peak Flow (m^3/s)	Average Minimum Monthly Flow (m^3/s)
Dunkirk	Mackay River	1,570	3.93	38.3	77.5	110	168	0.21
Snipe Creek	Dunkirk River	450	1.14	14.2	28.7	40.7	62.3	0.051
Dun1	Dunkirk River	69.6	0.17	3.2	6.5	9.2	14.2	0.006
Dover River	Mackay River	963	2.41	26.0	52.6	74.5	114	0.12
Dov1	Dover River	12.7	0.032	0.83	1.7	2.4	3.7	0.001
Dov2	Dover River	30.7	0.077	1.7	3.4	4.8	7.4	0.002
Dov3	Dover River	67.4	0.17	3.1	6.4	9.0	11.8	0.006
Site 1	Dov2	0.68	0.002	0.082	0.17	0.23	0.36	0.000
Site 2	Dov2	1.47	0.004	0.151	0.31	0.43	0.66	0.000
Site 3	Dov1	2.60	0.007	0.237	0.48	0.68	1.0	0.000
Site 4	Dov1	2.62	0.007	0.238	0.48	0.68	1.0	0.000
Site 5	Dov1	8.93	0.022	0.631	1.3	1.8	2.8	0.001
Site 6	Dov2	2.50	0.006	0.230	0.47	0.66	1.0	0.000
Site 7	Dov2	29.5	0.074	1.630	3.3	4.7	7.2	0.002
Lake L1	Dover River	3.30						
Lake L2	Dov1	0.25						
Lake L3	Dov2	1.88						
Lake L4	Dov2	1.05						
Lake L5	Dov1	0.03						
Lake L6	Dov1	0.11						
Lake L7	Dov1	0.07						

Local Channel Characteristics

Site inspections were carried out at seven sites in the vicinity of the Project on June 24-26, 2008 (CR #6, Figure 8). A summary of the channel characteristics observed at the sites is given in Table 4.6-4. The wetted width ranged from 1.0 m at Site 4 to 56 m at Site 3, and the mean velocity ranged from 0.0 m/s at Site 7 to 0.17 m/s at Site 4. Discharges estimated from the measurements ranged from no flow at Site 3 and 7 to 0.051 m^3/s at Site 4. The measured discharges are slightly greater than the mean annual flows expected for these drainage areas.

The drainage areas and mean annual flows estimated for local watersheds, including the seven sites in the vicinity of the Project Area, are summarised in Table 4.6-3. The table also shows estimates of extreme flows for the sites. Peak flows for watershed Dov2 may be overestimated because the large percentage of lake area in this watershed may delay the runoff relative to watersheds with less lake area.

Table 4.6-4 Summary of Channel Characteristics

Site	Water-shed	Location	Easting (m)	Northing (m)	Wetted Width (m)	Mean Velocity (m/s)	Discharge (m^3/s)
Site 1	Dov2	Upstream of L3	396,021	6,341,866	n/a	n/a	n/a
Site 2	Dov2	Upstream of L3	395,247	6,341,193	16.1[1]	0.04	0.029
Site 3	Dov1	Upstream of L2	395,593	6,339,607	56.0	0.00	0.000
Site 4	Dov1	Upstream of L2	394,869	6,338,431	1.0	0.17	0.051
Site 5	Dov1	Downstream of L2	396,259	6,339,444	6.0	0.01	0.031
Site 6	Dov2	Upstream of L4	398,520	6,341,350	n/a	n/a	n/a
Site 7	Dov2	Between L4 and L1	399,564	6,340,400	41.6	0.00	0.000

1 multiple channels

4.6.3 Potential Impacts

4.6.3.1 West Ells SAGD Project

Phase 1 Project Footprint

Sunshine considered potential impacts throughout the entire Project Area. Surface disturbances will occur from the construction of the plant site, two well pads, three camps, borrow pit, and the utility corridor for access road, powerline and pipeline right-of-ways. The total disturbed area due to Phase 1 of the Project is 60.7 ha. Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further environmental data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

All of the Project disturbances in Phase 1 will be located in the Dover River basin where two small watersheds, Dov1 and Dov2, will be affected. Table 4.6-5 summarizes the extent of the spatial disturbances within the individual watersheds.

Table 4.6-5 Summary of Spatial Extent of Disturbances Due to Phase 1 of the Project

Watershed	Disturbance Areas							Percent of Area (%)
	Drainage Area (ha)	Plant Site (ha)	Well Pads (ha)	Camps (ha)	Borrow Pit (ha)	Utility Corridor (ha)	Total (ha)	
Dov1	1267		3.1	9.0	2.0	4.2	18.3	1.4%
Dov2	3070	29.3	6.2		6.9		42.4	1.4%
Dover River Total	245,000	29.3	9.3	9.0	8.9	4.2	60.7	0.025%

Most of the surface disturbance, 42.4 ha, will be located in watershed Dov2; however, 18.3 ha will also located in watershed Dov1. About 1.4% of each watershed area will be disturbed. If the entire Dover River watershed is considered, the disturbance area decreases to about 0.025% of the drainage area. It would be very difficult to quantify the effect of this scale of development on any hydrologic parameter.

The plant site, south pad, camps, and borrow pit are located where they do not disturb any indentified drainage pathways so no stream disturbances are anticipated from these surface disturbances.

The north pad is located on a mapped drainage pathway upstream of Lake L3 (CR #6, Figure 16). Investigations of this drainage pathway at Site 2 (CR#6, Figure 10) indicated that the flow was distributed over a wide area where it crossed a cut line and diffused into a wetland upstream and downstream of the site. There were no defined channels in the undisturbed areas.

Surface drainage will be directed around the well pads (particularly the North Pad) using drainage ditches. The intent is to ensure surface flows do not get interrupted or impacted by the Project components.

Hydrologic Impacts

The potential effects of the Project on surface water within the property boundary include:

- changes to the surface runoff characteristics due to changes to the surface of the landscape and diversion of surface water for plant processes; and
- increased sediment concentrations in the local streams due to the effects of stream channel crossings and changes in surface runoff characteristics.

Project disturbances have the potential to cause changes to the surface runoff characteristics. Changes in surface drainage patterns or changes in the runoff coefficients may affect the flow volumes, flow rates, and timing of peak flows in the local streams. Water levels in lakes and

wetlands may also be affected. If these changes are significant they may in turn produce changes in the channel regime of the local streams.

To minimize the impacts on surface runoff, there will be no changes in the surface drainage patterns due to construction. Appropriate drainage will be provided at crossings of any significant drainage courses (CR#6, Figure 16). There will be no transfer of water from one watershed to another along ditches and road rights of way.

The effect of development on runoff volumes in each individual watershed depends on the proportion of the areas that are used for plant site, well pads, camps, borrow pit, and utility corridors. The plant site, borrow pits, and well pads will reduce the runoff volumes and flood peaks because runoff water will be contained within these areas. The camps will increase runoff because the runoff coefficient for these areas is greater than that for the undisturbed areas. Utility corridor areas will increase both runoff volumes and flood peaks due to the reduction in vegetation and the addition of less permeable surfaces.

The surface disturbances associated with the Project will produce some minor changes in runoff volumes and peak flows in the local watersheds (Table 4.6-6). The overall change to runoff in the Dover River will be negligible.

Table 4.6-6 Summary of Changes in Runoff Volume Due to Phase 1 Disturbances

Watershed	Natural Drainage Area (ha)	Mean Annual Flow[1] (m^3/s)	Change in Annual Runoff Volume (%)	Change in Mean Annual Flow (m^3/s)
Dov1	1,267	0.032	2.1	0.00067
Dov2	3,070	0.077	-1.4	-0.00106
Dover River Total	96,300	2.41	-0.017	-0.00041
Mackay River	557,000	14	-0.003	-0.00041

[1] March to Oct flows only

It is expected that changes in the flood peaks would probably be of similar magnitude to, or less than, the changes in the runoff volumes. Thus, the possibility of any significant changes to the regime of any of the streams in the area is very remote.

There is potential for the SAGD Project to affect lake levels because the Phase 1 footprint is upstream of Lake L2 in watershed Dov1 and Lake L3 in watershed Dov2. As well, both these watersheds drain into Lake L1. The slight increase in runoff in watershed Dov1 may cause a slight increase in peak water level in Lake L2 and the slight decrease in runoff in watershed

Dov1 may cause a slight decrease in peak water level in Lake L3. The overall change in level in Lake L1 will be less than the changes in Lakes L2 and L3 because Lake L1 is larger and the overall change in runoff is smaller. These changes in lake levels are not expected to be detectable relative to the natural variability in levels because the change to runoff volumes is small.

Sediment concentrations in streams have the potential to increase due to increases in streamflow or from sediment introduced to the stream from disturbances. Sediment concentrations in the streams are not expected to increase due to changes in the surface runoff characteristics. The projected changes in the flow regime due to surface disturbances are small so they will not impact the sediment concentrations significantly. There are no crossings of streams with distinct channels in the Phase 1 footprint, so no sediment inputs will occur from local disturbances.

4.6.3.2 Access Road

Project Footprint

The access road and borrow pits will be located in two watersheds of the Dunkirk River, Dun1 and Snipe Creek, as well as two watersheds of the Dover River, Dov1 and Dov3 (Table 4.6-7). The largest percentage of surface area of a watershed that is disturbed is in the order of 2.6%. If the entire Dover and Dunkirk watersheds are considered, the disturbance decreases to about 0.027% and if the entire MacKay River watershed is considered the disturbance decreases to 0.012%. It would be very difficult to quantify the effect of this scale of development on any hydrologic parameter.

Table 4.6-7 Summary of Spatial Extent of Access Road Disturbances

Watershed	Drainage Area (ha)	Disturbance Areas			Percent of Area (%)
		Access road (ha)	Borrow Pits (ha)	Total (ha)	
Dov1	1,267	22.4	10.1	32.5	2.6
Dov3	6,740	4.1	0.0	4.1	0.061
Dover River Total	96,300	26.5	10.1	36.6	0.038
Dun1	6,960	18.8	12.5	31.3	0.45
Dunkirk River Total	157,000	18.8	12.5	31.3	0.020
Mackay River Total	557,000	45.3	22.6	67.9	0.012

The access road crosses five mapped drainage pathways however, most of these drainage pathways are wetlands which do not have defined stream channels. Appropriate construction measures will be utilized during construction and operation to ensure potential impacts are mitigated.

Hydrologic Impacts

The potential affect of the access road on surface water within the property boundary include the following:

- changes to the surface runoff characteristics due to changes to the surface of the landscape; and
- increased sediment concentrations in the local streams due to the effects of stream channel crossings and changes in surface runoff characteristics.

Project disturbances have the potential to cause changes to the surface runoff characteristics. Changes in surface drainage patterns or changes in the runoff coefficients may affect the flow volumes, flow rates and timing of peak flows in the local streams. Water levels in lakes and wetlands may also be affected. If these changes are significant they may in turn produce changes in the channel regime of the local streams.

The changes in land use and the runoff coefficients will produce changes in runoff volumes and peak flows. The changes in runoff volume are summarized in Table 4.6-8. The overall change to runoff in the Dover and Dunkirk Rivers will be very small, as it will be for the MacKay River.

Table 4.6-8 Summary of Changes in Runoff Volume Due to Project Disturbances

Watershed	Natural Drainage Area (ha)	Mean Annual Flow[1] (m^3/s)	Change in Annual Runoff Volume (%)	Change in Mean Annual Flow (m^3/s)
Dov1	1,267	0.032	1.9	0.00060
Dov3	6,740	0.17	0.091	0.00015
Dover River Total	96,300	2.4	0.031	0.00074
Dun1	6,960	0.17	0.22	0.00039
Dunkirk River Total	157,000	3.9	0.010	0.00039
Mackay River	557,000	14	0.008	0.00113

[1] March to Oct flows only

The surface disturbances associated with the Project will produce some minor changes in runoff volumes and peak flows in the local catchments, however, at the mouth of the MacKay River,

the annual changes in runoff due to the total surface disturbance are expected to be about 0.008% of the annual runoff volumes. Changes in the peak flows are expected to be even less than this.

Lake levels are not generally expected to be affected by the Project disturbances due to the small changes in runoff which will occur. The access road footprint does not directly affect any lakes within the watershed.

Sediment concentrations in streams and lakes have the potential to increase due to increases in streamflow or from sediment introduced to the water body from disturbances. Sediment concentrations in the streams are not expected to increase due to changes in the surface runoff characteristics. The projected changes in the flow regime due to surface disturbances are small so they will not impact the sediment concentrations significantly.

The access road crosses five indentified drainage pathways; however, only one crossing has a defined channel. Appropriate sediment control will be implemented during construction to minimize the effects of the disturbances. Appropriate sediment control will also be implemented at the intersection of the streams and the access corridor ditches.

4.6.4 Mitigation and Monitoring

4.6.4.1 Mitigation

Sunshine will implement the following mitigation measures:

- natural drainage patterns will be maintained by utilizing culverts and drainage ditches and by providing flow pathways around the plant site and well pads;
- proper sediment management techniques will be utilized during the construction of stream crossings;
- runoff from the plant site and well pads can be controlled so that poor quality runoff does not enter the streams; and
- disturbed areas will be reclaimed and the landscape will be restored so that surface runoff will be similar to the pre-existing conditions.

4.6.4.2 Monitoring

Monitoring will be conducted as required by the terms and conditions of any EPEA approval granted.

4.6.5 Summary

The hydrologic impacts of the Project were classified into two categories, surface disturbances and stream disturbances. The impacts of surface disturbances caused by the development of the Project on the hydrology in the area were investigated and found to be small. The surface

disturbances associated with the Project will produce some minor changes in runoff volumes and peak flows but these changes are expected to be undetectable in the larger basins. Runoff from the well pads will be contained, and allowed to evaporate or will be treated and released into the natural drainage system once water quality objectives have been met. Runoff from the plant site will be contained as well and may be utilized to supplement the process water supply from groundwater. Disturbances to the streams will also be insignificant. The Phase 1 footprint does not disturb any streams with defined channels. The north pad and utility corridor cross a mapped drainage pathway but this drainage was found to be a wetland with no defined channel. Only one crossing of a stream with a defined channel is planned for the access road. Design and construction of this stream crossing will be carried out in a way so as to minimize any in-stream disturbances.

The impacts of disturbances caused by the development of the Project on the hydrology were investigated and found to be insignificant. Where impacts could potentially occur, the Project will be designed to minimize the effects of the impacts.

4.7 Noise Assessment

4.7.1 Introduction

Acoustical Consultants Inc. ("ACI"), was retained by Sunshine to conduct an environmental noise impact assessment ("NIA") for the proposed Project. The following section is a summary of the Environmental Noise Impact Assessment (without NCG injection) included as Consultant Report #7 ("CR #7"). NCG injection will add two natural gas drive compressors which will result in a small increase to the noise level of the Project, which is extimated to be below the Permissible Sound Level.

The purpose of the assessment was to:

- generate a computer model of anticipated noise levels that would result if the proposed Project is to proceed;
- determine the projected noise level impacts from operation of the proposed Project within the defined study area; and
- compare the projected noise level results to the Energy Resource Conservation Board permissible sound level guidelines (ERCB Directive 038 on Noise Control, 2007).

The ERCB's Directive 038 on Noise Control specifies that noise impact assessments are to be carried out to evaluate project impacts on the nearest dwelling. For the Project, however, there are no known permanent dwellings nearby. The Directive further specifies that, in the event the nearest dwelling is greater than a 1.5 km distance from the Project, new facilities must meet a permissible sound night time level of 40 dBA 1.5 km from the facility fence-line. Consequently,

the study area for the noise impact assessment for the Project is identified as being an area that encompasses a 1.5 km perimeter radius from the Project's CPF and well-pads.

4.7.2 Baseline Conditions

Given the remote location of the Project, the lack of permanent dwellings in close proximity to the Project, and the absence of nearby existing industrial noise sources, a baseline noise monitoring program was not conducted. This conforms with requirements of the ERCB's Directive 038 on Noise Control.

4.7.3 Potential Impacts

4.7.3.1 Measuring and Modeling Methods

The computer noise modeling was conducted using the CADNA/A (version 3.7.123) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and stationary sources.

The calculation method used for noise propagation follows the International Standards Organization (ISO) 9613-2. Noise modeling results were calculated in two ways. First, sound levels were calculated at specific receiver locations (i.e. receptors located at a 1500 m perimeter from the CPF and well-pads). Second, sound level conditions were calculated using a 5 m x 5 m receptor grid pattern within the entire study area.

The noise sources for the equipment associated with the Project data were obtained from previously conducted noise assessments for similar equipment directly from Project engineers (CR #7, Appendix I). Review of the data by **ACI** (i.e. comparison to **ACI** in-house noise data for similar equipment) indicated that, in general, the sound power levels ("SWLs") used in the modelling are considered conservative.

All noise sources (e.g. stacks, vent fans, motors, air compressors, and other operating equipment) have been modeled as point sources at their appropriate heights. Large buildings and storage tanks were included in the modeling calculations because of their ability to provide shielding as well as reflection for noise. Equipment located within buildings was modeled using the Overall Sound Power Levels (CR#7, Appendix I) and a 20 dBA reduction to account for noise reduction as a result of being inside the building. This is a conservative assumption based on a typical construction of a metal clad, insulated building with minimal windows and some man-doors and overhead doors. This also assumes that the doors and windows remain closed at all times.

Directive 038 also requires the assessment to include background ambient noise levels in the model. In most rural areas of Alberta where there is an absence of industrial noise sources, the

average night-time ambient noise level is approximately 35 dBA. This is known as the average ambient sound level (ASL). This value was used as the baseline condition in the modeling with the various CPF and well-pad noise sources added.

4.7.3.2 Permissible Sound Levels (PSL)

ERCB Directive 038 on Noise Control (2007) sets the Permissible Sound Levels (PSL) at the receiver location based on population density and relative distances to heavily traveled road and rail. As such, the PSL at the 1.5 km boundary is an L_{eq}Night of 40 dBA (night-time hours are 22:00 – 07:00) and an L_{eq}Day of 50 dBA (day-time hours are 07:00 – 22:00) with a recommendation that the resultant sound levels be 5 dBA lower than the PSL.

The results of the noise modelling are presented in Table 4.7.1. The results are provided as day/night since the noise levels will be essentially continuous. It can be seen that the projected noise levels at the 1.5 km boundary (from the CPF and well-pads) are below the PSL-Night of 40 dBA L_{eq}Night. The contribution from the Project equipment alone (without the ASL of 35 dBA) was generally well under 40 dBA which provides a factor of safety for any potential errors in the noise source determination and modeling error. It also provides a factor of safety for the potential of any low frequency tonal components often associated with boilers and heaters. Again, the results are considered conservative and it is likely that the actual noise levels will be lower.

Table 4.7-1 Modelled Project Sound Levels

Location (Distance from Nearest Noise Source)	Modeled L_{eq}Night (dBA)	PSL-Night (dBA)	Compliant
R1 (1.5 km)	31.9	40.0	YES
R2 (1.5 km)	32.6	40.0	YES
R3 (1.5 km)	35.0	40.0	YES
R4 (1.5 km)	34.1	40.0	YES
R5 (1.5 km)	30.8	40.0	YES
R6 (1.5 km)	27.5	40.0	YES
R7 (1.5 km)	31.8	40.0	YES
R8 (1.5 km)	34.7	40.0	YES
R9 (1.5 km)	37.5	40.0	YES
R10 (1.5 km)	34.6	40.0	YES

4.7.4 Mitigation and Monitoring

The results of the noise modelling indicate that noise mitigation is not required for normal operation of the Project.

