Part D - Environmental Impact Assessment

TABLE OF CONTENTS

D. ENVIRONMENTAL IMPACT ASSESSMENT 1
D.1 AIR QUALITY 2
D.1.1 Introduction and Terms of Reference 2
D.1.2 Air Quality and Metorological Observations 5
D.1.3 Emission Estimates 5
D.1.3.1 Existing Emissions 5
D.1.3.2 Project Emissions 6
D.1.3.3 Regional Emissions 6
D.1.4 Assessment Results 7
D.1.4.1 Sulphur Dioxide 7
D.1.4.2 Nitrogen Oxides 8
D.1.4.3 Carbon Monoxide 9
D.1.4.4 Particulate Matter 10
D.1.4.5 Potential Acid Input 11
D.1.4.6 Nitrogen Deposition Leading to Eutrophication 12
D.1.4.7 Volatile Organic Compounds and Polycyclic Aromatic Hydrocarbons 13
D.1.4.8 Ozone 13
D.1.4.9 Odour 13
D.1.4.10 Visibility 14
D.1.4.11 Upset Conditions 14
D.1.5 Mitigation and Monitoring 15
D.1.5.1 Mitigation 15
D.1.5.2 Monitoring 15
D.1.6 Summary 15
D.2 AQUATIC RESOURCES 19
D.2.1 Introduction and Terms of Reference 19
D.2.2 Baseline Conditions 20
D.2.2.1 Water Quality 20
D.2.2.2 Fish Resources 22
D.2.2.3 Physical Aquatic Habitat 23
D.2.2.4 Sediment Quality 24
D.2.2.5 Benthic Invertebrate Communities 24
D.2.2.6 Fish Habitat Suitability 24
D.2.2.7 Acid Sensitivity 25
D.2.3 Predicted Conditions 25
D.2.3.1 Surface Disturbance and Construction Activities 26
D.2.3.2 Intream Construction Activities 26
D.2.3.3 Changes in Surface Water Quality 27
D.2.3.4 Changes to Surface Water Flow Rates and Levels 28
D.2.3.5 Improved or Altered Access to Fish Bearing Waterbodies 28
D.2.3.6 Fish Health and Fish Tainting 29
D.2.3.7 Acidifying Emissions 29
D.2.4 Mitigation and Monitoring 29
D.2.4.1 Mitigation 29
D.2.4.2 Monitoring 30

D.2.5 Summary of VECs 31
D.3 GROUNDWATER 33
D.3.1 Introduction and Terms of Reference 33
D.3.2 Baseline Conditions 34
D.3.2.1 Geology 34
D.3.2.2 Hydrogeology 35
D.3.2.3 Groundwater Chemistry 36
D.3.2.4 Groundwater Use 37
D.3.2.5 Effects of Water Supply Wells on Groundwater Quantity and Levels 37
D.3.2.6 Effects of Surface Facilities on Groundwater Quality 38
D.3.2.7 Effects of Production/Injection Wells on Groundwater Quality 38
D.3.2.8 Effects of Disposal Wells on Groundwater Quality 38
D.3.2.9 Groundwater – Surface Water Interaction 38
D.3.3 Predicted Conditions 39
D.3.3.1 Effects of Water Supply Wells on Groundwater Quantity and Levels 39
D.3.3.2 Effects of Surface Facilities on Groundwater Quality 39
D.3.3.3 Effects of Production/Injection Wells on Groundwater Quality 40
D.3.3.4 Effects of Disposal Wells on Groundwater Quality 41
D.3.3.5 Groundwater – Surface Water Interaction 41
D.3.4 Mitigation and Monitoring 42
D.3.4.1 Mitigation 42
D.3.4.2 Monitoring 42
D.3.5 Summary of VECs 42
D.4 HISTORICAL RESOURCES 44
D.4.1 Introduction 44
D.4.2 Baseline Conditions 45
D.4.3 Predicted Conditions 45
D.4.4 Mitigation and Monitoring 46
D.4.5 Summary 46
D.5 HUMAN AND WILDLIFE HEALTH 46
D.5.1 Introduction and Terms of Reference 46
D.5.2 Assessment Approach 48
D.5.2.1 Problem Formulation 48
D.5.2.2 Exposure Assessment 50
D.5.2.3 Toxicity Assessment 51
D.5.2.4 Risk Characterization 52
D.5.3 Predicted Conditions 54
D.5.3.1 Acute Inhalation Results 54
D.5.3.2 Facility Upset Flaring Event: Acute Inhalation Assessment 54
D.5.3.3 Chronic Inhalation Results 54
D.5.3.4 Chronic Multiple Pathway Results 55
D.5.3.5 Mixture Results 55
D.5.3.6 Wildlife Chronic Soil and Surface Water Ingestion 56
D.5.4 Mitigation and Monitoring 56
D.5.4.1 Mitigation 56
D.5.4.2 Monitoring 56
D.5.5 Summary 56

D.6 HYDROLOGY 57
D.6.1 Introduction and Terms of Reference 57
D.6.2 Baseline Conditions 58
D.6.2.1 Surface Disturbances 58
D.6.2.2 Water Supply 59
D.6.2.3 Runoff Volumes and Streamflows 59
D.6.2.4 Water Levels and Surface Areas 61
D.6.2.5 Channel Morphology and Sediment Concentrations 61
D.6.3 Predicted Conditions 61
D.6.3.1 Surface Disturbances 61
D.6.3.2 Water Supply 62
D.6.3.3 Runoff Volumes and Streamflows 63
D.6.3.4 Water Levels and Surface Areas 64
D.6.3.5 Channel Morphology and Sediment Concentrations 64
D.6.4 Mitigation and Monitoring 64
D.6.4.1 Mitigation 64
D.6.4.2 Monitoring 65
D.6.5 Summary of VECs 65
D.7 NOISE 67
D.7.1 Introduction and Terms of Reference 67
D.7.2 Baseline Conditions 68
D.7.2.1 Permissible Sound Levels 68
D.7.2.2 Baseline Case Noise Levels 68
D.7.3 Predicted Conditions 69
D.7.3.1 Construction Scenario 69
D.7.3.2 Operations Scenario 69
D.7.4 Mitigation and Monitoring 70
D.7.4.1 Mitigation 70
D.7.4.2 Monitoring 70
D.7.5 Summary 70
D.8 SOCIO-ECONOMIC ASSESSMENT 70
D.8.1 Introduction and Terms of Reference 70
D.8.2 Baseline Conditions 72
D.8.2.1 Economic and Fiscal Assessment 72
D.8.2.2 Population Effects 73
D.8.2.3 Social Infrastructure Effects 73
D.8.2.4 Traditional Land and Culture 74
D.8.2.5 Transportation Effects 75
D.8.3 Predicted Conditions 75
D.8.3.1 Economic and Fiscal Assessment 75
D.8.3.2 Population Effects 78
D.8.3.3 Social Infrastructure Effects 78
D.8.3.4 Traditional Land and Culture 79
D.8.3.5 Transportation Effects 80
D.8.4 Mitigation and Monitoring 80
D.8.4.1 Mitigation 80
D.8.4.2 Monitoring 81

D.8.5 Summary ... 81
D.9 SOIL RESOURCES ... 81
D.9.1 Introduction and Terms of Reference ... 81
D.9.2 Baseline Conditions ... 83
D.9.2.1 Thickness of Soil Layers ... 84
D.9.2.2 Forest Soil Capability Classification ... 85
D.9.2.3 Reclamation Suitability ... 86
D.9.2.4 Erosion Risk Assessment ... 86
D.9.2.5 Soil Sensitivity - Acidification ... 87
D.9.3 Predicted Conditions ... 87
D.9.3.1 Soil Quality and Quantity ... 88
D.9.3.2 Erosion ... 90
D.9.3.3 Soil Biodiversity ... 90
D.9.3.4 Accidental Releases ... 91
D.9.3.5 Alteration of Terrain ... 91
D.9.4 Mitigation and Monitoring ... 92
D.9.4.1 Mitigation ... 92
D.9.4.2 Monitoring ... 92
D.9.5 Summary of VECs ... 92
D.10 VEGETATION, WETLANDS AND RARE PLANTS ... 94
D.10.1 Introduction and Terms of Reference ... 94
D.10.2 Baseline Conditions ... 96
D.10.2.1 Ecosite Phases ... 96
D.10.2.2 Rare Plants ... 97
D.10.2.3 Wetlands ... 98
D.10.2.4 Biodiversity ... 99
D.10.2.5 Forestry Resource ... 104
D.10.2.6 Old Growth Forest ... 104
D.10.2.7 Traditional Ecological Knowledge and Land Use ... 105
D.10.2.8 Non-native and Invasive Species ... 105
D.10.2.9 Potential Acid Input and Nitrogen Deposition ... 106
D.10.3 Predicted Conditions ... 106
D.10.3.1 Ecosite Phases ... 106
D.10.3.2 Rare Plants ... 107
D.10.3.3 Wetlands ... 108
D.10.3.4 Biodiversity ... 109
D.10.3.5 Forestry Resource ... 111
D.10.3.6 Old Growth Forest ... 111
D.10.3.7 Traditional Ecological Knowledge and Land Use ... 112
D.10.3.8 Non-native and Invasive Species ... 112
D.10.3.9 Potential Acid Input and Nitrogen Deposition ... 112
D.10.4 Mitigation and Monitoring ... 112
D.10.4.1 Mitigation ... 112
D.10.4.2 Monitoring ... 113
D.10.5 Summary of VECs ... 114
D.11 WILDLIFE ... 117
D.11.1 Introduction and Terms of Reference ... 117

D.11.2 Baseline Conditions 119
D.11.2.1 Wildlife Habitat 119
D.11.2.2 Biodiversity 121
D.11.2.3 Birds 122
D.11.2.4 Ungulates 123
D.11.2.5 Beaver 126
D.11.2.6 Predators 126
D.11.3 Predicted Conditions 127
D.11.3.1 Wildlife Habitat 127
D.11.3.2 Special Status Wildlife Species 127
D.11.3.3 Biodiversity 128
D.11.3.4 Traditional Land Use and Ecological Knowledge 128
D.11.3.5 Birds 128
D.11.3.6 Ungulates 130
D.11.3.7 Beaver 134
D.11.3.8 Predators 134
D.11.4 Mitigation and Monitoring 136
D.11.4.1 Mitigation 136
D.11.4.2 Monitoring 137
D.11.5 Summary of VECs 137
D.12 GREENHOUSE GAS AND CLIMATE CHANGE 141
D.12.1 Introduction and Terms of Reference 141
D.12.2 Greenhouse Gas 141
D.12.2.1 Project GHG Emissions 141
D.12.2.2 Greenhouse Gas Management Strategy 143
D.12.3 Climate Change 144
D.12.3.1 Construction and Decommissioning 145
D.12.3.2 Operations 145
D.12.3.3 Reclamation 145
D.13 LAND AND RESOURCE USE 146
D.13.1 Introduction 146
D.13.2 Baseline Conditions 146
D.13.2.1 Oil Sands Leases 146
D.13.2.2 Petroleum and Natural Gas Licenses and Leases 146
D.13.2.3 Forestry 148
D.13.2.4 Mineral Surface Lease and Miscellaneous Leases 148
D.13.2.5 Pipeline Agreements 151
D.13.2.6 Surface Material Leases, Licenses, and Exploration Disposition 154
D.13.2.7 Major Roads 155
D.13.2.8 Area Operating Agreement 155
D.13.2.9 Easements 155
D.13.2.10 License of Occupation 157
D.13.2.11 Industrial Sample Plot 160
D.13.2.12 Government Holdings 160
D.13.2.13 Miscellaneous Dispositions 160
D.13.2.14 Trapping Areas 160
D.13.2.15 Unique Sites and Special Features 161

D.13.2.16 Recreation and Tourism ... 161
D.13.3 Potential Impacts and Mitigation ... 161
D.13.3.1 Oil Sands Leases ... 161
D.13.3.2 Petroleum and Natural Gas Licences and Leases ... 161
D.13.3.3 Forestry ... 161
D.13.3.4 Mineral Surface Leases and Miscellaneous Leases ... 161
D.13.3.5 Pipeline Agreements ... 162
D.13.3.6 Surface Material Leases, Licences, and Exploration Dispositions ... 162
D.13.3.7 Major Roads ... 162
D.13.3.8 Area Operating Agreement ... 162
D.13.3.9 Easements ... 162
D.13.3.10 License of Occupation ... 162
D.13.3.11 Industrial Sample Plot ... 162
D.13.3.12 Government/Municipal Holdings ... 163
D.13.3.13 Miscellaneous Dispositions ... 163
D.13.3.14 Trappers ... 163
D.13.4 Summary and Conclusions ... 163
D.14 CONSTRAINTS MAPPING ... 163
D.14.1 Approach ... 163
D.14.2 Constraints Criteria – Environmental Considerations ... 164
D.14.2.1 Aquatic Resources (CR #2) ... 164
D.14.2.2 Hydrology (CR # 6) ... 164
D.14.2.3 Vegetation and Wetlands (CR #10) ... 165
D.14.2.4 Soils and Terrain (CR #9) ... 165
D.14.2.5 Wildlife (CR #11) ... 165
D.14.2.6 Historical (CR #4) ... 166
D.14.2.7 Land Use (Sec. D.13) ... 166
D.14.3 Constraints Criteria – Resource Considerations ... 167
D.14.3.1 Resource Utilization and Bitumen Recovery ... 167
D.14.3.2 Project Costs ... 167
D.14.3.3 Footprint ... 167
D.14.3.4 Constraints Evaluation ... 168

List of Tables

Table D.1.2.1 Location of Special Receptors ... 4
Table D.1.3.1 Summary of RSA Emission Rates for the Three Emission Scenarios ... 6
Table D.1.3.2 Changes in Key RSA Emissions ... 6
Table D.1.4.1 Predicted Sulphur Dioxide Concentrations ... 7
Table D.1.4.2 Predicted Nitrogen Dioxide Concentrations ... 8
Table D.1.4.3 Predicted Carbon Monoxide Concentrations ... 9
Table D.1.4.4 Predicted $PM_{2.5}$ Concentrations ... 11
Table D.1.6.1 Summary of Impact on Air Quality VECs ... 16
Table D.2.5.1 Summary of Impact Significance on Aquatic Resource VECs ... 32
Table D.3.5.1 Summary of Impact Significance on Groundwater VECs ... 43
Table D.6.2.1 Summary of Spatial Extent of Existing Development ... 59

Table D.6.2.2	Changes in Runoff Coefficients from Baseline Development	60
Table D.6.3.1	Summary of Spatial Extent of Disturbances (application case)	62
Table D.6.3.2	Changes in Runoff Coefficients from Baseline and Project Development	63
Table D.6.5.1	Summary of Impact Significance on Hydrological VECs	66
Table D.8.2.1	Project GDP and Income Effects	76
Table D.9.2.1	Soil layer thicknesses by SLM	84
Table D.9.2.2	Soil Capability in the LSA and Project Footprint	86
Table D.9.3.1	Baseline and Reclaimed Forest Land Capability Ratings for the Project Footprint (Phases 1 - 3)	88
Table D.9.5.1	Summary of Impact Significance on Soil Resource VECs	93
Table D.10.2.1	Distribution of Ecosite Phases	96
Table D.10.2.2	Wetland Distribution	98
Table D.10.2.3	Biodiversity Potential by Ecosite Phase	99
Table D.10.2.4	Vascular and Non-Vascular Plant Biodiversity Potential in the LSA	100
Table D.10.2.5	Vascular and Non-vascular Plant Biodiversity Potential in the RSA	100
Table D.10.2.6	Fragmentation Metrics for Ecosite Phases in the LSA	102
Table D.10.2.7	Fragmentation Metrics for Ecosite Phases in the RSA	103
Table D.10.2.8	Timber Productivity Rating	104
Table D.10.2.9	Berry species and Characteristic Ecosite Phases	105
Table D.10.5.1	Summary of Impact Significance on Vegetation, Wetland and Rare Plant VECs	115
Table D.11.2.1	Wildlife Habitat Availability	119
Table D.11.2.2	Habitat Availability for each VEC	120
Table D.11.2.3	Biodiversity Ranking in the LSA	121
Table D.11.2.4	Effective Habitat Patches	122
Table D.11.2.5	Caribou core security habitat patch metrics in the LSA	124
Table D.11.2.6	Density of linear features in the LSA and RSA	124
Table D.11.2.7	Guideline or Threshold Values for Cumulative Effects Indicators for Woodland Caribou	125
Table D.11.2.8	Moose core security habitat patch metrics	126
Table D.11.5.1	Summary of Impact Significance on Wildlife VECs	138
Table D.12.2.1	Summary of Annual Greenhouse Gas Emissions	141
Table D.12.2.2	Summary of Total Greenhouse Gas Emissions	142
Table D.12.2.3	Contribution of Connacher Expansion to Provincial and National GHG Emission Inventory	143
Table D.12.3.1	Projected Climate Parameters near Fort McMurray based on the median change scenario (Barrow and Yu 2005)	145
Table D.13.2.1	Oil Sands Leases	146
Table D.13.2.2	Petroleum And Natural Gas Licenses	147
Table D.13.2.3	Petroleum and Natural Gas Leases	147
Table D.13.2.4	Timber Allocations	148
Table D.13.2.5	Mineral Surface Leases and Miscellaneous Leases	148
Table D.13.2.6	Pipeline Installation Leases and Pipeline Agreements	151
Table D.13.2.7	Surface Material Leases and Licenses	154
Table D.13.2.8	Roads	155
Table D.13.2.9	Area Operating Agreement	155
Table D.13.2.10	Easements	155

Table D.13.2.11 Licence of Occupation 157
Table D.13.2.12 Industrial Sample Plot 160
Table D.13.2.13 Government and Municipal Dispositions 160
Table D.13.2.14 Miscellaneous Disposition 160
Table D.13.2.15 Trapping Areas 161
Table D.14.2.1 Environmental and Resource Utilization Constraints 166
Table D.14.2.2 Constraints Evaluation (Phase 1) 169

List of Figures

Figure D.13.2-1 Subsurface Dispositions
Figure D.13.2.-2 Trappers, FMA, ISP, and PNT
Figure D.13.2.-3a Surface Dispositions in Township 83
Figure D.13.2.-3b Surface Dispositions in Township 82
Figure D.13.2.-3c Surface Dispositions in Township 81
Figure D.14.0-1 Constraints Map

D. ENVIRONMENTAL IMPACT ASSESSMENT

This section of the Connacher Great Divide Expansion Project (the Project) application constitutes the Environmental Impact Assessment for the Project. Environmental baseline reports and impacts for each Project discipline are contained in Consultant Reports (CR #1 to CR #11). This section includes Connacher's evaluation and summary of pertinent information from each of the Consultant Reports along with commitments to monitoring and mitigation measures relating to the environmental resources associated with the Project. The Socio-Economic Impact Assessment is presented in Consultants Report #8 (CR #8) and also evaluated in this section.

The full methodology used in this assessment was provided in Part C. The Project will be developed in three phases covering approximately 521 ha. Due to differences in computer programs used for the modelling, there may be slight variations in the total disturbance areas used for the assessments. These differences are very small and do not impact the findings of the impact assessments.

The three development phases include:

Phase 1:

- expansion of the CPF by 3,800 m^3/day which will occur entirely within the existing Algar CPF footprint;
- additional lay down area adjacent to the CPF will be required;
- additional area for remote sumps will be required;
- nine well pads with 59 well pairs, required to increase production by 3,800 m^3/day (24,000 barrels/day);
- access roads and infrastructure, including borrow pits;
- total estimated footprint required is 145.5 ha.

Phase 2:

- twelve well pads with 73 well pairs, required to maintain the full production of 7,000 m^3/day (44,000 barrels/day);
- access roads and infrastructure, including borrow pits;
- additional area for remote sumps;
- total estimated footprint required is 189.9 ha.

Phase 3:

- nineteen well pads with 83 well pairs, required to maintain the full production of 7,000 m^3/day (44,000 barrels/day);
- access roads and infrastructure, including borrow pits;
- additional area for remote sumps;
- total estimated footprint required is 186.3 ha.

The final Terms of Reference were issued for the Project on July 17, 2009 and contained a number of conditions related to the information requirements for this application. These conditions from the Terms of Reference have been addressed in this section of the report and in the specific consultant's reports.

The Project EIA considers the following assessment scenarios:

- Baseline Case, which includes existing environmental conditions and existing projects or “approved” activities;
- Application Case, which includes the Baseline Case plus the Project; and
- Planned Development Case (Cumulative Effects), which includes the “Application Case” combined with past studies, existing and anticipated future environmental conditions, existing projects or activities, plus other “planned” projects or activities.

For the purposes of defining assessment scenarios, “approved” means approved by any federal, provincial or municipal regulatory authority, and “planned” means any project or activity that has been publicly disclosed prior to the issuance of the Project’s Terms of Reference or up to six months prior to the submission of the Project Application and the EIA report, whichever is most recent.

The EIA report has addressed impact concerns by identifying Valued Environmental Components (VECs). VECs for the Project are those environmental attributes associated with the proposed project development, which have been identified to be of concern either by directly-affected stakeholders, government or the professional community. VECs consider both biophysical (i.e., ecosystem) and socio-economic attributes because of the broad-based definition of environmental effect as outlined both in federal and provincial legislation.

The factors used to assess the predicted environmental effects of the Project are specific to the VECs for each biophysical or socio-economic component. For example, the assessment of environmental effects and determination of significance for each VEC which is population based (e.g. fish, wildlife, vegetation) may not be applicable for those VECs which are not population based (e.g. air quality, groundwater). This section identifies potential adverse effects and the assessment of their significance. Where possible, the determination of significance makes reference to existing standards, guidelines or recognized thresholds (e.g., Alberta Ambient Air Quality Objectives).

D.1 AIR QUALITY

D.1.1 Introduction and Terms of Reference

Connacher conducted an air quality assessment for the proposed Project. The following section is a summary of the Air Quality Assessment that was prepared by Millennium EMS Solutions Ltd. and included as Consultants Report #1 (CR #1). For full details of the assessment please refer to CR #1.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the Air Quality Impact Assessment components are provided in Section 2.7 and 3.2 and are as follows:

2.7 Air Emissions Management

[A] Provide emission profiles (type, rate and source) for the Project’s operating and construction emissions including point and non-point sources and fugitive emissions. Consider both normal and upset conditions. Discuss:

a) odorous or visible emissions from the proposed facilities;
b) annual and total greenhouse gas emissions during all stages of the Project. Identify the primary sources and provide examples of calculations;
c) the intensity of greenhouse gas emissions per unit of bitumen produced and discuss how it compares with similar projects;

d) *the Project's contribution to total provincial and national greenhouse gas emissions on an annual basis;*
e) *Connacher's overall greenhouse gas management plans;*
f) *amount and nature of Criteria Air Contaminants emissions;*
g) *the amount and nature of acidifying emissions, probable deposition patterns and rates;*
h) *control technologies used to minimize air emissions such as sulphur dioxide (SO2), hydrogen sulphide (H2S), oxides of nitrogen (NOX), greenhouse gases, volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), particulate matter (PMX), carbon monoxide (CO) and ammonia;*
i) *emergency flaring scenarios (e.g., frequency and duration) and proposed measures to ensure flaring events are minimized;*
j) *upset condition scenarios (e.g., frequency and duration) and proposed measures to ensure upset conditions are minimized;*
k) *gas collection and conservation, and the applicability of vapour recovery technology;*
l) *applicability of sulphur recovery, acid gas re-injection, or flue gas desulphurization to reduce sulphur emissions; and*
m) *fugitive emissions control technology to detect, measure and control emissions and odours from equipment leaks.Section 3.2.1 Baseline Information*

[B] Discuss the baseline climatic and air quality conditions including:
a) *the type and frequency of meteorological conditions that may result in poor air quality; and*
b) *appropriate ambient air quality parameters such as SO2, H2S, total hydrocarbons (THC), NOX, VOC, PAHs, individual hydrocarbons of concern in the THC, VOC and PAH mixtures, ground-level ozone (O3), visibility, odours, representative heavy metals, and particulates (road dust, PM10 and PM2.5).Provide representative baseline noise levels at receptor locations.*

3.2.2 Impact Assessment

[C] Identify components of the Project that will affect air quality, and:
a) *describe the potential for reduced air quality (including odours and visibility) resulting from the Project and discuss any implications of the expected air quality for environmental protection and public health;*
b) *estimate ground-level concentrations of appropriate air quality parameters;*
c) *discuss any expected changes to particulate deposition, nitrogen deposition or acidic deposition patterns;*
d) *identify areas that exceed Potential Acid Input (PAI) critical loading criteria;*
e) *discuss interactive effects that may occur as a result of co-exposure of a receptor to all emissions; and*
f) *describe air quality impacts resulting from the Project, and their implications for other environmental resources, including habitat diversity and quantity, soil resources, vegetation resources, and water quality.Identify stages or elements of the Project that are sensitive to changes or variability in climate parameters, including frequency and severity of extreme weather events. Discuss what impacts the change to climate parameters may have on elements of the Project that are sensitive to climate parameters.*

[D] Identify components of the Project that have the potential to increase noise levels and discuss the implications. Present the results of a noise assessment. Include:
a) *potentially-affected people and wildlife;*
b) *an estimate of the potential for increased noise resulting from the development; and*
c) *the implications of any increased noise levels.Describe how air quality and noise impacts resulting from the Project will be mitigated.*

[E] Describe the residual air quality and noise effects of the Project and Connacher's plans to manage those effects.

3.2.3 Monitoring

[A] Describe the monitoring programs proposed to assess any Project impacts to air quality and noise and to measure the effectiveness of mitigation.

[B] Describe any monitoring programs proposed to monitor the effects of acid deposition.

The Local (LSA) and regional study (RSA) areas were chosen based on the location of major regional industrial emission sources and the expected spread of project concentration and deposition contours. For the Project, maximum concentrations are expected to occur within 5km of the main emission sources and decrease with increasing distince beyond this point. The LSA is a 30 km by 30 km square centred approximately on Connacher's existing Algar and Great Divide operations (CR#1, Figure 2.1). The RSA is about 220 km by 330 km and includes the mining areas in the northern oilsands, down to the Air Weapons Range in the south (CR#1, Figure 2.1).

A number of potential VECs were identified during the issue scoping process as they relate to potential human or ecosystem health effects (CR #1, Section 2.2). Therefore the project VECs were:

- NO_2, SO_2, H_2S, CO, specific VOCs and PAHs;
- Potential Acid Input (PAI) and eutrophication (nitrogen deposition);
- GHG Emissions; and
- O_3.

In accordance with recent modelling practice, the CALMET and CALPUFF models were used in the air quality assessment as recommended models by AENV (2009a).

The dispersion model was applied to the three assessment scenarios. Predictions were made at a large number of specific locations in the community as listed in Table D.1.2.1 and shown in CR#1, Figure 2.1. Maximum points of impingement concentration in the LSA and RSA were based on modelling within the grid of receptors.

Table D.1.2.1 Location of Special Receptors

		UTM-E (km)	UTM-N (km)	Distance to Project (km)
R1	Connacher Algar Operators Camp	453.280	6219.360	2.4
R2	Connacher Algar Construction Camp	453.995	6219.050	1.6
R3	Connacher Great Divide Operators Camp	448.030	6219.230	7.6
R4	Romeo Gauthier new cabin	449.986	6219.240	5.6
R5	Don Huppie cabin	457.350	6233.375	15
R6	Romeo Gauthier old cabin	449.448	6220.145	6.3
R7	Algar Fire Lookout (old)	449.182	6219.915	6.5
R8	Algar Fire Lookout (new)	455.272	6224.245	5.3

D.1.2 Air Quality and Metorological Observations

Air quality and metorological observations for SO_2, NO_2, and $PM_{2.5}$, O_3, CO, and H_2S from the WBEA air quality monitoring stations nearest the proposed Project (Athabasca Valley, Patricia McInnes and Anzac) during the five-year period 2004 to 2008 were used in dispersion modelling (CR #1, Table 3.1). In summary the data indicates

- no exceedences of air quality objectives for SO_2;
- no exceedences of the NO_2 objectives occurred at the stations;
- $PM_{2.5}$ exceedences were measured for the AAAQO but not the Canada Wide Standard (CWS) which indicates that high measurements occur very infrequently;
- maximum 1-h O_3 concentrations exceed the AAAQO at all stations and that the CWS for ozone is not exceeded at any of the stations; and
- CO measured in Fort McMurray is less than half of applicable ambient objectives.

The maximum H_2S concentrations observations in the heart of the oil sands mining areas exceed AAAQOs (CR #1, Table 3.2). Although no measurements are available near the Project, it is expected these measurements substantially over-estimate concentrations in that area.

Potential acid input (PAI) deposition rates are estimated from continuous WBEA measurements from 2001 to 2007 and passive measurements from 2002 to 2004. The PAI estimates show substantial spatial variability with the smallest values based on measurements at Anzac and the largest values in Fort McMurray (CR #1, Table 3.3).

The CALMET interpolation of MM5 winds show the majority of winds blow from the southwest (CR #1, Figure 3.1).

Atmospheric stability controls dispersion of plumes. Stable atmospheres, most common at night and in winter, limit dispersion and enhance the channelling effects of terrain. Unstable conditions result in greater mixing and can result in elevated plumes impinging the surface. Based on the output from the CALMET meteorological model unstable conditions occur most often in spring and summer, and during midday, and stable conditions most often in winter (CR #1, Figure 3.2).

Mixing heights determine the extent to which emitted plumes are mixed in the vertical. Median mixing heights range from near 200 to 300 m during winter to over 1000 m during spring and summer afternoons (CR #1, Figure 3.3). Mixing heights show substantial diurnal variation in spring and summer, with the largest values in the afternoon due to thermal effects and values near 200 m at night due to mechanical turbulence.

D.1.3 Emission Estimates

D.1.3.1 Existing Emissions

The existing Algar facility operates six point sources with continuous emissions. These sources include two steam boilers, one utility boiler, one glycol heater, one crystallizer stack, and one cogen unit. The existing Algar facility is currently licensed to emit 1.98 t/d of SO_2.

The existing Great Divide Pod One Project operates five point sources with continuous emissions. These sources include two steam boilers, one utility boiler, one glycol heater and one recycle treater. The Pod One facility is currently licensed to emit 1.98 t/d of SO_2.

The Baseline Case emissions estimate for the existing Algar facility and Great Divide facility are summarized as follows: 3.96 t/d SO_2, 1.18 t/d NO_x, 2.31 t/d CO and 0.09 t/d $PM_{2.5}$ (CR #1, Table 4.1).

D.1.3.2 Project Emissions

Natural gas will be the prime fuel source for the Project. Some produced gas from the reservoir will be recovered and burned with the natural gas. Emissions for the Project were estimated based on an overall expanded production capacity of 5,400 m^3/day at the Algar plant (3,800 m^3/day from the Project, 1,600 m^3/day from the existing facility) and the conservative assumption that the steam-oil ratio for the Project will be 4.0 (compared to 3.0 for the existing Algar facility). Continuous emission sources at the proposed facility include five steam boilers, a utility boiler, a glycol heater, and a cogeneration unit. Flare stacks are used for emergency only.

As emissions from the existing Algar facility are modified because of the operation of the Project, the emission estimates from the existing Algar facility have been updated for the assessment. Emission estimates for the Project (application case) which include the existing Great Divide and existing Algar facilities are as follows: 3.97 t/d SO_2 (limits in EPEA approvals), 3.32 t/d NO_x, 8.59 t/d CO and 0.24 t/d $PM_{2.5}$ (CR #1, Table 4.2).

D.1.3.3 Regional Emissions

Emissions within the RSA from existing operating facilities, approved but not yet operating facilities, and proposed facilities, including those under regulatory review, were collected from various public domain documents. The data collected from these documents were based on continuous emissions that would be representative of typical operating conditions at the various facilities at full production capacity. The data were then used as model input in the three emission scenarios. Table D.1.3.1 summarizes the RSA emission rates of criteria air contaminants (CACs) for the three emission scenarios. The projects considered for each emission scenario are provided in CR #1, Table 4.4.

Table D.1.3.1 Summary of RSA Emission Rates for the Three Emission Scenarios

Emission Scenarios	RSA Emission Rates [t/d]			
	SO_2	NO_x	CO	$PM_{2.5}$
Baseline Emission Scenario	245.0	450.1	444.4	32.4
Application Emission Scenario	245.0	452.2	450.8	32.5
PDC Emission Scenario	280.6	541.0	598.0	40.5

Table D.1.3.2 summarizes estimated Project emissions and compares emission totals for the three assessment scenarios.

Table D.1.3.2 Changes in Key RSA Emissions

Scenario	SO_2 (t/d)	NO_x (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)
Connacher Expansion only (t/d)	0	2.1	6.3	0.15
Baseline (t/d)	245	450.1	444.4	32.4
Application (t/d)	245	452.2	450.8	32.5

Table D.1.3.2 Changes in Key RSA Emissions

Scenario	SO_2 (t/d)	NO_x (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)
Expansion increase relative to Baseline (%)	*0*	*0.4*	*1.4*	*0.5*
PDC (t/d)	281	541	598	40.5
PDC increase relative to Baseline (%)	*15*	*20*	*35*	*25*

D.1.4 Assessment Results

D.1.4.1 Sulphur Dioxide

Modelling (CALPUFF) results indicate indicate that there are no exceedences of the AENV Alberta ambient air quality objectives (AAAQOs) predicted at any locations for the three assessment scenarios (Table D.1.4.1).

Modelling predicts reductions in SO_2 concentrations or no change at all locations from the Baseline to Application phases and both increases and decreases from the Baseline to the PDC phase. Concentration decreases near the Project in Application and PDC cases are the result of engineering changes in stack parameters (such as height) while keeping emissions constant. Relative increases in concentration during the PDC case at some locations are the result of small increases in predicted concentration from additional industrial operations in the region.

The highest SO_2 concentration in the RSA for all averaging periods occur in the mining area north of Fort McMurray(CR #1, Figure 4.1 to 4.9). In the LSA, the maximum occurs near the expanded Project central facility.

Table D.1.4.1 Predicted Sulphur Dioxide Concentrations

	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	PDC ($\mu g/m^3$)	Connacher Only ($\mu g/m^3$)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
99.9th Percentile 1-hour						
Overall Maximum (RSA-MPOI)	271	271	271	-	0	0
Local Area Maximum (LSA-MPOI)	130	102	102	101	-22	-21
R1 - Algar Operators Camp	71	59	61	58	-18	-14
R2 - Algar Construction Camp	90	79	81	78	-12	-10
R3 - Great Divide Operators Camp	44	44	48	42	0	9
R4 - Cabin	52	51	51	51	-3	-3
R5 - Cabin	41	41	48	9	0	15
R6 - Cabin	50	50	51	50	-1	1
R7 - Algar Fire Lookout (old)	40	40	41	34	0	3
R8 - Algar Fire Lookout (new)	49	38	46	37	-23	-6
AENV AAAQO	**450**	**450**	**450**	**450**		
99.7th Percentile 24-hour						
Overall Maximum (RSA-MPOI)	62	62	63	-	0	0
Local Area Maximum (LSA-MPOI)	35	27	28	27	-23	-22
R1 - Algar Operators Camp	21	18	20	17	-15	-7
R2 - Algar Construction Camp	22	16	17	15	-26	-23
R3 - Great Divide Operators Camp	12	12	14	9	0	14

Table D.1.4.1 Predicted Sulphur Dioxide Concentrations

	Baseline ($\mu g/m^3$)	Application ($\mu g/m^3$)	PDC ($\mu g/m^3$)	Connacher Only ($\mu g/m^3$)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
R4 - Cabin	13	13	14	13	0	10
R5 - Cabin	12	12	14	3	0	13
R6 - Cabin	12	12	14	11	0	17
R7 - Algar Fire Lookout (old)	12	12	14	7	0	16
R8 - Algar Fire Lookout (new)	12	12	14	6	-2	12
AENV AAAQO	**150**	**150**	**150**	**150**		
Annual Average						
Overall Maximum (RSA-MPOI)	7.4	7.4	7.8	-	0	5
Local Area Maximum (LSA-MPOI)	3.3	2.7	3.1	2.6	-19	-7
R1 - Algar Operators Camp	2.8	2.6	3.0	1.6	-4	10
R2 - Algar Construction Camp	2.7	2.5	2.9	1.5	-7	7
R3 - Great Divide Operators Camp	1.3	1.3	1.7	0.4	-3	27
R4 - Cabin	2.7	2.6	3.1	1.5	-2	15
R5 - Cabin	1.6	1.6	2.2	0.2	-1	36
R6 - Cabin	2.1	2.1	2.5	1.1	-2	19
R7 - Algar Fire Lookout (old)	1.6	1.6	2.0	0.5	-3	23
R8 - Algar Fire Lookout (new)	1.9	1.8	2.4	0.7	-5	22
AENV AAAQO	**30**	**30**	**30**	**30**		

D.1.4.2 Nitrogen Oxides

The model results in no exceedences of the AENV AAAQOs for any of the assessment scenarios (Table D.1.4.2). Increases over Baseline are small in an absolute sense at all locations, with percentage increases ranging up to 8% for hourly predictions, 3% for daily and 15% for annual at the Algar construction camp immediately adjacent to the Project. In the LSA, concentrations increase as a result of increased SAGD development in the area. Absolute increases are small. The highest NO_2 concentrations in the LSA occur adjacent to Highway 63 near the existing Great Divide plant site (CR #1, Figure 4.10 to 4.18).

Table D.1.4.2 Predicted Nitrogen Dioxide Concentrations

	Baseline (µg/m3)	Application (µg/m3)	PDC (µg/m3)	Connacher Only (µg/m3)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
99.9th Percentile 1-hour						
Overall Maximum NO_x (RSA-MPOI)	2,577	2,577	1,763	-	0	-32
Local Area Maximum NO_x (LSA-MPOI)	375	375	553	-	0	47
Overall Maximum NO_2 (RSA-MPOI)	209	209	176	-	0	-16
Local Area Maximum NO_2 (LSA-MPOI)	87	87	104	72	0	19
R1 - Algar Operators Camp	66	69	70	68	5	6
R2 - Algar Construction Camp	65	71	71	70	8	9
R3 - Great Divide Operators Camp	62	62	66	32	0	8
R4 - Cabin	74	74	77	45	0	4
R5 - Cabin	66	66	67	15	0	1
R6 - Cabin	73	73	76	42	0	3
R7 - Algar Fire Lookout (old)	66	66	67	37	1	2
R8 - Algar Fire Lookout (new)	62	68	67	66	8	8
AENV AAAQO	**400**	**400**	**400**	**400**		

Table D.1.4.2 Predicted Nitrogen Dioxide Concentrations

	Baseline (µg/m3)	Application (µg/m3)	PDC (µg/m3)	Connacher Only (µg/m3)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
99.7th Percentile 24-hour						
Overall Maximum NO_x (RSA-MPOI)	962	962	657	-	0	-32
Local Area Maximum NO_x (LSA-MPOI)	84	84	118	-	0	41
Overall Maximum NO_2 (RSA-MPOI)	95	95	80	-	0	-16
Local Area Maximum NO_2 (LSA-MPOI)	42	42	45	42	0	9
R1 - Algar Operators Camp	34	34	36	34	2	6
R2 - Algar Construction Camp	33	34	35	34	3	4
R3 - Great Divide Operators Camp	33	33	34	12	0	3
R4 - Cabin	36	37	40	17	1	10
R5 - Cabin	34	34	35	5	1	4
R6 - Cabin	35	35	38	15	0	7
R7 - Algar Fire Lookout (old)	33	33	34	15	0	3
R8 - Algar Fire Lookout (new)	33	33	35	20	1	6
AENV AAAQO	**200**	**200**	**200**	**200**		
Annual Average						
Overall Maximum NO_x (RSA-MPOI)	144	144	104	-	0	-28
Local Area Maximum NO_x (LSA-MPOI)	18	19	27	-	3	46
Overall Maximum NO_2 (RSA-MPOI)	39	39	33	-	0	-14
Local Area Maximum NO_2 (LSA-MPOI)	15	15	18	6.8	1	19
R1 - Algar Operators Camp	7.5	8.4	11	1.9	13	47
R2 - Algar Construction Camp	6.1	7.0	9	1.8	15	48
R3 - Great Divide Operators Camp	4.8	5.1	6.6	0.7	6	37
R4 - Cabin	13	13	16	1.4	1	18
R5 - Cabin	5.3	5.5	7.2	0.3	3	36
R6 - Cabin	7.7	8.1	11	1.5	5	39
R7 - Algar Fire Lookout (old)	5.3	5.7	7.5	1.1	8	40
R8 - Algar Fire Lookout (new)	5.0	5.6	7.3	1.1	12	47
AENV AAAQO	**60**	**60**	**60**	**60**		

D.1.4.3 Carbon Monoxide

Results of modeling indicates there are no exceedences of the AENV AAAQOs at the MPOI or any of the receptors (Table D.1.4.3). The Project is expected to have negligible impact on CO values at the regional and local MPOIs and result in a small absolute increase at camp or cabin locations nearest the central plant. All maximum values occur near Highway 63 adjacent to the existing Great Divide central plant (CR #1, Figure 4.19 to 4.24).

Table D.1.4.3 Predicted Carbon Monoxide Concentrations

	Baseline (µg/m3)	Application (µg/m3)	PDC (µg/m3)	Connacher Only (µg/m3)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
99.9th Percentile 1-hour						
Overall Maximum (RSA-MPOI)	2,624	2,624	3,951	-	0	51
Local Area Maximum (LSA-MPOI)	2,392	2,392	3,553	658	0	49

Table D.1.4.3 Predicted Carbon Monoxide Concentrations						
	Baseline (µg/m3)	**Application (µg/m3)**	**PDC (µg/m3)**	**Connacher Only (µg/m3)**	**Application Increase Over Baseline (%)**	**PDC Increase Over Baseline (%)**
R1 - Algar Operators Camp	243	275	364	231	13	50
R2 - Algar Construction Camp	155	375	384	313	142	147
R3 - Great Divide Operators Camp	98	104	143	61	7	47
R4 - Cabin	1,012	1,012	1,500	90	0	48
R5 - Cabin	85	85	118	33	0	39
R6 - Cabin	1,002	1,002	1,485	80	0	48
R7 - Algar Fire Lookout (old)	217	217	316	76	0	46
R8 - Algar Fire Lookout (new)	129	169	208	146	31	61
AENV AAAQO	**15,000**	**15,000**	**15,000**	**15,000**		
Maximum 8-hour Average						
Overall Maximum (RSA-MPOI)	1,527	1,528	2,147	-	0	41
Local Area Maximum (LSA-MPOI)	1,228	1,229	1,814	594	0	48
R1 - Algar Operators Camp	185	185	268	128	0	45
R2 - Algar Construction Camp	113	166	170	159	48	51
R3 - Great Divide Operators Camp	72	72	105	49	0	47
R4 - Cabin	858	858	1270	73	0	48
R5 - Cabin	71	71	97	21	0	37
R6 - Cabin	595	597	883	65	0	48
R7 - Algar Fire Lookout (old)	197	199	292	48	1	48
R8 - Algar Fire Lookout (new)	68	77	98	75	13	44
AENV AAAQO	**6,000**	**6,000**	**6,000**	**6,000**		

D.1.4.4 Particulate Matter

The CALPUFF model was used to estimate the concentration of $PM_{2.5}$ that could occur for the three assessment scenarios. The secondary production of nitrates and sulphates within the dispersion model is included in the predicted results along with direct emissions. Results of the modeling indicates that the Canada Wide Standard for predicted PM2.5 would be exceeded only at the regional MPOI in all emission scenarios, and at the local MPOI in no scenarios (Table D.1.4.4). The AENV AAAQO is exceeded at the regional MPOI in all scenarios and at the local MPOI in the PDC scenario. The 1-h AAAQG is exceeded at the regional and local MPOIs, the latter due to assumed emissions from diesel highway traffic.

The RSA maximum is near a mine in the Baseline scenario and in Fort McMurray in the PDC case, based on a projected increase in population. In the LSA, the exceedence in the PDC case is due to an assumed increase in future traffic on the highway.

The Project contribution to $PM_{2.5}$ concentrations is small in the Application scenario at all locations. The Connacher contribution at most locations is small. In particular, at the local MPOI, the contribution is about 20%, with the remainder largely due to traffic sources.

In the LSA, the highest values are associated with traffic emissions on Highway 63 and emissions from the existing Great Divide facility west of the highway (CR #1, Figures 25 to 4.27).

Table D.1.4.4 Predicted $PM_{2.5}$ Concentrations

	Baseline (µg/m3)	Applicatio n (µg/m3)	PDC (µg/m3)	Connacher Only (µg/m3)	Application Increase Over Baseline (%)	PDC Increase Over Baseline (%)
9th Maximum 1-hour Average						
Overall Maximum (RSA-MPOI)	141	141	206	-	0	46
Local Area Maximum (LSA-	120	120	178	13	0	48
R1 - Algar Operators Camp	15	15	21	5.8	5	45
R2 - Algar Construction Camp	16	16	18	7.7	4	15
R3 - Great Divide Operators Camp	15	15	18	1.9	0	17
R4 - Cabin	53	53	79	2.6	0	47
R5 - Cabin	16	16	17	1.1	0	2
R6 - Cabin	51	51	75	2.6	0	47
R7 - Algar Fire Lookout (old)	17	17	24	2.4	0	44
R8 - Algar Fire Lookout (new)	14	14	16	4.0	0	15
AENV AAAQG	**80**	**80**	**80**	**80**		
99.7th Percentile 24-hour						
Overall Maximum (RSA-MPOI)	50	50	61	-	0	22
Local Area Maximum (LSA-	25	25	35	5.7	0	41
R1 - Algar Operators Camp	6.5	6.5	10	1.9	0	61
R2 - Algar Construction Camp	6.2	6.2	9.0	1.9	0	47
R3 - Great Divide Operators Camp	5.8	5.8	7.9	0.6	0	36
R4 - Cabin	15	15	20	0.7	0	36
R5 - Cabin	6.9	6.9	8.8	0.3	0	28
R6 - Cabin	11	11	16	0.6	0	46
R7 - Algar Fire Lookout (old)	6.5	6.5	8.4	0.7	0	30
R8 - Algar Fire Lookout (new)	6.1	6.1	7.8	0.7	0	27
AENV AAAQO	**30**	**30**	**30**	**30**		
98th Percentile 24-hour						
Overall Maximum (RSA-MPOI)	36	36	45	-	0	26
Local Area Maximum (LSA-	15	15	22	3.6	0	45
R1 - Algar Operators Camp	4.6	4.6	7.3	0.9	1	60
R2 - Algar Construction Camp	4.3	4.3	7.0	1.0	0	62
R3 - Great Divide Operators Camp	3.7	4.0	5.5	0.5	8	47
R4 - Cabin	10	10	14	0.4	0	43
R5 - Cabin	4.3	4.3	5.3	0.2	1	24
R6 - Cabin	7.6	7.6	11	0.5	0	40
R7 - Algar Fire Lookout (old)	4.4	4.4	6.5	0.4	1	48
R8 - Algar Fire Lookout (new)	3.7	3.7	5.6	0.4	1	51
CWS	**30**	**30**	**30**	**30**		

D.1.4.5 Potential Acid Input

CALPUFF was used to estimate the deposition of PAI that would occur for the assessment scenarios. Precursor emissions include NO_x and SO_2. Use of CASA critical, target and monitoring loads uncoupled from RELAD modeling is limited to the use of these values in the identification of areas potentially at risk of becoming acidified. The provincial acid deposition management framework specifies that an exceedence of a target load at a local scale (e.g., project EIA) is not to be considered to be an exceedence of an environmental objective.