Should a complaint be made, Sunshine will work with stakeholders to ensure that the issue is addressed.

4.7.5 Summary

The results of the noise modeling indicated projected noise levels below the ERCB's Directive 038 Permissible Sound Level of 40 dBA L_{eq}Night for all receptors at 1.5 km from the CPF and well-pads. In addition, all noise levels from the facility equipment alone (i.e. no ambient sound level included) are projected to be close to 5 dBA below the Permissible Sound Level, providing an adequate factor of safety for potential sources of error in sound source determination, modeling error, and/or low frequency tonal components. No noise mitigation measures are required for normal operation of the Project.

4.8 Soils

4.8.1 Introduction

Millennium EMS Solutions Ltd. (MEMS) was retained by Sunshine to conduct a baseline soil survey and effects assessment for the proposed Project and access road. The following section is a summary of the Baseline Soil Survey and Terrain Assessment included as Consultant Report #8 ("CR #8").

Objectives of the baseline soil survey were to:

- produce a pre-disturbance soil inventory of the Project area based on acceptable levels of soil survey data collection, i.e. Survey Intensity Level 2 ("SIL 2") for the local study areas ("LSA") and Survey Intensity Level 1 ("SIL 1") for the proposed disturbance areas; and
- provide soil inventory information (i.e. baseline soil and topographic/landscape patterns) to determine current baseline conditions and assist with preparation of a conceptual reclamation plan for the Project.

The investigation of the soil resource for the proposed Project includes the assessment of two study areas, one for the Project and one for the access road. The study area for the Project encompasses 2,359 ha (CR #8, Figure 3). The soils access road has a 500 m buffer along the proposed access road, and is approximately 766 ha of area (CR #8, Figure 3). Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed

within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further soils data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

4.8.2 Baseline Conditions

The soil baseline data for the Project included the collection of data from 260 soil inspection points and 27 soil sample locations distributed over 3,125 ha (CR #8, Figure 4). At each inspection site the soil profile was investigated to a minimum depth of 100 cm for upland soils and to a minimum depth of 120 cm or until mineral contact was made for organic soils (maximum depth of investigation for organic soils was 220 cm). Soil characteristics were recorded at all inspections sites to allow for detailed soil classification based on the Canadian System of Soil Classification (SCWG, 1998).

Soil characteristics recorded at inspection sites included:

- horizon designation and depth;
- parent geologic material (terrain type);
- color identification using Munsell color charts;
- structure and consistence;
- manual hand texture and coarse fragment content (% volume);
- slope class, position and aspect;
- drainage and water table, if present within the sampling depth of the soil profile; and
- additional soil attributes, if evident, that aid in soil classification and/or description.

Sampling was completed on soils determined to be representative of the study areas. The baseline soil survey of the study areas was completed in June 2008 and a subsequent soil survey of the access road and Phase 1 footprint was completed in October 2008.

4.8.2.1 Baseline Soil Units

Each site inspection point was classified to the subgroup level (i.e. Orthic Gray Luvisol) and associated parent materials including textural characteristic were classified based on classification methodologies from AGRASID. The results of these classifications were merged to define soil series level taxa based on the AGRASID Alberta Soil Name File (ASIC, 2001)

Representative soil series, associated variants and parent material types identified in the study areas are provided in Table 4.8-1.

Table 4.8-1 Summary of Soil Series, Variants, and Parent Material Characteristics of the Study Areas

Soil Series/Variant (Code)	Subgroup	Classification Notes	Parent Material
Bitumont (BMT)	Orthic Gleysol	Peaty (pt) variants common	Glaciofluvial outwash material (C2)
Chateh (CHT)	Orthic Gleysol	Peaty (pt) variants common, limited to south portion of access corridor	Fine textured water laid materials (F1/F3)
Dover (DOV)	Orthic Gray Luvisol	Occurrence limited to south portion of access corridor	Fine textured till like material (F3)
Dover – gleyed (DOVgl)	Gleyed Gray Luvisol	Occurrence limited to south portion of access corridor	Fine textured till like material (F3)
Horse River (HRR)	Orthic Gray Luvisol	Occurs in upland terrain	Medium textured slightly to moderately calcareous t till (M4)
Horse River – gleyed (HRRgl)	Gleyed Gray Luvisol	Gleyed profile displays evidence of gleyed conditions	Medium textured slightly to moderately calcareous t till (M4)
Livock (LVK)	Orthic Gray Luvisol	Occurs in upland terrain	Medium textured glaciofluvial deposits (>30 cm thick) over Horse River till (L3)
Livock – gleyed (LVKgl)	Gleyed Gray Luvisol	Gleyed profile displays evidence of gleyed conditions	Medium textured glaciofluvial deposits (>30 cm thick) over Horse River till (L3)
Mariana (MRN1)	Terric Mesisol	Often mapped with peaty Gleysols, and map unit is displayed as MRN1-G	40 – 100 cm of bog peat over[1]: • coarser textured mineral material (MRN1c - L11), medium textured mineral material (MRN1m - L12) and fine textured mineral material (MRN1f - L13)
Mildred (MIL)	Eluviated Eutric Brunisol	Occurs in sandy deposits and glaciofluvial blankets in upland terrain	Sandy glaciofluvial outwash material (C2)
Mildred – gleyed (MILgl)	Gleyed Eluviated Dystric Brunisol	Gleyed profile displays evidence of gleyed conditions	Sandy glaciofluvial outwash material (C2)
Mildred – fine (MILfi)	Eluviated Eutric Brunisol	Gleyed variation also recorded	Moderately coarse glaciofluvial material (C3)
Mikwa (MKW)	Mesic/Fibric Organic Cryosol	Ice typically encountered with 100 cm, in some instance between 100-130 cm	Bog Peat material, depth to mineral typically not known due to frozen layer
McLelland1[1] (MLD1)	Terric Mesisol	Very poorly drained, occur in fen landscapes	40-100 cm of fen peat over [1]: • coarser textured mineral material (MLD1c - L11), • medium textured mineral material (MLD1m - L12) and • fine textured mineral material (MLD1f - L13)

Table 4.8-1 Summary of Soil Series, Variants, and Parent Material Characteristics of the Study Areas

Soil Series/Variant (Code)	Subgroup	Classification Notes	Parent Material
McLelland2[1] (MLD2)	Terric or Typic Mesisol	Very poorly drained, occur in fen landscapes	100-200 cm of fen peat over 1: • coarser textured mineral material (MLD2c - L11), • medium textured mineral material (MLD2m - L12) and fine textured mineral material (MLD2f - L13)
McLelland3[1] (MLD3)	Typic Mesisol	Very poorly drained, occur in fen landscapes	>200 cm of dominantly fen peat (P2)
Moonshine (MNSaa)	Orthic Luvic Gleysol	Home SCA is 17, poorly drained, often associated with peaty variants (pt)	Medium textured slightly to moderately calcareous t till (M4)
Muskeg2[1] (MUS2)	Terric/Typic Mesisol (modal)	Poorly to very poorly drained	100-200 cm of bog peat over[1]: • coarser textured mineral material (MUS2c - L11), • medium textured mineral material (MUS2m - L12) and • fine textured mineral material (MUS2f - L13)
Muskeg3[1] (MUS3)	Typic Mesisol (modal)	Poorly to very poorly drained	>200 cm of dominantly bog peat (P1)
Peavine (PEA)	Orthic Gray Luvisol	Sporadic throughout the study area and access corridor	Medium textured water laid materials (M2/M3)
Peavine – gleyed (PEAgl)	Gleyed Gray Luvisol	Sporadic throughout the study area and access corridor	Medium textured water laid materials (M2/M3)
Sutherland (SUT)	Eluviated Eutric Brunisol	A result of a thick coarse glaciofluvial veneer over till	Coarse glaciofluvial material over medium textured till (M4), till occurs relatively deep in the profile (>70 cm)
Wanham (WHMaa)	Orthic Luvic Gleysol	Common in drainage locations	Medium textured water laid materials (M2/M3)
Wanham peaty (WHMaapt)	Orthic Luvic Gleysol	Peaty variant very common, often associated with shallow organics	Medium textured water laid materials (M2/Me)

[1] Numerical identifier and lower case letter used to differentiate organic soil types indicates overall depth of peat plus general texture of underlying substratum and are **not** soil series or variants as specified in the Alberta Soil Names File (ASIC 2001, Brierley et al. 2006).

4.8.2.2 Terrain Type Classification

During the soil investigation, thirteen terrain types, were recognized as being large enough to map at the 1:15,000 scale. They are differentiated by surface expression and slope. The thirteen terrain types encountered in the study areas are summarized in Table 4.8-2.

Table 4.8-2 Summary of Terrain Type Features in the Project and Access Road Study Areas

Terrain Type	LM Symbol	Description (with Slope Classes)
Hummocky	**H1l** **H1m**	• l. low relief, slope class 4 (5-10% slopes) • m. moderate relief, slope class 5 (10-15% slopes)
Undulating	**U1l** **U1h**	• l. low relief, slope classes 1-2 (0-2% slopes) • h. high relief, slope class 3 (2-5% slopes)
Organic (Bog & Fen)	**O1** **O2** **O3** **O5**	Organic (peat land) landforms may be dominated by bog or fen peat, and have the following general surface features: • **O1** - level, flat, horizontal, or plateau; nearly level landscapes • **O2** - basin or bowl; slope classes 1-3 (0-5% slopes on the edges of the basins) • **O3** - channelled, along stream channels; slope classes 1-2 (0-2% slopes) • **O5** - level with small, elevated knolls or hummocks; slope classes 1-2 (0-2% slopes), hummocks may have slopes ranging from 3-5 (5-15% slopes). Hummocks considered to be frozen peat mounds found in Cryosol landscapes
Level	**L1**	A level plain with little to no relief, slope class 1 (0-0.5% slopes)
Water bodies	**ZWA**	Open water bodies (i.e. lakes, sloughs, and ponds)
Disturbed Lands	**ZDL**	Lands previously disturbed by human activity, not recorded in the access corridor.

4.8.2.3 Soil Models

The soil map unit symbols utilized for the soil map display a unique soil descriptor as well as a landscape descriptor. The soil descriptor or **Soil Model** is the numerator and the terrain descriptor (landscape model) is the denominator. The Soil Model (numerator) is created by using one or two soil series symbols (e.g. HRR and LVK is displayed as HRLV) that are considered dominant or co-dominant in that particular polygon. Additionally, a numbering system is applied (i.e. HRLV**9**) that identifies recognizable patterns of soils within a polygon. Section 3.4 of CR #8 describes in detail the numbering system applied for the Project.

Organic soil map units were identified somewhat differently than those dominated by upland soils. To simplify the complexity of peat-dominated areas with respect to peat composition and thickness, the soil series used were restricted to Marianna (MRN), McLelland (MLD) or Muskeg (MUS). MLD was used with fen ecosite types; MRN was used for shallow bog vegetation (40-

100 cm of peat) and MUS was used with deeper bog vegetation (> 100 cm of peat). The numerical portion of the map unit symbol indicates depth of peat as follows:

1 Average peat depth 40-100 cm

2 Average peat depth 100-200 cm

3 Average peat depth >200 cm

The lower case symbols “c - coarse”, “m - medium”, “f - fine” were used in all organic map units where mineral soil was encountered to describe the texture of the underlying mineral strata. In the study areas, medium textures dominate; hence the symbol “m” was used most frequently. Map units dominated by Organic soils, but containing significant peaty Gleysolic soils, were identified with a “-G” postscript in the symbol (i.e. MRN1m-G).

Both organic and upland soil models contained a landscape denominator (Table 4.8-2).

4.8.2.4 Soil Patterns

The Phase 1 Project footprint area is located on approximately 61 ha and encompasses 68% upland soils and with the remaining 32 % being organic soils. The access road footprint is approximately 68 ha and contains an estimated 74% upland soils and 26% organic soils. Soil patterns were mapped to a planned scale of 1:15,000 (CR #8, Figures 5a and 5b). Map unit areas and polygon counts were calculated using ArcMap GIS software for both study areas and associated footprints. Table 4.8-3 displays the soil models, associated areas, and percent coverage for the Soils LSA and Phase 1 footprint, and Table 4.8-4 shows the same information for the access road LSA and access road footprint.

Table 4.8-3 Soil Model Unit Areas and Counts for the Project Area

Soil Model	Project Study Area		Phase 1 Footprint	
	Study Area (ha)	% of LSA	Footprint (ha)	% of Footprint
UPLAND SOILS				
BMT21	21.8	0.9	6.8	11.2
HRLVgl2	71.2	3.0	1.8	3.0
HRLV9	559.3	21.8	16.4	27.1
LVPE2	5.1	0.2	--	--
MISU18	251.5	10.7	13.4	22.1
MNWH20	108.4	4.6	--	--
MNWH21	60.4	2.6	2.7	4.3
Upland totals	***1,077.7***	***46***	***41.1***	***67.8***
ORGANIC SOILS				
MKW1	155.9	6.6	--	--
MLD1m	45.9	1.9	--	--
MLD2m	26.9	1.1	0.2	0.4
MLD3	3.0	0.1	--	--
MRNf1-G	18.6	0.8	--	--
MRN1m	369.5	15.7	9.5	15.5
MRN1m-G	144.4	6.1	9.9	16.3
MRN1c-G	64.0	2.7	--	--
MUS2m	101.0	4.3	--	--
MUS3	51.5	2.2	--	--
Organic Totals	***980.7***	***41.6***	***19.6***	***32.2***
NON-SOIL UNITS				
ZDL	**2.6**	**0.1**	--	--
ZWA	**297.9**	**12.6**	--	--
TOTALS	**2,359**	**100**	**61**	**100**

Table 4.8-4 Soil map unit areas for the Access Road LSA and Access Road Footprint

Soil Model	Access Road LSA		Access Road Footprint	
	LSA - Area	% of LSA	Footprint - Area	% of Footprint
UPLAND SOILS				
DOV9	24.1	2.5	6.6	9.8
HRLV9	178.8	18.8	21.6	32.0
HRLVgl2	18.2	1.9	--	--
LVPE2	49.2	5.2	10.4	15.3
MISU18	10.1	1.1	--	--
MNWH20	65.0	6.8	5.9	8.7
MNWH21	86.1	9.1	5.3	7.8
Totals	***431.5***	***45.4***	***49.8***	***73.6***
ORGANIC SOILS				
MKW1	105.4	11.1	3.3	4.8
MLD2m	51.1	5.4	0.6	0.8
MRN1m	66.4	7.0	3.2	4.8
MRN1m-G	90.2	9.5	4.6	6.8
MUS2m	86.8	9.1	1.5	2.2
MUS3	46.2	4.9	1.1	1.7
MRN1f-G	40.6	4.3	3.6	5.3
Organic Totals	***486.7***	***51.2***	***17.9***	***26.4***
NON-SOIL UNITS				
ZDL	1.1	0.1	--	--
ZWA	27.9	2.9	--	--
Totals	***29.0***	***3.0***	--	--
TOTALS*	**947**	**100**	**68**	**100**

* Final totals are rounded.

Baseline soil conditions were evaluated for the study areas with respect to layer thickness, forest capability, reclamation suitability, and erosion potential utilizing the following information sources:

- 260 inspection sites collected within the study areas;
- laboratory analysis of 27 sampled inspection sites in the study areas;

- relevant soil series chemical and physical data from the Alberta Soil Names (AG30SNF) and Soil Layer (AG30SLF) files in AGRASID (ASIC 2001); and
- soils information from the AOSERP document (Turchenek and Lindsay 1982b).

Baseline interpretations for the study areas were determined using all available data collected during the 2008 investigation. The data was not separated by study area, moreover, the large pool of data collected from both study areas allows for a better representation of the soil and landscapes in the area as opposed to separate analyses for each individual study area.

Soil layer depths were calculated by averaging all inspection points grouped by Soil Model. Determining profile thicknesses in this manner allows for a good representation of typical profile orientations based on the landscape in which these profiles were formed. Sites deemed to be inclusions within each Soil Model were excluded from the averaging calculation. Table 4.8-5 presents the layer thicknesses for each Soil Model; their extents within the study areas are presented in CR#8, Figure 6.

Table 4.8-5 Surface Litter, Peat, Topsoil, and Subsoil thicknesses by Soil Model

	Thickness (cm) [1]			
Soil Model	**Surface Litter/Peat**	**Peat (>40)**	**Topsoil**	**Upper Subsoil**
BMT21	35	-	20	30
DOV9	15	-	10	50
HRLVgl2	5	-	10	40
HRLV9	10	-	10	40
LVPE2	10	-	15	35
MISU18	8	-	15	50
MNWH20	15	-	10	40
MNWH21	30	-	5	35
MKW1	-	105	-	-
MLD1m	-	60	-	-
MLD2m	-	115	-	-
MLD3	-	200	-	-
MRN1f-G	40	-	-	55[2]
MRN1m	-	70	-	30[2]
MRN1m-G	-	50	-	30[2]
MRN1s-G	-	40	5	30[2]
MUS2m	-	120	-	-
MUS3	-	220	-	-

Table 4.8-5 Surface Litter, Peat, Topsoil, and Subsoil thicknesses by Soil Model				
	Thickness (cm) [1]			
Soil Model	Surface Litter/Peat	Peat (>40)	Topsoil	Upper Subsoil

[1]Litter layers <10 cm thick were not rounded. All other depths were rounded to the nearest 5 cm.
[2]Subsoil layers comprised of mainly BCg layers.

4.8.2.5 Reclamation Suitability

Topsoil and subsoil materials were assessed for reclamation suitability following the *Soil Quality Criteria Relative to Disturbance and Reclamation Guidelines* as specified for the Northern Forest Region of Alberta (SQCWG 1987). Rating the upper lift (topsoil and surface litter) and lower lift (B horizons)of the soil map units assists in site development and soil handling by determining which soils may present challenges during site construction and reclamation.

Organic map units (> 40 cm of surface peat) were not included in the assessment of the upper lift as the guidelines are specific to upland soils. The guidelines state that organic soils should be salvaged and utilized as a soil conditioner (SQCWG 1987). However, if the soils with peaty surface layers did contain a lower lift (B horizon) the suitability interpretations were completed for the lower lift.

Soil ratings for the upland topsoil within the study areas ranged from fair to poor with inclusions of Good ratings (CR#9, Table 6). Generally, the greatest limitations to topsoil horizons (A horizons) are soil pH (slightly acidic) and coarse textures. Subsoil horizons were generally rated as fair to good with limitations associated with fine textures and soil pH (acidic or basic). With respect to organic soils, all surface peat material is considered to be suitable for reclamation and the underlying subsoil material ranged from good to poor with limitations associated with fine texture and acidic or basic soil pH.

4.8.2.6 Forest Soil Capability Classification

Forest soil capability was determined using the *Land Capability Classification System (LCCS) for Forest Ecosystems in the Oil Sands* (CEMA 2006). The baseline forest land capabilities for the Soil Models within the study areas are presented in Table 4.8-6. The land capability ratings are presented for Phase 1 of the Project and access road in Table 4.8-7 and Table 4.8-8.