Modeled (CALPUFF) results in the RSA indicate the maximum predicted PAI value is 1.5 keq/ha/yr in Baseline and Application cases, dropping to 1.1 keq/ha/yr in the PDC case as a result of NOx emission reductions from mine fleets (CR #1, Table 4.16). In the Application case, the area within the CASA critical load (0.25 keq/ha/yr) in the RSA is 2800 km^2. The area within the CASA monitoring load (0.17 keq/ha/yr) is 4900 km^2. These area estimates include the area of all disturbed lands within the PAI isopleths. The results of CALPUFF modelling also indicate that the Project contributes no additional PAI to the local MPOI, nothing to the area above the monitoring load and nothing to the area above the critical load.

PDC emissions result in a decrease of 29% in the maximum predicted deposition at the regional (RSA) MPOI as well as increases of about 11 and 24% above Baseline in the area within the monitoring and critical load thresholds, respectively.

In the LSA, the maximum predicted PAI remains constant at 0.27 keq/ha/yr in the Application case and then increases to 0.29 ke/ha/yr in the PDC case, as a result of increased emissions from SAGD projects. Also in the Application case, the area above the 0.17 keq/ha/yr threshold increases by a large relative amount, although the absolute increase due to the Project is 0.06 km^2 (about 6 ha) – a very small value.

PAI averaged over 1° latitude by 1° longitude grid cells (CR #1, Table 4.17) indicates the Project contributes to small increases in grid-average deposition in two grid cells (increases of 1 and 3%). Increases in the PDC scenario are predicted in all RSA grid cells but one.

Patterns of annual PAI deposition in the three assessment scenarios show regional maxima in the mining area north of Fort McMurray and smaller local maxima associated with traffic on Highway 63 near the Great Divide central facility (CR #1, Figure 4.28 to 4.30).

D.1.4.6 Nitrogen Deposition Leading to Eutrophication

Deposition of nitrogen can lead to eutrophication in water bodies or changes in growth rates of terrestrial vegetation and its calculation includes both wet (removal in precipitation) and dry (direct contact with surface features) processes. NO_2 was assumed to be deposited by dry processes only, based on annual average predicted concentrations and a locally determined deposition velocity.

Results of the modeling, indicating that the regional maximum predicted N deposition is 7.5 kg/ha/yr (CR #1, Table 4.18). The most sensitive ecosystems in the region may be affected by as little at 5 kg/ha/yr of deposited nitrogen (WHO 2000). The Baseline area above this threshold is 40,000 km^2 in the RSA. There is no deposition above this threshold in the LSA and the Project contribution is therefore negligible as well.

In the LSA, where the impacts of mine fleet NO_x emission reductions are negligible, the increases in maximum deposition and area affected are due to regional growth of SAGD facilities and assumed highway traffic increases. While the increases appear large in a relative sense, the actual Application-case increase in area above 2 kg/ha/yr (which is a very low rate of deposition), is equivalent to a 10 by 10 km area.

The regional MPOI is in the mining area north of Fort McMurray and the local maxima are south of the operating Great Divide facility and Highway 63 (CR #1, Figures 4.31 to 4.33).

D.1.4.7 Volatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

The chemical compounds assessed in the section have been identified as those emitted by the proposed facility that may potentially have a deleterious effect on human health if present in air in sufficient concentration, and whose concentrations are subject to AAAQOs.

Predictions of the impact of COPCs at MPOI, community and receptor locations near the Project are presented here and include Acetaldehyde, Benzene, Benzo(a)Pyrene, Formaldehyde, n-Hexane, Hydrogen Sulphide, Toluene and xylenes. Potential impacts from other COPCs are considered in the Human Health Risk Assessment (Section D.5).

There were no predicted exceedences of AAAQOs of any COPC at the local MPOIs or at any of the cabin/camp receptors but there were predicted hourly exceedences at the regional MPOI for the following chemicals: benzene, H2S, toluene, and xylenes (CR #1, Table 4.19 to 4.26). There were predicted daily exceedences at the regional MPOI for H_2S, toluene, and xylenes.

All regional MPOIs occur in the mining area north of Fort McMurray.

For most COPCs, the contribution of the Project at any location was negligible. For others, absolute contributions were small even though percentage increases may be larger. The largest absolute and percentage increases were for formaldehyde and n-hexane at receptors nearest the expansion Project, although the predictions were much less than AAAQOs.

D.1.4.8 Ozone

There is a potential for the photochemical production of surface ozone (O_3) from emissions of anthropogenic NO_x, anthropogenic VOC, and biogenic VOC compounds. The monitoring results suggested emissions from the key points sources in the area contributed up to an additional 30 ppb of ozone downwind. The potential for high ozone production exists for a relatively small number of hours each year.

Observations of ozone in the oilsands area have been summarized by AENV (2009c) for three year periods from 2001 to 2007, in accordance with CWS protocol. Measurements were typically in the 50-57 µg/m3 range, with no evidence of regional trends.

Photochemical models can be used to predict the secondary formation of ozone based on precursor emissions and meteorological conditions. Based on the application of CALGRID model results, the Project contributes to a 0.5% increase in regional NO_x emissions and therefore the contribution to regional ozone would be approximately 0.035%, which is a negligible increase. In the PDC scenario, in which background emissions of NO_x are expected to increase by 20% compared to Baseline, the predicted increase in ozone concentration would be less than 1.5%. Based on CMAQ model results, the addition of NO_x emissions from the Project would also result in a negligible change in O_3 concentrations in the region.

D.1.4.9 Odour

The predicted maximum air concentrations for COPCs are compared with established odour thresholds or those AAAQOs that have been established based on odour perception.

All predicted 3-minute, 9th highest concentrations at the MPOI in the LSA were well below odour thresholds; most predicted concentrations are fractions of a percent of the lower threshold. Predicted concentrations of NO_2 were about 40% of the AAAQO (and lower odour threshold). Predicted concentrations at the nearest camps and cabins were lower than MPOI predictions.

D.1.4.10 Visibility

Three types of visibility are considered: appearance of stacks, flames at flare tip, and presence of steam plumes. The tallest Project stacks are the flare stack (40 m), the steam boiler stacks (30 m) and the cogen stacks (20 m). Their appearance will depend on the height of the tree canopy, the viewpoint of an observer and sky conditions.

The flare pilot will burn continuously and small flames at the tip may be visible, especially at night. Larger flames several metres long will appear during upset flaring, and these conditions are expected to occur infrequently.

The cogens and steam boilers will be the largest sources of water vapour emissions, and the plumes from these sources will be visible when the steam in the plumes condenses, most likely in winter or when the air is saturated. Visibility is most likely to be associated with low temperatures and stable conditions. The plumes may be visible from distances of several kilometres but are not expected to restrict visibility at ground level.

Predicted cogen plume heights range from about 50 to 140 m in D stability, and these heights bracketed plume heights in E and F stability. For the steam boilers, plume heights were 40 to 120 m. During daylight hours in winter, these plumes are likely to be below typical mixing heights, which are somewhat less than 200 m.

D.1.4.11 Upset Conditions

It is the design intent that the existing Connacher Algar flare stack be used as an emergency system for the expanded facility, with any normal process vents processed through the steam generators. Thus, under normal conditions at the facility, there will be negligible emissions from the combustion of natural gas by the pilot flame. In case of a facility upset, emergency flaring will take place resulting in SO_2 and NO_x emissions to the atmosphere.

Dispersion modelling of updated Project SO_2 and NO_x emissions from emergency flaring was performed using the CALMET and CALPUFF model. The predicted 99.9^{th} percentile hourly average ground-level SO_2 concentration at the MPOI for the Connacher-only case (modelled by itself without any other nearby or regional sources) under upset conditions is 101 $\mu g/m^3$, which is below the AAAQO for SO_2. Under normal operating conditions, the Connacher-only 99.9^{th} percentile hourly prediction at the MPOI is also 101 $\mu g/m^3$. This means that the operation of the flare under this upset scenario will have negligible impact on air quality. The predicted 99.9^{th} percentile hourly average SO_2 concentration for the flare operating by itself under this upset scenario is only 0.6 $\mu g/m^3$.

Similarly, the predicted 99.9^{th} percentile hourly NO_2 concentration at the MPOI for the Connacher-only sources is the same (72 $\mu g/m^3$) regardless of whether or not the upset flaring is occurring concurrently. The predicted 99.9^{th} percentile hourly average NO_2 concentration for the flare operating by itself under this upset scenario is only 1.3 $\mu g/m^3$. As such, exceedences of the AAAQO for NO_2 as a result of this upset scenario would not be expected.

Based on these predictions, the worst case upset scenario for the Project is not expected to contribute significantly to ground-level SO_2 and NO_2 concentrations.

D.1.5 Mitigation and Monitoring

D.1.5.1 Mitigation

Mitigation to reduce potential impacts of the Project on air quality include:

- sulphur recovery, if required, will meet ERCB requirements;
- there will be no continuous flaring other than pilot and purge gas;
- the emergency flare system will include liquid knockout facilities, pilot/purge gas, continuous monitoring and burner management;
- vapour recovery systems will be installed;
- the selection of low NO_x emissions technology as required by the CCME National Emission Guideline for Commercial / Industrial Boilers and Heaters;
- the use of process designs that reduce VOC emissions;
- plant-wide fugitive emissions identification and control using the protocol recommended by the CCME guideline "Environmental Code of Practice for the Measurement and Control of Fugitive Emissions from Equipment Leaks" (CCME 1993);
- a vapour recovery unit (VRU) to condense and recover emissions;
- floating roofs on storage tanks, where appropriate;
- ultra-low sulphur diesel fuel will be used for tanker trucks hauling bitumen from the plant site;
- U.S. EPA Tier 4 standards will apply to haul trucks; and
- watering of any unpaved portions of the haul truck route to prevent dust emissions.

D.1.5.2 Monitoring

Connacher will conduct the following source monitoring:

- produced gas will be tested for H_2S content and SO_2 emissions will be estimated from the produced gas flow rate;
- produced gas composition and fuel use will be monitored to determine GHG emissions;
- NO_x emissions from one of the Project steam boilers and the cogen will be tested within six months of project start-up, and thereafter surveyed annually.
- continue to operate the existing air monitoring trailer at the Algar site for six months each year. Monitored parameters will include wind speed and direction, SO_2, NO_x and H_2S. Measurements of SO_2 and NO_x could be used to provide input to estimation of acid deposition.

D.1.6 Summary

A summary of potential environmental effects on the VECs along with the planned mitigation and residual effects for the Project presented in Table D.1.6.1. With mitigation, the effects of the Project on air quality VECs are considered insignificant.

Main Menu | Search | Main TOC

Table D.1.6.1 Summary of Impact on Air Quality VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. NO_2 Concentration												
	Potential human health effects	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to low (<5%) (1-h and 24-h concentrations) High (>10%) (annual concentrations) but small absolute increases	Negative	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	Moderate (<10%) (1-h and 24-h) High (>10%) (annual). All absolute increases low.	Negative	Moderate	Medium	Insignificant
2. SO_2 Concentration												
	Potential human health and vegetation effects	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to High (at nearest receptors)w	Neutral to Positive	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	Low to High in a relative sense. Low in an absolute sense.	Negative and Positive	Moderate	Medium	Insignificant
3. $PM_{2.5}$ Concentration												
	Potential human health effects and visibility impairment	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to Low	Negative	Moderate (greater uncertainty in PM secondary formation)	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase)	Negative	Moderate	Medium	Insignificant
4. CO Concentration												
	Potential human health effects	refer to Section D.1.5 and	Project Residual	Local	Long	Continuous	Reversible in long term	Low in percent increase or small absolute increase	Negative	High	High	Insignificant

Table D.1.6.1 Summary of Impact on Air Quality VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
		CR #1, Sections 1.2 and 5.3	Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase). Absolute increases <10% of AAQO.	Negative	Moderate	Medium	Insignificant
5. PAI Deposition												
	Potential acidification of sensitive soils, water bodies and vegetation	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to low in percentage or absolute sense	Negative	Moderate (more uncertainty in deposition estimates)	Medium	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase) in LSA. Variable in RSA.	Negative. Positive in RSA for highest values	Low	Low	Insignificant
6. N Deposition												
	Potential eutrophicatio n of sensitive ecosystems	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to low in percentage or absolute sense	Negative	Moderate (more uncertainty in deposition estimates)	Medium	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase) in LSA. Variable in RSA.	Negative. Positive in RSA for highest values	Low	Low	Insignificant
7. Ozone Concentration												
	Potential human health effects	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Regional	Long	Continuous	Reversible in long term	Nil to Low	Negative	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	Low (<5% increase)	Negative	Low	Medium	Insignificant
8. VOC, PAHs and non-CACs Concentration												

Table D.1.6.1 Summary of Impact on Air Quality VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
	Potential human health effects	refer to Section D.1.5 and CR #1, Sections 1.2 and 5.3	Project Residual	Local	Long	Continuous	Reversible in long term	Nil to Low in percentage or absolute terms	Negative	Moderate	Medium	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	Low to High. Typically Low in an absolute sense.	Negative	Low future (regional emissions less certain)	Medium	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.2 AQUATIC RESOURCES

D.2.1 Introduction and Terms of Reference

Connacher conducted an assessment of surface aquatic resources for the Project. The following section is a summary of the Surface Aquatic Resources Report that was prepared by Hatfield Consultants and included as Consultants Report #2 (CR #2). For full details of the assessment please refer to CR #2.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the aquatic resource component are provided in Section 3.6 and are as follows:

3.6.1 Baseline Information

[A] Describe the existing fish and other aquatic resources (e.g., benthic invertebrates). Identify species composition, distribution, relative abundance, movements and general life history parameters.

[B] Describe and map, as appropriate, the fish habitat and aquatic resources of the lakes, rivers, ephemeral water bodies and other waters and identify:

- *a) key indicator species and provide the rationale and selection criteria used;*
- *b) critical or sensitive areas such as spawning, rearing, and over-wintering habitats. Discuss seasonal habitat use including migration and spawning routes; and*
- *c) current and potential use of the fish resources by aboriginal, sport or commercial fisheries.*

3.6.2 Impact Assessment

[A] Describe the potential impacts to fish, fish habitat, and other aquatic resources (e.g., stream alterations and changes to substrate conditions, water quality and quantity) considering:

- *a) fish tainting, survival of eggs and fry, chronic or acute health effects, and increased stress on fish populations from release of contaminants, sedimentation, flow alterations, temperature and habitat changes;*
- *b) potential impacts on riparian areas that could impact aquatic biological resources and productivity;*
- *c) the potential for increased fishing pressures in the region that could arise from the increased workforce and improved access as a result of the Project. Identify the implications on the fish resource and describe any mitigation strategies that might be planned to minimize these effects, including any plans to restrict employee and visitor access; and*
- *d) changes to benthic invertebrate communities that may affect food quality and availability for fish.Discuss the design, construction and operational factors to be incorporated into the Project to minimize effects to fish and fish habitat and protect aquatic resources during all stages of the Project.*

[B] Identify plans proposed to offset any loss in the productivity of fish habitat. Indicate how environmental protection plans address applicable provincial and federal policies on fish habitat including the development of a "No Net Loss" fish habitat objective.

[C] Describe the effects of any surface water withdrawals considered including cumulative effects on aquatic resources during all stages of the Project.

[D] Describe the residual effects of the Project on fish, fish habitat, and other aquatic resources and discuss their significance in the context of local and regional fisheries. Describe Connacher's plans to manage those effects.

3.6.3 Monitoring

[A] Describe the monitoring programs proposed to assess any Project impacts to fish, fish habitat and other aquatic resources and to measure the effectiveness of mitigation measures.

The LSA encompasses portions of the Horse River watershed and the Christina River watershed within approximately 1 km of the RDA and the downstream portion of the watercourses, within approximately 4 km to the nearest confluence with a larger watercourse (CR #2, Figure 3). The Christina River watershed within the LSA contains five fish-bearing lakes and a series of third- and lower-order streams, while the Horse River watershed within the LSA containsfirst and second-order streams.

The Regional Study Area (RSA) includes the watercourses of the LSA and the main stem of the Christina and Horse rivers downstream to their confluence to a major watercourse (CR #2, Figure 3). For the Christina River this is the Clearwater River and for the Horse River this is the Athabasca River. Within the RSA, the Christina River is a fourth- to sixth-order watercourse, while the Horse River is a third- to fifth-order watercourse. .

The VECs evaluated in the aquatic resource assessment include surface water quality and fisheries resources.

D.2.2 Baseline Conditions

The aquatic resources Baseline Case consists of a description of surface water quality, fish resources, physical aquatic habitat, sediment quality, and benthic invertebrate communities, first for the watercourses within the LSA, followed by the lakes within the LSA, and then the watercourses that comprise the RSA.

The following Baseline Case assumes that:

- any effects of the existing projects on aquatic resources are already reflected in the data gathered to establish the baseline conditions;
- these existing projects will not cause any different effects on aquatic resources in the future; and
- the following Baseline Case therefore includes the influences of all existing projects.

D.2.2.1 Water Quality

Water quality sampling in the LSA was undertaken:

- at 15 watercourses (CR #2, Figure 5) over five seasons between fall 2006 and fall 2007;
- in spring 2008 and summer 2007 at an additional 20 locations on three watercourses as part of stream crossing assessments (CR #2, Figure 5); and
- at four lakes in fall 2006 and winter 2007, at five lakes in spring and summer 2007 and one lake in the fall 2007 (CR #2, Figure 5).

The water quality of watercourses and lakes in the LSA is generally characteristic of highly-coloured brown-water systems with a median true color level of 330 TCU and DOC concentration of 46 mg/L for watercourses and 150 TCU and a DOC concentration of 22 mg/L for lakes. Surface water in the LSA is slightly hard, with median hardness of 35 mg/L and 20 mg/l in watercourses and lakes, respectively. Water in watercourses and lakes of the LSA generally have circumneutral pH, with a higher range of pH in spring than in other seasons.

Surface water in the LSA has low concentrations of TDS (median value of 90 mg/L and 60 mg/L for watercourses and lakes, respectively) and conductivity (median value of 55 µS/cm and 33 µS/cm for watercourses and lakes, respectively) compared with TDS and conductivity in watercourses in the Athabasca oil sands region (RAMP 2010).

Median concentrations of TSS are 7.5 mg/L and range from below detection limits to 51 mg/L in LSA watercourses; the median TSS concentration in lakes is below detection limits, with maximum-measured concentrations of 9mg/L.

Watercourses in the LSA are classified as eutrophic based on summer total phosphorus concentrations. Total phosphorus concentrations are indicative of mesotrophic to eutrophic conditions for lakes in the LSA.

The ionic composition of the watercourses and lakes in the LSA is dominated by calcium-magnesium and bicarbonate and is similar to the ionic composition of shallow groundwater in the LSA. Both surface water and shallow groundwater exhibit similar characteristics of a 'calcium-magnesium bicarbonate' type water, with a few number of shallow groundwater samples and lake samples showing predominantly 'sodium-potassium sulfate' ionic composition. In general, the similarities in chemical composition between surface water and shallow groundwater indicate that there are likely direct connections between surface water and the shallow groundwater system in the LSA.

Most of the cases in which concentrations of water quality variables exceed their guidelines in the watercourses and lakes of the LSA are attributable to total iron, total aluminum, total phosphorus, and dissolved oxygen (CR #2, Table 9, Table 10). Concentrations of total iron, total aluminum and total phosphorus are generally above their water quality guidelines throughout the Athabasca oil sands region and are positively correlated with concentrations of TSS (Golder 2003, RAMP 2006). Concentrations of dissolved oxygen in watercourses and lakes in the LSA are often below the chronic guideline for the protection of aquatic life and in some watercourses and seasons (particularly winter for both watercourses and lakes as well as summer for watercourses) were below the acute guideline. The rest of the water quality guideline exceedances in the watercourses and lakes of the LSA were occasional exceedances of sulfide, pH, nitrate and nitrite, total Kjeldahl nitrogen and cobalt.

Concentrations of a number of water quality variables, including selenium, total mercury, and phenols, were never above their water quality guidelines in the watercourses and lakes of the LSA, while concentrations of total arsenic were below water quality guidelines in all but two cases in LSA watercourses. In addition, concentrations of naphthenic acids and total recoverable hydrocarbons were below detection limits across all seasons in both watercourses and lakes.

Water quality sampling occurred at one site (site C13) within the RSA in spring and summer 2007 (CR #2, Table 5, Figure 5). Water at site C13 in 2007 was highly-coloured (true colour measured at 160 and 250 TCU) and concentration of DOC measured at 29mg/L and 42mg/L. Water was slightly hard (average hardness of 29mg/L) and had low alkalinity (average alkalinity of 23mg/L). The concentration of TSS was below the detection limit in spring 2007 and 34mg/L in summer 2007. Concentrations of all water quality variables were below water quality guideline values at site C13 in spring and summer 2007 with the exception of total Kjeldahl nitrogen in summer 2007 and total aluminum and iron in spring 2007. The concentration of naphthenic acids and total recoverable hydrocarbons were below detection limits at site C13 in both spring and summer 2007.

RAMP annually samples water quality at two locations in the RSA for this Project: a baseline station approximately 120 km downstream of the LSA boundary, and a test station (i.e., downstream of RAMP-member oil sands development projects) and approximately 280 km downstream of the LSA boundary on the Christina River. As of 2009, water quality at the lower RAMP station in the Christina River was assessed as being moderately different from regional baseline conditions as a result of higher concentrations of total nitrogen, total boron, and several ions at this station compared to regional baseline ranges for these water quality variables. Water quality at the upper RAMP station on the Christina River was assessed as having negligible-low differences from regional baseline conditions.

There is no water quality information for the Horse River watershed except for 2009 water quality data collected on the upper Horse River (RAMP 2010), upstream of its confluence with Horse Creek. At this station, concentrations of a number of selected water quality measurement endpoints in fall 2009 were outside the range of regional *baseline* concentrations. In 2009, water quality at this station was assessed as being moderately different from regional baseline concentrations, primarily due to relatively high concentrations of nutrients (nitrogen and phosphorus) and total mercury.

D.2.2.2 Fish Resources

The watercourses in the LSA consist of first order to third order streams. The analysis of FWMIS dataset indicates a low probability of first order streams containing small-bodied fish in the LSA (CR #2, Table 12). In addition, there is a low probability of first order and second order streams in the LSA containing either large-bodied fish or sport fish species, and that if these fish groups are found in first order and second order streams, the fish species are likely to be white sucker, northern pike, and Arctic grayling. Third order streams in the LSA can be expected to have a much higher probability or all types of fish and much more diverse species assemblage than lower order streams.

Baseline fish inventories were conducted at 15 watercourse locations and in five lakes in the LSA (CR #2, Table 5, Figure 5). In total, 590 fish comprising five species were captured in watercourses in the LSA (CR #2, Table 13). The majority of fish captured (93%) were brook stickleback with fewer lake chub (4%), white sucker (3%), Arctic grayling (<1%) and finescale dace (<1%). Most of the fish were captured at site C12 in the Christina River watershed (76%). Arctic grayling were captured only in site C07 of the Christina River watershed, while finescale dace were captured only in site C22 in the Horse River watershed.

A total of 356 fish of three species were captured in the lakes in the LSA (CR #2, Table 14). Brook stickleback was the only small-bodied fish captured in the lakes, while northern pike and white sucker were the large-bodied fish captured in these lakes. Northern pike was the only fish species captured in lakes C02 and C03 despite both lakes being sampled using both gillnets and minnow traps.

Site C13 in the RSA (CR #2, Table 5, Figure 5) was sampled for fish in spring 2007. No fish were caught during this sampling session. A total of 23 fish species are documented in fourth- and higher-order streams in the Christina and Horse River watersheds (CR #2, Table 11).

While information on fish health specific to the Christina and Horse River watersheds is not available, there is some information for other watersheds in the Fort McMurray region. The majority of information on fish health comes from studies conducted in the Athabasca or Clearwater Rivers, and the data presented here is based on data collected for RAMP. RAMP (2010) reported that:

- mean mercury concentrations across all size classes in northern pike in the Clearwater River were below the Health Canada guideline for subsistence fishers indicating a negligible-low risk to human health;
- a negligible-low risk to the health of northern pike was identified given all metals in composite samples were below sublethal effects and no-effects criteria; and
- all tainting compounds in northern pike muscle tissue from the Clearwater River were below guideline concentrations indicating a negligible-Low influence on fish palatability.

D.2.2.3 Physical Aquatic Habitat

Detailed physical aquatic habitat surveys were conducted at 35 watercourse locations in the LSA, 20 of which were conducted in support of stream crossing assessments, as well as for five lakes (CR #2, Table 5, Figure 5).

The watercourses in the LSA have mostly a run morphology (CR #2, Table 15). Vegetation bordering the sampled watercourses is comprised of grasses and shrubs with some muskeg and immature to established deciduous or mixed forest. Instream vegetation is minimal, but stream courses were often braided around small patches of vegetation. Woody debris is generally limited to complete and incomplete beaver dams, and the sparse canopy cover is limited to that provided by shrubs.

Instream cover in these watercourses is dominated by overhanging vegetation with approximately equal amounts of small and woody debris, deep pools, instream vegetation and undercut banks. Stream substrates are dominated by fines and organic material with lesser amounts of gravels, cobbles, and boulders.

Visual aerial observations of watercourses in LSA and RSA made during the baseline field studies suggest that most reaches in the watercourses have similar characteristics as those described above. In particular, beaver dams, often well-established, are frequent in the watercourses of the LSA. Visual observations in fall 2006 indicated that water was not flowing over all of these beaver dams, suggesting that they form potential fish migration barriers for at least part of the year in some years.

Fall lake habitat characteristics were generally similar across all five lakes with respect to water depth, vegetation, cover and bed material. A minimal amount of submergent aquatic vegetation was present in all lakes surveyed, and limited observations of bed materials suggest that substrates in these lakes are dominated by fines and organics. Lake waters are typically surrounded by muskeg wetlands which may extend up to 100 m before terminating in forested shorelines. Shorelines are dominated by established black spruce, tamarack, jackpine forests. Evidence of current and past beaver activity is present at all lakes in the form of lodges and/or dams.

Fall water quality profiles are consistent across the four lakes for which these profiles were obtained (CR #2, Appendix A4). No thermocline or chemocline was detected in any of the lakes in fall 2006 surveys with the possible exception of a decline in dissolved oxygen in lake C04 at about 1.5 m. This is not unexpected, given that the lakes are shallow and any autumn mixing would have likely already occurred by the time the fall 2006 sampling program took place.

Winter habitat quality with respect to fish overwintering was variable (CR #2, Table 16). Lakes C02, CO3, and CO5 appear to have conditions suitable for successful overwintering of both large-bodied and small-bodied fish species. These three lakes had water depth below the ice in fall 2007 ranging from 125 cm (lake C03) to 200 cm for lake C05 (CR #2, Table 16) and dissolved oxygen profiles indicating fair dissolved oxygen levels in the winter 2007 season for overwintering fish species. A literature review in AEP (1997) indicates dissolved oxygen concentrations resulting in short-term toxic effects to fish beginning at 0.25 mg/L to 3.4 mg/L, depending on the species. A substantial portion of the water column in lakes C02, CO3, and CO5 had measured dissolved oxygen levels above 3.4 mg/L in winter 2007. Dissolved oxygen levels causing acute effects on white sucker were not found in the scientific literature. Casselman and Lewis (1996) report that the upper range of the lower incipient lethal oxygen concentration is 0.5 to 1.5 mg/L; measured dissolved oxygen levels in most of the below-ice water columns in lakes C02, CO3, and CO5 were higher than these levels in winter 2007 (CR #2, Appendix A4).

In contrast, lake C01 does not appear to contain suitable overwintering habitat for large-bodied fish as in winter 2007 it was almost completely frozen to depth, with only 6 cm of water remaining unfrozen below the ice. Also, while lake C04 had 60 cm of water below the ice in winter 2007 (CR #2, Table 16), its dissolved oxygen levels in winter 2007 throughout the below-ice water column were extremely low (i.e., below 0.5 mg/L).

D.2.2.4 Sediment Quality

Sediment quality was assessed at three lakes and six watercourse locations (CR #2, Table 5, Figure 5). A summary of sediment quality data is presented in CR #2, Table 17 and Table 18.

Sediments in watercourses in the LSA are dominated by sand with smaller amounts of silt and clay, while sediments in lakes in the LSA are dominated by clays with smaller amounts of silt and sand. Concentrations of arsenic, cadmium, and F3 (C16-C34) hydrocarbons exceeded sediment quality guidelines in some watercourses. Concentrations of cadmium exceeded sediment quality guidelines in all sampled lakes, while concentrations of smaller amounts of silt and sand. Concentrations of arsenic, cadmium, and F3 (C16-C34) hydrocarbons and zinc exceeded sediment quality guidelines in two of three and one of three lakes sampled, respectively.

D.2.2.5 Benthic Invertebrate Communities

Benthic invertebrate samples were collected at nine sites in the Local Study Area in fall 2007, of which three sites were from lakes and six sites were from watercourses (CR #2, Table 5, Figure 5). As watercourses in the LSA are dominated by depositional habitats, all six watercourse locations that were sampled for benthic invertebrate communities are depositional habitats. A summary of the benthic invertebrate community baseline for the LSA is provided in CR #2, Table 19.

The abundance of benthic invertebrate communities in depositional watercourses in the LSA ranged from 1,000 organisms/m^2 to 89,870 organisms/m^2; within the sampled lakes, density ranged from 889 organisms/m^2 to 10,710 organisms/m^2. From 6 to 20 taxa were enumerated at sampled watercourses, evenness ranged from 0.10 to 0.67, Simpson's diversity varied from 0.50 to 0.86, while no orders Ephemeroptera, Trichoptera and Plecoptera (taxa that are sensitive to environmental pollution) were recovered in any of the watercourses. In the lakes that were sampled, richness ranged from 9 to 13 taxa, evenness ranged from 0.32 to 0.72, Simpson's diversity ranged from 0.74 to 0.88, and %EPT ranged from 0% to 2.5%

The values of all these benthic invertebrate community indices are within the range of regional baseline values for these indices for depositional watercourse habitats and lakes in the RAMP study area (RAMP 2010).

D.2.2.6 Fish Habitat Suitability

A number of habitat suitability index (HSI) models were applied to the LSA to assess overall habitat suitability for fish populations in the LSA. HSI models were applied to all species captured during baseline studies as well as longnose sucker which, based on its distribution patterns identified in RAMP (2005), is expected to be present in the LSA. Habitat suitability index models were run (CR #2, Table 20) and the details of the application of the habitat suitability index models are provided in CR #2, Appendix A7.

Based on data available, the habitat suitability models suggest that the Christina River and Horse River watersheds are suitable for all life stages of the fish species captured and expected, particularly longnose sucker, brook stickleback, finescale dace, and white sucker. Most sites show average to above average suitability for all species assessed with the following exceptions:

- Christina River watershed was considered to have excellent habitat for longnose sucker. This species was not captured during sampling, but was expected to be present;
- both watersheds were found to have below average suitability for brook stickleback, despite this species being the most abundant fish species captured in the baseline field studies of 2006 to 2008; and
- lake habitat of the Christina River watershed was found to have no suitable habitat for white sucker or Arctic grayling.

Fine sediments, low levels of aquatic vegetation in watercourses, constraints due to shallow lake depths, and high summer water temperatures generally reduced HSI values for many of the species considered. Additionally, low winter dissolved oxygen, and short frost-free seasons were assessed as reducing habitat suitability in the LSA for Arctic grayling and northern pike, respectively. An abundance of run-type habitat restricted habitat suitability for nearly all species modeled. Riffles, commonly used by fish as spawning habitat, were uncommon in both the Horse and Christina Rivers.

D.2.2.7 Acid Sensitivity

Acid-sensitive lakes occur in areas with little or no capacity to neutralize acidic deposition. This capacity is determined by basin soil characteristics (e.g., soil chemistry, composition, and depth), extent and type of vegetation cover, and drainage patterns (Holowaychuk and Fessenden 1987, Lucas and Cowell 1984). Typically, these lakes occur in areas of moderate to high elevation and high relief, with severe, short-term changes in hydrology, small drainage systems, and minimal contact between drainage waters and basin soils or geologic materials.

Acid-sensitive surface waters typically exhibit low pH (<6.5), low concentrations of all major ions (i.e., specific conductance is <25 µS/cm), low organic acid concentrations (i.e., DOC concentration is typically less than 3 to 5 mg/L), and low acid neutralizing capacity (i.e., ANC <200 µeq/L) (Sullivan 2000).

Chemical characteristics of the lakes within the LSA are shown in CR #2, Table 21. Using the alkalinity-based classification system developed by Saffran and Trew (1996), lake C01 is classified as having high sensitivity to acidification, lakes C02, C03, and C04 have moderate sensitivity, and lake C05 has low sensitivity to acidification. Baseline Case PAI inputs for lake C01 are also assessed as being approximately 5% greater than the Critical Load value for the lake.

D.2.3 Predicted Conditions

The surface aquatic resource issues considered in the assessment of the application and planned development cases include:

- changes in surface water quality;
- changes in fish health and fish tissue, including fish tainting; and
- alteration/loss of fish resources and aquatic habitat.

The Project is located at in the most upstream region of both the Christina and Horse River watersheds, so planned developments located downstream of the Project LSA will have no cumulative effect on the local surface aquatic resource conditions, apart from those Projects which have the potential to release acidifying emissions.

The only planned development within the LSA that may cumulatively impact upon surface aquatic resources is the expansion of Highway 63. It is expected that the highway drainage for the expansion will be designed according to current guidelines and best management practices and the mitigation measures implemented will minimize impacts to water quality, surface water flow rates, fish habitat and fish movement.

D.2.3.1 Surface Disturbance and Construction Activities

A number of surface disturbance and construction activities will take place within the LSA during construction, reclamation and decommissioning phases of the Project that may give rise to increased sediment loading in watercourses and waterbodies. These activities may have consequent effects on water quality, aquatic habitat and fish populations and include:

- vegetation clearance and overburden stripping for access roads and utility corridor construction, borrow pit development, sump construction and well pad construction;
- management of soil stockpiles;
- dismantling of all project facilities; and
- re-grading and re-vegetation of reclamation areas.

With strict implementation of the proposed mitigation measures and undertaking the conservation and reclamation measures potential impacts of surface disturbance activities are predicted to be insignificant for the following reasons:

- impacts from construction activities which have been identified as potentially adverse are mitigable using standard engineering and environmental design applications;
- potential adverse effects associated with sedimentation will be localized, that is, they will occur mainly during periods of construction and reclamation and will be confined to the immediate and downstream areas of the surface disturbance activities;
- surface run-off from active areas such as well pads and roads will be managed in a manner in which erosion from surface water runoff will be minimized. Ditches will be designed to avoid ponding of water along the road surface. Flows will be maintained across drainages and wetlands with the appropriate use of culverts; and
- construction of well pads and associated infrastructure will follow the schedules outlined in the phased development plan. These activities will be carried out sequentially and at intervals, before the development of new areas.

Because the residual effects of the Project on surface aquatic resources through surface disturbance and construction activities are assessed as Insignificant in the LSA, these residual effects: (i) are also assessed as Insignificant for the RSA; and (ii) are not assessed for the Planned Development Case (PDC).

D.2.3.2 Intream Construction Activities

Direct changes and physical loss of aquatic habitat may occur during in-stream construction works, such as watercourse crossing sites (roads or utilities) by the direct disturbance of the streambed, banks or riparian areas. Direct habitat effects can include alteration or loss of specific habitat features, such as pools, aquatic vegetation and bed materials, that ultimately lead to loss or impairment of habitat functions, such as overwintering, spawning and rearing. The specific effects will depend on the type of habitat at the crossing site, the type of crossing method used and the timing of the construction period.

Six locations have been identified where road and utility corridors may cross watercourses with defined channels (CR #2, Figure 7, Table 22). One location has also been identified where the construction of a well pad may directly impinge upon a watercourse with a defined channel.

With strict implementation of the mitigation measures summarized above, potential impacts of in-stream construction activities are predicted to be insignificant for the following reasons:

- impacts from in-stream construction are mitigable using standard engineering and environmental design applications and adhering to work timing windows;
- potential adverse effects associated with sedimentation will be temporary, short-term and localized, that is, they will occur mainly during periods of construction and reclamation and will be confined to the immediate and downstream areas of the surface disturbance activities; and
- a minimum 30 m buffer will be maintained from the edge of the stream bank for all other construction activities which are proposed to take place in close vicinity to watercourses.

Since the residual effects of the Project on surface aquatic resources through in-stream construction activities are assessed as insignificant in the LSA and are expected to be local in geographic extent, no effects are predicted within the RSA and therefore no cumulative impacts are expected.

D.2.3.3 Changes in Surface Water Quality

The following Project activities may negatively affect surface water quality, and may give rise to resultant changes to aquatic habitat and fish populations:

- discharge of Project-affected water to natural watercourses;
- accidental spills of hydrocarbons, chemicals and waste products used and stored within Project Area; and
- changes in shallow groundwater quality.

With strict implementation of the proposed mitigation measures, potential impacts to aquatic resources through changes in surface water quality and discharge of Project-affected water into natural watercourses are predicted to be insignificant for the following reasons:

- no planned discharges of process-affected waters will take place from the Project;
- occasional releases from the storm water retention pond may take place, but water will always be tested prior to discharge and will only be released in strict accordance with the terms and conditions of the operating approval;
- design features, management practices, mitigation plans and emergency response procedures will minimize the potential for accidental release of substances into waterbodies or watercourses; and

Shallow groundwater quality is not expected to be significantly impacted by Project activities, therefore resultant changes to surface water are not expected.

Since the residual effects of the Project on surface aquatic resources due to changes in surface water quality are assessed as insignificant in the LSA and are expected to be local in geographic extent, no effects are predicted within the RSA and therefore no cumulative impacts are expected.

D.2.3.4 Changes to Surface Water Flow Rates and Levels

Changes in stream flow can affect spawning, rearing, feeding, migration and overwintering habitats of fish-bearing streams and rivers (i.e., reduced stream area and shallow depth, reducing dissolved oxygen under the ice), and can also affect the watercourse productivity and availability of food for fish (e.g., benthic invertebrates). Changes in stream flow can also alter the presence of macrophytes, which provide cover, spawning material or food for fish. Changes in lake levels can affect shoreline habitat for fish (e.g., area of littoral zone and macrophyte growth); overwintering capacity of fish-bearing waterbodies; primary productivity (i.e., effect on food for fish, including benthic invertebrates); and discharges to outlet creeks.

Changes to surface water flow rates could result from:

- surface disturbance activities altering natural run-off and drainage patterns;
- surface water withdrawal activities required to meet water requirements for the Project's SAGD process;
- release of process affected waters to natural waterbodies; and
- changes in the amount of shallow groundwater reporting to surface water.

Potential impacts to aquatic resources through changes in surface water flow rates are predicted to be insignificant for the following reasons:

- only small increases in surface water runoff volumes are predicted as a result of surface disturbances and only relatively small average increases in stream flow are predicted;
- no planned discharges of Project-affected waters will take place from the Project therefore no resultant changes to surface water flow rates are expected;
- occasional releases from the storm water retention pond may take place, but water will be released at a controlled rate in strict accordance with the terms and conditions of the operating approval; and
- shallow groundwater levels are not expected to be affected by Project activities therefore no resultant changes to surface water flow rates are expected.

Since the residual effects of the Project on surface aquatic resources due to changes in surface water flow rates are assessed as insignificant in the LSA and are expected to be local in geographic extent, no effects are predicted within the RSA and therefore no cumulative impacts are expected.

D.2.3.5 Improved or Altered Access to Fish Bearing Waterbodies

Improved access and increased workforce in the area as a result of the Project could increase fishing pressure and fish harvest in local fish-bearing waterbodies and watercourses. This could, in turn, result in a decreased abundance of sport fish if fishing pressure and/or fish harvest were not appropriately managed.

While many fish populations in the region are sensitive to angling pressure, and while the workforce may potentially catch additional fish, it is expected that with mitigationthese effects of increased angling on LSA fish populations will be insignificant.

Since the residual effects of the Project on surface aquatic resources from improved or altered access to fish bearing water courses and water bodies are assessed as insignificant in the LSA and are expected to be local in geographic extent, no effects are predicted within the RSA and therefore no cumulative impacts are expected.

D.2.3.6 Fish Health and Fish Tainting

Changes in water quality have the potential to affect the health of fish and other aquatic organisms. With implementation of the mitigation measures to address potential sedimentation of surface waters, as well as any releases of process-affected water and accidental spills of contaminants to surface waters) potential impacts to fish health through potential changes in water quality are predicted to be insignificant.

D.2.3.7 Acidifying Emissions

The Project will result in the release of acidifying emissions, as described in the Air Quality Assessment (Section D.1, CR #1); therefore there is the potential for acidifying emissions from the Project to affect surface aquatic resources in both the Air Quality LSA and RSA.

The predicted annual input of acidifying substances (PAI) for Baseline and Application cases (Section D.1.4.5, CR #1) is presented in CR #2, Table 23. For Baseline and Application cases, predicted PAI values at all lakes are significantly below Alberta's Clean Air Strategic Alliance (CASA) target level of 0.25 keq H^+/ha/yr.

PAI values are predicted to increases for the five lakes by between 1.3 and 1.8% from the Baseline Case to the Application Case. The predicted PAI for lake C01 in the Application Case is predicted to be 6% greater than its Critical Load; this compares to a predicted PAI for the Baseline Case for lake C01 that is 4% greater than its Critical Load. The predicted PAI in the Application Case for the other lakes in the LSA is lower than the Critical Loads for those lakes.

The area within the Air Quality RSA which receives PAI in excess of 0.25 keq H+/ha/yr is predicted to remain the same at 2800 km^2 under the Baseline Case, to the Application Case. This effected area represents less than 4% of the total area of the Air Quality RSA (72,600 km^2) and a very minor proportion of the Application PAI values are likely to be attributable to this Project. No increases in potential for acidification from Baseline to Application Case are predicted to result from the Project within the Air Quality RSA.

The residual (after mitigation) effects of the Project in the Application Case on surface aquatic resources through acidifying emissions are assessed as Insignificant for both the Air Quality LSA and Air Quality RSA. Because the residual effects of the Project on surface aquatic resources from changes in acidifying emissions are assessed as Insignificant for both the LSA and RSA, these effects are not assessed for the PDC.

D.2.4 Mitigation and Monitoring

D.2.4.1 Mitigation

Connacher will utilize the following measures to mitigate potential impacts to aquatic resources:

- earthworks contractors will be required to submit a sediment control plan;
- sediment control measures as those described in the *Alberta Code of Practice for Watercourse Crossings* (AENV 2000a) will be implemented for earthworks which take place within or in close proximity to watercourses;
- whenever possible, surface disturbance activities in close proximity to watercourses will be carried out during periods of relatively low surface runoff in late fall, winter and early spring (from October to April);

- a buffer (vegetation) strip will be left between disturbance sites and watercourses except at stream crossings and diversions;
- the time interval between clearing/grubbing and subsequent earthworks will be minimized, particularly at or in the vicinity of watercourses or in areas susceptible to erosion;
- when required, slope grading and stabilization techniques will be adopted in order to reduce erosion risk;
- as required, surface runoff collection and treatment systems will be used to direct surface runoff from both disturbed areas and constructed areas (well pads and roads) into settling impoundments/sumps for removal of settleable solids;
- progressive disturbance and reclamation will be undertaken to reduce the amount of disturbed area at any given time;
- where necessary, interim erosion/sediment control measures will be utilized until long-term protection can be effectively implemented;
- all watercourse crossings will be designed and constructed in compliance with the *Alberta Code of Practice for Watercourse Crossings* (AENV 2000a) and associated guidelines;
- the existence and location of a defined stream channel at well pad 106 (Phase 3 development) has not been confirmed through either aquatic resources or hydrology fieldwork. The nature of the stream should be assessed prior to well pad construction and where possible, construction works should aim to avoid direct impact to the watercourse and provide a minimum 30 m buffer from the edge of the stream bank;
- surface water run-off from the plant site will be directed to a storm water retention pond and returned to the central processing facility (CPF) for use as plant makeup water. However, it is anticipated that occasionally, depending upon site and operating conditions, the surface runoff collected in the settling pond may be released into the surrounding watershed receiving waters;
- retention pond water will always be tested prior to discharge and will only be released in accordance with the terms and conditions of the operating approval;
- additionally, an Environmental Health and Safety Management Plan which will describe the contingency plans for responses to accidental releases;
- diverting runoff from disturbed areas into the natural environment, away from the existing stream networks;
- phasing reclamation activities such that they commence before the entire Project is developed;
- returning the Project area to a natural state when the Project is completed; and
- discouraging fishing by Project employees within the Project Area.

D.2.4.2 Monitoring

Connacher's monitoring program will include:

- suspended sediments will be routinely monitored (upstream and downstream) during construction periods for all in-stream construction activities; and
- monitoring at specific locations in specific drainages in accordance with the terms and conditions of the EPEA approval.

D.2.5 Summary of VECs

A summary of potential environmental effects on the VECs along with the planned mitigation and residual effects for the Project presented in Table D.2.5.1. With mitigation, the effects of the Project on the aquatic resource VECs are considered insignificant.

Table D.2.5.1 Summary of Impact Significance on Aquatic Resource VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
Water Quality & Fish Resources												
	Changes to water quality and aquatic habitat and resources from surface disturbance and construction activities.	refer to Section D.2.4 and CR #2, Section 4.1.1.2	Application	Local	Long	Occasional	Reversible in short term	Low	Negative	High	High	Insignificant
			Planned Development	No change expected from Application Case								
	Changes to surface aquatic resources from acidifying emissions	refer to Section D.2.4 and CR #2, Section 4.1.7.2	Application	Local and Regional	Long	Continuous	Reversible in long term	Low	Negative	Moderate	High	Insignificant
			Planned Development	No change expected from Application Case								
Fish Resources												
	Changes to fish and fish habitat due to in-stream construction activities.	refer to Section D.2.4 and CR #2, Section 4.1.2.2	Application	Local	Long	Occasional	Reversible in short term	Low	Negative	High	High	Insignificant
			Planned Development	No change expected from Application Case								
	Changes to surface water flow rates and levels	refer to Section D.2.4 and CR #2, Section 4.1.4.2	Application	Local	Long	Occasional to seasonal	Reversible in the long term	Low	Negative	High	High	Insignificant
			Planned Development	No change expected from Application Case	Long	Occasional	Reversible in short term	Low	Negative	High	Medium to High	Insignificant
	Changes to fish health, including fish tainting	refer to Section D.2.4 and CR #2, Section 4.1.6.2	Application	Local	Long	Occasional to accidental	Reversible in short term	Low	Negative	High	Low	Insignificant
			Planned Development	No change expected from Application Case								
Water Quality												
	Changes in surface water quality.	refer to Section D.2.4 and CR #2, Section 4.1.3.2	Application	Local	Long	Occasional to accidental	Reversible in short term	Low to Moderate	Negative	High	Medium	Insignificant
			Planned Development	No change expected from Application Case								
	Changes local fish populations due to changes in angling pressure	refer to Section D.2.4 and CR #2, Section 4.1.5.2	Application	Local	Long	Occasional	Reversible in short term	Low	Negative	High	High	Insignificant
			Planned Development	No change expected from Application Case								

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.3 GROUNDWATER

D.3.1 Introduction and Terms of Reference

Connacher conducted a groundwater assessment for the proposed Project. The following section is a summary of the Groundwater Assessment report that was prepared by Millennium EMS Solutions Ltd. and included as Consultants Report #3 (CR #3). For full details of the assessment please refer to CR #3.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the hydrogeological component are provided in Section 3.3 and are as follows:

3.3.1 Baseline Information

[A] Provide an overview of the existing geologic and hydrogeologic setting from the ground surface down to, and including, the oil producing zones and disposal zones. Document any new hydrogeological investigations, including methodology and results, undertaken as part of the EIA, and:

a) present regional and Project Area geology using structure contour maps, geologic cross sections and isopach maps to illustrate depth, thickness and spatial extent of lithology, stratigraphic units and structural features;

b) present regional and Project Area hydrogeology describing:

i. the major aquifers, aquitards and aquicludes (Quaternary and bedrock), their spatial distribution, properties, hydraulic connections between aquifers, hydraulic heads, gradients, groundwater flow directions and velocities. Include maps and cross sections,

ii. the chemistry of groundwater aquifers including baseline concentrations of major ions, metals and hydrocarbon indicators,

iii. the potential discharge zones, potential recharge zones and sources, areas of groundwater-surface water interaction and areas of Quaternary aquifer-bedrock groundwater interaction,

iv. water well development and groundwater use, including an inventory of groundwater users,

v. the recharge potential for Quaternary aquifers,

vi. potential hydraulic connection between bitumen production zones, deep disposal formations and other aquifers resulting from Project operations,

vii. the characterization of formations chosen for deep well disposal, including chemical compatibility and containment potential, injection capacity, hydrodynamic flow regime, and water quality assessments, and

viii. the locations of major facilities associated with the Project including facilities for waste storage, treatment and disposal (e.g., deep well disposal) and describe site-specific aquifer and shallow groundwater conditions beneath these proposed facilities. Provide supporting geological information.