Table 4.8-6 Baseline Forest Land Capability Ratings by Soil Model the Project		
Map Unit (SLM)	Final Rating Index for SLM	Final Land Capability Rating
BMT21	23	4W

Table 4.8-6 Baseline Forest Land Capability Ratings by Soil Model the Project

Map Unit (SLM)	Final Rating Index for SLM	Final Land Capability Rating
DOV9	62	2
HRLVgl2	57	3W
HRLV9	55	3VD
LVPE2	58	3VD
MISU18	43	3X
MNWH20	43	3WF
MNWH21	26	4W
MKW1	3	5WF
MLD1m	3	5WF
MLD2m	3	5WF
MLD3	2	5WF
MRNf1-G	10	5WF
MRN1m	0	5WF
MRN1m-G	10	5WF
MRN1s-G	9	5WF
MUS2m	0	5WF
MUS3	0	5WF

Table 4.8-7 Land Capability for the Project Area

Land Capability Class	Project LSA		Phase 1 Footprint	
--	Area (ha)	Percentage	Area (ha)	Percentage
Class 1	--	--	--	--
Class 2	71.2	3.0	1.8	3.0
Class 3	672.8	28.5	30.8	50.7
Class 4	333.7	14.1	8.5	14.1
Class 5	980.7	41.6	19.6	32.2
Not Rated	300.2	13.7	--	--
Total	**2,359**	**100**	**60.7**	**100**

Table 4.8-8 Land Capability for the Access Road Area

Land Capability Class	Access Road LSA		Access Road Footprint	
--	Area (ha)	Percentage	Area (ha)	Percentage
Class 1	--	--	--	--
Class 2	24.1	2.5	6.7	9.8
Class 3	321.3	33.9	38.0	56.0
Class 4	86.1	9.1	5.3	7.8
Class 5	486.7	51.4	17.9	26.4
Not Rated	29.0	3.1	--	--
Total	**947.2**	**100.0**	**67.8**	**100**

Class 2 soils are defined as having moderate capability for forest production, Class 3 low capability, Class 4 conditionally productive (with management inputs) and Class 5 non-productive (CEMA 2006).

With respect to proposed disturbance, the Phase 1 footprint is covered by predominantly Class 3 (50.7%) and Class 5 soils (32.2%). Limitations to Class 3 soils within the Phase 1 footprint are similar to those of the surrounding Soils LSA (pH, consistence and drainage). Class 4 soils cover approximately 14.1% of the Phase 1 footprint and are limited by poor drainage. Class 4 Soil Models represent transitional areas between the upland (Class 2 and 3) and organic soils (Class 5). Class 5 soils are limited by poor drainage, and often the water table is near or at the surface.

The access road footprint is predominantly Class 3 soils (56.0%) limited by soil pH (subclass V), subsoil soil consistence (subclass D) and to a lesser extent drainage issues (subclass W). Class 4 and 5 soils account for 34.2% of the access road footprint. This corresponds to organics and poorly drained transitional landscapes between the upland and peat landscapes. Limitations are predominantly poor drainage (subclass W).

4.8.2.7 Reclaimed Forest Soil Capability Classification

In order to evaluate equivalent land capability post reclamation, the LCCS was utilized to predict the capability ratings of the reclaimed soils. Reclaimed forest soil capability was assessed using the same methodology as for the baseline calculations. The reclaimed capability ratings were calculated based on assumptions about soil conditions after completion of site reclamation and implementation of appropriate mitigative measures (i.e. de-compaction activities).

All soil models analyzed maintained the same final land capability rating as the baseline soil models; however, there were subtle changes in the final index ratings assigned. In some cases the reclaimed soil models displayed slightly improved final index ratings. Detailed comparison of the baseline and reclaimed capability ratings is discussed in CR#8, Section 5.3.

4.8.2.8 Baseline Erosion Risk Assessment

Erosion of soil materials by wind or water is a natural landform process. Erosion of soil can be magnified in areas where vegetation has been cleared and the soil surface disturbed. Soil erosion is dependent on soil texture, landform slope and length of slope, and vegetation type and cover.

Within the study areas, the risk of water erosion is predominantly low as the soil surface is currently well protected by tree and understory cover. An extensive litter/surface organic layer covers the majority of the soils within the study areas. However, the coarse textured MISU18 Soil Model within the Project Area (251.5 ha) is considered to have a moderate erosion risk by water during extreme precipitation events due to the thin vegetative litter layer and coarse textured surface soils.

Significant tree and understory cover and an extensive litter layer result in minimal exposure of surface soil material to wind. Soils on crests of slopes and windward locations have a slight potential for wind erosion. A majority of the soil series in the region have a low potential for soil erosion via wind (Pedocan, 1993).

The exception is the soils located in the MISU18 Soil Model, which contain coarse textured materials throughout the profile and have a high potential of erosion via wind. Undisturbed organic soils recorded throughout the study areas have a low risk of erosion by water or wind as most peat landscapes have significant vegetative cover, occur in level or nearly level terrain, and may have water at surface for a portion of the year

4.8.3 Potential Impacts

4.8.3.1 Loss of Diversity

Upland areas will be reclaimed to provide a level of moisture regime, topographic variability, and surface drainage patterns that resemble conditions in pre-disturbance landscapes, thus providing a similar degree of diversity. Over time, it is anticipated that moisture regimes will re-establish within the landscape to pre-disturbance conditions, allowing the soil-forming processes to also re-establish similar to pre-disturbance conditions.

4.8.3.2 Admixing of Soil

Soils within the footprints occur on a variety of landscapes, all with unique soil profile orientations. Soil profile thicknesses are variable and dependent on landscapes.

During construction of the Project, soil salvage will consist of a single lift operation, also referred to as a "topsoil lift", mainly across upland terrain. The topsoil lift operation is intended to "capture" the topsoil plus leaf litter/shallow surface peat horizons located in the mineral soil terrain. Topsoil and subsoil horizon thicknesses are naturally variable, although typically this variability is sub-metre. This means that material depths (Table 4.8-5) are expected to be variable throughout the proposed disturbance area.

On the CPF, upper subsoil material will also be salvaged and stored for later use at reclamation. Thicknesses in the upper subsoil layers are expected to display variability similar to that of the surface layers.

Topsoil and subsoil materials will be salvaged and stored separately from each other.

4.8.3.3 Reclamation and Land Capability

The main goal for the reclamation program is to achieve land capability equivalent to pre-disturbance conditions. The reclaimed soil profiles were created based on assumptions on proper soil handling, and reclamation practices. Overall, there were no differences in overall land capability classes between baseline and reclaimed soil models for either footprint. There are, however, differences in subclasses and final calculated index point ratings between baseline and reclaimed soils. In some instances the reclaimed soil models rated slightly higher than the baseline conditions. These differences are a result of the following:

- predicted drier landscapes for various transitional soils (Peaty Gleysols) including the WHMaa and MNSaa, which altered the final ratings of the reclaimed Soil Models; and
- amalgamation or "blending" of soil chemical and physical properties in the top 20 cm of the profile (depending on the parameter) often resulted in increased ratings of the reclaimed profile.

4.8.3.4 Erosion of Reclaimed Soils

Due to the variability of terrain in Phase 1 of the Project and access road footprints, there is potential for soil erosion either by water and/or wind in the disturbed upland terrain. Erosion is of concern on all areas where bare mineral soil is exposed. This includes disturbed areas cleared of vegetation prior to soil salvage operations and areas where topsoil materials have been replaced but re-vegetation activities have not been completed.

Implementation of mitigative measures such as timely re-vegetation of disturbed areas and establishing sediment traps (e.g. ditch blocks) will minimize erosional impacts. Various components of the Phase 1 development footprint are located in areas that contain the coarse textured MISU18 Soil Model. Through proper soil management techniques and timing of clearing, soil salvage and re-vegetation operations, the impact on soil erosion will be minimal (CR #2).

4.8.4 Mitigation and Monitoring

In order to reduce the impact of the Project on soil resources, the following measures will be implemented.

- all available topsoil and overlying litter/surface peat material (<0.4 m in thickness) within the Project disturbance area will be salvaged for replacement;
- within the CPF a lift of upper subsoil (maximum depth of 30 cm) will also be salvaged to return a rooting zone similar to that which existed prior to the disturbance;
- soil stockpiles will be constructed appropriately (suitable slopes) and revegetated to prevent erosion. All soil stockpiles will be stored in locations that will minimize the potential for impacts as a result of site activities and will reduce the potential for erosion;
- all salvaged topsoil and subsoil materials will be replaced on re-contoured areas. Prior to replacement of topsoil, all compacted areas will be deep tilled to promote de-compaction of the overburden material;
- peat landscapes (> 40 cm of peat) will likely be padded over during construction and the options are described in Section 4.2.3. All peat landscapes padded over during construction will have geotextile and clay pads removed during reclamation. Efforts to de-compact and condition the peat material will be undertaken to allow for appropriate vegetation establishment and promote a moisture regime similar to that of pre-disturbance conditions;
- it is likely that other methods of site construction will also be implemented in peat landscapes, and could include partial or complete salvage of peat deposits. Peat landscapes disturbed as a result of the Project by methods other than padding will be reclaimed accordingly depending on the method of soil salvage, storage and intended final land use to ensure the desired land capability can be attained; and
- reclaimed areas will be appropriately revegetated following cover-soil replacement operations to reduce erosion potential and promote vegetation establishment.

4.8.6 Summary

The Project contains adequate soil resources for reclamation. By utilizing acceptable soil salvage, soil handling and reclamation practices the impact to soil resources will be minimal throughout the life of the Project.

4.9 Vegetation Assessment

4.9.1 Introduction

Sunshine retained Geographic Dynamics Corp. to conduct a vegetation impact assessment for the proposed Project and access road. The following section is a summary of the Vegetation Impact Assessment included as Consultant Report #9 (CR #9).

This vegetation assessment included:

- rare plant and rare plant community survey (Project);
- plant diversity survey (Project);
- ecosite classification and mapping (Project and access road);
- old growth forest assessment (Project and access road); and
- wetland classification and mapping (Project and access =road).

The vegetation and wetlands resources local study area ("LSA") encompasses nine sections and the access road study area includes a 9 km road with a 500 m buffer on both sides of the centreline (CR #9, Figure 1a). Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further vegetation data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

4.9.2 Baseline Conditions

The Project is located in the Central Mixedwood Natural Subregion of the Boreal Forest Natural Region. The area is characterized by a variety of mixed stand types including aspen, balsam poplar, paper birch, white spruce, jack pine and balsam fir stands. Medium to tall, closed stands of trembling aspen and balsam poplar with white spruce, black spruce, and balsam fir, occurring in late succession stages, is most abundant. Understorey vegetation is primarily shrubs and forbs such as prickly rose, low-bush cranberry, bunchberry, wild sarsaparilla and dewberry. Cold and poorly-drained fens and bogs are covered with tamarack and black spruce.

4.9.2.1 Rare Plants and Rare Plant Communities

The rare plant and rare plant community survey was performed in accordance with ANPC guidelines (2,000a). Within the LSA, the rare plant survey was restricted to the Phase 1 footprint to ensure coverage of areas most likely to be impacted by construction. The purpose of the survey outside the Phase 1 footprint was to determine the distribution and abundance of ecosite phases within the LSA (CR #9, Section 3.0) to collect information to measure biodiversity. Rare plant surveys were not performed at locations outside the Phase 1 footprint. However, any rare plants observed outside the Phase 1 footprint but still within the LSA (ecosite phase surveys) were also documented and are included in this assessment. While moving from one plot to another, surveyors scanned the area for rare or unique plants and communities. Voucher specimens of non-vascular species that were not field identifiable were sent to outside taxonomists for identification and confirmation of any rare species. At the time of preparing this report, identification of only the vascular species was complete. Only rare species that have been confirmed to date are discussed below, and the complete results of the 2008 rare plant survey will be available once taxonomic validation is finished.

In total, 32 plots were surveyed for rare plant and/or community occurrences in the LSA. However, as the location of the Phase 1 footprint and access road were not available at the time of the survey, only one plot is within the Phase 1 footprint and one along the access road (CR #9, Figure 1b). Sampling occurred in the spring of 2008 (June 20-24, 2008).

Seven plant species identified in the LSA were on the Alberta Rare Plant Tracking and Watch Lists (Gould 2006), with eighteen occurrences. Two rare vascular plants were found with four occurrences, two rare bryophytes were found with a total of two occurrences, and three rare lichen species with 24 occurrences were found during the field survey (CR#9, Figure 2, Table 2.2).

While all these species are of significant conservation concern in Alberta, none of these species are globally rare, and all are globally ranked as being secure, most likely secure, or not ranked.

There were no rare or special plant communities found in the LSA.

The final location of the Project footprint and access road were not available before the spring survey was conducted, and only three rare plant plots fall within these areas. Therefore, an additional rare plant survey will be conducted in the Project footprint and access road study area in 2010 and the results will be provided as they are tabulated.

4.9.2.2 Ecosite Classification and Species Richness

The purpose of the ecosite classification and mapping was to determine the distribution and abundance of ecosystems in both the Project and access road study areas. The main objectives were to:

- determine the distribution and abundance of ecosite phases within the Project and the access road study areas;
- identify and document main species composition;
- identify and document plant community types;
- calculate the area and percentage within the Phase 1 footprint and the proposed access road that each ecosite phase occupies;
- calculate species richness and diversity;
- identify the types of old growth forests in the Project and the access road study areas; and
- determine the amount of area within the Project and the access road study areas that is occupied by the identified old growth forest types.

The LSA covers a total area of 2,358 ha of which 787 ha (33%) are upland areas and 1,264 ha (54%) are lowland areas (ecosites g through l) (Table 4.9-1). Existing disturbances, including clearings, pipelines, transmission lines, and well sites, cover approximately 16 ha (0.7%) of the LSA, and water (lakes, ponds, and rivers) occupies 293 ha (13%) (CR #9, Figure 5a). Descriptions of the various ecosite phases are included in CR #9, Section 3.3.2.2.

Table 4.9-1 Areas of Ecosite Phases within the Vegetation LSA and Phase 1 Footprint

Ecosite phase/ AVI code	Total area in LSA (ha)	Percent of LSA (%)	Total area in Phase 1 footprint (ha)	Percent relative to LSA (%)[1]
a1-lichen Pj	0.3	0.01	-	-
b1-blueberry Pj-Aw	-[2]	-	-	-
b2-blueberry Aw(Bw)	1.4	0.06	-	-
b3-blueberry Aw-Sw	2.6	0.1	-	-
c1-Labrador tea-mesic Pj-Sb	60.1	2.5	-	-
d1-low-bush cranberry Aw	321.4	13.6	20.2	0.9
d2-low bush cranberry Aw-Sw	347.4	14.7	6.6	0.3
d3-low bush cranberry Sw	26.3	1.1	-	-
e1-dogwood Pb-Aw	7.1	0.3	-	-
e2-dogwood Pb-Sw	0.8	0.03	-	-
f1- horsetail Pb-Aw	7.8	0.3	-	-
f2-horsetail Pb-Sw	8.6	0.4	-	-
f3-horsetail Sw	2.7	0.1	-	-
g1-Labrador tea –subhygric Sb-	75.7	3.2	-	-
h1-Labrador tea/horsetail Sw-Sb	123.6	5.2	4.9	0.2
i1-treed bog	427.9	18.1	3.1	0.1
i2-shrubby bog	263.1	11.2	0.5	0.02
j1-treed poor fen	158.3	6.7	10.1	0.4
j2-shrubby poor fen	104.8	4.4	9.2	0.4
k1-treed rich fen	21.9	0.9	5.8	0.2
k2-shrubby rich fen	23.1	1.0	0.3	0.01
k3-graminoid rich fen	55.2	2.3	-	-
l1-marsh	10.1	0.4	-	-
CIP - Pipelines, transmission	12.6	0.5	-	-
CIW - Seeded well sites	2.9	0.1	0.01	0.0004
NWR-river	1.3	0.05	-	-
NWL - lake, pond	291.5	12.4	-	-
Total	2,358.3	100.0	60.7	2.6

[1] % area calculated as (Area in Phase 1 footprint/Area in LSA) x 100%.

[2] Classification from field survey observations, area too small for classification from air photo interpretation.

The proposed access road has been mapped to include a 1,000 m buffer (approximately 500 m on each side of the road center line). The total area of this buffer is 947 ha (Table 4.9-2) of which

214 ha (22.6%) are upland areas and 705 ha (74.4%) are lowland areas. In addition, 28.4 ha (3%) is water (lakes and ponds).

Table 4.9-2 Areas of Ecosite Phases within the Access Road Buffer

Ecosite phase/ AVI code	Area of Buffer (ha)	Percent of Buffer (%)	Area of Access Road (ha)	Percent Relative to Buffer (%)[1]
a1-lichen Pj	0[1]	-	-	-
b1-blueberry Pj-Aw	0.1	0.0	-	-
c1-Labrador tea-mesic Pj-Sb	43.7	4.6	3.4	0.4
d1-low-bush cranberry Aw	84.2	8.9	13.5	1.4
d2-low bush cranberry Aw-Sw	85.6	9.0	14.9	1.6
g1-Labrador tea –subhygric Sb-Pj	71.4	7.5	7.1	0.8
h1-Labrador tea/horsetail Sw-Sb	21.9	2.3	2.0	0.2
i1-treed bog	179.1	18.9	8.9	0.9
i2-shrubby bog	329.9	34.8	13.9	1.5
j1-treed poor fen	27.0	2.8	1.5	0.2
j2-shrubby poor fen	17.0	1.8	0.8	0.09
k1-treed rich fen	12.2	1.3	0.8	0.09
k2-shrubby rich fen	36.2	3.8	1.0	0.1
k3-graminoid rich fen	10.4	1.1	0.02	0.002
NWL - lake, pond	28.4	3.0	-	-
Total	**947.2**	**100**	**67.8**	**7.16**

[1] Negligible.

Biodiversity analysis, as measured by species richness, diversity and evenness (Table 4.9-3), found considerable differences between the plant community types in the study area. The highest species richness was found in the lowland ecosite phase j1 (treed poor fen; 34.6), and the lowest was found in the l1 (marsh; 6.3). Shannon diversity was highest in the e2 ecosite phase (2.67), and lowest in the l1 ecosite phase (0.7). The highest evenness (mean=0.8) was in e2 and d2 (low-bush cranberry aspen-white spruce) ecosite phases and lowest again in the l1 ecosite phase (0.37).

Table 4.9-3 Species Richness, Diversity and Evenness of Ecosite Phases

Ecosite phase	# of sites (n)	Richness		Diversity		Evenness	
		Mean	StDev	Mean	StDev	Mean	StDev
a1	1	28.0	-	1.8	-	0.5	-
b1	1	18.0	-	1.6	-	0.6	-
b2	2	29.5	3.5	2.3	0.2	0.7	0.05
b3	1	31.0	-	2.3	-	0.7	-
c1	3	26.0	3.5	2.0	0.08	0.6	0.01
d1	8	24.3	8.8	2.3	0.4	0.7	0.09
d2	8	23.8	6.2	2.4	0.3	0.8	0.07
d3	4	21.8	2.9	1.8	0.4	0.6	0.1
e1	0[1]	-	-	-	-	-	-
e2	2	34.5	7.8	2.7	0.08	0.8	0.07
f1	2	30.5	6.4	2.6	0.4	0.8	0.06
f2	1	13.0	-	1.1	-	0.4	-
f3	3	30.3	4.0	2.4	0.09	0.7	0.05
g1	5	16.6	10.6	1.6	0.8	0.6	0.1
h1	8	28.9	9.6	2.1	0.8	0.6	0.2
i1	6	20.7	5.7	1.8	0.1	0.6	0.06
i2	4	17.3	4.4	1.8	0.08	0.7	0.06
j1	5	34.6	10.6	2.4	0.3	0.7	0.04
j2	4	19.8	6.3	2.0	0.2	0.7	0.08
k1	2	24.0	4.2	2.0	0.3	0.6	0.06
k2	5	31.0	4.3	2.2	0.4	0.6	0.1
k3	5	10.8	2.3	1.0	0.2	0.4	0.07
l1	4	6.3	2.9	0.7	0.6	0.4	0.3

[1] Ecosite phase e1 was not observed in the field survey however is present in the Vegetation LSA based on aerial photo interpretation.

4.9.2.3 Old Growth Forest

The purpose of the old growth forest analysis is to determine what types of old growth forests are in the area and which ones will be affected by the proposed development. The specific objectives are to:

- identify the types of old growth forests in the Project and access road study areas; and
- determine the amount of area within the Project and access road study areas that are occupied by the identified old growth forest types.

Old growth is defined according to tree species, using the following criteria:

- White spruce, black spruce, and tamarack forests that are 140 years or older
- pine forests and mixed pine-spruce/tamarack forests that are 120 years or older
- deciduous and mixed coniferous-deciduous forests that are 100 years or older

Mixed stands are defined as those with less than 80% cover of the dominant tree species, or those with 20% or more of the tree type that would otherwise give a younger old growth criterion.

The LSA contained scattered stands of old growth forests (CR #9, Figure 6) that totalled 18.9 ha, comprising 0.8% of the LSA. Mixed aspen forests occupied the largest amount of area of old growth forest, while pure aspen forests occupied the least. Table 4.9-4 lists the types of old growth forests and their area and proportion within the LSA.

Table 4.9-4 Areas and Percent Cover for Old Growth Forests in the LSA

Forest Type	Age (years)	Number of polygons	Total Area in the LSA (ha)	Percent of the LSA(%)
Aspen pure	100-140	1	0.3	0.01
Aspen mixed	100	3	13.1	0.6
White spruce pure	140	6	3.4	0.1
White spruce/deciduous mixed	100-140	1	2.1	0.09
Total	-	11	**18.9**	**0.8**

There are no old growth stands within the Phase 1 footprint or along the access road.

4.9.2.4 Wetland Classification

The purpose of the wetland assessment was to acquire baseline data on all wetlands, peatlands, and riparian plant communities, as well as to map and describe wetlands following the Alberta Wetland Inventory Standards (Halsey and Vitt 1996). The specific objectives required to accomplish this were as follows:

- describe wetland community distribution, structure, and diversity using ecosite phases (after Beckingham and Archibald 1996);
- characterize all riparian/wetland communities according to the appropriate classification guides (Alberta Wetlands Inventory Standards); and
- establish a detailed mitigation and reclamation strategy to minimize Project effects.

Within the LSA, five different wetland types were identified (Table 4.9-5) covering a total of 1064 ha (45% of the LSA). The most common wetland types identified were bogs (691 ha).

Other wetland classes identified were fens (363 ha), and marshes (10 ha). A map of the dominant wetlands (i.e. those that occupy the majority of their respective polygons) of the LSA is provided in CR #9, Figure 7a.

The marsh type of wetland (MONG) is the only wetland of restricted distribution within the LSA (<1%).

Table 4.9-5 Wetlands within the LSA and Phase 1 footprint

AWIS Classification	Area in LSA (ha)	Percent of LSA (%)	Area in Phase 1 footprint (ha)	Percent of Wetland Type (%)[1]	Percent relative to LSA (%)[2]
BTNN	690.9	29.3	3.5	0.5	0.1
FONG	55.2	2.3	-	-	-
FONS	23.1	1.0	0.3	1.3	0.01
FTNN	284.9	12.1	25.2	8.8	1.1
MONG	10.1	0.4	-	-	-
Total Wetland	**1,064.2**	**45.1**	**29**	**2.7**	**1.2**

[1] % of wetland type calculated as: (Amount of wetland type in Phase 1 footprint/Amount same type in LSA) x 100%.

[2] % area calculated as: (Area in Project footprint/Total Area in LSA) x 100%.

Within the access road and buffer, 1208 ha of wetlands were found (Table 4.9-6). Treed bog ("BTNN") was the most common followed by treed fen ("FTNN"). A map of the dominant wetlands (i.e. those that occupy the majority of their respective polygons) along the access road is given in CR #9, Figure 7b.

Table 4.9-6 Wetlands within the Access Road Buffer

AWIS Classification	Area in buffer (ha)	Percent of buffer (%)	Area in access road (ha)	Percent of Wetland Type (%)[1]	Percent relative to buffer (%)[2]
BTNN	502.9	53.1	22.6	4.5	2.4
FONG	10.4	1.1	0.02	0.2	0.002
FONS	36.2	3.8	1.0	2.7	0.1
FTNN	60.8	6.4	3.1	5.1	0.3
MONG	-	-	-	-	-
Total Wetland	**610.4**	**64.4**	**26.7**	**4.4**	**2.8**

[1] % of wetland type calculated as: (Amount of wetland type in access road footprint/Amount same type in LSA) x 100%.

[2] % area calculated as: (Area in access road/Total Area in LSA) x 100%.

4.9.3 Potential Impacts

4.9.3.1 West Ells SAGD Project

Rare Plants within the Phase 1 Footprint

One rare plant, *Cladina stygia*, was found at the north end of borrow pit #1 (CR #9, Figure 1b). The plot center is outside the Phase 1 footprint, but within 35 m of the borrow pit, and because of the wandering nature of rare plant surveys, it is possible that *C. stygia* may fall inside the Phase 1 footprint. It is ranked S1 (critically imperilled) in Alberta and G5 (secure) globally. However, *C. stygia* was found 16 other times, outside the Phase 1 footprint, in a variety of ecosite phases (CR #9, Table 2.2). Therefore no mitigation is recommended for this species.

An assessment of Project's Phase 1 effects and any mitigation requirements for additional rare plants in the Phase 1 footprint will be completed once the 2010 survey has been concluded.

Mitigation is not be intended for rare plants found within the LSA but outside the Project footprint efforts will be made to prevent accidental disturbance to these rare plant locations. A list of each rare plant occurrence in the LSA and the associated GPS coordinates can be found in CR #9, Appendix 1.

Ecosite Classification and Species Richness

Clearing and construction within the Phase 1 footprint will impact 60.7 ha of area (2.6% of the LSA), of which 1.2% are upland and 1.4% are lowland ecosites. Of the ecosites of restricted distribution that occur in the LSA, 5.8 ha of treed rich fen (k1) will be removed from the Phase 1 footprint. However, given the small area to be disturbed, and because all ecosites that will be potentially affected are regionally common (including k1), no additional mitigation (beyond reclamation and revegetation at Project closure) is required for ecosites phases.

Old Growth Forest

No old growth stands fall within the Phase 1 footprint.

Wetland Classification

The Project will have an effect on wetlands in the Phase 1 footprint in that they will be cleared and/or filled during construction and operation. The Phase 1 of the Project will remove 29 ha of wetlands (1.2% of the total area of LSA). However, this effect is expected to be minimal, as the amount of wetland to be affected constitutes only 2.7% of the total wetland area in the LSA, and all are locally and regionally common. Marshes (MONG) had the only restricted distributions (< 1% of the LSA), but none occur in or near the Phase 1 footprint. Therefore, no additional mitigation (beyond reclamation at Project closure) is required for wetlands in the LSA.

4.9.3.2 Access Road

Rare Plants

One rare plant, *Cladina stygia*, was found at the north end of borrow pit #1 (CR #9, Figure 1b). Due to overlapping study areas this is the same location as described in Section 4.9.3.1. No additional mitigation is required.

Ecosite Classification and Species Richness

The clearing and construction of the access road will disturb 67.8 ha of area, of which 32 ha are upland and 36 ha are lowland ecosites. The road footprint is relatively small and does not significantly impact any ecosite of restricted distribution. Therefore no additional mitigation (beyond reclamation and revegetation at Project closure) is required for ecosites phases along the access road.

Old Growth Forest

No old growth stands were found along the access road and therefore mitigation is not required for old growth.

Wetland Classification

The Project will have an effect on wetlands along the access road in that they will be cleared and/or filled during construction and operation. The Phase 1 access road will remove 27 ha of wetlands. However, this effect is expected to be minimal, as the amount of wetland to be affected constitutes only 2.4% of the total wetland area in the access road buffer, and all are locally and regionally common. There are no wetlands of restricted distribution along the access road. Therefore, no additional mitigation (beyond reclamation at Project closure) is required for wetlands.

4.9.4 Mitigation and Monitoring

4.9.4.1 Mitigation

Mitigation measures that will be implemented include:

- marking of locations of rare plants near or inside the Project footprint to minimise accidental disturbance;
- preserving adjacent suitable habitat for rare species identified;
- minimizing overall disturbance footprint where possible;
- utilizing a non-invasive seed mix for reclamation; and
- developing a management plan to control non-native and invasive species.

4.9.4.2 Monitoring

Monitoring will include:

- conducting a rare plant survey on any new development areas;
- checking the success of revegetation activities; and
- checking the success of weed control activities.

4.9.5 Summary

Overall impact of the Project on vegetation resources is low. Proper reclamation and revegetation techniques will reduce any long term impacts that may occur due to the Project.

4.10 Wildlife

4.10.1 Introduction

Sunshine retained Westworth Associates Environmental Ltd. ("WAEL") to conduct a Wildlife Assessment for the proposed Project and access road. The following section is a summary of the Wildlife Assessment included as Consultant Report #10 ("CR #10").

The proposed Project Area falls within the Central Mixedwood Subregion and the Boreal Highlands Subregion of the Boreal Forest Natural Region. However, most of the Project Area is located in the Central Mixedwood Subregion, which is characterized by a mix of black spruce bog, aspen and white spruce forest. The Project area is dominated by black spruce lowland forest, which is important for several sensitive, rare and endangered wildlife species, including woodland caribou. In addition to aspen and white spruce forests in the upland areas, balsam poplar and white birch forests frequently occur in wet areas.

The wildlife local study area (LSA) encompasses nine sections and the access road study area includes a 9 km road with a 500 m buffer on both sides of the centreline (CR #10, Figure 2). Future facilities (Figure 2.1-1) including well pads, borrow pits and utility corridors are proposed to be developed within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further wildlife data for these future facilities will be collected during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

4.10.2 Baseline Conditions

The baseline assessment included a thorough review of relevant wildlife information. Relevant wildlife survey data was reviewed from other recent oil sands applications in northeastern Alberta. In addition, the following agencies and databases were contacted or searched to obtain background information on the wildlife resources present in the West Ells area including:

- Alberta Sustainable Resource Development (ASRD);
- Fish and Wildlife Management Information System (FWMIS)
- Alberta Natural Heritage Information System (ANHIC);
- Alberta Caribou Committee (ACC); and
- Cumulative Environmental Management Association (CEMA).

Field assessments conducted included:

- *wildlife habitat assessment March - October 2008* – purpose was to identify potential wildlife use of habitats throughout the study area and to identify the presence of important wildlife features for birds, amphibians and mammals (specifically for woodland caribou);
- *winter tracking survey March 2008* – purpose was to obtain information on habitat use and winter distribution of fur-bearing mammals and ungulates;
- *winter aerial ungulate survey March 2008* – purpose was to obtain information on ungulate distribution, habitat use and population size and structure;

- *aerial access road survey* – purpose was to identify wildlife trails and other important habitat features along the proposed access road;
- *owl survey April 2008* – purpose was to detect breeding nocturnal owls;
- *forest raptor survey May 2008* – purpose was to detect forest raptors;
- *amphibian and yellow rail surveys May 2008* – purpose was to identify the presence or absence of amphibians and yellow rails;
- *breeding bird survey June 2008* – purpose was to determine the diversity and abundance of songbirds across each habitat type;
- *aerial waterbird survey June and October 2008* – purpose was to detect breeding and migrating waterbirds in all waterbodies; and
- *aerial beaver survey fall 2008* – purpose was to record, describe and map each lodge and cache in the surveyed waterbodies.

Surveys in the access road study area were limited to a reconnaissance helicopter overflight to identify wildlife trails and important features for wildlife. Information collected as part of the wildlife survey program in the Project study area was extrapolated to the access road study area.

4.10.2.1 Wildlife Habitat Assessment

The Project LSA occupies 2,359 ha while the access road LSA covers 951 ha, which includes approximately 500 m on each side of the proposed road centerline. Wildlife data were summarized and presented according to general wildlife habitat classes, which were based either on ecosite phases (CR #9, Figure 5a), or field observations during wildlife surveys. In the first case, ecosite phases were grouped into habitat classes based on similarities in vegetation species composition, moisture regime, topographic position, and general value to wildlife.

Project LSA

The Project LSA is composed of a mosaic of habitat types, the most dominant being lowland tree and shrub, mixedwood and deciduous stands (Table 4.10-1). Lowland habitats are expected to have relatively high value for woodland caribou, an "At Risk" species in Alberta. Deciduous and deciduous-dominated mixedwood stands support a diversity of species ranging from warblers to moose. Waterbodies, which comprise 12.5% of the area, provide habitat for breeding and migrating waterfowl and shorebirds. Although white spruce represents a relatively small proportion of the total area, it provides habitat for warblers such as the Cape May warbler. Sedge meadows and marshes are important habitats that collectively account for 2.5% of the Project LSA. Existing disturbance currently accounts for just 15.5 ha, or 0.7% of the area.

Table 4.10-1 Aerial extent of Habitat Types in the Project LSA

Habitat Types	Ecosite Phases	Area (ha)	Cover (%)	Description
Lowland treed	i1, j1, k1	638.1	27.1	Treed bogs/fens, black spruce/tamarack dominated, with Labrador tea, dwarf birch, and bog cranberry
Lowland shrub	i2, j2, k2	362.2	15.4	Shrubby bogs and fens with Labrador tea, black spruce, dwarf birch and willow
Deciduous-dominated mixedwood	d2	353.6	15.0	Aspen-dominated mixedwood with white spruce and minor components of birch/balsam poplar; high shrub diversity
Deciduous	b2, d1, e1, f1	345.9	14.7	Aspen dominated with some balsam poplar, shrubs include prickly rose, willow, cranberry, and dogwood
Waterbody	NWL, NWR	293.9	12.5	Open water
White spruce	d3, e3, f3, h1	141.7	6.0	White spruce dominated with balsam fir/deciduous component; understory includes prickly rose and twin-flower
Mixed coniferous	c1, g1	138.7	5.9	Black spruce and jack pine with Labrador tea and bog cranberry
Sedge meadow	k3	49.8	2.1	Graminoid fens with sedges, reed grass and moss
Disturbance	CIP, CIU, CIW	15.5	0.7	Well pads, pipelines, cutblocks and other cleared areas
Coniferous-dominated mixedwood	f2	9.3	0.4	White spruce –dominated mixedwood with white birch and minor components of aspen and poplar
Marsh	l1	10.0	0.4	Cattails, sedges and reed grasses.
Totals		**2,358.8**	**100.0**	

Access Road LSA

The access road LSA also has a range of habitat types and is primarily dominated by lowland shrub, and to a lesser extent lowland treed, habitat (Table 4.10-2). As such, the access road passes through prime caribou habitat and does in fact bisect the Wabasca-Dunkirk Caribou Management Zone. Deciduous stands are relatively uncommon in this study area. There are several lakes that may provide both breeding and migratory habitat for waterbirds and living habitat for beaver. Similar to the Project LSA, existing disturbance is a minor component of the baseline habitat available to wildlife.

Table 4.10-2 Aerial Extent of Habitat Types in the Access Road LSA

Habitat Types	Ecosite Phases	Area (ha)	Cover (%)	Description
Lowland shrub	i2, j2, k2	383.4	40.3	Shrubby bogs and fens with Labrador tea, black spruce, dwarf birch and willow
Lowland treed	i1, j1, k1	217.1	22.8	Treed bogs/fens, black spruce/tamarack dominated, with Labrador tea, dwarf birch, and bog cranberry
Mixed coniferous	c1, g1	115.2	12.1	Black spruce and jack pine with Labrador tea and bog cranberry
Deciduous-dominated mixedwood	d2	89.6	9.4	Aspen-dominated mixedwood with white spruce and minor components of birch/balsam poplar; high shrub diversity
Deciduous	b2, d1, e1, f1	84.2	8.9	Aspen dominated with some balsam poplar, shrubs include prickly rose, willow, cranberry, and dogwood
Waterbody	NWL, NWR	29.5	3.1	Open water
White spruce	d3, e3, f3, h1	18.0	1.9	White spruce dominated with balsam fir/deciduous component; understory includes prickly rose and twin-flower
Sedge meadow	k3	10.3	1.1	Graminoid fens with sedges, reed grass and moss
Disturbance	CIP, CIU, CIW	3.9	0.4	Wellpads, pipelines, cutblocks and other cleared areas
Coniferous-dominated mixedwood	f2	0.1	<0.1	White spruce –dominated mixedwood with white birch and minor components of aspen and poplar
Marsh	l1	0	0	Cattails, sedges and reedgrasses.
Totals		**951.1**	**100.0**	

4.10.2.2 Winter Tracking Survey

Twenty-eight transects varying in length from 250 – 300 m were surveyed in March 2008 in different habitat types throughout the Project LSA for a total sampling effort of 7650 m in nine habitat types. Overall, total wildlife track frequency was highest in white spruce, followed by mixed coniferous, deciduous-dominated mixedwood and deciduous forest (CR #10, Table 8, Figure 4).

Carnivores

Six species of carnivores were recorded in the Project LSA during the winter track count survey (Table 4.10-3). Two of these species (fisher and Canadian lynx) are considered "Sensitive" in Alberta and are also identified as Priority 1 CEMA listed species.

Table 4.10-3 Track Densities of Carnivores Recorded in Project LSA during Winter Track Surveys (SD[1])

Habitat	American Marten	Ermine	Fischer	Least Weasel	Coyote	Canadian Lynx
Deciduous	0.8 (3.3)	0.4 (2.4)	0.8 (3.3)	0	0.4 (2.4)	0
Disturbance	0	0	0	0	0	0
Lowland shrub	0.2 (1.6)	0.8 (3.8)	0	0	0	0.2 (1.6)
Lowland treed	4.5 (8.7)	0.7 (3.1)	0	0.2 (1.4)	0	0
Mixed coniferous	2.0 (5.9)	0.4 (2.3)	0	0	0	0.4 (2.3)
Deciduous-dominated mixedwood	1.4 (4.2)	0.7 (3.0)	0.2 (1.8)	0.2 (1.8)	0	0.2 (1.8)
Sedge meadow	0	0	0	0	0	0
White spruce	3.8 (8.6)	1.3 (5.8)	0	0	0	0
Overall	**2.2 (6.2)**	**0.7 (3.3)**	**0.1 (1.3)**	**0.1 (1.1)**	**0.04 (0.8)**	**0.1 (1.3)**

[1] Standard deviation

Rodents and Snowshoe Hare

Two rodents, red squirrel and beaver, were noted during the winter track surveys (Table 4.10-4). Although snowshoe hare was the only lagomorph recorded, it was extremely common and widespread throughout the Wildlife SAGD Study Area. None of these species are considered "Sensitive" in Alberta, although beaver is a Priority 2 CEMA-listed species and snowshoe hare is listed as Priority 1 because of its importance as a prey species.