3.3.2 Impact Assessment

[A] Describe Project components and activities that have the potential to affect groundwater resource quantity and quality at all stages of the Project.

[B] Describe the nature and significance of the potential Project impacts on groundwater with respect to:

a) inter-relationship between groundwater and surface water in terms of surface water quantity and quality;

b) implications for terrestrial or riparian vegetation, wildlife and aquatic resources including wetlands;

c) changes in groundwater quality and quantity;

d) conflicts with other groundwater users, and proposed resolutions to these conflicts;
e) potential implications of seasonal variations; and
f) groundwater withdrawal for Project operations, including any expected alterations in the groundwater flow regime during and following Project operations..

[C] Describe programs to manage and protect groundwater resources including:
a) the early detection of potential contamination; and
b) groundwater remediation options in the event that adverse effects are detected.Identify measures to reduce the environmental risks from casing failures.

[E] Describe the residual effects of the Project on groundwater quality and quantity and Connacher's plans to manage those effects.

3.3.3 Monitoring

[A] Describe the monitoring programs proposed to assess any Project impacts to groundwater quality and quantity and to measure the effectiveness of mitigation plans.

Experience with projects of this type has shown that impacts on the hydrogeological regime do not go beyond the lease boundaries. With this in mind, this assessment does not distinguish between regional and local study areas. The hydrogeological study area is the Connacher lease boundary (CR #3, Figure 1.1).

Groundwater VECs for the Project are those environmental attributes associated with the proposed project development, which have been identified to be of concern either by directly-affected stakeholders, government or the professional community. The Project VECs and potential impacts of the project include:

- 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; and
- groundwater – surface water interaction.

D.3.2 Baseline Conditions

The baseline study was completed using:

- recent geologic information on-file at Connacher;
- site-specific hydrogeological information; and
- other information in the public domain.

This report also relied on the information contained in the hydrogeological reports (Westwater 2005: Millennium 2007a) submitted in support of the applications by Connacher for the Great Divide and Algar Projects.

D.3.2.1 Geology

<u>Quaternary and Tertiary</u>

The Leismer Buried Channel is located approximately 16 km east and (after it turns west) 30 km south of the study area. There are no tributary buried channels in the vicinity of the Algar Project (CR #3, Figure 3.2).

The elevation of the bedrock surface within the study area ranges from 530 to 580 m. At the Plant site, bedrock occurs at an elevation of approximately 550 m asl. Approximately 130 to 155 m of glacial drift sediments overlies the bedrock surface at the Plant site.

Auger drilling in 2008 revealed that the study area is generally underlain by clay till (CR #3, Appendix B-1). Sand, silt and gravel are locally present but are not extensive. At the plant site there was sand to a depth of 4.2 m and clay till to 10 m. Geotechnical boreholes on the plant site encountered clay and clay till to depths of 24 m.

Bedrock

The uppermost bedrock strata are the Upper Cretaceous La Biche and Viking Formations, and the Lower Cretaceous Joli Fou, Grand Rapids, Clearwater and McMurray Formations (CR #3, Figure 3.1).

The La Biche strata are made up of shales with subordinate shaly conglomerates, sandstones and siltstones; the Viking Formation is composed of relatively shaly, fine- to coarse-grained sandstone; the Joli Fou Formation comprises dark grey, calcareous shale with minor interbedded fine- and medium-grained sandstone.

The Grand Rapids Formation comprises three major sandstone units (A, B and C) separated by siltstones and shales. The elevation of the Grand Rapids surface ranges in the study area from 440 m in the southwest to 455 in the north (CR #3, Figure 3.3) and the total thickness is approximately 90 m. The lower portion of the Grand Rapids Formation represents a potential water supply for the Project and is approximately 24 m thick (CR #3, Figure 3.4).

The Clearwater Formation consists of soft black and greenish-grey shales with interbedded grey and green sandstones. Within the study area, the elevation of the Clearwater surface ranges from 350 m in the southwest to 375 m in the north m (CR #3, Figure 3.5). The Clearwater ranges in thickness from 62 to 92 m (CR #3, Figure 3.6). The water sand reaches approximately 20 m at the northeast corner of the study area.

The McMurray Formation is composed of sand (saturated with bitumen and/or water), siltstone, shale and mudstone. The elevation of the McMurray surface ranges from 275 to 285 m in the SA and the thickness is approximately 50 m. The basal McMurray water sand has not been identified in the majority of the study area (CR #3, Figure 3.7).

D.3.2.2 Hydrogeology

Quaternary/Tertiary Units

Sandy zones are not frequent in the Quaternary deposits and those that are present do not correlate from one core hole to the next which indicates that aquifers were not present in the Quaternary deposits.

Hydraulic conductivity is reflective of the dominance of glacial till in the Quaternary deposits. Values of hydraulic conductivity have been observed to range over three orders of magnitude from 0.6 to 40 x 10^{-7} m/s (CR #3, Table 3.1). This range would be ranked as low on an absolute scale of hydraulic conductivity.

A search of well information from Alberta Environment's water well database within 10 km of the plant site produced records for 22 locations (CR #3, Table 3.2). Of these, only two may be water wells that could be in place and these are completed in surficial deposits.

Bedrock Units

Groundwater Flow

The inferred horizontal component of groundwater flow direction is to the northwest for the Grand Rapids Formation and to the west for the water sand in the Clearwater Formation. Hydraulic head values range from 484 to 496 and 460 to 465 m for the Grand Rapids and Clearwater respectively; the vertical component of groundwater flow is therefore downwards from the Grand Rapids Formation (CR #3, Figure 3.9).

The depth to water in the Grand Rapids and Clearwater Formations is 250 to 280 m below ground surface. There is a strong hydraulic gradient directed downward. The decline in hydraulic head averages approximately 0.7 metre of head decline per metre of depth. Under these prevailing conditions, there are no significant areas of groundwater discharge in the study area, the entire area is a groundwater recharge area.

Hydrogeological Parameters

Hydrogeological parameters, including hydraulic conductivity, transmissivity and storativity have been determined from pumping tests in this area.

For the Grand Rapids Formation, the transmissivities would approximate a hydraulic conductivity of 1 x 10^{-5}m/s. A swab test of the Clearwater Formation (in 30-82-11-W4M) found that the formation produced at a rate of approximately 65 m^3/day over a period of 4 hours with no measurable drawdown of water level; and the depth to static water level was approximately 290 m, giving a hydraulic head of 440 m ASL.

The shale portion of the Clearwater Formation is the cap rock overlying the water sand. Bachu et al (1996) indicated a vertical hydraulic conductivity value of 3.0 x 10^{-8} m/s and Gulf (2001) reported a range of 2 x 10^{-10} to 6.7 x 10^{-9} m/s. Petro-Canada (2001) reported a horizontal hydraulic conductivity of 1.0 x 10^{-9} m/s, a vertical hydraulic conductivity of 1.0 x 10^{-10} and a specific storage coefficient of 3.0 x 10^{-5}.

Under natural conditions, the McMurray Formation has a permeability in the order of 5 millidarcy (md). This permeability is a function of both the rock and the highly-viscous bitumen. The purpose of the steam injection is to increase the permeability by reducing the viscosity of the bitumen. Outside of the steam injection zone the permeability remains in the range stated above. A permeability of 5 md translates into a hydraulic conductivity of 5 x 10^{-8} m/s.

D.3.2.3 Groundwater Chemistry

Quaternary and Tertiary Units

The shallow groundwater in the study area may be expected to have the following characteristics (CR #3, Table 3.3 to 3.5):

- TDS up to 530 mg/L;
- characterized as a “calcium-magnesium bicarbonate” water type;
- sodium less than 80 mg/L;
- chloride less than 25 mg/L;
- pH below 9;
- aluminum above Groundwater Remediation Guidelines;
- arsenic concentrations frequently exceeding the Guidelines;
- iron and manganese commonly exceeding Guidelines;

- lead occasionally exceeding Guidelines;
- selenium exceeding Guidelines;
- benzene, toluene and ethylbenzene are not detectable;
- xylene will be largely undetectable;
- dissolved organic carbon will be very low; and
- phenols will be generally undetectable.

Bedrock Units

The TDS in the Grand Rapids Formation from a well in 19-82-11-W4M ranged from 1,600 to 1,900 mg/L (CR #1, Table 3.6) and may be characterized as sodium bicarbonate with significant chloride.

Groundwater sampling and analysis have been conducted as a condition of the Water Licence for supply wells for the Great Divide and the Algar projects to determine the groundwater quality of the Grand Rapids Formation. Total dissolved solids (TDS) have ranged from 1,200 to 2,600 mg/L. The water in the Grand Rapids Formation is not suitable for human consumption.

The TDS in the Clearwater sandstone at a well located north of the Algar plant site was determined to be 3,110 mg/L. The water may be characterized as sodium bicarbonate/chloride. The TDS in the Clearwater water sands was determined to be 3,600 mg/L at a well north of the Great Divide plant site (Westwater 2006). This water is not suitable for human consumption.

Groundwater chemistry data for the McMurray water sand was not available because that unit is not present. However, to the south of the study area, the TDS of water in the McMurray Formation water quality was estimated to be 14,000 to 20,000 mg/L (Westwater 2005).

From a dissolved metals point-of-view, with the exception of boron, the water from the Grand Rapids meets human consumption guidelines but the water in the Clearwater Formation exceeds human consumption guidelines for boron and lead (CR#3, Table 3.7).

Water in the Grand Rapids Formation is also not suitable for human consumption due to elevated natural benzene concentrations (CR #3, Table 3.8).

D.3.2.4 Groundwater Use

There are no other users of the lower Grand Rapids Formation within the study area. Beyond the fact that the area is not inhabited, the lower Grand Rapids Formation is not desirable as a water source other than for SAGD for the following reasons:

- the depth of 350 m makes the cost of each well very expensive;
- the presence of natural gas in the upper Grand Rapids Formation adds costs for drilling and surface control;
- the lift of more than 250 m to the surface makes production costly; and
- the chemical make-up makes it undesirable for most uses.

D.3.2.5 Effects of Water Supply Wells on Groundwater Quantity and Levels

There are approved groundwater diversions from the lower Grand Rapids Formation of 0.29 million cubic metres per year from three wells for the Great Divide Project and 0.33 million cubic metres per year from four wells for the Algar Project, totalling 0.62 million cubic metres per year.

Pumping of wells completed in the Grand Rapids will cause a decrease in pressure in the aquifer at the site of the well. The pressure decrease will create a hydraulic cone of depression in the aquifer as pumping progresses and would extend outward from the well site. This drawdown of water levels (drawdown) in the Grand Rapids was modeled (CR #3, Figure 4.2) and the results are used in the assessment of the Application Case.

There are no identified users of the Grand Rapids within the study area and therefore, for the Baseline Case, there will not be any effect of this cone of depression on other users.

D.3.2.6 Effects of Surface Facilities on Groundwater Quality

The existing Great Divide and Algar Plant Site facility design and material handling methods are such that the surface facilities should have no effects on groundwater quality under normal operating conditions. Groundwater monitoring for the existing development is conducted as required in the EPEA Approvals. In the event that an impact on groundwater quality is detected, a groundwater response plan will be implemented. As a result, any spills or leaks should have no significant impact on the groundwater and surface water resources.

D.3.2.7 Effects of Production/Injection Wells on Groundwater Quality

Potential impact could occur due to:

- annular leakage;
- leakage between injection zones; and
- thermal effects in glacial deposits.

Connacher has been monitoring a localized aquifer in the surficial deposits close to a SAGD pad that began operations in 2007. The monitoring has shown no change in groundwater temperature or arsenic concentration. Connacher has also undertaken groundwater monitoring in the vicinity of the Great Divide and Algar Projects as required in the EPEA approvals.

D.3.2.8 Effects of Disposal Wells on Groundwater Quality

Disposal wells are not planned for the Project, therefore there will be no effects.

D.3.2.9 Groundwater – Surface Water Interaction

It has been shown that the hydraulic gradient is downward with 250 m of head loss in the approximately 350 m of depth to the lower Grand Rapids. It has been further shown (CR #3, Figure 4.4) that pumping of the lower Grand Rapids may reduce the hydraulic head an approximate average of 7 m over the area of influence. This would have the effect of increasing the existing gradients by no more than 2 %. This would not cause a significant impact on surface water or any non-saline aquifers.

There are no activities that will have significant impacts on groundwater / surface water interactions.

D.3.3 Predicted Conditions

D.3.3.1 Effects of Water Supply Wells on Groundwater Quantity and Levels

Application Case

The lower portion of the Grand Rapids Formation (Grand Rapids) is intended to be used as an initial, and perhaps permanent, water source for the Project. This use will be compliant with Alberta policy for the use of non-saline water.

The blended water requirement for Great Divide, Algar and this project will be 1.1 million cubic metres per year. Even though the volumes will be blended in to the Project water demand, the incremental water use for the Project from the lower Grand Rapids Formation will be 0.48 million cubic metres per year from a well field located in the vicinity of the Algar Plant.

Pumping of wells completed in the Grand Rapids will cause a decrease in pressure in the aquifer at the site of the well. The pressure decrease will create a hydraulic cone of depression in the aquifer as pumping progresses and would extend outward from the well site. There are no identified users of the Grand Rapids within the study area and therefore there will not be any effect of this cone of depression on other users.

The drawdown of water levels (drawdown) in the Grand Rapids was modelled. The project case model consisted of increasing the pumping rates of the four Algar Project wells, as they are in the vicinity of the Project. The predicted drawdowns are the combined effect of the approved and proposed diversions (CR #2, Figure 4.3). The drawdown caused soley by the incremental diversion of 0.48 million m^3/year required for the Project was then calculated by subtracting the baseline drawdowns (shown on CR #3, Figure 4.2) from those of the total drawdown (shown in CR #3, Figure 4.3). The results of this calculation represent the net drawdown caused by the proposed Project over that of the Great Divide and Algar Projects combined. A net maximum drawdown of 11 m is predicted around the active well field (CR #3, Figure 4.4). The drawdown outside of the Connacher lease resulting from the Project is a maximum of 4.5 m on the east side. Given that the non-pumping hydraulic head is approximately 60 m above the top of the lower Grand Rapids, these predicted drawdowns are less than 8 percent of the available hydraulic head.

Planned Development Case

The groundwater in the lower Grand Rapids Formation is not desirable as a source of supply for purposes other than industrial processes. The cumulative effect of the existing and approved project results in a drawdown of water levels that generally extends approximately 4 km from the well field after the Project has been in operation for 20 years (CR #3, Figure 4.3). There are no competing users nor is the water of the lower Grand Rapids Formation important to any nearby ecological system. The cumulative effect is insignificant.

D.3.3.2 Effects of Surface Facilities on Groundwater Quality

In consideration of the facility design and material handling methods (Part B), the surface facilities should have no effects on groundwater quality under normal operating conditions. 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, lubricants, etc.

The plant site was constructed as part of the Algar project and does not require any additional area to accommodate the expansion, except for the laydown area. A groundwater monitoring network has been established and monitoring is occurring and will continue throughout the life of the Project.

The mitigation measures to be implemented should be effective in preventing or minimizing any fluids from adversely affecting the shallow groundwater. In the event that a impact on groundwater quality is detected, a groundwater response plan will be implemented. The response plan will be effective at avoiding a significant effect on groundwater quality, preventing impacted groundwater from reaching surface water bodies and restoring groundwater quality. As a result, any spills or leaks should have no significant impact on the groundwater and surface water resources.

Potential Project effects are related to effects of surface facilities on groundwater quality resulting from construction and operation of the Project. With mitigation, application case effects are local in extent, short in duration, periodic in frequency, reversible in the short term, of low magnitude, and have a negative contribution. The confidence rating of the assessment is moderate, the probability of the effect is medium, and overall, the Project effect is insignificant.

D.3.3.3 Effects of Production/Injection Wells on Groundwater Quality

Potential impact of the production/injection wells could occur due to:

- annular leakage;
- leakage between injection zones; and
- thermal effects in glacial deposits.

Annular Leakage

The planned drilling, completion and operational process is designed to operate at pressures well below those that would cause fracturing. This means that there is very little probability that fracturing could occur that would carry these fluids into other zones.

In addition, the intermediate casing strings (placed between the land surface and the bitumen-recovery zone) in the production and injection wells will not be subjected to abnormal pressures because tubing is used to conduct fluids into or out of these wells. If there is a leak in the tubing it will be contained within the casing string. As well, any leak would immediately cause injection to cease. Consequently, casing failures followed by annular leakage into the overlying potable aquifers should not occur.

With respect to annular leakage, the operation of the production and injection wells should not have any effect on the chemical quality of the groundwater in potable aquifers. Therefore, the impact is not significant.

Leakage Between Injection Zones

In SAGD there is a production well completed several metres below the injection well. This setup creates a hydraulic gradient from the injector to the producer which collects the mobilized fluids. The entire purpose of SAGD is to recover mobilized fluids and every effort is made to make this as efficient as possible. Thus, the tendency for fluids to migrate elsewhere than the producer well is minimal.

With respect to migration of injected fluids to aquifers, the combination of:

- low hydraulic conductivity and thickness of the McMurray Formation;
- low hydraulic conductivity and thickness of the Clearwater Formation;

- collection of fluids by the producer;
- low hydraulic gradients; and
- lack of potability.

This means that there is no likelihood of migration of injected fluids to aquifers. The impact is not significant.

Thermal Effects in Glacial Deposits

An increase in arsenic in groundwater aquifers in glacial drift in the Cold Lake area has been attributed to the influence of temperature changes on geochemical equilibrium in the drift. Although the Cold Lake area is approximately 150 km southeast of the Site, the issue of the effects of heating in the glacial drift on the geochemistry of glacial aquifers warrants assessment at this location.

There is abundant circumstantial evidence of low probability that heating will release arsenic into aquifers in the glacial drift including the following:

- the Marie Creek till has low total concentrations of arsenic, similar to the lowest found in the Cold Lake area, therefore there is low availability of arsenic for thermal release;
- the groundwater in the area is naturally lower in arsenic than is the case in the Cold Lake area which this substantiates the relative lack of arsenic in the drift deposits;
- the general lack of surficial aquifers in the LSA means that there is virtually no potential for the development of groundwater supply from the glacial till; and that there are minimal pathways for significant movement; and
- the presence of abundant till in the surficial deposits means that groundwater flow is very slow, allowing abundant time for dilution and dispersion of any arsenic released.

Ultimately, the lack of aquifers in the Quaternary deposits means that there is no probability of contamination of an aquifer. The impact is therefore not significant.

D.3.3.4 Effects of Disposal Wells on Groundwater Quality

Disposal wells are not planned for the Project, therefore there will be no effects.

D.3.3.5 Groundwater – Surface Water Interaction

It has been shown that the hydraulic gradient is downward with 250 m of head loss in the approximately 350 m of depth to the lower Grand Rapids. It has been further shown (CR #3, Figure 4.4) that pumping of the lower Grand Rapids may reduce the hydraulic head an approximate average of 7 m over the area of influence. This would have the effect of increasing the existing gradients by no more than 2 %. This would not cause a significant impact on surface water or any non-saline aquifers.

There are no activities that will have significant impacts on groundwater / surface water interactions.

D.3.4 Mitigation and Monitoring

D.3.4.1 Mitigation

In addition to the facilities design and operation details discussed in Part B, Connacher will undertake the following mitigation to reduce the potential for impacts to the groundwater resource:

- utilize standard material handling methods in accordance with current regulations;
- utilize industry-standard operating practices of preparedness for upset conditions and appropriate management of upset conditions;
- utilize facility design and operating procedures as discussed in Part B such as cemented surface casing and cemented production casing to preventing casing failures and annular leakage from occurring; and
- utilize instrumentation that will detect a casing failure cause automatic shutdown of wells.

D.3.4.2 Monitoring

Connacher's monitoring program will include:

- continuation of existing groundwater monitoring programs, in place as required in the EPEA approvals, for the Great Divide and Algar Projects; and
- evaluation of the performance of the water supply wells in the Grand Rapids in accordance with requirements of the Water Act licence.

D.3.5 Summary of VECs

A summary of potential environmental effects on the VECs along with the planned mitigation and residual effects for the Project presented in Table D.3.5.1. With mitigation, the effects of the Project on the hydrogeological VECs are considered insignificant.

Table D.3.5.1 Summary of Impact Significance on Groundwater VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent [1]	Duration [2]	Frequency[3]	Reversability[4]	Magnitude [5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Effects of the water supply wells on groundwater quantity and levels												
		refer to Section D.3.4 and CR #3, Section 4.2.4	Application	Local	Extended	Continuous	Reversible in long term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible in long term	Low	negative	high	high	Insignificant
2. Effects of the surface facilities on groundwater quality												
		refer to Section D.3.4 and CR #3, Section 4.3.3	Application	Local	short	periodic	Reversible in short term	low	negative	moderate	medium	Insignificant
			Cumulative	Local only, no cumulative effect								
3. Effects of the production/injection wells on groundwater quality												
		refer to Section D.3.4 and CR #3, Section 4.4.3	Application	Local	short	periodic	Reversible in short term	low	negative	high	medium	Insignificant
			Cumulative	Local	short	periodic	Reversible in short term	low	negative	high	medium	Insignificant
4. Effects of the disposal wells on groundwater quality												
		refer to Section D.3.4	Application	No activity so no impact								
			Cumulative	No activity so no impact								
5. Groundwater – surface water interaction												
		refer to Section D.3.4	Application	Local	short	periodic	Reversible in short term	low	negative	high	medium	Insignificant
			Cumulative	Local	short	periodic	Reversible in short term	low	negative	high	medium	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.4 Historical Resources

D.4.1 Introduction

Connacher conducted an assessment of historical resources for the proposed Project. The following section is a summary of the Historical Resource Impact Assessment (HRIA) that was prepared by FMA Heritage Inc. and included as Consultants Report #4 (CR #4). For full details of the assessment please refer to CR #4.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the historical resource component are provided in Section 4.0 and are as follows:

4.0 Historic Resources

[A] Describe consultation with Alberta Culture and Community Spirit (ACCS) concerning the need for a Historic Resource Impact Assessment (HRIA) for the Project, and:

- *a) provide a general overview of the results of any previous historic resource studies that have been conducted, including archaeological resources, palaeontological resources, historic period sites, and any other historic resources as defined within the Historical Resources Act;*
- *b) summarize the results from the field program performed to assess archaeological, palaeontological and historic significance of the LSA;*
- *c) provide a summary of the results of the HRIA conducted to assess the potential impact of the Project on archaeological, palaeontological and historic resources;*
- *d) provide an outline of the program and schedule of field investigations that ACCS may require Connacher to undertake to further assess and mitigate the effects of the Project on historic resources; and*
- *e) document any historic resources concerns raised during consultation on the Project.*

In Alberta, historical resources are protected under the Historical Resources Act (RSA 2000) and are defined as precontact, historic, and palaeontological sites and their contents. Traditional Use sites may also be associated with historical resources. Because the cultural milieu in which historic resources functioned no longer exist, these resources are non-renewable. Although the cultures responsible for depositing historical resources cannot be observed, the preserved context and associations related to the remains can reveal much about past human behaviour, adaptations, and relationships. Once a site is disturbed, context cannot be replaced, recreated, or restored.