Table 4.10-4 Rodents and Snowshoe Hare Track Densities Recorded in Project LSA during Winter Track Surveys (SD[1])

Habitat	Snowshoe Hare	Red Squirrel	Beaver
Deciduous	37.9 (36.2)	35.0 (50.7)	0
Disturbance	0	0	0
Lowland shrub	9.1 (20.9)	7.8 (16.4)	0.2 (1.6)
Lowland treed	25.5 (35.5)	6.7 (14.1)	0
Mixed coniferous	57.4 (64.1)	36.4 (43.5)	0
Deciduous-dominated mixedwood	45.2 (37.3)	26.2 (27.0)	0
Sedge meadow	0	0	0
White spruce	55.2 (47.6)	40.0 (47.3)	0
Overall	**31.9 (41.5)**	**18.9 (32.2)**	**0.1 (1.3)**

[1] Standard deviation

Ungulates

A single ungulate species (moose) was detected during the winter track surveys. Other potential ungulates that could occur in the Project Area include deer and woodland caribou, given the proximity of the Wabasca-Dunkirk caribou management zone. Movement of ungulates smaller than moose may have been affected by the deep snow conditions that were encountered during the winter track survey, which may have resulted in the lack of field observations.

Moose were recorded in three habitats including deciduous, lowland shrub and lowland treed habitats (Table 4.10-5).

Grouse

A number of grouse species may occur in the Project LSA, including ruffed grouse, spruce grouse, sharp-tailed grouse and willow ptarmigan. Grouse tracks were recorded in five habitat types ranging from deciduous forest to lowland treed types, although there was no significant difference in track frequency among habitats (Table 4.10-5).

Table 4.10-5 Moose and Grouse Track Densities Recorded in Project LSA during Winter Track Surveys (SD[1])

Habitat	Moose	Grouse
Deciduous	0.4 (2.4)	0.4 (2.4)
Disturbance	0	0
Lowland shrub	3.8 (8.8)	0.4 (2.2)
Lowland treed	0.4 (2.4)	0.6 (2.7)
Mixed coniferous	0	0.8 (3.2)
Deciduous-dominated mixedwood	0	3.3 (1.7)
Sedge meadow	0	0
White spruce	0	0
Overall	**1.0 (4.7)**	**1.0 (5.6)**

[1] Standard deviation

4.10.2.3 Winter Aerial Ungulate Survey

Project LSA

No moose were observed within the Project LSA during the aerial ungulate survey, but two cow moose were observed 1.7 km outside of it (CR #10, Figure 5). A bull moose was also recorded during the fall waterfowl survey along the shores of the largest lake (Lake 2) in the study area, but no deer or woodland caribou were detected.

Access Road LSA

Fifteen wildlife trails were recorded intersecting the access road during the October 2008 survey (CR #10, Figure 6). Eight of these trails were classified as moose trails, while the other seven may have been used by other species such as caribou and deer.

4.10.2.4 Owl Survey

Eight owls were recorded during the nocturnal owl surveys, with the most common being the boreal owl (Table 4.10-6). The boreal owl is a Priority 2 CEMA-listed species. Five observations of boreal owls resulted in a density of 0.14 owls/40 ha in the Project LSA. Other species found included the great-horned owl and the barred owl. The barred owl is considered "Sensitive" in Alberta due to the loss of contiguous, mature forest upon which it depends.

Table 4.10-6 Owls Observed during the Nocturnal Owl Surveys in the Project LSA, April 2008

Species	*No.*	*Density (No./40 ha)*
Great-horned owl	2	0.06
Boreal owl	5	0.14
Barred owl	1	0.03

4.10.2.5 Forest Raptor Survey

Two raptors responded to the call-playback during the raptor surveys which included a red-tailed hawk and a sharp-shinned hawk .

4.10.2.6 Amphibian and Yellow Rail Surveys

Wood frogs and boreal chorus frogs were the only amphibian species recorded in the Project LSA. No Canadian or western toads were recorded. In addition, no yellow rails were detected during the survey.

4.10.2.7 Songbird Survey

The most common songbird species were Tennessee warbler, yellow-rumped warbler and chipping sparrow (Table 4.10-7). Several "Sensitive" species were relatively common in the Project LSA including the bay-breasted warbler and Cape May warbler. One other "Sensitive" species, the western tanager, was also observed during the breeding bird surveys.

Table 4.10-7 Songbird Densities in the Project LSA, June 2008

Common Name	*Density (Territories/40 ha)*	*Common Name*	*Density (Territories/40 ha)*
Tennessee warbler	50.96	Pine siskin	4.37
Yellow-rumped warbler	32.03	Ruby-crowned kinglet	4.37
Chipping sparrow	23.29	Black-and-white warbler	2.91
Bay-breasted warbler	13.10	Black-capped chickadee	2.91
Dark-eyed junco	11.65	Red-winged blackbird	2.91
Ovenbird	8.74	Western tanager	2.91
Cape May warbler	7.28	Alder flycatcher	1.46
Magnolia warbler	5.82	Golden-crowned kinglet	1.46
Palm warbler	5.82	Hermit thrush	1.46
Red-breasted nuthatch	5.82	Le Conte's sparrow	1.46
Swainson's thrush	5.82	Lincoln's sparrow	1.46
Boreal chickadee	4.37	Marsh wren	1.46
Gray jay	4.37	White-throated sparrow	1.46

The overall density of the songbird territories in the Project LSA was 211.1 territories/40 ha breeding territories/40 ha. Lowland treed habitat had the highest density of songbirds, closely followed by the coniferous–dominated and deciduous-dominated mixedwood types (Table 4.10-8). Sensitive species including bay-breasted warbler, Cape May warbler and western tanager were all found in mixedwood stands; however, none were recorded in lowland treed. Deciduous, sedge meadow and white spruce habitats had moderate bird densities, although the latter habitat type appeared to be important for bay-breasted and Cape May warblers. Lowland shrub (shrubby bogs and willow-dominated fens) and mixed coniferous habitat types had the lowest songbird density.

Table 4.10-8 Density and Species Richness of Songbirds by Habitat Type in the Project LSA

Habitat	No. of Sites Surveyed	Species Richness	Density (Territories/40 ha)	Diversity Index
Deciduous-dominated mixedwood	9	14	226.3	0.945
Coniferous-dominated mixedwood	6	9	229.3	0.837
Lowland treed	6	10	263.3	0.927
White spruce	6	9	186.8	0.829
Deciduous	3	9	186.4	0.932
Lowland shrub	2	3	101.9	0.452
Sedge meadow	2	6	203.8	0.753
Mixed coniferous	1	3	152.9	0.477
Total	**35**	**27**	**211.1**	**1.170**

4.10.2.9 Waterbird Survey

Twelve species were confirmed to be using the area during the mid-June and October aerial waterbird surveys in the Project LSA, with four of these considered "Sensitive" in Alberta. A number of additional species were recorded during songbird surveys conducted in mid-June. These species included sora, common loon, American wigeon, solitary sandpiper and Wilson's snipe. The sora is the only species considered "Sensitive" in Alberta (Table 4.10-9).

In general, fall waterfowl numbers far exceeded those in the spring surveys, indicating that the lakes in the Project LSA are important during the migratory period.

Table 4.10-9 Waterbirds Recorded during Surveys Conducted in the Project LSA

Common Name	Scientific Name	Counts		Alberta Status	COSEWIC Status
		Spring	Fall		
American coot	*Fulica americana*	0	6	Secure	Not listed
American wigeon	*Anas americana*	3	0	Secure	Not listed
Bufflehead	*Bucephala albeola*	58	267	Secure	Not listed
Blue-winged teal	*Anas discors*	1	0	Secure	Not listed
Canvasback	*Aythya valisineria*	0	46	Secure	Not listed
Common goldeneye	*Bucephala clangula*	0	20	Secure	Not listed
Common loon	*Gavia immer*	9	0	Secure	Not at Risk
Common merganser	*Mergus merganser*	0	42	Secure	Not listed
Gadwall	*Anas strepera*	1	0	Secure	Not listed
Great blue heron	*Ardea herodias*	1	0	Sensitive	Not listed
Green-winged teal	*Anas crecca*	3	0	Sensitive	Not listed
Lesser scaup	*Aythya affinis*	55	65	Sensitive	Not listed
Scaup spp.	*Aythya spp.*	15	100	-	-
Mallard	*Anas platyrhynchos*	23	37	Secure	Not listed
Red-necked grebe	*Podiceps grisegena*	2	2	Secure	Not at Risk
Ruddy duck	*Oxyura jamaicensis*	54	0	Secure	Not listed
Surf scoter	*Melanitta perspicillata*	0	4	Secure	Not listed
White-winged scoter	*Melanitta fusca*	8	0	Sensitive	Not listed
Scoter spp.	*Melanitta spp.*	9	0	-	-

4.10.2.10 Aerial Beaver Survey

Aerial surveys of waterbodies in the Project LSA revealed a widespread occurrence of beaver on five lakes, and included evidence of eighteen lodges, five of which were older, disused lodges. Two of the lodges were located just outside of the study area, but beaver living in these lodges are expected to use the entire lake and adjacent riparian area (CR #10, Table 21; Figure 12).

4.10.2.11 Special Status Wildlife Species

Special status wildlife species that may occur in the Project LSA were identified based on various information sources including the General Status of Alberta Wild Species (ASRD 2005), the Cumulative Environmental Management Association (CEMA 2001), and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2008) (CR#10, Section 2.2.3).

Based on these information sources, 50 special status wildlife species may occur, including Canadian toad, pileated woodpecker and woodland caribou. Eight of these species have been recorded within the Project LSA either as tracks, scat, auditory or visual observations (Table 4.10-10).

Table 4.10-10 Wildlife Special Status Species that may occur in the Project Area

Common Name	Scientific Name	Alberta Status	COSEWIC Status
Amphibians and Reptiles:			
Canadian Toad	*Bufo hemiophrys*	May Be at Risk	Not at Risk
Red-sided Garter Snake	*Thamnophis sirtalis*	Sensitive	-
Birds:			
Pied-billed Grebe	*Podilymbus podiceps*	Sensitive	-
Horned Grebe	*Podiceps auritus*	Sensitive	-
Western Grebe	*Aechmophorus occidentalis*	Sensitive	-
American White Pelican	*Pelecanus erythrorhynchos*	Sensitive	Not at Risk
American Bittern	*Botaurus lentiginosus*	Sensitive	-
Great Blue Heron	*Ardea herodias*	Sensitive	-
Green-winged Teal	*Anas crecca*	Sensitive	-
Northern Pintail	*Anas acuta*	Sensitive	-
Lesser Scaup	*Aythya affinis*	Sensitive	-
White-winged Scoter	*Melanitta fusca*	Sensitive	-
Osprey	*Pandion haliaetus*	Sensitive	-
Bald Eagle	*Haliaeetus leucocephalus*	Sensitive	Not at Risk
Northern Harrier	*Circus cyaneus*	Sensitive	Not at Risk
Northern Goshawk	*Accipiter gentilis*	Sensitive	Not at Risk
Broad-winged Hawk	***Buteo platypterus***	***Sensitive***	***Not at Risk***
Sharp-tailed Grouse	*Tympanuchus phasianellus*	Sensitive	-
Yellow Rail	*Coturnicops noveboracensis*	Undetermined	Special Concern
Sora	***Porzana carolina***	***Sensitive***	**-**
Sandhill Crane	*Grus canadensis*	Sensitive	-
Upland Sandpiper	*Bartramia longicauda*	Sensitive	-
Black Tern	*Chlidonias niger*	Sensitive	Not at Risk
Northern Hawk Owl	*Surnia ulula*	Sensitive	Not at Risk
Barred Owl	*Strix varia*	Sensitive	-
Great Gray Owl	*Strix nebulosa*	Sensitive	Not at Risk
Short-eared Owl	*Asio flammeus*	May Be at Risk	Special Concern
Common Nighthawk	*Chordeiles minor*	Sensitive	Threatened
Black-backed Woodpecker	*Picoides arcticus*	Sensitive	-
Pileated Woodpecker	***Dryocopus pileatus***	***Sensitive***	**-**
Olive-sided flycatcher	*Contopus cooperi*	Secure	Threatened
Least Flycatcher	*Empidonax minimus*	Sensitive	-
Eastern Phoebe	*Sayornis phoebe*	Sensitive	-
Barn Swallow	*Hirundo rustica*	Sensitive	-
Brown Creeper	*Certhia americana*	Sensitive	-
Cape May Warbler	***Dendroica tigrina***	***Sensitive***	**-**

Table 4.10-10 Wildlife Special Status Species that may occur in the Project Area

Common Name	Scientific Name	Alberta Status	COSEWIC Status
Black-throated Green Warbler	*Dendroica virens*	Sensitive	-
Blackburnian Warbler	*Dendroica fusca*	Sensitive	-
Bay-breasted Warbler	***Dendroica castanea***	***Sensitive***	**-**
Common Yellowthroat	*Geothlypis trichas*	Sensitive	-
Canada Warbler	*Wilsonia canadensis*	Sensitive	Threatened
Western Tanager	***Piranga ludoviciana***	***Sensitive***	**-**
Rusty Blackbird	*Euphagus carolinus*	Sensitive	Special Concern
Mammals:			
Northern Long-eared Bat	*Myotis septentrionalis*	May Be at Risk	-
Silver-haired Bat	*Lasionycteris noctivagans*	Sensitive	-
Hoary Bat	*Lasiurus cinereus*	Sensitive	-
Fisher	***Martes pennanti***	***Sensitive***	**-**
Wolverine	*Gulo gulo*	May Be at Risk	Special Concern
Canada Lynx	***Lynx canadensis***	***Sensitive***	***Not at Risk***
Woodland Caribou	*Rangifer tarandus caribou*	At Risk	Threatened

[1] Bolded and italicized species indicate that the species have been observed in the Project Area.

The Project LSA is located 4.5 km north of the Wabasca-Dunkirk Caribou Management Zone, and therefore the potential for occurrence of caribou in the Project Area is high. The access road LSA passes directly through the caribou management zone. Caribou from the West Side of the Athabasca River herd (WSAR) may occur in this region. The location of the Project relative to the caribou zone means that caribou need to be carefully considered when planning and executing the Project.

4.10.3 Potential Impacts

Potential effects of the Project include direct and indirect habitat loss. Direct effects include the clearing of natural vegetation during construction of the access road, borrow pits, and central processing facility, while indirect effects include sensory disturbance caused by facility operation and travel along the access road.

In addition, mortality or habitat fragmentation and loss of connectivity can occur with Project development. Each of these potential effects is discussed in relation to five valued ecosystem components (VECs), which include the Canadian toad, waterbirds, beaver, moose and woodland caribou.

4.10.3.1 Overview of Habitat Loss in Project LSA

A total of 60.7 ha of habitat will be lost in the Project LSA due to the development of the Project. Most of the habitat lost will be deciduous and treed lowland forests, representing 5.8% and 3.1% of the total habitat available, respectively, in the Project LSA at baseline (Table 4.10-11). Smaller amounts of lowland shrub, deciduous-dominated mixedwood and white spruce habitats will also be lost as a result of the Project. No waterbodies or marshes will be disturbed.

Table 4.10-11 Extent of Wildlife Habitat Loss in the Project LSA

Habitat	Habitat Loss (ha)	% of Total Lost	% of Total Available in Study Area
Deciduous	20.2	33.3	5.8
Lowland treed	19.6	32.3	3.1
Lowland shrub	9.4	15.5	2.6
Deciduous-dominated mixedwood	6.6	10.9	1.9
White spruce	4.9	8.1	3.5
Disturbance	<0.1	<0.1	<0.1
Coniferous-dominated mixedwood	0	0	0
Marsh	0	0	0
Mixed coniferous	0	0	0
Sedge meadow	0	0	0
Waterbody	0	0	0
Total	**60.7**	**100.0**	**2.6**

4.10.3.2 Effects on VECs in Project LSA

Canadian Toad

At baseline, 304 ha of potential breeding habitat (waterbodies and marshes) are present in the Project LSA. None of this habitat will be directly affected by construction or operation of Phase 1 of the Project In addition, at baseline, 559.3 ha of suitable Canadian toad hibernating habitat is present in the Project LSA, of which 26.8 ha will be affected by Phase 1 ofthe Project. This represents an approximate 4.8% loss of potential over-wintering habitat for Canadian toads. Since breeding habitat is not limiting, and potential hibernating habitat will still be available in the Project LSA, effects of direct habitat loss on Canadian toads are expected to be minimal.

There is little evidence of sensory disturbance resulting in habitat avoidance by Canadian toads; rather, physical disturbance of hibernacula is a much greater threat to this species (Hamilton et al. 1998), therefore indirect habitat loss to Canadian toads is negligible.

Less than 5% of the potential hibernating habitat in the Project LSA will be disturbed, and therefore the probability of disturbing over-wintering toads during construction of Phase 1 of the Project, which could lead to mortality, is low. Since only access roads to the plant site and well pads will be present in the Project LSA, the risk of mortality due to vehicles is considered negligible.

Although Phase 1 Project infrastructure will fragment Canadian toad hibernating habitat and reduce connectivity to a small extent, there is sufficient alternate habitat and effects on toads are expected to be minimal.

Waterbirds

Of the 127.5 ha of nesting habitat for waterbirds available at baseline, including untreed habitats within 250 m of waterbodies, only 0.2 ha of lowland shrub habitat will result from Phase 1 development and no loss of waterbodies within the Project LSA will occur. As a result, direct loss of breeding or migratory habitat for waterbirds and waterfowl is negligible.

Most waterbodies are far enough from Phase 1 development that waterbirds are unlikely to be affected by the Phase 1 -related activities and suffer indirect loss of habitat due to sensory disturbance.

Since very little potential waterbird habitat will be affected by the Phase 1 development, mortality due to destruction of nests or vehicular collisions is expected to be negligible. In addition, contamination of waterbodies from accidental spills of deleterious substances is not expected with the implementation of a Spill Management Plan, and potential increases in hunting can be minimized by controlling access to the lease. Project-related mortality is unlikely to affect waterbirds and waterfowl in the Project LSA.

The Phase 1 development is also not expected to have any effects on fragmentation and connectivity of waterbird habitat because most facilities will not be located close to waterbodies.

Beaver

No waterbodies will be directly affected by the Phase 1 development in the Project LSA, and therefore there should be no impacts on beaver cover habitat. Forage habitat, considered to be deciduous or deciduous-dominated mixedwood stands within 200 m of waterbodies, will

decrease by 2% in the Project LSA. This is not expected to affect beaver, which are also unlikely to be affected by sensory disturbance associated with Phase 1 of the Project.

Overall, increases in mortality risk for beaver associated with vehicular collisions and trapping in the Project LSA are expected to be negligible due to the short access routes and the implementation of an Access and Recreation Management Plan.

There is very little impact to beaver habitat, both waterbodies and adjacent forage, and therefore connectivity and fragmentation is not likely to be an issue.

Moose

Approximately 36.2 ha of moose habitat (deciduous, deciduous-dominated mixedwood, lowland shrub, marsh and sedge meadow) in the Project LSA will be directly affected by the development of Phase 1. This represents approximately 3% of the total moose habitat available in the study area at baseline, which is a relatively minor amount for moose.

Indirect loss of habitat may occur within 300 m of noisy developments (e.g., plant site, borrow pits, roads). Habitat within these zones of influence ("ZOI") is expected to receive less use than similar habitat further from disturbance. Therefore, impacts on moose habitat availability are considered moderate during construction, but minor for the remainder of the Project. On a regional scale, the Project is not expected to affect moose populations because of habitat availability in adjacent regions.

Hunting-related mortality is not expected to have a significant effect on moose mortality in the Project LSA with the implementation of an Access and Recreation Management Plan to control access into the Project Area and minimize hunting by employees. Since vehicle speeds within will be strictly controlled and access routes are short, the effects of vehicular collisions on moose are expected to be negligible.

The Phase 1 footprint does not appear to fragment high quality moose habitat since suitable moose habitat is already patchy and broadly distributed within the study area, however, the first phase footprint may have an impact on moose movements through the Project LSA and beyond. Based on the occurrence of drainages and riparian corridors, several potential corridors for moose exist which may be affected by Phase 1 development (CR #10, Figure 13). Use of these corridors by moose can be confirmed with further assessment. Once movement pathways have been confirmed, mitigation measures such as adjusting infrastructure placement where possible, wildlife crossings/ramps, and road signage can be used to reduce effects of the Project on moose movements.

Woodland Caribou

Phase 1 development will result in the direct loss of 29 ha of lowland treed (19.6 ha) and lowland shrub (9.4 ha) habitats, which are considered relatively high quality for woodland caribou. This represents just 1.2% of the total habitat available in the Project LSA (2,358 ha), and 2.9% of the available high quality habitat (1,000 ha). Direct habitat loss is not expected to have a significant effect on woodland caribou at the scale of the Project LSA or region.

Woodland caribou have been found to avoid new well pads (<15.5 months) by a maximum of 1,000 m during calving season (late winter and spring), and old well pads by up to 500 m during the same time period (Dyer 1999). Of the 1,000 ha of relatively high quality caribou habitat that occurs within the Project LSA, approximately 31% of lowland treed and lowland shrub habitat will be deemed to fall within ZOI (CR #10, Table 28). However, it should be noted that this does not indicate that caribou will avoid use of habitat located in the Phase 1 ZOI, but rather caribou will likely use these areas at lower levels. Caribou use of the ZOI may also increase slightly after Project construction is completed although caribou are typically sensitive to any human activity. Based on the analysis of habitat ZOI, effects of the Phase 1 development on caribou are considered to be moderate, and particularly during construction, since caribou may be deflected around the Project LSA into other, more unsuitable habitats. The amount of caribou habitat that will be indirectly affected by the Phase 1 development is significant at the local level but given the widespread availability of suitable habitat in adjacent areas, these effects are not considered significant at the regional scale.

Improved access via the access road may result in higher rates of predation and more opportunities for poaching of caribou in the Project LSA. Although predation is difficult to control, human access can be controlled with an Access and Recreation Management Plan. With mitigation, only a minor increase in caribou mortality rates is expected.

The north pad and utility corridor are located within a large area of lowland treed habitat (CR #10, Figure 2), which could result in caribou moving east-west across the study area being deflected by Project infrastructure into low quality habitats with higher predator densities. However, effects on caribou movement cannot be fully assessed without knowledge of trail systems and movement patterns. These data can be collected with additional surveys. Consequently, the Phase 1 development has the potential to affect caribou movement patterns and habitat connectivity in the Project LSA. Mitigation measures can be implemented to reduce this effect.

4.10.3.3 Overview of Habitat Loss in Access Road LSA

The most direct effect of the Project in the access road LSA will be habitat loss associated with road construction. It is expected that 67.8 ha of wildlife habitat will be disturbed (Table 4.10-12). Most of the habitat disturbed will be lowland shrub, deciduous-dominated mixedwood and deciduous, respectively representing 4.0%, 16.7% and 16.1% of the total habitat available in the access road LSA at baseline. Smaller amounts of lowland treed, mixed coniferous and white spruce will also be lost during Project development. Coniferous-dominated mixedwood, marsh, mixed coniferous, sedge meadow and waterbody types in the access road LSA will not be affected by road construction.

Table 4.10-12 Aerial Extent of Wildlife Habitat Disturbed by the Proposed Access Road

Habitat	Area Disturbed (ha)	% of Total Disturbed	% of Total Available in Study Area
Lowland shrub	15.4	22.7	4.0
Deciduous-dominated mixedwood	14.9	22.0	16.7
Deciduous	13.5	20.0	16.1
Lowland treed	11.5	16.9	5.3
Mixed coniferous	10.5	15.5	9.1
White spruce	1.9	2.9	10.8
Sedge meadow	0.1	0.1	0.2
Coniferous-dominated mixedwood	0.0	0.0	0.0
Disturbance	0.0	0.0	0.0
Marsh	0.0	0.0	0.0
Waterbody	0.0	0.0	0.0
Total	**67.8**	**100.0**	**7.1**

4.10.3.4 Effects on VECs in Access Road LSA

Canadian Toad

None of the baseline Canadian toad breeding habitat will be directly affected by construction or operation of the access road, however 27.1 ha of potential hibernating habitat within the access road LSA will be affected, representing an approximate 14.0% loss of potential over-wintering habitat for toads. Data suggest that toads are uncommon in the area due to the unavailability of suitable habitat, but this should be confirmed by conducting surveys in the access road LSA. As such, the Project has the potential to affect over-wintering habitat for Canadian toads within the access road LSA, but this effect is unlikely to be significant at a regional level.

The probability of increased mortality of Canadian toads occurring in the access road LSA as a result of access road development is considered to be relatively low because only a small amount of potential hibernating habitat will be disturbed by clearing, and the risks of vehicular mortality can be minimized through the appropriate use of culverts and bridges to maintain connectivity of aquatic habitat.

The access road may affect connectivity of Canadian toad habitat, however, with mitigation such as culverts and bridges, significant Project-related effects are not expected to occur.

Waterbirds

The availability of 52.3 ha of suitable waterbird nesting habitat changes very little with Project development, with the loss of only 1.0 ha of lowland shrub habitat and less than 0.1 ha of sedge meadow. Similarly, the Project does not affect any waterbodies in the access road LSA, and therefore, direct loss of breeding or migratory habitat for waterbirds and waterfowl is negligible.

Most of the waterbodies in the access road LSA are within the average disturbance distance of 300 m (Ruddock and Whitfield 2007) (CR #10, Table 31) and therefore, sensory disturbance to waterbirds is a potential issue. Sensory disturbance is most likely to occur during Project-related construction, while disturbance associated with operations and maintenance activities will be limited mostly to vehicular traffic along the access road. Since disturbance distances are typically lower with vehicles than human disturbance, it is expected that sensory disturbance will be negligible following Project-related construction.

Potential increases in hunting can be minimized by controlling access to the access road LSA and preventing employees from hunting on-site. Contamination of waterbodies from accidental spills of deleterious substances is also not expected to be an issue, and the immediate clean-up of any accidental spills of vehicle fluids and other chemicals will prevent pollution of waterbird habitat. Therefore, Project-related mortality is unlikely to affect waterbirds and waterfowl in the access road LSA.

The Project is also not expected to have any impacts on fragmentation and connectivity of waterbird habitat because the access road will not be located close to most waterbodies.

Beaver

No waterbodies will be directly affected by Project-related development in the access road LSA, and there should be no impacts on beaver cover habitat. Overall, forage habitat availability for beaver in the access road LSA will decrease by 4.2 ha or 13.2% (CR #10, Table 32). While this may appear significant at the local level (because of the small size of the study area), effects of the Project on beaver foraging habitat is expected to be negligible at the regional level.

Overall, Project-related effects on beaver mortality in the access road LSA are expected to be negligible with the implementation of an Access and Recreation Management Plan.

Some fragmentation of deciduous and deciduous-dominated mixedwood habitats will occur with Project-related development, however most waterbodies are far enough from the road that beavers will still be able to access forage without having to cross roads. In addition, waterbodies in the access road LSA will not be affected. Overall, Project-related effects related to habitat fragmentation and connectivity are not expected to affect beaver at the local or regional levels.

Moose

Approximately 44 ha of relatively high quality moose habitat (i.e., deciduous, deciduous-dominated mixedwood, and lowland shrub) (CR #10, Table 29) will be cleared during construction of the access road. This represents a loss of 7.7% of the potential moose habitat available in the access road LSA, which is a considered to be a relatively minor loss for moose.

With Project-related development, however, moose habitat availability (based on ZOI of 100–300 m) in the access road LSA will be reduced by about 216 ha or 61.3% (CR #10, Table 33). While this suggests that moose habitat near the access road will be indirectly affected by sensory disturbances associated with road construction, moose are expected to use these habitats once construction has been completed. Overall, a temporary reduction in moose habitat suitability is expected during construction of the access road, but this disturbance effect is not expected to affect local or regional moose populations.

Hunting pressure on moose may be reduced with the implementation of an Access and Recreation Management Plan. Due to the increased levels of activity in the access road LSA, predation is not likely to increase greatly with the Project. Vehicular collisions are a potential threat to moose attempting to cross the access road or travel along it, particularly at night. Impacts can be minimized with appropriate mitigative measures including placing signage at potential crossing areas along the road, and enforcing low speed limits. With these measures, mortality due to vehicular collisions is expected to be minor for moose.

The access road is expected to reduce connectivity of habitat and have low to moderate effects on movement of moose throughout the access road LSA. Based on the occurrence of trails in the access road LSA, several potential corridors for moose exist which may be affected by access road construction. This may disrupt movement of moose in the access road LSA and into the surrounding region, which could result in moose mortality from vehicular collisions or moose travelling through lower quality habitat. Use of these corridors by moose can be confirmed using remote camera monitoring of potential wildlife trails. Once movement corridors have been

confirmed, mitigation measures such wildlife crossing signage and reduced speed limits can be used to reduce effects of the access road on moose movements.

Woodland Caribou

Project development will result in the direct loss of 26.9 ha of lowland treed and lowland shrub habitats (CR #10, Table 29), which are considered relatively high quality for woodland caribou. This represents just 4.5% of the total habitat available in the access road LSA. Direct habitat loss is not expected to have a significant effect on woodland caribou within the access road LSA or in the region.

Assuming that caribou will avoid the access road footprint by 1 km during construction (Dyer 1999), construction of the access road may lead to indirect habitat loss for woodland caribou at the local level. Caribou may be forced out of the access road LSA and into adjacent areas, including the Wabasca-Dunkirk Caribou Management Zone. Because of the large size of the caribou zone and relative lack of development in this region, construction of the access road is unlikely to affect caribou populations at the regional level. While the access road alone is unlikely to affect caribou in the Wabasca-Dunkirk management zone, increasing regional activity may have some impact on caribou. At the present time, the presence of the Project access road is not considered significant, but with increasing development, effects may become significant for caribou due to threshold exceedances (CR #10, Table 34).

Hunting pressure on caribou may be reduced with the implementation of an Access and Recreation Management Plan. Predation is not likely to increase greatly with the Project due to the increased levels of activity in the access road LSA. Vehicular collisions are a potential threat to caribou attempting to cross the access road or travel along it, particularly at night. Impacts can be minimized with appropriate mitigative measures including placing signage at potential crossing areas along the road, and enforcing low speed limits. With these measures, mortality due to vehicular collisions is expected to be minor for caribou.

As previously discussed, caribou tend to follow traditional trails and if these trails are bisected by a busy access road, are reluctant to cross. A number of these trails that may be important in maintaining caribou movement through the access road LSA and surrounding region were identified in the aerial ungulate survey. Use of these corridors by caribou can be confirmed with further assessment. Once movement corridors have been confirmed, mitigation measures such wildlife crossing signage and reduced speed limits can be used to reduce effects of the access road on caribou movements. However, even with these mitigation measures, the presence of the access road is still expected to affect caribou habitat connectivity within the access road LSA.

The effects of the access road on regional caribou populations, such as those within the Wabasca-Dunkirk Caribou Management Zone, are not expected to be significant because there is relatively little development in this region and cumulative effects are fairly minor. However, the contribution of future projects within the caribou management zone may add pressure to existing caribou populations in the region.

4.10.4 Mitigation and Monitoring

4.10.4.1 Mitigation

With the following mitigation, Project effects are expected to be minor:

Habitat Loss

- final location and size of plant, well pads, roads and borrow pits have been located to maximize resource recovery and to reduce the impact to old-growth forests, riparian areas and other unique habitats;
- vegetation clearing will be conducted during the winter months to avoid sensory disturbance of breeding birds and calving woodland caribou. An "early-in, early-out" policy will be employed with regard to caribou (i.e. start activities October 15 and be out of the area by March 15, whenever possible);
- the reclamation plan will include measures such as progressive reclamation of unused features (e.g., temporary road widening to facilitate construction vehicles), conversion of borrow pits into wetlands for amphibians and waterbirds, and use of native species for reclamation. The access road will be promptly rolled back and reclaimed when no longer required; and
- hydrological flow will be maintained through use of culverts, bridges and other devices as necessary.

Mortality

- if vegetation clearing cannot be accomplished during the fall and winter months, nest searches will be conducted prior to clearing between May and August. This will reduce the probability of destroying raptor, songbird and waterfowl/waterbird nests.
- an Access and Recreation Management Plan will be designed and implemented to minimize recreational use of the area once the road has been constructed. This will include, but will not be limited to the following:
    - restriction of the recreational use of snowmobiles and ATVs along the access road and utility corridors by Project employees;
    - new linear features (cutlines) that are connected to the main access road will be blocked to minimize recreational use;
    - project employees will be restricted from hunting along the access road and in the Project LSA;
    - access will be coordinated with neighbouring operators;

  - low speed limits will be enforced along all access roads and signs will be posted at wildlife crossings or important wildlife habitat areas to minimize mortality risk;
  - a policy will be implemented concerning no-littering, no feeding and no harassment of wildlife by on-site workers; and
  - all wildlife mortalities resulting from collisions with vehicles will be promptly reported to ASRD.
- a Spill Management Plan will be developed and implemented, including measures such as refuelling vehicles away from waterbodies, access to spill kits and prompt reporting and cleaning up of accidental spills; and
- to minimize interactions with bears and other scavenging wildlife, all garbage will be stored in bear-proof containers until such time as it is transported to off-site waste treatment facilities.

Habitat Fragmentation and Connectivity

Pre-disturbance surveys will be carried out to confirm the occurrence of wildlife trails within the Project LSA and access road LSA. These surveys may involve a combination of ground surveys and remote cameras, and aerial surveys in areas not previously surveyed. Data from these surveys will be used to determine placement of road signage to limit vehicle speeds in areas identified as wildlife crossings, place wildlife crossing structures where appropriate (necessary only if aboveground pipeline is adjacent to the road) and to monitor changes in wildlife use in the area.

4.10.4.2 Monitoring

A wildlife monitoring program will be put in place during the operations and decommissioning phases of the Project. The goals of the wildlife monitoring program will be to evaluate the effectiveness of wildlife mitigation and reclamation procedures. Sunshine will work with ASRD to develop the details of such a monitoring program.

4.10.5 Summary

Potential impacts to wildlife include habitat loss and fragmentation, increased risk of wildlife mortality, increased sensory disturbance to wildlife, and loss of biological diversity. However, the Phase 1 development and access road were designed in such a way as to minimize those potential effects. In addition to the design of the project, several mitigation and monitoring measures will be implemented to further minimize the effects of the Project on wildlife.

4.11 Land and Resource Use

4.11.1 Introduction

The purpose of this section is to identify potential impacts to land and resource use within the Land Use Study Areas. The Project local study area ("LSA") encompasses nine sections and the access road study area includes a 9 km road with a 500 m buffer on both sides of the centreline (Figure 4.11-1A).

Baseline conditions will be assessed and the level of potential impact determined. Where required, potential mitigation techniques will be proposed.

4.11.2 Baseline Conditions

The Project is located outside the boundaries of existing sub-regional integrated resource plans (IRP); therefore, no specific IRP has been referenced. However, Sunshine has considered the development philosophies described for adjacent IRPs (i.e. The Fort McMurray-Athabasca Oil Sands Sub-regional Integrated Resource Plan (AEP 1996a)).

Figure 4.11-1A and Figure 4.11.-1b show all subsurface dispositions within the Project LSA and the access road LSA, while Figure 4.11-2A and Figure 4.11-2B show the surface dispositions in relation to the Project Phase 1 and 2 along with future development scenarios..

4.11.2.1 Oil Sands Leases

The Project LSA falls within six different Oil Sands Leases (Table 4.11-1A), including Oil Sands Lease ("OSL") No. 7407050234 in the northwest portion held by Agadir Resources Inc. The remainder of the leases are held by Sunshine.

Table 4.11-1 Oil Sands Leases in Project LSA

Disposition	Disposition Holder	Location
OSL 7407060175	Sunshine Oilsands Ltd.	30;31;32-94-17-W4M
OSL 7407020023	Sunshine Oilsands Ltd.	25;36-94-18-W4M
OSL 7407070311	Sunshine Oilsands Ltd.	33-94-17-W4M
OSL 7407110284	Sunshine Oilsands Ltd.	3-95-17-W4M

Table 4.11-1 Oil Sands Leases in Project LSA		
Disposition	**Disposition Holder**	**Location**
OSL 7407060184	Sunshine Oilsands Ltd.	4-95-17-W4M
OSL 7407050234	Agadir Resources Inc.	5-95-17-W4M

The northern portion of the access road LSA is located within OSLs held by Agadir Resources Inc. Canadian Coastal Resources Ltd. holds the OSL in the southern portion, while Bancroft Oil & Gas Ltd. holds a lease in the central portion, as listed in Table 4.11-2A.

Table 4.11-2 Oil Sands Leases in Access Road LSA		
Disposition	**Disposition Holder**	**Location**
OSL 7407060176	Agadir Resources Inc.	NE24-94-18-W4M
OSL 7407060174	Agadir Resources Inc.	19-94-17-W4M
OSL 7407090438	Bancroft Oil & Gas Ltd.	18-94-17-W4M
OSL 7406090442	Canadian Coastal Resources Ltd.	5;6;7;8-94-17-W4M

4.11.2.2 Petroleum and Natural Gas Leases and Licences

Paramount Energy Operating Corp. (“Paramount”), Enermark Inc. (“Enermark”), and Bonavista Petroleum Ltd. (“Bonavista”) jointly hold three Petroleum and Natural Gas (“PNG”) Leases that fall within the Project LSA (Figure 4.11-1A, Figure 4.11-1B and Table 4.11-3). Paramount also holds one hundred percent ownership in another PNG Lease. A PNG Licence is jointly held by Paramount, Giant Grosmont Petroleums Ltd., and EnCana Oil & Gas Company Ltd. (“EnCana”). EnCana also holds an individual PNG Licence.