This LSA for the Historical Resource Assessment includes the entire Connacher Project Area (CR #4, Figure 2). The Regional Study Area (RSA) for historical resources has been defined as an area that includes the LSA and encompasses a larger area within which cultural continuity is expected in the archaeological and historic record. For the current project, the RSA is bounded generally by the Athabasca and Clearwater Rivers on the north, the Athabasca River on the west, Gordon Lake and Birch Lake on the east, and Christina Lake on the south (CR #4, Figure 2). The RSA is based on the borden block designation system.

The assessment of Historical Resources included:

- review of data on file at Alberta Culture and Community Spirit (ACCS) to determine the number and nature of previously recorded sites within the RSA;
- review of the Listing of Historical Resources (March 2010 Edition) to determine the Historical Resources Value (HRV) of the lands located within the LSA:
- literature review to provide the archaeological and historical context for the area and to determine whether significant and/or sensitive historical resources sites may be present in the LSA;

- review of four Historical Resource Assessments previously conducted in the LSA; and
- a review of surficial and bedrock geology maps and drift thickness maps in order to determine palaeontological potential.

D.4.2 Baseline Conditions

The LSA lies within portions of five Archaeological Borden Blocks. Of these, Borden Blocks HaOv, HaOx and HbOx do not contain any previously recorded historical resources sites. Block HaOw contains a single site, the historic Algar Tower, which is located within the Project Area. Block HbOw contains two precontact archaeological sites, including one isolated artifact find with low heritage value, and one subsurface artifact scatter with high heritage value. Both of these precontact sites are located outside of the LSA; however, the identification of a site with high heritage value within proximity of the Project illustrates that the area does have the potential to contain significant archaeological sites. Within the RSA defined for the Project, a total of 68 historic period sites and 96 precontact archaeological sites have been recorded. Many of these are deemed to have high heritage value.

Four previous studies have been conducted for Connacher's Great Divide and Algar Projects, including a Historical Resources Impact Assessment (HRIA) of the Great Divide Airstrip Project in 2006 as well as assessments of various proposed footprints for both the Great Divide and Algar Projects in 2007 and 2008. HRIA studies have effectively been completed for a significant portion of the Great Divide Expansion Project as a result of previous historical resources studies. No precontact period archaeological sites were identified during these studies. One previously recorded historic period site, the Algar Tower, was documented during the assessment of the Great Divide Airstrip.

As part of the 2007 and 2008 studies, a model of archaeological potential was developed using Geographic Information System (GIS). The model was developed in order to determine the relative ranking of terrain features in terms of the potential to identify precontact archaeological sites. Overall the potential of the area is low to moderate, although some areas of high potential are present within the lease. The model of aechaeological potential is illustrated in CR #4, Figure 3.

Thick till covers the Project Area; project development is not expected to disturb bedrock at the surface, nor is it expected to intersect surface surficial deposits with palaeontological potential. The likelihood of project impacts to significant palaeontological resources is low.

The Traditional Land Use report completed for the Project does not indicate that any concerns were raised during the studies regarding historical resources (Section F.4).

D.4.3 Predicted Conditions

The Project footprint was compared with the model of archaeological potential, the locations of known historical resources sites, and the locations of previous assessment (shovel test locations). A single known historical resource site is on record within the Project Area. The historic Algar Tower was originally recorded near the airstrip. However, the HRIA study conducted on the proposed airstrip expansion recommended that no further study be required on the Algar Tower as fire had previously destroyed all historic components of this site; only contemporary (non-historic) components of the Algar Tower were observed during that study. The Algar Tower was subsequently moved to another location away from the Great Divide Project.

A relatively significant number of shovel tests have been excavated east of Highway 63 within proximity of the Phase 1 footprint. No known sites are on record within this area, and it is anticipated that the potential for unknown sites to be present is low. The potential for impact to historical resources sites to occur as a result of development of the Phase 1 footprint is low.

Shovel tests have not been conducted within the Phase 2 footprint that extends to the southeast of the Phase 1 area. The Phase 2 footprint includes some areas with moderate to high archaeological potential, particularly at two stream crossings. Similarly, shovel tests have not been conducted within the Phase 3 footprint and there is potential for these areas to contain unrecorded historical resources sites.

There is potential for unknown historical resources sites to be impacted by the Phase 2 and 3 development. As such, it is recommended that an HRIA of the Phase 2 and 3 project footprints be conducted prior to initiation of any development or disturbance, including vegetation clearing. The HRIA would target areas of moderate to high archaeological potential within the project footprint for assessment in order to identify currently unrecorded historical resources sites. Should any sites be identified during those HRIA studies, the heritage value of the site would be assessed, and recommendations formulated as to mitigation measures.

D.4.4 Mitigation and Monitoring

To mitigate potential impacts to Historical Resources Connacher will:

- apply to ACCS for clearance to develop new facilities, as reqruied;
- undertake required mitigation recommended by ACCS; and
- notify ACCS if a historic resource not previously identified is encountered during construction of Project facilities.

D.4.5 Summary

Although the Project Area is largely of low to moderate archaeological potential, some areas of moderate to high potential do exist, based on the model of archaeological potential and on in-field observations. In addition, sites of significance are on record within the RSA, including one site of significance within proximity of the lease. Assessment conducted within the general Phase 1 area has not resulted in the identification of historical resources sites; no further study is recommended for the Phase 1 footprint relative to historical resources. However, portions of the Phase 2 and 3 footprint have not been assessed; it is recommended that HRIA studies on the Phase 2 and 3 footprint take place prior to development.

Mitigation measures relative to historical resources are issued by ACCS. Given that ACCS effectively determines the threshold for impact to historical resources by issuing study requirements, it is assumed that after the effects of mitigation studies (HRIA level assessment and implementation of adequate site-specific mitigation measures), the effect on historical resources sites is not considered by ACCS to be significant.

D.5 Human and Wildlife Health

D.5.1 Introduction and Terms of Reference

Connacher conducted a human health risk assessment for the proposed Project. The following section is a summary of the Human Health Risk Assessment that was prepared by Intrinsik Environmental Sciences Inc. (Intrinsik) and included as Consultants Report #5a (CR #5a). For full details of the assessment please refer to CR #5a.

Intrinsik Science also conducted a Screening Level Wildlife Risk Assessment (SLWRA) for the proposed Project. The following summary also includes select information from the SLWRA included as Consultant Report #5b (CR#5b).

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the human health component are provided in Section 6.0 and potential effects of air quality on wildlife are in Section 3.8.2:

6.0 Public Health and Safety Assessment

[A] Describe those aspects of the Project that may have implications for public health or the delivery of regional health services. Determine whether there may be implications for public health arising from the Project. Specifically:

- *a) assess the potential health implications of the compounds that will be released to the environment from the Project in relation to exposure limits established to prevent acute and chronic adverse effects on human health;*
- *b) provide the data, exposure modeling calculations, and describe the methods Connacher used to assess impacts of the Project on human health and safety;*
- *c) provide information, including chemical analyses and modeling results, on samples of selected environmental media (e.g., soil, water, air, vegetation, wild game, etc.) used in the assessment;*
- *d) discuss the potential for changes to water quality, air quality and soil quality to increase human exposure to contaminants taking into consideration all Project activities;*
- *e) identify the human health impact of the potential contamination of country foods and natural food sources taking into consideration all Project activities;*
- *f) document any health concerns raised by stakeholders during consultation on the Project;*
- *g) document any health concerns identified by aboriginal communities or groups resulting from impacts of existing development and of the Project specifically on their traditional lifestyle and include an aboriginal receptor type in the assessment;*
- *h) assess the cumulative human health effects to receptors, including First Nations and Métis receptors;*
- *i) as appropriate, describe anticipated follow-up work, including regional cooperative studies. Discuss how such work will be implemented and coordinated with ongoing air, soil and water quality initiatives;*
- *j) describe the potential health impacts due to higher regional traffic volumes and the increased risk of accidental leaks and spills; and*
- *k) discuss mitigation strategies to minimize the potential impact of the Project on human health.*

3.8.2 Wildlife Impact Assessment

[A] Describe and assess the potential impacts of the Project on wildlife populations and wildlife habitat addressing:

- *a) potential effects on wildlife as a result of changes to air and water quality including both acute and chronic effects on animal health;*

The Human Health Risk Assessment (HHRA) describes the nature and significance of potential short-term (i.e., acute) and long-term (i.e., chronic) health risks to humans associated with exposure to the Chemicals of Potential Concern (COPC) emitted or released from the Project. The HHRA examines the potential health risks attributable to the Project in combination with existing and planned emission sources in the region. The SLWRA addresses the same components with respect to effects on wildlife.

Health was raised as one of the key issues of concern, with residents in the area indicating that they are concerned about an overall deterioration in air quality, water quality and traditional food quality (i.e., fish and game). This concern is addressed in the HHRA and SLWRA.

The HHRA and SLWRA focused on the potential risks associated with chemical emissions in the local and regional study areas which are consistent with the Air Quality Study areas (Section D.1).

The HHRA assessed both short and long term health risks to people associated with the chemicals emitted or released from the Project and the SLWRA assessed both short and long term health risks to wildlife. The two exposure durations used can be described as follows:

- Acute: exposure extends over a time period covering minutes to a day for humans and hours to days for wildlife.
- Chronic: exposure occurs continuously or regularly over extended periods, lasting for periods of months to years, and possibly extending over an entire lifetime.

Although the operational life of the Project is expected to be 25 years, the HHRA and SLWRA assumed that the chemical emissions or releases attributable to the Project would continue for a period of 80 years. The assumption of 80 years, to coincide with a person's assumed lifespan (Health Canada 2009a).

D.5.2 Assessment Approach

The potential health risks associated with the Project emissions were examined using a conventional risk assessment paradigm. The risk assessment paradigm is consistent with those developed by Health Canada (1995; 2009a), the Canadian Council of Ministers of the Environment (CCME 1996), and the US Environmental Protection Agency (US EPA 2005). This methodology has been endorsed by a number of provincial regulatory authorities in the past, including Alberta Environment, Alberta Health and Wellness (AHW), and the Alberta Energy Resources Conservation Board (ERCB).

The risk assessment paradigm for both the HHRA and SLWRA involves the following steps:

- Problem Formulation: identification of the COPCs associated with Project emissions or releases, characterization of people/wildlife potentially 'at risk' and identification of relevant exposure pathways;
- Exposure Assessment: quantification of the potential amount or dose of each COPC that could be received by humans (i.e., local members of the public)/wildlife through all relevant exposure pathways;
- Toxicity Assessment: identification of potential adverse health effects associated with exposure to each of the COPCs, the conditions under which these effects are observed and determination of the maximum safe dose of the chemical for sensitive human subjects following exposure for a prescribed period (i.e., identification of acute and chronic exposure limits for the COPCs). For wildlife it is the determination of levels of exposure associated with minimal impact to wildlife populations following exposure; and
- Risk Characterization: comparison of estimated exposures (identified in the exposure assessment) with exposure limits (identified during the toxicity assessment) to identify potential health risks for the different assessment cases, as well as discussion of sources of uncertainties and how these were addressed.

D.5.2.1 Problem Formulation

<u>Identification of Chemicals of Potential Concern</u>

Problem formulation is the initial step of the assessment, in which all chemicals associated with Project emissions or releases are identified, receptors characterized, and relevant exposure pathways are identified.

The COPCs for the Project were identified through the development of a comprehensive inventory of chemicals that could be emitted or released by the Project and to which people or wildlife might be exposed.

The selection of COPCs for this Project also took into consideration whether or not sufficient toxicological information is available to assess the potential health risks; and, the availability of chemical surrogates to represent any of the substances or groups of substances for which no toxicological information is available.

Only Project emissions or releases resulting in potential changes to environmental quality were considered as COPCs. As the Project will not release any chemicals into groundwater or surface water, the COPC for the HHRA and SLWRA were based on air emissions only. Although no direct discharges of effluents to surface water will occur, there will be some deposition of air emission COPCs into surface water bodies in the LSA. Therefore, the risks associated with exposure to surface water that may have COPCs deposited into them were considered in the assessments.

The COPCs that were included in the HHRA are listed in CR #5a, Table 1 and those assessed in the SLWRA are listed in CR #5b, Table 1. In general the COPCs include:

- criteria air contaminants (CAC);
- carcinogenic polycyclic aromatic carbons (PAHs);
- petroleum hydrocarbon (PHC) fractions;
- volatile organic compounds (VOCs); and
- total reduced sulphur (TRS) compounds.

Identification and Characterization of Receptors

The HHRA was structured to characterize the potential health risks to area residents who reside in the area over the long-term. In the SLWRA the potential risks to wildlife species were not assessed for individual species, but instead, predicted COPC concentrations were compared to toxicity data and generic soil and water quality guidelines considered protective of all wildlife species.

Twenty-nine discrete receptor locations within the RSA were selected for consideration in the HHRA (CR #5a, Figure 2). The 29 locations included in the HHRA were grouped according to their assumed land-use. Six general types of individuals were evaluated in the HHRA:

- **MPOI:** includes people who may be present at the locations where the highest COPC concentration could occur (*i.e.*, maximum ground level air concentration or "MPOI");
- **Aboriginal Residents (Aboriginal):** This group of locations represents known aboriginal communities within the study area. It was assumed that these individuals live permanently in the area, and practice a traditional lifestyle that involves a high level of consumption of local country foods and traditional plants;
- **Residents**: includes permanent residents in neighbouring communities such as Anzac, Mariana Lake and Janvier. These individuals were assumed to live permanently in the study area and that they consume local country foods;
- **Cabins**: includes individuals that may use the cabins located near the Project site as a temporary shelter while engaged in activities such as hunting, fishing or trapping; Although the exact frequency of use is not documented, for the purposes of the HHRA, it was assumed that these individuals use this cabin on a regular basis for several months per year;

- **Recreational:** This group includes individuals who may visit local campgrounds or other sites for recreational purposes for various durations of time (days, months) but do not permanently reside in the area; and
- **Workers**: this group includes Connacher workers staying at camps during both construction and operation phases.

It was assumed that temporary visitors would only be near the Project on a short-term (acute) basis, and that they could be exposed to concentrations equivalent to the local MPOI along the site boundary or within the LSA. Inhalation of the COPCs emitted from the Project to the air, was deemed to be the only potential exposure pathway for this receptor group.

Potentially chronically exposed individuals residing in the RSA include additional exposure pathways and include both aboriginals and non-aboriginal people. All age classes (life stages) were considered in a multiple pathway exposure assessment. The five receptor life stages that were included in the HHRA are consistent with Health Canada guidance (Health Canada 2009a):

- infant (0 to 6 months – 0.5 years);
- toddler (7 months to 4 years – 4.5 years);
- child (5 to 11 years – 7 years);
- adolescent (12 to 19 years – 8 years);
- adult (20 to 80 years – 60 years).

For the assessment of carcinogens, a "composite individual" who represents all life stages (e.g., from infant to adult) was used to represent cumulative exposure over an 80-year lifetime.

D.5.2.2 Exposure Assessment

The following exposure pathways were included, as applicable, in the HHRA (CR #5a, Table 5):

- inhalation of air;
- inhalation of dust;
- ingestion of soil (inadvertent);
- ingestion of water;
- ingestion of local above-ground plants (including fruit and vegetables);
- ingestion of local below-ground plants (root vegetables);
- ingestion of local fish;
- ingestion of local wild game;
- dermal contact with water; and
- dermal contact with soil.

In the SLWRA the ingestion and inhalation exposure pathways were assessed.

Inhalation Assessment

All of the COPCs emitted to air from the Project were included in the HHRA and SLWRA inhalation assessment on both an acute and chronic basis, where applicable. Inhalation exposure estimates were based on the results of the air dispersion modeling that was described in Section D.1 and CR #1.

Multiple Exposure Pathway Assessment

For the assessment of exposure pathways other than inhalation, it was necessary to identify COPC emitted from the Project that may deposit to the surrounding terrestrial environment and possibly persist or accumulate in sufficient quantities for people and wildlife to be exposed via soil, food and water pathways. For this purpose, the list of COPC was divided into two general categories:

- **Gaseous COPCs**, are not likely to contribute to human or wildlife exposure via secondary pathways. In addition, the health effects of these gaseous COPC are strictly related to inhalation (i.e., at the point of contact); and
- **Non-gaseous COPCs** may deposit in the vicinity of the Project and persist or accumulate in the environment in sufficient quantities for exposure via soil, food and water pathways.

To identify non-gaseous COPCs that could persist or accumulate in the terrestrial environment, consideration was given to the inherent physical/chemical properties of each COPC that would influence its fate and persistence in the environment, and subsequently its potential presence in secondary pathways of exposure. Of the 31 COPCs identified 16 were included in the HHRA and SLWRA multiple exposure pathway assessment (CR #5a, Table 6 and CR #5b, Table 2).

Environmental Media Concentrations

Measured ambient measurements in the area of the Project were included where available to characterize the background concentrations of COPCs in environmental media. When measured data was not available or analytical results were below detection limits, exposure models were used to predict environmental media COPC concentrations (CR #5a, Section 3.2.2.3, Appendix B1 and B2).

D.5.2.3 Toxicity Assessment

The toxicity assessment involves having an understanding of the critical toxicological effects that can result from exposure to the COPCs. Such information is generally obtained from published scientific studies conducted in animals or humans under controlled experimental conditions, or observations from human epidemiological studies that examine the relationship between adverse effects and exposure to individual chemicals or groups of chemicals. Potential human health effects associated with exposures to the COPCs, along with the basis and selection of the exposure limits, are described in CR #5a, Appendix A.

When evaluating the toxicological potential for a substance in relation to human health, consideration must be given to the dose to which a person is exposed, as the dose determines the type and potentially the severity of any adverse effects that may be observed. Specifically, it is the amount of the substance that is absorbed and reaches the toxicological site of interest in the organism that determines the probability of an adverse effect occurring. Substances may differ greatly with respect to the dosage required to result in an adverse effect, as well as in the mechanism(s) by which the adverse effects are elicited.

Two categories of COPCs were assessed in the HHRA based upon their mechanism of toxicity: threshold and non-threshold COPCs. Threshold substances are generally those that require that a certain level of exposure (or minimum dose) be exceeded before toxic effects occur. For threshold substances, it is necessary to evaluate the available information to identify effect-levels at which either no effects are observed (e.g., a no-observed-adverse-effect level [NOAEL] or a no-observed-effect level [NOEL]) or adverse effects are first observed (e.g., a lowest observed adverse effect level [LOAEL] or lowest observed effect level [LOEL]).

Non-threshold substances are carcinogens capable of producing cancer through one or more of a number of possible mechanisms that, in theory, do not require the exceedance of a threshold. In general, carcinogenic potency data from animals or human epidemiological studies were evaluated by jurisdictional authorities. From these data sets, Unit Risks (URs) or Slope Factors (SFs) are identified, which are in turn used to develop applicable exposure limits (risk specific doses or risk specific concentrations).

Exposure Limits

Exposure limits (also known as toxicological reference values or TRVs) that have been developed by scientific and/or regulatory agencies aimed at the protection of human health were identified for each COPC on both an acute and chronic basis.

Separate assessments were completed for both the acute and chronic exposure scenarios in recognition of the fact that the toxic response produced by chemicals and the target tissues affected can change, depending on whether exposure is short term or long term. As a result, different exposure limits were selected for each chemical included in the acute and chronic assessments

For the purposes of the HHRA, reliance was placed on exposure limits developed by regulatory or reputable scientific agencies as criteria (i.e., objectives, guidelines or standards) for the protection of air quality and human health. The exposure limits selected for use in the acute inhalation, chronic inhalation and chronic multiple pathway exposure assessments are provided in CR #5a, Tables 10, 11 and 12, respectively.

To assess potential risks to terrestrial wildlife, predicted chemical exposures were compared with TRVs (CR #5b, Tables 5 and 6) and soil and surface water quality guidelines protective of the health of terrestrial wildlife populations (CR #5b, Tables 7 and 8).

Chemical Mixtures

Given that chemical exposures rarely occur in isolation, the potential health effects associated with mixtures of the COPC were assessed in the HHRA.

Potential additive interactions were identified in the HHRA for specific COPC that may cause:

- irritation of the eyes, upper or lower respiratory tract;
- liver toxicity;
- kidney toxicity;
- neurotoxicity; and
- cancers.

D.5.2.4 Risk Characterization

This final step of the risk assessment involves comparing estimated exposures (identified in the exposure assessment) with exposure limits (identified during the toxicity assessment) to determine potential health risks for the different assessment cases. To evaluate the potential health impacts associated with COPC, predicted exposures were compared to the selected exposure limits.

Non-Cancer Risks

In the HHRA risk quotients (RQs) were calculated by comparing the predicted levels of exposure for the non-carcinogenic COPC to their respective exposure limits (CR #5a, Appendix A) that have been developed by regulatory and scientific authorities. Interpretation of the RQ values proceeded as follows:

- **RQ ≤ 1.0** indicates that the estimated exposure is less than or equal to the exposure limit (i.e., the assumed safe level of exposure). RQ values less than or equal to 1.0 are associated with negligible health risks, even in sensitive individuals given the level of conservatism incorporated in the derivation of the exposure limit and exposure estimate; and
- **RQ > 1.0** indicates that the exposure estimate exceeds the exposure limit. This suggests an elevated level of risk, the significance of which must be balanced against the high degree of conservatism incorporated into the risk assessment (i.e. the margin of safety is reduced but not removed entirely).

Cancer Risks

Health Canada (2009a) specifies that carcinogens be assessed on an incremental basis, and mandate an "acceptable" incremental lifetime cancer risk (ILCR) of one in 100,000. For the purposes of this assessment, ILCR estimates have been determined for the project alone as well as the incremental contribution of the future emission sources. Interpretation of these ILCR values was based on comparison of the ILCR associated with the project alone against the Health Canada (2009a) *de minimus* risk level of one in 100,000 (i.e., one extra cancer case in a population of 100,000 people).

Interpretation of the ILCR values proceeded as follows:

- **ILCR ≤ 1.0** denotes an incremental lifetime cancer risk that is below the benchmark ILCR of one in 100,000 (i.e., within the accepted level of risk set by Alberta Environment and Health Canada), and
- **ILCR > 1.0** indicates an incremental lifetime cancer risk that is greater than the *de minimus* risk level of one in 100,000, the interpretation of which must consider the conservatism incorporated into the assessment.

Wildlife Health

The risk characterization step of the SLWRA for inhalation exposure involved comparing maximum predicted COPC air concentrations for each of the assessment cases to identified wildlife inhalation TRVs.

Hazard quotients (HQs) were calculated by dividing the predicted contaminant concentration in air by the available TRV. Interpretation of the predicted HQ values was as follows:

- HQ ≤ 1: estimated maximum exposure is less than the associated TRV, indicating that risks to wildlife are negligible for the COPC; and
- HQ >1: estimated maximum exposure is greater than the associated TRV, indicating that potential wildlife health effects may exist.

Where maximum predicted soil concentrations did not exceed SQGs, it was assumed that potential risks to wildlife would be negligible. Where maximum predicted COPC concentrations exceed SQGs, it was assumed that potential wildlife health effects may exist and the potential health risks were discussed further.

It was assumed that potential risks to wildlife would be negligible where maximum predicted surface water COPC concentrations did not exceed SWQGs. Where maximum predicted COPC concentrations exceed surface water quality guidelines, it was assumed that potential wildlife health effects may exist and the potential health risks were discussed further.

D.5.3 Predicted Conditions

D.5.3.1 Acute Inhalation Results

All acute RQ values identified in the HHRA were less than 1 (CR #5a, Tables 15 to 20), suggesting a low probability of adverse health impacts attributable to air emissions. In general, the predicted RQ values for the Application Case were similar to those predicted in the Baseline Case, indicating that the Project emissions are expected to have a negligible impact on predicted health risks.