These licences are managed by Alberta Department of Energy, Mineral Development and Strategic Resources, and do not expire.

Table 4.11-3 Petroleum and Natural Gas Leases and Licences in Project LSA

Disposition	Disposition Holder	Location
PNG Lease 0598010379	Paramount Energy Operating Corp.	30-94-17-W4M
PNG Lease 0587020317	Paramount Energy Operating Corp. Enermark Inc. Bonavista Petroleum Ltd.	25;36-94-18-W4M
PNG Lease 0588050446	Paramount Energy Operating Corp. Enermark Inc. Bonavista Petroleum Ltd.	31-94-17-W4M
PNG Lease 058112B320	Paramount Energy Operating Corp. Enermark Inc. Bonavista Petroleum Ltd.	5-95-17-W4M
PNG Licence 5497120145	EnCana Oil & Gas Co Ltd.	32;33-94-17-W4M
PNG Licence 5494110068	Paramount Energy Operating Corp. Giant Grosmont Petroleums Ltd. EnCana Oil & Gas Co Ltd.	3;4-95-17-W4M

Table 4.11-4 lists PNG Leases and Licences and the respective owners of those licences that pertain to the access road LSA (Figure 4.11-1A).

Table 4.11-4 Petroleum and Natural Gas Leases and Licences in access road LSA		
Disposition	**Disposition Holder**	**Location**
PNG Lease 0588050452	Paramount Energy Operating Corp. Enermark Inc. Bonavista Petroleum Ltd.	NE24-94-18-W4M
PNG Lease 0598010379	Paramount Energy Operating Corp.	19-94-17-W4M
PNG Licence 5498100116	Paramount Energy Operating Corp.	7;8;18-94-17-W4M
PNG Licence 5498100110	Paramount Energy Operating Corp.	5;6-94-17-W4M

4.11.2.3 Metallic and Industrial Mineral Development

There are three Metallic and Industrial Mineral ("MIM") permits (Figure 4.11-1A, Figure 4.11-1B and Table 4.11-5) within the Project LSA. Two of the MIM permits are held by Athabasca Minerals Inc. and the other is held by Grizzly Diamonds Ltd. These dispositions are on crown land and are administered by the Government of Alberta.

Table 4.11-5 Metallic and Industrial Mineral Permits in Project LSA		
Disposition	**Disposition Holder**	**Location**
MIM 9306110755	Athabasca Minerals Inc.	30;31;32;33-94-17-W4M
MIM 9305031145	Grizzly Diamonds Ltd.	25;36-94-18-W4M
MIM 9306110758	Athabasca Minerals Inc.	3;4;5-95-17-W4M

MIM permits that are within the access road LSA are held by Grizzly Diamonds Ltd. and Athabasca Minerals Inc., as shown in Table 4.11-6.

Table 4.11-6 Metallic and Industrial Mineral Permits in Access Road LSA		
Disposition	**Disposition Holder**	**Location**
MIM 9305031145	Grizzly Diamonds Ltd.	NE24-94-18-W4M
MIM 9306110755	Athabasca Minerals Inc.	5;6;7;8;18;19-94-17-W4M

4.11.2.4 Forestry

The Project LSA falls entirely within Forestry Management Area ("FMA") 9100029 (Table 4.11-7). The overall size of the FMA is 5,548,481 ha (13,710,597 acres) and is held by Alberta-Pacific Forest Industries Incorporated ("AlPac").

Table 4.11-7 Timber Allocations in Project LSA			
Disposition	**Disposition Holder**	**Location**	**Size**
			Hectares
FMA 9100029	Alberta Pacific Forest Industries Inc.	Encompasses all sections in 94-17-W4M, 94-18-W4M and 95-17-W4M	5,548,481

4.11.2.5 Mineral Surface Lease and Other Public Lands Dispositions

Exploration and delineation of minerals has been performed through the drilling of many exploration wells in the area. Within the Project LSA, there are three wellsite Mineral Surface Leases ("MSL") held by Sunshine, two held by EnCana and two held by Paramount (Table 4.11-8, Figure 4.11-2A and Figure 4.11-2B).

Table 4.11-8 Public Lands Dispositions in the Project LSA

Disposition	Disposition Holder	Description	Location	Size
				Hectares
MSL 962997	EnCana Oil & Gas Co Ltd.	Wellsite	NW-4-95-17-W4M	0.8
MSL 840161	Paramount Energy Operating Corp.	Wellsite	SW-5-95-17-W4M	1.0
MSL 080279	Sunshine Oilsands Ltd.	Wellsite	NW-30-94-17-W4M	0.5
MSL 841731	Paramount Energy Operating Corp.	Wellsite	SW-31-94-17-W4M[1]	1.1
MSL 080275	Sunshine Oilsands Ltd.	Wellsite and access road	NW-31-94-17-W4M	0.5
MSL 982318	EnCana Oil & Gas Co Ltd.	Wellsite	NW-33-94-17-W4M	0.8
MSL 080285	Sunshine Oilsands Ltd.	Wellsite	SE-36-94-18-W4M	0.5
MLL 070168	Sunshine Oilsands Ltd.	Industrial Campsite	NW,NE-4-95-17-W4M	3.8

[1] Paramount well is located within the first phase of proposed SAGD development

Two wellsite Mineral Surface Leases near the access road LSA are held by Paramount (Figure 4.11-2A, Figure 4.11-2B and, Table 4.11-9).

Table 4.11-9 Public Lands Dispositions in Access Road LSA				
Disposition	**Disposition Holder**	**Description**	**Location**	**Size**
				Hectares
MSL 983587	Paramount Energy Operating Corp.	Wellsite	NW8-94-17-W4M	0.8
MSL 055265	Paramount Energy Operating Corp.	Wellsite	SE6-94-17-W4M	0.8

There are eight Pipeline Agreements ("PLA") for pipelines located in the Project LSA (Figure 4.11-2A, Figure 4.11-2B and, Table 4.11-10). Four PLAs are held by Paramount, two are held by Nova Gas Transmissions Ltd, and two by EnCana.

Table 4.11-10 Pipeline Agreement Dispositions in Project LSA				
Disposition	**Disposition Holder**	**Location**	**Product**	**Area (ha)**
PLA 050272[1]	Paramount Energy Operating Corp.	NW-4-95-17-W4M 5-95-17-W4M SW,NW-31-94-17-W4M	-	5.9
PLA 850082	Paramount Energy Operating Corp.	SW-5-95-17-W4M SW,NW,NE-25-94-18-W4M NW-30-94-17-W4M SW,NW-31-94-17-W4M	Natural Gas	19.8
PLA 931049	Nova Gas Transmission Ltd.	NW-4-95-17-W4M SW,NW,NE-5-95-17-W4M	Natural Gas	11.3

Table 4.11-10 Pipeline Agreement Dispositions in Project LSA				
Disposition	**Disposition Holder**	**Location**	**Product**	**Area (ha)**
PLA 961477	EnCana Oil & Gas Co Ltd.	NW-4-95-17-W4M	Natural Gas	0.8
PLA000017	Paramount Energy Operating Corp.	SW,NW,NE-25-94-18-W4M NW,NE-30-94-17-W4M SE,SW-31-94-17-W4M	Natural Gas	16.4
PLA 931051	Nova Gas Transmission Ltd.	SW,NW,NE-25-94-18-W4M NW-30-94-17-W4M SW,NW-31-94-17-W4M	Natural Gas	19.8
PLA 013553	Paramount Energy Operating Corp.	SW-31-94-17-W4M	Natural Gas	0.2
PLA 010745	EnCana Oil & Gas Co Ltd.	SE,NW,NE-33-94-17-W4M	Natural Gas	1.7
[1] Pipeline has not been constructed				

PLAs near the access road LSA are held by Paramount and are listed in Table 4.11-11.

Table 4.11-11 Pipeline Agreement Dispositions in Access Road LSA				
Disposition	**Disposition Holder**	**Location**	**Product**	**Area (ha)**
PLA 000017	Paramount Energy Operating Corp.	NW8-94-17-W4M	Natural Gas	16.4
PLA 054269	Paramount Energy Operating Corp.	SE6-94-17-W4M	Natural Gas	0.7

4.11.2.6 Sand and Gravel

There are no sand and gravel dispositions located within the Project LSA or the access road LSA.

4.11.2.7 Infrastructure

Power Transmission Lines

There are no dispositions for high voltage transmission lines within the Project LSA or the access road LSA.

Roads

EnCana holds three dispositions for access roads throughout the northern portion of the Project LSA and Paramount holds four dispositions for access roads throughout the western portion (Table 4.11-12).

Table 4.11-12 Licenses of Occupation and Easements in Project LSA

Disposition	Disposition Holder	Location	Size (ha)
LOC 080441	Sunshine Oilsands Ltd.	NW-3-95-17-W4M NE-4-95-17-W4M	3.2
LOC 981754	EnCana Oil & Gas Co Ltd.	SE,SW-4-95-17-W4M NE-4-95-17-W4M NW,NE-32-94-17-W4M NW-33-94-17-W4M	3.4
LOC 881421	EnCana Oil & Gas Co Ltd.	NW-4-95-17-W4M 5-95-17-W4M	31.4
LOC 840104	Paramount Energy Operating Corp.	SW-5-95-17-W4M	4.7
LOC 841106	Paramount Energy Operating Corp.	SW-5-95-17-W4M SW, NW-31-94-17-W4M	1.7
LOC 841486	Paramount Energy Operating Corp.	SW,NW,NE-25-94-18-W4M NW-30-94-17-W4M SW-31-94-17-W4M	7.6

Table 4.11-12 Licenses of Occupation and Easements in Project LSA			
Disposition	**Disposition Holder**	**Location**	**Size (ha)**
LOC 080169	Sunshine Oilsands Ltd.	NW,NE-30-94-17-W4M	0.3
LOC 982691	Paramount Energy Operating Corp.	NE-30-94-17-W4M SE,SW-31-94-17-W4M	1.4
LOC 080173	Sunshine Oilsands Ltd.	SW,NW-31-94-17-W4M SE-36-94-18-W4M	0.9
LOC 080461	Sunshine Oilsands Ltd.	SW-31-94-17-W4M	0.6
LOC 080463	Sunshine Oilsands Ltd.	SW-31-94-17-W4M	0.5
LOC 080430	Sunshine Oilsands Ltd.	NW-31-94-17-W4M	0.7
LOC 080464	Sunshine Oilsands Ltd.	NW-31-94-17-W4M	0.6
LOC 981755	EnCana Oil & Gas Co Ltd.	SE,NW,NE-33-94-17-W4M	1.0
Note: All access roads are currently for winter use only.			

Near the access road LSA, Paramount holds three dispositions for access roads (Table 4.11-13).

Table 4.11-13 Licenses of Occupation and Easements in Land Use Access Road Study Area			
Disposition	**Disposition Holder**	**Location**	**Size (ha)**
LOC 982758	Paramount Energy Operating Corp.	NW18-94-17-W4M	6.9
LOC 053588	Paramount Energy Operating Corp.	NW8-94-17-W4M	3.9

Table 4.11-13 Licenses of Occupation and Easements in Land Use Access Road Study Area			
Disposition	**Disposition Holder**	**Location**	**Size (ha)**
LOC 982760	Paramount Energy Operating Corp.	NW8-94-17-W4M	1.1

Area Operations Agreement

Paramount Energy Operating Corp. holds an Area Operations Agreement (AOA 060028) with Alberta Sustainable Resource Development (ASRD) within 94-17-W4M, 94-18-W4M and 95-17-W4M.

Water Source Facilities

Currently no water source facilities exist within the Project LSA or the access road LSA.

4.11.2.8 Trappers

There are three Trapping Area (TPA) dispositions within Project LSA or the access road LSA. These dispositions are held by one individual in the northern portion, (TPA21), one individual in the central and southeast (TPA 771) and another individual in the southwest portion (TPA 879) (Table 4.11-14).

Table 4.11-14 Trapping Areas in Project LSA and Access Road LSA	
Disposition	**Location**
TPA 21	3; 4; 5-95-17-W4M
TPA 771	5;6;7;18;19;30; 31; 32; 33-94-17-W4M 36-94-18-W4M
TPA 879	25-94-18-W4M NE24-94-17-W4M

4.11.2.9 Fishing

Although both large and small bodied fish are found in some lakes within the LSA, sport fishing within the Project LSA is limited.

4.11.2.10 Hunting

The Project is located in the Fort McMurray Fish and Wildlife District where moose and black bear are the primary species hunted.

4.11.2.11 Miscellaneous

The Project Area is located adjacent to the Wabasca-Dunkirk Caribou Management Zone and the access road LSA falls within this Caribou Management Zone (Figure 4.11-2A and Figure 4.11-2B), managed by Alberta Department of Sustainable Resource Development, Lands and Forest Division. Surface access in the caribou zone is subject to specific restriction.

4.11.3 Impacts

The following section outlines the potential impacts of the Project and access road on land and resource use.

4.11.3.1 Oil Sands Leases

Development of the Project will not impact other oil sands users. Sunshine holds the OSLs within all but one section of land within the Project LSA. Agadir Resources Inc. holds this lease, which will not be impacted by project development.

OSLs within the Project LSA are held by Agadir Resources Inc., Bancroft Oil & Gas Ltd., and Canadian Coastal Resources Ltd. Consultation with these other oil sands developers are ongoing.

4.11.3.2 Petroleum and Natural Gas Licences

On October 15, 2009, ERCB issued its interim decision # 2009-0061 which ordered all specified natural gas production in the West Ells PDA to be shut in until a final hearing has taken place. Sunshine will continue to consult with affected P&NG rights holders to ensure future conflicts are avoided.

4.11.3.3 Metallic and Industrial Mineral Development

Sunshine's development activities will not impact mineral development on this area. MIM disposition holders in the area will be made aware of Sunshine's development plans.

4.11.3.4 Forestry

The Project LSA for the Project is located completely within the confines of Al-Pac's FMA. Sunshine's operations and development will require the clearing of timber within the FMA. Although the actual extent of disturbance is minimal, some form of mitigation between Sunshine and Al-Pac will be necessary. Sunshine will work with Al-Pac to ensure that all merchantable timber located within the Project footprint is salvaged and made available to the operator.

4.11.3.5 Mineral Surface Leases and Other Public Lands Dispositions

The Mineral Surface Leases for wellsites in the Project LSA are held by Sunshine, EnCana and Paramount. Sunshine has initiated discussions with these companies to ensure that lease development activities will address potential conflicts in a manner that minimizes the effect on the users.

4.11.3.6 Sand and Gravel

The Project operations will not have an impact on current sand and gravel exploration or development as there are no sand and gravel dispositions within the Project LSA and the access road LSA.

4.11.3.7 Infrastructure

LOCs held by EnCana and Paramount for access roads exist throughout the Project LSA and in the central portion of the access road LSA. Sunshine has initiated discussion with these companies regarding development plans.

4.11.3.8 Trappers

Three individuals hold trapping agreements with the Project LSA and the access road LSA and may be affected by the development of the Project. Sunshine will discuss a compensation program with these agreement holders in order to minimize the effect of the Project on the trapping resource. Sunshine will also work with the trappers to allow access onto lands that are not being developed by the Project.

4.11.3.9 Fishing

There are no commercial fishing opportunities on the Sunshine lease and only limited opportunities for recreational fishing. The Project will not affect the fishing opportunities.

4.11.3.10 Hunting

Sunshine will control access in the vicinity of direct disturbance and also restrict hunting activity in that area. The remainder of the area will be available for hunting activities, however hunting activities along the access road will be restricted. An Access and Recreation Management Plan will be developed to address issues of access for hunting activities.

4.11.3.11 Miscellaneous

Potential impacts to the Wabasca-Dunkirk Caribou Management Zone are discussed in detail in Section 4.10 and CR#10 Wildlife. An Access and Recreation Management Plan will be developed to address issues of access that may affect caribou.

4.11.4 Summary and Conclusions

The Project will have an insignificant impact on land and resource use. Sunshine has identified potential stakeholders within the Project LSA and the access road LSA and through its ongoing Stakeholder Consultation Program, will ensure impacts to these users are minimized.

4.12 Constraints Mapping

Constraints mapping is an approach used by SAGD operators in the Fort McMurray Oil Sands Region to identify potential areas of sensitivity related to project development. Typically as part of the application process, project proponents collect baseline information for all the major environmental disciplines, In which areas of sensitivity are identified. Constraints mapping is the formalized method of bringing all these sensitivities together on a single map. Sunshine has provided a constraints map (Figure 4.12-1A and Figure 4.12-1B) that consolidates the environmental, social, cultural and resource development areas of sensitivity.

The initial footprint of the West Ells SAGD Project encompasses approximately 60.7 ha of surface disturbance in the first phase of project development which includes:

- plant site – 29.3 ha
- north pad – 4.9 ha
- south pad – 4.4 ha
- construction camp – 4.9 ha
- operator's camp – 2.9 ha
- supervisor's camp – 1.2 ha
- borrow pit # 1 – 8.9 ha
- utility corridor – 4.2 ha

The access road into the Project from the proposed AOSC Dover facility will encompass approximately 67.8 ha.

The proposed footprint for these activities forms the basis for the constraints mapping exercise.

4.12.1 Approach

Sunshine identified the environmental and social sensitivities along with resource development requirements early in the Project design. Early planning activities were able to minimize environmental impacts and maximize resource recovery. Most of this was done well in advance of the formal constraints mapping exercise. The key components of this approach included:

- collecting comprehensive environmental and cultural information from within the Study Area;
- defining and mapping the environmental constraints;
- addressing each constraint "individually or in conjunction with others" if overlap occurred, rather than providing a weighted ranking. Overlapping constraints were evaluated to determine the impacts on one or all, if the disturbance occurred; and
- demonstrating that planning and design considered the constraints while optimizing resource recovery.

If a constraint was identified within the development area, the first action would be avoidance and subsequent actions would be to minimize the impact with appropriate mitigation and monitoring. The constraints mapping approach assists to validate the environmental assessment conclusions including focused mitigation and monitoring programs to neutralize effects.

4.12.2 Constraints Criteria – Environmental Considerations

Constraints were identified as environmental, social or cultural sensitivities that exist within the study area and the Phase 1 footprint (Table 4.12-1) as identified by the various Consultant Reports that support the application. Constraints that were non-spatial in nature were not included in this exercise since they are difficult to map.

4.12.2.1 Aquatic Resources (CR #3)

Potential impacts to surface water quality and fisheries resources occur primarily from introduction of foreign substances into the water courses. Substances of concern would be the introduction of suspended solids through surface runoff or the introduction of contaminants due to product spills. The maintenance of a 50 m buffer along water courses along with erosion control measures, including revegetation activities would provide sufficient watershed protection. Spill prevention and emergency response plans mitigate the product spill potential.

Mapping Constraint

- 50 m buffer along water courses

4.12.2.2 Hydrology (CR #6)

The main area of concern related to hydrology that was considered as a constraint is the potential for surface runoff/sedimentation. The identification of a 50 m buffer along all water courses should be sufficient protection from surface runoff and the resulting sedimentation.

Mapping Constraint

- 50 m buffer along water courses

4.12.2.3 Vegetation and Wetlands (CR #9)

There are five potential constraints related to vegetation and wetlands:

- uncommon or sensitive ecosites;
- uncommon or sensitive wetlands;
- rare plants or communities;
- riparian areas; and
- old growth forests.