All predicted acute HQ values identified in the SLWRA were well below 1 (CR #5b, Table 9).

D.5.3.2 Facility Upset Flaring Event: Acute Inhalation Assessment

No exceedances of the Alberta AAQO were predicted for either SO_2 or NO_2 under upset conditions for the Project alone or in combination with estimated background concentrations (CR #5a, Table 21). As such, the release of SO_2 and NO_2 during an emergency flare event is not expected to result in adverse health effects.

D.5.3.3 Chronic Inhalation Results

Chronic inhalation risks were evaluated for the Aboriginal, recreational and community resident groups only. The MPOI location was not evaluated on chronic basis since it is intended to reflect worst-case exposure to a transient, hypothetical person who might be in the area when worst case emissions and meteorological conditions are occurring. As such, the chronic inhalation pathway is not considered relevant to the local MPOI.

Non-Carcinogens

The results of the non-carcinogenic assessment are expressed as risk quotients (RQs). All chronic RQ values were less than 1 (CR #5a, Tables 22 to 26), suggesting that the predicted air concentrations of the COPCs for the various assessment cases not expected to result in adverse health effects. The predicted RQ values for the Baseline and Application Cases were generally very similar. This suggests that the contributions of the Project with respect to emissions will likely have a negligible impact on health.

Carcinogens

All predicted ILCR values were determined to be less than 1 in 100,000 (CR #5a, Tables 27 to 31), indicating that the incremental contributions from the Project and future emission sources are associated with an essentially negligible degree of risk. The ILCR values presented in the assessment represent a composite individual exposed over an assumed lifetime to each carcinogen, for each group of individuals.

Wildlife Chronic Inhalation

All predicted chronic inhalation HQ values did not exceed 1 under any of the assessment cases (CR #5b, Table 10). The chronic inhalation assessment predicted maximum annual average air concentrations for all COPCs would pose negligible to low inhalation health risks to mammalian and avian wildlife in the region.

D.5.3.4 Chronic Multiple Pathway Results

As in the chronic inhalation assessment, separate assessments were completed for non-carcinogenic and carcinogenic exposures in the multiple pathway assessment to reflect the different approaches used in calculating and interpreting the risk estimates. Predicted health risks are expressed as RQs for the non-carcinogenic COPCs, and as ILCRs for the carcinogenic COPCs. Risk quotients are presented for the Baseline, Application and Planned Development Cases, while ILCRs are provided only for the two incremental cases (Project and Future).

Non-Carcinogen Results

All multiple pathway RQ values for the Baseline, Application and Planned Development Cases for both the resident and worker groups were less than 1 (CR #5a, Table 32 & 33). For all of the COPCs, only a very minimal change in RQ value was observed between the Baseline and Application Cases, indicating that the incremental change associated with the Project is negligible. Overall, the potential for adverse non-carcinogenic health impacts is anticipated to be low.

Carcinogen Results

All ICLR values for the resident and worker group were less than one (CR #5a, Tables 34 & 35), indicating that the Project and the Future sources (in the PDC) are associated with negligible degree of incremental cancer risk.

D.5.3.5 Mixture Results

Acute Inhalation Mixture Results

All mixture RQ values were less than 1 (CR #5a, Tables 36 to 41), indicating that the risk of additive effects occurring as a result of the combined exposure to COPCs with common acute toxicological endpoints is negligible.

Chronic Inhalation Mixture Results

The chronic non-carcinogenic inhalation mixture RQs values were less than 1 (CR #5a, Tables 42 to 46), indicating that the risk of additive effects occurring as a result of the combined exposure to COPCs with common acute toxicological endpoints is low.

Mixture incremental lifetime cancer risk (ILCR) values were predicted for the Project and Future cases only, for all receptors except the MPOI. All potentially additive ILCR for the only carcinogenic mixture identified for the inhalation assessment (leukemogens) were less than 1 in 100,000 for all groups of individuals, for both the Project and Future cases (CR #5a, Table 47). This suggests that the additive carcinogenic risk for this endpoint is essentially negligible.

Chronic Multiple Exposure Pathway Mixture Results

The chronic multiple pathway mixture results for the resident and worker groups are presented in CR #5a, Table 48. As no mixtures for carcinogenic endpoints were identified therefore results are provided for non-carcinogenic endpoints only. The RQ values for the renal toxicants mixture for both groups were less than 1 in all cases, indicating that the additive risk of renal toxicity is negligible.

D.5.3.6 Wildlife Chronic Soil and Surface Water Ingestion

Predicted maximum soil concentrations under the three assessment cases are less than their respective SQGs for all of the COPCs (CR #5b, Table 11), indicating that predicted long-term soil concentrations for these COPCs are not expected to have an adverse impact on wildlife populations in the study area.

Predicted maximum surface water concentrations do not exceed any of the SWQGs for wildlife under any of the three assessment cases (CR #5b, Table 12), indicating that predicted long-term surface water concentrations associated with the Project and planned project activities will not adversely affect wildlife populations in the region.

D.5.4 Mitigation and Monitoring

D.5.4.1 Mitigation

Mitigation of potential health effects due to the project relies on appropriate mitigation of impacts to Air Quality (Section D.1.4) and Surface Water Quality (Section D.2.4)

D.5.4.2 Monitoring

Connacher currently monitors air and surface water quality in the area. If any issues arise from existing monitoring programs or concerns raised from local stakeholders Connacher will initiate the appropriate mitigation measures to ensure operations do not pose additional risk to human or wildlife health.

D.5.5 Summary

The chemical emissions from the Project are not expected to result in adverse health effects in the region. For most of the COPCs, the magnitude of the differences in predicted health risks between the Baseline and Application Cases is negligible. The key findings of the HHRA are as follows:

- Acute Inhalation Assessment - The potential short-term health risks associated with the Project and other emissions sources were evaluated through the comparison of predicted air concentrations (10-minute, 1-hour, 8-hour or 24-hour) against health-based criteria (i.e., exposure limits). Overall, there were minimal changes between the Baseline and Application Cases, indicating that the Project emissions are not anticipated to have an impact on human health in the area;
- Chronic Inhalation Assessment - Predicted risks associated with continuous, long-term inhalation of the COPCs were evaluated through the comparison of predicted annual average air concentrations with health-based exposure limits. No exceedances of health-based exposure limits were predicted in the chronic inhalation assessment. All incremental lifetime cancer risks associated with continuous air inhalation were predicted to be less than one in 100,000, which is the benchmark considered to be essentially negligible by Health Canada (2009a); and
- Chronic Multiple Pathway Assessment - The potential long-term health risks associated with exposure to the COPCs via multiple pathways of exposure were evaluated for permanent and seasonal residents in the area. In all instances, potential risks were determined to be negligible. All incremental lifetime cancer risks associated with exposure via multiple pathways of exposure were predicted to be less than one in 100,000, suggesting that the cancer risks associated with the Project are negligible.

The results of the SLWRA indicate that the overall risks posed to wildlife health will be negligible. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations and predicted maximum soil and surface water concentrations. The confidence in the prediction is high since highly conservative assumptions were applied in the SLWRA.

D.6 HYDROLOGY

D.6.1 Introduction and Terms of Reference

Connacher conducted an assessment of surface hydrology for the proposed Project. The following section is a summary of the Surface Hydrology Assessment that was prepared by Northwest Hydraulic Consultants and included as Consultants Report #6 (CR #6). For full details of the assessment please refer to CR #6.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the hydrology component are provided in Section 3.4 and are as follows:

3.4.1 Baseline Information

[A] Describe and map the surface hydrology. Include flow regimes of streams in the Project Area.
[B] Provide surface flow baseline data, including:
a) seasonal variation, low, average and peak flows for watercourses, and
b) low, average and peak levels for waterbodies.
[C] Identify any surface water users who have existing approvals, permits or licenses.

3.4.2 Impact Assessment

[A] Discuss changes to watersheds, including surface and near-surface drainage conditions, potential flow impediment, and potential changes in open-water surface areas caused by the Project.
[B] Describe the extent of hydrological changes that will result from disturbances to groundwater and surface water movement:
a) include changes to the quantity of surface flow, water levels and channel regime in watercourses (during minimum, average and peak flows) and water levels in waterbodies,
b) assess the potential impact of any alterations in flow on the hydrology and identify all temporary and permanent alterations, channel realignments, disturbances or surface water withdrawals,
c) discuss both the Project and cumulative effect of these changes on hydrology (e.g.,timing, volume, peak and minimum flow rates, river regime and lake levels), including the significance of effects for downstream watercourses, and
d) identify any potential erosion problems in watercourses resulting from the Project.
[C] Discuss changes in sedimentation patterns in receiving waters resulting from the Project.
[D] Describe impacts on other surface water users resulting from the Project. Identify any potential water use conflicts.
[E] Describe potential downstream impact if surface water is removed.
[F] Discuss the impact of low flow conditions and in-stream flow needs (IFN) on water supply and water and wastewater management strategies.
[G] Discuss how potential impacts of temporary and permanent roads and well pads on wetland hydrology will be minimized and mitigated.
[H] Describe mitigation measures to address impacts during all stages of the project including:
a) alteration in flow regimes,
b) potential water use conflicts, and
c) increased sediment loadings.
[I] Describe residual effects of the Project on hydrology and Connacher's plans to manage those effects.

3.4.3 Monitoring

[A] Describe the monitoring programs proposed to assess the impacts of changes in surface water flows and levels on aquatic resources, wildlife and vegetation and to measure the effectiveness of mitigation plans.

The Project lies within an area of the Lower Boreal Highlands, in the headwaters of two major streams – the Christina River and the Horse River. This area of the Lower Boreal Highlands drains into the surrounding lower Central Mixedwood Subregion.

The local study area (LSA) used for the hydrology assessment includes the lease area and surrounding areas which may be affected by direct runoff from the Project (CR #6, Figure 3). The regional study area (RSA) focuses on four watersheds, Watersheds A and B draining into the Horse River basin and Watersheds C and D draining into the Christina River (CR #6, Figure 2). The RSA is limited to these watersheds as potential impacts to the streams downstream of these watersheds are anticipated to be negligible.

The Project may potentially affect a number of valued environmental components (VECs) related to hydrology including:

- runoff volumes and streamflows;
- water levels and surface areas; and
- channel morphology and sediment concentrations.

D.6.2 Baseline Conditions

The baseline data collection and review included:

- regional climatic characteristics such as air temperature, precipitation, and evaporation (CR #6, Section 2.2);
- regional hydrology characteristics including an assessment of flows in thestreams which drain the RSA as well as an analysis of runoff and flows from gauges in the vicinity of the RSA (CR #6, Section 2.3);
- local hydrology data including hydrography, snow depths and densities, water levels and streamflow (CR #6, Section 2.4); and
- streamflow and water level simulations using the Hydrologic Simulation Program – FORTRAN (HSPF) (CR #6, Section 2.4.5).

D.6.2.1 Surface Disturbances

Existing and approved resource extraction developments within the LSA include the existing Great Divide SAGD project and the approved Algar SAGD project. Other significant existing developments in the LSA include Highway 63 and a cleared utility corridor which runs parallel to the highway on the west side. There are other minor sources of disturbances within the LSA such as cutlines for seismic exploration and access for oil and gas extraction. These types of activities are wide spread in the region and any hydrologic effects of such minor disturbances will be reflected in the regional historical streamflow data presented in the baseline hydrology study. The spatial disturbances within individual watersheds are summarized in Table D.6.2.1.

Table D.6.2.1 Summary of Spatial Extent of Existing Development

Water-shed	Drainage Area (ha)	Disturbance Areas								Percent of Drainage Area (%)
		Road & Utility Corridor (ha)	Plant Sites (ha)	Camps (ha)	Well Pads (ha)	Water Wells (ha)	Airstrip (ha)	Borrow Pits (ha)	Total (ha)	
A1a	704.4	25.5							25.5	3.6
A1b	621.6	19.3							19.3	3.1
B1	4301.5	73.9					1.6		75.6	1.8
B3a	1062.8	7.2							7.2	0.67
B3b	1973.4	88.3			3.5		9.0	7.5	108.3	5.5
B3c	696.1	13.1	2.2		13.2			0.0	28.5	4.1
B3d	803.1	34.9	14.7	2.6				8.5	60.7	7.6
B3e	1208.7	11.5							11.5	0.95
B4	1596.5	48.7							48.7	3.0
C1b	1609.0	22.9	25.9	11.4	14.2	1.7		19.7	95.8	6.0
C2a	2250.6	10.2	5.9				9.7	7.9	33.7	1.5
Total	**16827.7**	**355.5**	**48.7**	**14**	**30.9**	**1.7**	**20.3**	**43.6**	**514.8**	

The percentage disturbances in the larger scale watersheds are very small. The percentage disturbance in Watershed A is 0.41%; the percentage disturbance in Watershed B is 1.4%; and the percentage disturbance in Watershed C is 0.14%. It is difficult to measure the effect of this very low intensity scale of development on any hydrologic parameter.

A number of highway culverts were identified in the LSA which correspond to existing drainage patterns across the highway (CR #6, Table 16, Figure 21). There are 14 culverts, most of which are located in drainages without defined channels. Three of the highway culverts are located on streams with defined channels, one channel in Watershed A1a and two channels in Watershed B3b.

In addition, the Great Divide road and utility corridor crosses one stream with a defined channel in Watershed B3b. The Algar road and utility corridor does not cross any streams which have defined channels.

D.6.2.2 Water Supply

Pond One and Algar Projects both use water to make steam for injection into the oil bearing formation. Some make-water is required and is obtained from local deep groundwater supplies. Connacher has not licenced any use of water from the storm water run-off pond to date.

D.6.2.3 Runoff Volumes and Streamflows

There are no significant changes in the surface drainage patterns due to the existing and approved SAGD projects; however, the highway construction has caused some minor changes in the drainage in Watershed B. Runoff from small areas of the headwaters of the watershed was diverted into neighbouring drainages within the watershed. There will be no effects on water levels in wetlands since drainage patterns to wetlands were maintained.

The borrow pits will tend to reduce runoff volumes and flood peaks because water will not be released from these areas. Road and utility corridors, camps, well pads and water well pads will tend to increase both runoff volumes and flood peaks due to the reduction in vegetation and the addition of less permeable surfaces. The plant sites will tend to reduce the flood peaks because the runoff is detained in water quality ponds before being discharged to the natural environment.

Changes in runoff volumes were estimated assuming a worst case condition of the disturbed areas being directly connected to the drainage networks in the watersheds and that the estimated runoff coefficients for each disturbance type are applicable for all runoff events. These changes in runoff volumes are summarized in Table D.6.2.2. The greatest changes in runoff volume occur in Watershed B3b and B3c, with increases of 3.5% and 4.9% respectively.

Table D.6.2.2 Changes in Runoff Coefficients from Baseline Development

Watershed	Natural Drainage Area (ha)	Mean Annual Flow[1] (m^3/s)	Change in Runoff Volume (%)
A1a	704	0.019	1.9%
A1b	622	0.017	1.5%
B1	4302	0.118	0.9%
B3a	1063	0.029	0.2%
B3b	1973	0.054	3.5%
B3c	696	0.019	4.9%
B3d	803	0.022	0.4%
B3e	1209	0.033	0.5%
B4	1596	0.044	1.5%
C1b	1609	0.044	2.4%
C1c	252	0.007	0.0%
C2a	2251	0.062	0.4%
C2b	1860	0.051	0.0%
C2c	1698	0.047	0.0%
C3	1729	0.047	0.0%
C4	6080	0.167	0.0%
D1	6527	0.179	0.0%

[1] March to Oct flows only

HSPF modelling was used to further assess the hydrologic effects of the existing and approved developments relative to pre-development conditions. Simulations of the pre-development condition used the land runoff parameters determined by calibration to measured data from undeveloped basins as presented in CR#6, Section 2.4.5. There were no perceptible impacts on either the magnitude of annual peak flows or on the timing of runoff hydrographs due to the baseline development; however, summer peaks flows were slightly greater. The simulated annual peak flows were dominated by snowmelt events. These snowmelt events were less affected by the changes in runoff parameters because evapotranspiration effects are generally not significant during the period of snow accumulation and because the effects of compaction are less important when the ground is frozen.

No significant changes to annual minimum flow rates are anticipated in most streams because they have little or no flow in winter. The simulations indicate that the annual minimum monthly flow rates were less than 0.5% lower for the baseline case than they were for the pre-development case for watersheds C1b and C2a. The effects on low flows are reduced in these watersheds because both these streams have upstream lakes which supply base flow during dry periods. Watershed B3b which does not have any lakes was found to have annual minimum monthly low flows about 5% lower due to the existing development.

D.6.2.4 Water Levels and Surface Areas

Annual peak water levels and surface areas in the streams are not anticipated to change due to project disturbances because snowmelt-dominated annual peak flows will not change. However, stream minimum water levels and surface areas may be about 2% lower due to reduced minimum flows.

The existing and approved SAGD projects have some disturbed area in the watershed of Lake UL1. There were no perceptible effects on maximum water levels.

There is no change in the annual maximum surface area in Lake UL1 because the annual maximum water level range is not anticipated to change. The annual minimum surface area may be up to 5% greater in dry years due to project effects.

D.6.2.5 Channel Morphology and Sediment Concentrations

Sediment concentrations in the streams in the LSA do not appear to have increased due to changes in the surface runoff characteristics. The changes in the flow regime due to surface disturbances are very small and would not have a perceptible impact the sediment concentrations significantly.

D.6.3 Predicted Conditions

The only planned development within the LSA is the expansion of Highway 63. It is presumed that the highway drainage for the Project will be designed according to current practices and will not increase peak flows or divert water from one watershed to the next.

The cumulative impact of projects in the hydrology RSA was considered, however the only activity in the LSA is a gravel operation in Watershed A and some minor oil and gas developments.

The oil and gas developments in the RSA are typical of the developments which are distributed throughout the region. The hydrologic effects of such developments are not believed to be significant and are already included in the regional flow analysis in the assessment of baseline conditions. No further evaluation of these developments was carried out.

The gravel mining operation occupies an area of about 15 ha in Watershed A. The area of this disturbance is quite small relative to the 10,935 ha drainage area of Watershed A so the effect of this disturbance is insignificant. The gravel mining operation also has a water licence to use 73,000 m^3/yr of water from an unnamed aquifer in this watershed. No project development is proposed in Watershed A so no cumulative impact analysis was carried out.

D.6.3.1 Surface Disturbances

Surface disturbances will occur from the construction of the laydown area, road/utility corridors, remote sumps, well pads, and from borrow pits excavated for construction material. The project will be developed over time in three phases. Over the life of the project, surface disturbances will be located in 14 separate watersheds which drain the LSA (Table D.6.3.1; CR #6, Figure 21).

Table D.6.3.1 Summary of Spatial Extent of Disturbances (application case)

Watershed	Drainage Area (ha)	Disturbance Areas						Percent of Drainage Area (%)
		Laydown (ha)	Road & Utility Corridor (ha)	Remote Sumps (ha)	Well Pads (ha)	Borrow Pits (ha)	Total (ha)	
B1	4302		20.1		23.0	8.2	51.3	1.2
B3a	1063		2.8			6.8	9.6	0.90
B3b	1973		47.0	6.2	43.9	12.2	109.3	5.5
B3c	696		1.5		4.0	6.5	12.0	1.7
B3d	803		4.5		4.0		8.5	1.1
B3e	1209		2.0		3.3		5.3	0.4
B	24305		77.9	6.2	78.3	33.6	196.0	0.81
C1b	1609	7.8	51.1	7.2	33.0	25.8	124.9	7.8
C1c	252				2.4	0.0	2.4	1.0
C2a	2251	2.1	41.2	5.9	17.9	7.5	74.7	3.3
C2b	1860		29.2	4.0	11.4	14.8	59.4	3.2
C2c	1698		7.5		8.6		16.1	0.95
C3	1729		13.5	4.0	12.1	0.3	29.9	1.7
C4	6080		1.6		0.1	7.2	8.9	0.15
C	93599	9.9	144.0	21.1	85.6	55.6	316.3	0.34
D1	6527		1.1		0.1	7.5	8.6	0.13
Total	**149956**	**19.8**	**445**	**54.6**	**327.7**	**186**	**1033.2**	

Six locations have been identified where the road and utility corridors will cross streams which have defined channels (CR#6, Figure 21, Table 20). These channels are generally quite narrow, with the widest crossings occuring near measurement Sites 5 and 6 where the bankfull channel widths were about 9 and 3 m respectively. These channels can be crossed with single span structures so no disturbance of the channels is required.

All other types of disturbed area will be located away from the channels, except Well Pad 106 in Phase 3 of the Project, which may impinge on a stream channel in Watershed B3b. This site will be investigated further before the well pad is constructed.

D.6.3.2 Water Supply

As with the existing operations, process water will be re-circulated and reused as much as possible. However, some of the water will be lost in the formation and some of the water will be taken up in disposing of unwanted by-products. This lost water must be replaced from an external supply. It is anticipated that local deep groundwater supplies will be used to provide water for the project. No surface water will be used for process water.

D.6.3.3 Runoff Volumes and Streamflows

To minimize the impacts on surface runoff, there will be no significant changes in the surface drainage patterns due to Project. Drainage around the development is shown in CR#6, Figure 22.

Appropriate drainage will be provided at crossings of any significant drainage courses and there will be no transfer of water from one watershed to another along ditches and road right-of-ways. Drainage patterns to lakes and wetlands will be maintained.

Changes in runoff volumes due to the project development were estimated assuming a worst case condition of the disturbed areas being directly connected to the drainage network in the watersheds and that the estimated runoff coefficients for each disturbance type are applicable for all runoff events. These changes in runoff volumes are summarized in Table D.6.3.2.

Table D.6.3.2 Changes in Runoff Coefficients from Baseline and Project Development

Water-shed	Natural Drainage Area (ha)	Mean Annual Flow[1] (m^3/s)	Change in Runoff Volume due to Baseline Development (%)	Change in Runoff Volume due to Project Development (%)	Total Change in Runoff Volume due to Development (%)	Average Change in Runoff Volume due to Baseline Development (%)	Average Total Change in Runoff Volume due to Development (%)
A1a	704	0.019	1.9%	0%	1.9%		
A1b	622	0.017	1.5%	0%	1.5%		
B1	4302	0.118	0.9%	1.5%	2.4%		
B3a	1063	0.029	0.2%	-0.3%	-0.1%		
B3b	1973	0.054	3.5%	6.5%	10.0%	1%	1.7%
B3c	696	0.019	4.9%	0.6%	5.4%		
B3d	803	0.022	0.4%	1.7%	2.1%		
B3e	1209	0.033	0.5%	0.8%	1.3%		
B4	1596	0.044	1.5%	0.0%	1.5%		
C1b	1609	0.044	2.4%	7.0%	9.4%	1.4%	2.2%
C1c	252	0.007	0.0%	2.1%	2.1%		
C2a	2251	0.062	0.4%	3.3%	3.7%	-0.2	-0.1
C2b	1860	0.051	0.0%	2.1%	2.1%		
C2c	1698	0.047	0.0%	1.6%	1.6%		
C3	1729	0.047	0.0%	2.1%	2.1%		
C4	6080	0.167	0.0%	-0.1%	-0.1%		
D1	6527	0.179	0.0%	-0.1%	-0.1%		

[1] March to Oct flows only

HSPF modelling was also used to further assess the hydrologic effects of the project and baseline developments relative to pre-development conditions. Simulations of the project development condition incorporate the modifications for the baseline development case and project development conditions assuming a maximum-impact scenario with full development of all project phases before any reclamation occurs. Simulations were carried out for three watersheds, B3b, C1b, C2a, including flow routing through Lake UL1 contained within Watershed C2a and Lake UL3 contained within Watershed C1b. The effects on runoff volume were greatest for watershed C1b with an overall average increase of 2.2% over pre-development conditions. Runoff volume increases were smallest in wet years while larger impacts occurred in dry years, when annual flow volumes increase by up to 6.0% above pre-development conditions.