A target of retaining 1% of the uncommon ecosites within the terrestrial area is the objective in an attempt to ensure the sustainability of sensitive ecosite and wetland areas. If this target cannot be achieved through avoidance, then the appropriate mitigation measures must be implemented. There is one uncommon ecosite or wetland (l1 or MONG) found in the Study Area. It is located on the east side of a large lake and will not be disturbed by Phase 1 development.

Mapping Constraints

- riparian areas maintain a 50 m buffer along water courses;
- old growth forest;
- uncommon ecosites – one found within Study Area (outside Phase 1 footprint and will not be impacted);
- rare plants – known sites will have a 50 m buffer - *Cladina stygia* – was found outside of the Phase 1 footprint and will not be disturbed, no mitigation is required; and
- uncommon wetlands – one found within Study Area.

4.12.2.4 Soils and Terrain (CR #8)

There are three main constraints for soils and terrain which include:

- riparian areas;
- sensitive soils; and
- steep slopes which may be prone to erosion or slumping.

Maintenance of a 50 m buffer along water courses will protect the riparian areas. Soils with poor reclamation suitability and areas prone to erosion or slumping will be identified and special mitigation measures implemented.

Mapping Constraints

- riparian areas maintain a 50 m buffer along water courses;
- sensitive soils – none identified; and
- steep slopes that have moderate to high erosion potential – none identified.

4.12.2.5 Wildlife (CR #10)

The wildlife discipline is one which is difficult to spatially reference. In an attempt to include this in the constraints mapping process, Sunshine has chosen to focus on the wildlife habitat for sensitive species. Sunshine has identified riparian areas as a potential constraint as it adds high quality habitat for a number of species. A 50 m buffer along watercourses will account for this and other values such as water quality and hydrology.

Mapping Constraint

- 50 m buffer along water courses

4.12.2.6 Historical (CR #5)

The historical resource assessment included a literature search and development of an archaeological model. Constraints include areas of known historical and archaeological sites and areas of moderate and high archaeological potential. All known sites that have been identified will have a 50 m buffer to ensure protection. Areas that have not been investigated and that have a moderate to high probability of occurrence will be identified and protected. Areas that have not been investigated will have to be surveyed prior to construction. If avoidance is not possible, suitable mitigation will be implemented.

Mapping Constraint

- 50 m buffer around known sites – none identified
- areas of moderate and high archaeological potential – all proposed project development activities that fall within moderate to high potential will require additional inspection to determine if historical resources are present.

Table 4.12-1 Environmental and Resource Utilization Constraints	
Constraint	**Identifier**
Surface Water Quality	
	50 m buffer on all watercourses
Hydrology	
	50 m buffer on all watercourses
Vegetation	
Riparian areas	50 m buffer
Old Growth Forest	none found within Study Area
Uncommon Ecosites (<1% of study area)	one found within Study area
Rare Plants	known sites will have a 50 m buffer *(Cladina stygia)* – not within the Phase 1 footprint and no mitigation is required
Uncommon Wetlands (<1% of study area)	One found within the Study Area (same site as uncommon ecosite) – not within the Phase 1 footprint
Soil Resources	
Soils prone to erosion	None identified
Riparian areas	50 m buffer on all watercourses
steep slopes that have moderate to high erosion potential	None identified
Wildlife	
Habitat – riparian areas	50 m buffer on all watercourses
Historical Resources	
Identified historical sites	None identified

Table 4.12-1 Environmental and Resource Utilization Constraints	
Constraint	**Identifier**
Potential areas of high or moderate potential for occurrence	Field investigation of surveyed footprint is required
Resource Utilization	
Developable Bitumen	15 m Net Process Pay Isopach

4.12.3 Constraints Criteria – Resource Considerations

4.12.3.1 Resource Utilization and Bitumen Recovery

The key consideration during the site selection process is the maximization of resource utilization. The prime target of the SAGD bitumen reservoir development in the study area is shown on Figure 4.12-1A and Figure 4.12-1B.

In many instances the locations of the SAGD components considered the constraints prior to finalizing the location. Several options to maximize the bitumen reservoir development were tested.

4.12.3.2 Project Costs

The capital and operating costs are important considerations and factor significantly into siting the locations of the SAGD development activities. Each of the three main components considered were rated based on projected costs:

- construction
- drilling
- reclamation

4.12.3.3 Footprint

The selection of the most advantageous access corridor that satisfies the current needs and has maximum flexibility for the long term lease development needs is another major consideration. Combining activities into a common corridor and using as much existing clearing as possible are important development considerations. Three main components considered are:

- minimizing resource conflict;
- utilizing a common corridor; and

- minimizing new clearing.

4.12.4 Constraints Evaluation

The West Ells SAGD Project facilities must take into account the opportunity for sharing of infrastructure with future developments of the lease. A simple rating system was developed to address the non-environmental based criteria. Four categories were developed to assist in determining the final site selection:

1. No Activity
2. Fair – meets few objectives
3. Good – meets some objectives
4. Best – meets most objectives

The rating system used for each of the major environmental disciplines was presence or absence. Table 4.12-2 summarizes the ratings for both environmental and non-environmental based criteria.

Future facilities (Figure 4.12.-1B) including well pads, borrow pits and utility corridors are proposed to be developed within the Project Area. These will be constructed, operated and reclaimed using similar mitigation measures as proposed for the initial facilities. Further constraints evaluation for these future facilities will be conducted during the summer of 2010 and this information will be provided to the regulators once the assessment of the entire footprint has been completed.

Table 4.12-2 Constraints Evaluation West Ells SAGD Project

Facility Component	Breakdown		Bitumen Recovery	Costs			Footprint			Rating	Environmental Constraints (Present or Absent)[1]							
				Drilling	Construction	Reclamation	Minimize Resource Conflict	Common Corridor	Minimize New Clearing	Total	*Hydrology*	*Surface WQ*	*Vegetation & Wetlands*	*Rare Plants*	*Soils and Terrain*	*Wildlife*	*Historical*	*Mitigation Required*
Central Processing Facility	Pad	Proposed	2	0	3	3	2	3	1	14	A	A	A	A	A	A	P	Y
		Alternate	3	0	1	3	3	3	1	14	A	A	P	P	A	A	P	Y
North Well Pad	Pad	Proposed	3	3	3	3	3	3	3	21	A	A	A	A	A	A	A	N
		Alternate	2	3	3	3	3	3	3	20	A	A	P	A	A	A	A	Y
South Well Pad	Pad	Proposed	3	3	3	3	3	3	3	21	A	A	A	A	A	A	P	Y
		Alternate	2	3	3	3	3	3	3	20	A	A	A	P	A	A	P	Y
Borrow Pit	Borrow	Proposed	0	0	3	3	3	3	3	15	A	A	A	A	A	A	A	N
Utility Corridor	Access	Proposed	0	0	3	3	3	2	2	13	A	A	A	A	A	A	A	N
		Alternate	0	0	1	1	3	3	3	11	A	A	A	P	A	A	A	Y
Construction		Proposed	0	3	3	3	3	3	3	18	A	A	A	A	A	A	A	N
Operator Camp		Proposed	0	3	3	3	3	3	3	18	A	A	A	A	A	A	P	Y
Supervisor Camp		Proposed	0	3	3	3	3	3	3	18	A	A	A	A	A	A	P	Y
Access Road	Access	Proposed	0	3	3	3	3	3	3	18	A	A	A	A	A	A	P	Y
		Alternate	0	3	3	3	3	3	3	18	A	A	A	A	A	A	P	Y

Note 1:
P – Sensitivity or constraint present
A – Sensitivity or constraint absent
Y – Mitigation required
N – Mitigation not required

5 EPEA APPROVALS

5.1 Application

Sunshine applies under Part 2, Division 2 of the EPEA for approval to construct and operate the Project. The information provided in this Application is in compliance with the requirements of the *Approvals and Registrations Procedure Regulation* (Alberta Regulation 113/93). To facilitate the review process, the information presented below is in each case followed by the corresponding reference in AR 113/93.

5.2 Project Description

The location, description, capacity and size of the Sunshine West Ells SAGD Project are included in Sections 1 and 2 and Figures1.1-1 and 1.1-2 of this Application.

AR 113/93 reference: 3(1)(b)

Specific project details, including the nature of the activity are outlined in Section 2 of this Application.

AR 113/93 reference: 3(1)(c)

5.3 Energy Resources Conservation Board Approval

An application to the ERCB is included in Sections 1 to 4 of this Application.

AR113/93 reference: 3(1)(d)

5.4 Environmental Assessment

As per Schedule 2 of AR 111/93 the *Environmental Assessment (Mandatory and Exempted Activities) Regulation* (Alberta Regulation 111/93), this Project is not a Mandatory Activity and therefore an Environmental Impact Assessment Report is not required.

Specialized consultants have been hired to complete reports related to the Project. These reports are included in the Application (Consultant Reports 1 – 10). Summaries of the relevant environmental studies set out in detail within the Consultant Reports are included in Section 4 of this Application.

AR 113/93 reference: 3(1)(e)

5.5 Existing Approvals

There are no existing EPEA approvals for the Project. ERCB, AENV and Alberta Sustainable Resource Development approvals have been issued for the survey, corehole drilling and seismic in the area of the Project.

AR 113/93 reference: 3(1)(f)

5.6 Project Schedule

A Project schedule is provided in Section 1.7.1 and Figure 1.7-1 of this Application.

AR 113/93 reference: 3(1)(g)

5.7 Emissions and Control

The primary emissions from the Project are related to air. A description of the predicted air emissions from the Project plant site is found in Section 4.1 of this Application and in Consultant Report #1, Section 6.0.

A description of wastewater disposal is included in Section 2.8.5 of this Application. Drilling fluid and solid waste disposal is discussed in Section 2.5.3 of this Application. Surface runoff from the plant site is discussed in Section 2.8.4.1 of this Application.

A summary of the Sunshine waste management program is included in Section 2.10.2.4 of this Application.

AR 113/93 reference: 3(1)(h)

5.8 Environmental Monitoring Summary

There has been no previous environmental monitoring as this is a new project. Section 4 of this Application contains a summary of the environmental information including monitoring information.

AR 113/93 reference: 3(1)(i)

5.9 Emission Control Performance

A description of the predicted air emissions is found in Section 4.1.3 of this Application and Consultant Report #1, Section 6.0. The proposed mitigation measures are included in Section 4.1.4 of this Application.

The materials and energy balance is included in Section 2.7 of this Application and the water management program is included in Section 2.8 of this Application.

AR 113/93 reference: 3(1)(j)

5.10 Emissions Justification and Control

A description of the predicted air emissions is found in Section 4.1.3 of this Application and Consultant Report #1, Section 6.0. Proposed mitigation measures are found in Sections 4.1.4 of this Application.

AR 113/93 reference: 3(1)(k)

5.11 Waste Management

Waste generated from the construction and operation of the Project will be minimal. The measures that will be implemented to minimize the amount of waste produced and a list of the wastes, including the disposal methods, is provided in Section 2.10 of this Application.

AR 113/93 reference: 3(1)(l)

5.12 Environmental Impacts

The environmental impacts are set out in detail in the Consultant Reports and are summarized in Section 4 of this Application.

AR 113/93 reference: 3(1)(m)

5.13 Emergency Response

An Emergency Response Plan will be filed with the Regional Municipality of Wood Buffalo. A description of the emergency response plan to be developed for the Project is included in Section 2.10.2.3 of this Application.

AR 113/93 reference: 3(1)(n)

5.14 Accidental Release Contingency Plans

Sunshine will develop a corporate emergency response plan that sets out procedures and identifies responsible personnel to deal with emergency situations. This plan is discussed in Section 2.10.2 of this Application.

AR 113/93 reference: 3(1)(o)

5.15 Conservation and Reclamation

Reclamation activities are referred to in Section 4.2 of this Application and in Consultant Report #2.

AR 113/93 reference: 3(1)(p)

5.16 Public Consultation

The public consultation program is described in Section 3 of this Application.

AR 113/93 reference: 3(1)(q)

5.17 Supplementary Submissions

No other submissions are being made under EPEA in respect of the Project.

AR 113/93 reference: 3(1)(r)

5.18 Additional Information

There is no other information required by the Director with respect to the Project.

Sunshine is also applying for approvals in accordance with the *Oil Sands Conservation Act* (Sections 1 to 4) of this Application and the *Water Act* (Section 6) of this Application.

AR 113/93 reference: 3(1)(s)

6 WATER ACT APPLICATION

Sunshine is applying for a *Water Act* licence to divert water for operation of the proposed West Ells SAGD Project.

The water use requirements for the Project have been estimated to be:

- Steady state operations of the facility:

  Daily volume – 966 m^3

  Annual volume – 352,590 m^3
- Start-up water requirements in addition to steady state requirements:

  Daily volume – an additional 1,075 m3/d is required

  Total temporary volume for start-up – and additional 96,750 m3/y (based on 90 day start up) for two years is required for start up of both phases of development for a total start up requirement of 193,500 m3
- The water supply for the Project will come from both surface and groundwater sources.

6.1 Surface Water Diversion from the Storm Water Retention Pond

Sunshine plans to construct a storm water retention pond on the CPF. The pond will have a water storage capacity of 11,300 m^3. If available, Sunshine plans to utilize up to 79,800 m^3 of this surface water annually in the steam generation process. Sunshine is applying for a license to utilize up to 79,800 m^3 annually of surface water collected in the storm water retention pond.

6.2 Groundwater Diversion

Sunshine will be testing the Viking or Grand Rapids formation in the winter of 2010 to determine its salinity and deliverability as source water for the Project. Sunshine is applying for the following:

- Steady state operations - require annual diversion of 352,590 m^3/year, or 966 m^3/day
- Additional temporary diversion for the Project start-up – 96,750 m^3/y for two years for a total start up requirement of 193,500 m^3

Water recycling will be undertaken. Sunshine will continue to evaluate the potential for brackish water sources that can be used for the Project.

6.3 Conclusions

Sunshine investigated the impacts of disturbances caused by the development of the Project on groundwater and surface water and found those impacts to be negligible. Groundwater

production should have no significant effects on the quantity of water in other formations, the surface water resources or on vegetation. Considering the remoteness of the Project location relative to other groundwater users in the region, it is reasonable to conclude that the impacts to other groundwater users will be low.

Sunshine will require a total of 352,590 m^3 of water per year to run the CPF under steady state conditions. Sunshine requests the full volume from the Viking Formation. Sunshine also plans to utilize surface water collected in the storm water runoff pond, up to a maximum of 79,800 m^3 per year. The use of surface water will result in a reduction of groundwater that will be required; the annual combined supply will not exceed 352,590 m^3. For the start up of the operation, Sunshine requests a temporary license for an additional 193,500 m^3 of groundwater to be supplied from the Viking Formation over two years for the two Project phases.

6.4 Water Act Application

Documents or information provided to Alberta Environment pursuant to section 15(1)(a) of the *Water (Ministerial) Regulation* are public records and are accessible by the public.

Check one or more of the following to indicate type of application:

Diversion of water ☒ Renewal of a licence ☐ Constructing Works ☐

APPLICANT:

Print Name and Company Name (if applicable):		Home Telephone:	Bus. Telephone:
Sunshine Oilsands Ltd.		**N/A**	**(403) 984-1450**
Address (Street, PO Box, etc.):	**Place, Province:**	**Postal Code:**	**Fax:**
1400, 700-4th Ave SW	**Calgary, AB**	**T2P 3J4**	**(403) 455-7674**

Are you the registered landowner? Yes ☐ No ☒ If no, please attach a copy of the consent from the landowner.

Consultant, Signing Authority, or Applicant's Representative (if applicable):

Print Name and Company Name (if applicable):		Home Telephone:	Bus. Telephone:
Jason Hancheruk, RPFT, Sunshine Oilsands Ltd		**N/A**	**(403) 984-5144**
Address (Street, PO Box, etc.):	**Place, Province:**	**Postal Code:**	**Fax:**
1400, 700-4th Ave SW	**Calgary, AB**	**T2P 3J4**	**(780) 464-7662**

Contact Person if not shown above:

Print Name:	Telephone:	Fax:

Project Description:

Tentative Starting Date: 3rd Quarter, 2011
Duration of Construction/Development: 12 months (if applicable)
Duration of Water Diversion/Use: 25 years

Provide a detailed description including location of works and activities relating to the project and attach plans:

Project details are set out in Section 2 of Sunshine's West Ells SAGD Project Application. Specific details concerning water management are set out in Section 2.8 of the Application and, for Hydrogeology, in Section 4.8 of the Application and Consultant Report #4.

Affected Water Sources (Location of Works and Activities):
Surface Water (if only constructing works, complete the first two columns):

Source (e.g. lake, stream, or name of source, if known)	Diversion/Activity Location ¼	sec	twp	rge	m	Annual Quantity (cubic m)	Rate of Diversion (show units)	Is Construction or Development Required? (Yes or No)	Purpose
1. Storm water runoff pond	NE	31	94	17	4	79,800	As available	Yes	SAGD
2.									
3.									

Groundwater:

Date Well Drilled or proposed drilling date	Well (proposed) Locations ¼	sec	twp	rge	m	Total Depth (m)	Production Interval (m)	Pumping Rate (show units)	Annual Quantity (cubic m)	Purpose
1. Winter 2010/11		3	94	17	4	110 -130	110 - 130	966 m3/day	352,590m^3/ year	SAGD
2. Winter 2010/11		4	94	17	4	110 -130	110 - 130			
3. Winter 2010/11		9	94	17	4	110 -130	110 - 130			
4. Winter 2010/11		33	95	17	4	110 -130	110 - 130			
5. Winter 2010/11		34	95	17	4	110 -130	110 - 130			

Please attach a separate sheet if you wish to provide more information.

Statement of Confirmation:

The information given on this form is true to the best of my knowledge.

Mar. 15, 2010		**Songbo Cong**	**Sunshine Oilsands Ltd.**
Date of Signing	**Signature**	**Print Name**	**Company Name (if applicable)**

Return the completed form to an Alberta Environment Regional office nearest you:

Northern Region, Peace River
Bag 900–5 Provincial Building
9621 – 96 Avenue
Peace River, AB T8S 1T4
Telephone **(780) 624-6167**
Fax: (780) 624-6335

Northern Region, Edmonton
Twin Atria
111, 4999 – 98 Avenue
Edmonton, AB T6B 2X3
Telephone: (780) 427-5296
Fax: (780) 427-7824

Spruce Grove
250 Diamond Avenue
Spruce Grove AB T7X 4C7
Telephone: (780) 960-8600
Fax: (780) 960-8605

Central Region, Red Deer
304, Provincial Building
4920 - 51 Street
Red Deer, AB T4N 6K8
Telephone: (403) 340-7052
Fax: (403) 340-5022

Southern Region, Calgary
2938 - 11 Street, NE
Calgary, AB T2E 7L7
Telephone: (403) 297-6582
Fax: (403) 297-2749

2nd Floor, Provincial Building
200 - 5 Avenue, South
Lethbridge, AB T1J 4L1
Telephone: (403) 382-4254
Fax: (403) 381-5337

(call the Regional office for the location of area offices)

OFFICE USE:

File Number:	Fee Receipt Number:	Application ID: Operation ID:
Notice Information:	Application Completion Date:	Priority Number:

7. APPENDICES