There were no perceptible impacts on either the magnitude of peak annual flows or on the timing of runoff hydrographs due to the project development but summer peaks flows were slightly greater. The simulated peak annual flows were dominated by snowmelt events. These snowmelt events were less affected by the changes in runoff parameters because evapotranspiration effects are generally not significant during the period of snow accumulation and because the effects of compaction are less important when the ground is frozen. Summer peak flows tended to be slightly greater for the project development case and were consistent with the runoff volume analysis presented in Table D.6.3.2.

No significant changes to low flow rates are anticipated in most streams in the LSA because they have little or no flow in winter. The simulations indicate that the annual minimum monthly flow rates were less than 1% lower for the application case than they were for the pre-development case for watersheds C1b and C2a. The effects on low flows are reduced in these watersheds because both these streams have upstream lakes which supply base flow during dry periods. Watershed B3b which does not have any lakes was found to have annual minimum monthly low flows about 5% lower after development; however, these affects were due to the existing developments rather than the application case.

D.6.3.4 Water Levels and Surface Areas

Annual peak water levels and surface areas in the streams are not anticipated to change due to project disturbances because annual peak flows will not change. However, stream minimum water levels and surface areas may be about 2% lower due to reduced minimum flows.

D.6.3.5 Channel Morphology and Sediment Concentrations

Sediment concentrations in the streams are not anticipated 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 stream crossings in the project footprint will be designed to minimize the disturbance to the channels so sediment inputs are not anticipated to increase due to local disturbances.

D.6.4 Mitigation and Monitoring

D.6.4.1 Mitigation

Connacher will undertake the following mitigation measures to reduce potential hydrological impacts from the Project:

- reclaim the landscape to be similar hydrologically to the pre-existing conditions;
- design stream crossings to avoid or minimize any impact on stream channels and erosion of channel banks;
- release water from stormwater runoff pond into natural environment away from streams;
- construct stream crossings in accordance with the Code of Practice for Watercourse Crossings (2007);
- maintain drainage disturbances so that runoff is not directed from one watershed into another; and
- maintain adequate buffers between stream channels and facility development.

D.6.4.2 Monitoring

Connacher will:

- conduct monitoring as required in the EPEA approval;
- monitor water prior to release from the stormwater runoff pond; and
- conduct sediment monitoring during construction of watercourse crossings.

D.6.5 Summary of VECs

With appropriate mitigation and monitoring there will be an insignificant impact on flow and sedimentation within local and regional watercourses. Table D.6.5.1 summarizes the significance of impacts on VECs.

Table D.6.5.1 Summary of Impact Significance on Hydrological VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Runoff Volumes and Streamflows												
	Changes to runoff volume, peak flows, and low flows	refer to Section D.6.4 and CR #6, Section 7	Project	Local	Long	Seasonal	Reversible in long term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Long	Seasonal	Reversible in long term	Low	Negative	High	High	Insignificant
2. Water Levels and Surface Areas												
	Changes in water levels and surface area due to streamflow changes	refer to Section D.6.4 and CR #6, Section 7	Project	Local	Long	Seasonal	Reversible in long term	Low	Negative	High	High	Insignificant
			Cumulative	Local	Long	Seasonal	Reversible in long term	Low	Negative	High	High	Insignificant
3. Channel Morphology and Sediment Concentration												
	Changes in channel shape and sediment conc. due to flow changes and crossing construction	refer to Section D.6.4 and CR #6, Section 7	Project	Local	Long	Occasional	Reversible in long term	Low	Negative	High	Low	Insignificant
			Cumulative	Local	Long	Occasional	Reversible in long term	Low	Negative	High	Low	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.7 NOISE

D.7.1 Introduction and Terms of Reference

Connacher conducted an assessment of noise impacts for the proposed Project. The following section is a summary of the Noise Impact Assessment that was prepared by aci Acoustical Consultants Inc. included as Consultants Report #7 (CR #7). For full details of the assessment please refer to CR #7.

Alberta Environment issued the Terms of Reference (ToR) for the project on July 17, 2009. The specific requirements for the NIA are provided in Section 3.2 of the ToR and are as follows:

3.2.1 Baseline Information

[A] Provide representative baseline noise levels at receptor locations.
[B] Identify components of the Project that have the potential to increase noise levels and discuss the implications. Present the results of a noise assessment. Include:

- *a) potentially-affected people and wildlife*
- *b) an estimate of the potential for increased noise resulting from the development; and*
- *c) the implications of any increased noise levels*

[D] Describe how air quality and noise impacts resulting from the Project will be mitigated.
[E] Describe the residual air quality and noise effects of the Project and Connacher's plans to manage those effects.

3.2.3 Monitoring

[A] Describe the monitoring programs proposed to assess any Project impacts to air quality and noise and to measure the effectiveness of mitigation

- *a) Nature and significance of changes in noise levels as a result of the Project;*
- *b) Implications of increased noise levels and proposed measures to minimize noise resulting from the development. This will be done considering magnitude, frequency, duration and time of day and the performance potential of these measures;*
- *c) An assessment of cumulative effects of the Project on air quality and noise in the Regional Study Area(s); and*
- *d) Mitigation and monitoring measures to address air quality and noise concerns.*

The purpose of the NIA was to:

- generate an updated computer model of the existing and pending Connacher facilities in the area to determine updated baseline noise levels;
- augment the baseline noise model with additional noise sources associated with the Project;
- compare the projected noise level results to the Alberta Energy Resources Conservation Board (ERCB) permissible sound level guidelines (ERCB Directive 038 on Noise Control, 2007); and
- provide noise mitigation recommendations.

The ERCB Directive 038 specifies that noise impact assessments are to be carried out to evaluate project impacts on the nearest dwelling. The nearest known dwelling is a Trapper's Cabin, which is located in between Pod One and Algar, as shown in CR#7, Figure 1. 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 radius from all Project noise sources. The local study area (LSA) includes areas within a radius of

1.5 km from the Project noise sources and the regional study area (RSA) includes areas within a radius of 5 km from the Project noise sources since anything further away will be insignificant.

The NIA conforms with the requirements of the ERCB Directive 038 on Noise Control. The computer noise modeling was conducted using the CADNA/A (version 3.72.131) software package. Topographical features such as land contours, vegetation, and bodies of water and meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction are considered in the assessment. The modeling methods used met or exceeded the requirements of the ERCB Directive 038 on Noise Control.

All sound power levels (SWLs) used in the modeling are considered conservative. The noise sources for the equipment associated with the Project were obtained either from:

- noise measurement assessments carried out for other projects using similar operating equipment;
- aci in-house information and calculations using methods presented in various texts; or
- sound level information provided by equipment vendors.

Due to the large size of the study area and the density of vegetation within the study area, vegetative sound absorption was included in the model. An absorption coefficient of 0.5 was used along with a temperature of 10^0C and a relative humidity of 70%. Note that trees were not specifically modeled. Over the large distance from the sources to the receivers, trees will add sound absorption. As a result, all sound level propagation calculations are considered conservatively representative of summertime conditions (as specified in Directive 038).

D.7.2 Baseline Conditions

D.7.2.1 Permissible Sound Levels

Environmental noise levels from industrial noise sources are commonly described in terms of equivalent sound levels or Leq. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These Leq in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) LeqDay and night-time (22:00 to 07:00) LeqNight while other criteria use the entire 24-hour period as Leq24.

Directive 038 sets the PSL at the receiver location based on population density and relative distances to heavily traveled road and rail. At the trapper's cabin, there is a Basic Sound Level (BSL) of 40 dBA for the night-time (night-time hours are 22:00 – 07:00) and 50 dBA for the day-time (day-time hours are 07:00 – 22:00) due to the proximity to Highway 63 (350 m) which is considered heavily traveled during the night-time. Note that for this location none of the other adjustments to the BSL discussed in Directive 038 apply. In addition, Directive 038 specifies that new facilities must meet a PSL-Night of 40 dBA at 1,500 m from the facility fence-line if there are no closer dwellings. As such, the PSLs at a distance of 1,500 m are an LeqNight of 40 dBA and an LeqDay of 50 dBA while the PSL at the trapper's cabin is 45 dBA LeqNight and 55 dBA LeqDay.

D.7.2.2 Baseline Case Noise Levels

The baseline assessment includes modelling all noise sources associated with:

- the existing Pod One CPF;
- the existing Pod One wellpads (x2);

- the Algar CPF; and
- the Algar wellpads.

Results of the noise modeling for the baseline case show that noise levels will be under the PSL-Night of 45 dBA at the trapper's cabin and under the PSL-Night of 40 dBA at all of the 1,500 m receptor locations (CR #7, Table 2, Figure 2).

In addition to the broadband A-weighted sound levels, the modeling results at the various receptor locations indicated C-weighted sound levels have been calculated (CR #7, Table 3). For most of the receptors, the dBC sound levels will be less than 20 dB above the dBA sound levels. As specified in Directive 038, if the dBC – dBA sound levels are less than 20 dB, the noise is not considered to have a low frequency tonal component. At some of the receptors, however, the dBC – dBA sound levels are greater than 20 dB. These receptors, however, are very far from the CPFs and have very low dBA sound levels. The reason for the larger difference between the dBC and dBA sound levels is because the higher frequency sounds from the CPF will be absorbed by the atmosphere and vegetation more than the low frequency sounds. This is not necessarily an indication of a strong low frequency noise source. In addition, even with a low frequency tonal penalty of 5 dBA (detailed in Directive 038) added to the modeled sound levels at these receptors, the overall noise levels would still be well below their respective PSLs. As such, there is no additional low frequency noise mitigation required as per ERCB Directive 038.

D.7.3 Predicted Conditions

As part of the application case assessment, two specific noise modeling scenarios were conducted including:

- a construction scenario which included all equipment and noise sources associate with the Baseline Case (Section D.7.2.2) as well as those associated with typical industrial construction equipment for the proposed Algar Expansion (3,800 m3/d); and
- an operational scenario which included all equipment and noise sources associate with the Baseline Case (Section D.7.2.2) as well as those associated with the operation of the proposed Algar Expansion and all 45 future wellpads.

An assessment for the Planned Development Case (PDC) was not conducted since there are no known proposed facilities within at least 5 km of the Project.

D.7.3.1 Construction Scenario

The results of the Application Case construction scenario noise modeling show that the modeled noise levels at all receptor locations will be under 40 dBA L_{eq} during the night-time and under 50 dBA L_{eq} during the day-time (CR #7, Table 4 and Figure 3). Although there is no specific criteria for construction noise within ERCB Directive 038, the results indicate minimal impact relative to the Baseline Case.

D.7.3.2 Operations Scenario

The results of the Application Case operational scenario noise modeling show that the modeled noise levels will be under the PSL-Night of 45 dBA at the trapper's cabin and under the PSL-Night of 40 dBA at all of the 1,500 m receptor locations (CR #7, Table 5, Figure 4).

In addition to the broadband A-weighted sound levels, the modeling results at the various receptor locations indicated C-weighted sound levels have been calculated (CR #7, Table 6). Similar to the

Baseline Case, the dBC sound levels will be less than 20 dB above the dBA sound levels for most of the receptors while greater than 20 dB above the dBA sound levels at some of the receptors. As stated with the Baseline Case, the noise levels are very low and no low frequency noise mitigation is required as per ERCB Directive 038.

D.7.4 Mitigation and Monitoring

D.7.4.1 Mitigation

Although results of the noise modeling indicated that no specific additional noise mitigation measures are required for project equipment Connacher will utilize the following mitigation measures, where possible, to reduce the potential impacts associated with noise from the project:

- construction activity will be conducted between the hours of 07:00 and 22:00;
- internal combustion engines will be fitted with appropriate muffler systems; and
- respond to any noise related issues raised by stakeholders.

D.7.4.2 Monitoring

As per ERCB Directive 038, post-commissioning noise monitoring is not required. If, however, a noise complaint is filed with the ERCB or Connacher, Connacher will conduct a comprehensive sound level survey in accordance with the requirements of ERCB Directive 038.

D.7.5 Summary

The results of the noise modeling indicated Baseline Case night-time noise levels below the ERCB Directive 038 permissible sound levels of 45 dBA at the nearby trapper's cabin and 40 dBA for all surrounding 1,500 m receptors. Further, the dBC – dBA sound levels indicated minimal likelihood of low frequency tonal components.

The Application Case construction scenario noise levels were only marginally higher than the Baseline Case and still below 40 dBA L_{eq} during the night-time and below 50 dBA L_{eq} during the day-time.

The Application Case operational scenario night-time noise levels were below the ERCB Directive 038 permissible sound levels at the nearby Trapper's Cabin and all surrounding 1,500 m receptors. Further, the dBC – dBA sound levels indicated minimal likelihood of low frequency tonal components. As such, no additional noise mitigation is required for the normal operation of the Project.

D.8 Socio-Economic Assessment

D.8.1 Introduction and Terms of Reference

Connacher conducted a socio-economic assessment for the proposed Project. The following section is a summary of the Soci-Economic Assessment that was prepared by Nichols Applied Management and included as Consultants Report #8 (CR #8). For full details of the assessment please refer to CR #8.

Alberta Environment issued the Terms of Reference (ToR) for the project on July 17, 2009. The specific requirements for the Socio-Economic Impact Assessment (SEIA) are provided in Section 7.0 of the ToR and are as follows:

7.1 Baseline Conditions

[A] Describe the existing socio-economic conditions in the region and in the communities in the region.

[B] Describe factors that may affect existing socio-economic conditions including:

a) population changes;
b) Connacher's policies and programs regarding the use of regional and Alberta goods and services;
c) a project schedule and a general description of the overall engineering and contracting plan for the Project;
d) workforce requirements for the Project, including a description of when peak activity periods will occur; and
e) planned accommodations for the workforce during the life of the Project.

7.2 Impact Assessment

[A] Describe the socio-economic effects of construction and operation of the Project, including:

a) impacts related to:
  i) local training, employment and business opportunities,
  ii) regional and provincial economic benefits,
  iii) housing,
  iv) recreational activities,
  v) gathering, trapping, hunting and fishing, and
  vi) effects on First Nations and Métis (e.g., traditional land use and social and cultural implications);
b) estimated total Project cost, including a breakdown for engineering and project management, equipment and materials, and labour for both construction and operation stages. Indicate the percentage of expenditures expected to occur in the region, Alberta, Canada outside of Alberta, and outside of Canada;
c) impacts of the Project on the availability of affordable housing and the quality of health care services. Provide a summary of any discussions that have taken place with the local municipalities and local environmental public health office of Alberta Health Services concerning housing availability and health care services respectively;
d) discuss any effects expected on primary and secondary highway systems and other regional roads caused by anticipated traffic changes;
e) the impact on local and regional infrastructure and community services, including consideration of municipal "hard services", education/training services, social services, urban and regional recreation services, law enforcement and emergency services; and
f) describe municipal growth pressures as they relate to the Project and the need for additional Crown land to meet these needs.

[B] Describe the socio-economic effects of any construction camp required for the Project and identify:

a) its location,
b) the number of workers it is intended to house,
c) whether the camp will service the Project only or other clients,
d) the length of time the camp will be in service, and
e) describe what services will be provided in the camp (e.g., security, recreation and leisure, medical services).

[C] Discuss options for mitigating impacts including:

a) Connacher's policies and programs regarding the use of regional and Alberta goods and services;

b) plans to work with First Nations and Métis communities and groups and other local residents and businesses with regards to employment, training needs, and other economic development opportunities arising from the Project;
c) steps that have been undertaken by industry, the municipality, provincial government or through regional and cooperative initiatives to address socio-economic concerns and impacts to local and regional transportation infrastructure;
d) the potential to avoid overlap with other Projects that are reasonably anticipated during all stages of the Project;
e) mitigation plans that will be undertaken to address issues related to the availability of affordable housing and the quality of health care services; and
f) strategies to mitigate socio-economic concerns raised by the local municipality and other stakeholders in the region.

[D] Describe the residual effects of the Project on socio-economic conditions and Connacher's plans to manage those effects.

7.3 Monitoring

[A] Describe the monitoring plans proposed to assess any Project socio-economic impacts and the effectiveness of mitigation plans.

The socio-economic impact assessment (SEIA) addresses the human environment with and without the Project. The key socio-economic issues considered in the analysis fall into the following categories:

- employment effects;
- regional and provincial economic benefits;
- population effects;
- effects on regional infrastructure and services;
- traditional land use effects; and
- transportation effects.

The Regional Study Area (RSA) is defined as the Edmonton-Fort McMurray corridor. The definition of the RSA for the Project is informed by the proponent's past experience with the hiring of labour and procurement of supplies for the construction and operations of the Pod One and Algar sites.

The focus of the analysis of employment, income, population, and infrastructure effects is on the Edmonton Census Metropolitan Area (CMA) part of the RSA. Transportation issues are analyzed with special attention to the corridor along Highway 63 between the Project and the City of Edmonton and effects on police, emergency, and health services focus on the Urban Services Area of the Regional Municipality of Wood Buffalo (Fort McMurray). Some fiscal effects transcend the RSA boundary and accrue to Alberta and Canada.

D.8.2 Baseline Conditions

D.8.2.1 Economic and Fiscal Assessment

All the construction workers at the Algar site and all but one of the operations workers at the Pod One, reside permanently outside the RMWB. 95% of construction workers stated that they do not have any plans to move to the region;

The majority of supplies used for the construction of Pod One and Algar were procured in the Edmonton CMA and elsewhere in Alberta.

Connacher has stronger economic ties to the Edmonton CMA as compared to Fort McMurray, where contractors tend to focus on the large mining projects north of Fort McMurray rather than the smaller SAGD projects.

D.8.2.2 Population Effects

The estimates of the RMWB forecasting initiative indicate a population in Fort McMurray of 72,470 in 2008, 90,140 in 2018, 106,380 in 2023 and 133,000 by 2028. Most of this population growth in the 2010 to 2018 period is linked to projects assumed in the Base Case. Population increases beyond 90,000 to 95,000 persons imply oil sands projects that currently do not have regulatory approval.

The average annual growth rate of the population in the Wood Buffalo region is expected to decline over time and average 3% to 45% over the next 15 years. This is lower than the growth experienced in recent years.

The growth in the small RSA communities under Base Case assumptions is expected to reflect the last five to 10 years of experience. Using the 5 year average annual growth rate, the population of the small RSA communities is expected to increase from 14,553 in 2006 to 15,374 in 2018, and 16,111 in 2028.

The Growth Plan released by the Capital Region Board (CRB) anticipates that the Edmonton CMA population will increase with an average annual growth rate of about 2% from 1,094,105 in 2008 to 1,305,593 in 2018 and 1,498,322 in 2028 (CRB 2009).

D.8.2.3 Social Infrastructure Effects

The growth in the population of Fort McMurray and the RMWB has caused effects on infrastructure and service providers, including:

- difficulty in recruiting and retaining personnel;
- high cost of doing business;
- response delays for most public service systems;
- increasing traffic levels; and
- difficulty in finding volunteers and generally, a sense of community impermanence.

A more detailed analysis of the situation by selected service provider is provided in CR #8, Section 6.2.

The Government of Alberta and the RMWB have put in place planning and funding initiatives to meet the housing, municipal infrastructure, and social, health, policing, emergency response and other services for this population level and more. Oil sands companies have community investment programs in place to provide assistance where appropriate.

Demand for health and other services in the small RSA communities is expected to increase marginally with population. Demand for emergency response services along Highway 63 is expected to increase over time as traffic volumes increase. The demand for emergency services will be affected by the twinning of Highway 63, as divided highways have lower collision rates than two-lane secondary highways.

Demand for health and other services in the Edmonton CMA is expected to increase marginally with population. Most of this demand is driven by general economic growth, which is expected to be positive but lower than experienced between 2001 and 2008.

The experience of the recent period of growth indicates that economic growth has outpaced social investment in the Edmonton CMA and the province. Social housing is in short supply and many people with lower skill levels have only been able to find lower-paying jobs. Housing affordability remains an issue despite some retrenchment of prices from their heights of early 2007. Many of the growth-related pressures are expected to reflect the experience of the years prior to the onset of the 2008 recession.

D.8.2.4 Traditional Land and Culture

There are five First Nations within the Regional Municipality of Wood Buffalo, with a registered population of about 6,400 members. The Heart Lake First Nation, located in Lakeland County, also has traditional land use territory in the southern portion of the RMWB.

Along with First Nations, the Wood Buffalo region is home to seven Métis locals of Region 1 of the Métis Nation of Alberta.

Aboriginal peoples have lived in northeastern Alberta for 10,000 years or more, engaging in hunting, trapping, fishing, and gathering of food and medicinal plants. Carrying out these traditional activities continues to this day and is intimately related to the culture, spirituality and identity of Aboriginal peoples.

Development in the region, exposure to external cultural influences and the wage economy has eroded the ability of Aboriginal peoples to pursue traditional activities, and hence their ability to retain and pass on their culture.

Development has also brought along with it increases in the regional population which, in turn, increases the exposure of youths and older community members to non-aboriginal culture. As well, infusions of wage income to Aboriginal communities may fuel dysfunction, including drug and alcohol use and abuse, in people with limited exposure to wage economy realities.

Aboriginal communities in the region have responded in a number of ways to development pressures, including engaging with the oil sands industry by developing employment and contracting capacity. In 2008, there were approximately 1,500 Aboriginal employees in permanent jobs in the oil sands industry and over $575 million in contract work performed by Wood Buffalo Aboriginal companies (OSDG 2009).

The cultural changes and community stresses resulting from development mean that many Aboriginal community members need, and will likely continue to need, assistance in managing the changes brought on by oil sands expansion. Oil sands developers and other companies in the region have pledged to support the development of First Nations in the area through the ATC/Athabasca Resource Developers All Parties Core Agreement. Extended for the 2007 to 2010 period, the agreement provides base funding of $230,000 to each of the five ATC First Nations for Industry Relations Corporations (IRC). The IRCs assist each community to consult with industry and identify issues relating to industrial development.

Many companies in the region also work through the OSDG Aboriginal Affairs committee and with the IRCs to determine how best to accommodate and mitigate the adverse social and cultural effects of development. A number of companies support cultural retention and other initiatives aimed at helping Aboriginal communities maintain their social cohesion and unique characteristics.

In response to growth pressures, the preservation of traditional cultural and environmental knowledge is also changing, moving from a mostly oral and activity-based tradition of preservation to greater emphasis on systematic documentation. This is done primarily through traditional land use studies, traditional ecological knowledge initiatives, oral history projects and other initiatives. Traditional resource use is also addressed through the Sustainable Ecosystems Working Group (SEWG), a working group of the Cumulative Environmental Management Association (CEMA) that has a mandate to address issues on sustainable ecosystems, wildlife and biodiversity.

D.8.2.5 Transportation Effects

Oil sands expansion in the RMWB has led to increased traffic on Highway 63. The average annual rate of growth varies between 5.2% and 9.0%.

Residents in the Fort McMurray–Edmonton corridor region have specific concerns regarding traffic in the region, including:

- traffic safety;
- traffic congestion; and
- transportation of hazardous material.

Ongoing construction of oil sands facilities will contribute to traffic increase in the Base Case. Traffic volumes on Highway 63 near Thorhild are estimated at 3,100 AADT in 2015. Traffic near the intersection of Highway 63 and the Project access road, near Wandering River, is estimated at 6,978 daily vehicle movements in 2015. These baseline volumes reflect an assumed annual growth rate of 5.2% and 9.0% on these highway segments respectively, which are the average annual growth rates experienced along these segments of Highway 63 in the last nine years. It is expected that this rate of baseline growth will continue until 2020 as well.

Currently, Connacher trucks in diluent and trucks out the dibit from the Pod One facility. The trucking program accounts for 114 vehicle movements per day, or roughly 3% of the 2008 traffic volume near the Project site. The intersection of the Pod One access road and Highway 63 has been improved with a southbound acceleration lane to accommodate this traffic.

D.8.3 Predicted Conditions

D.8.3.1 Economic and Fiscal Assessment

<u>Project Income Effects</u>

The Project construction capital expenditures are estimated at approximately $600 million (CR #8, Table 4-1). Construction capital expenditures include wages and salaries paid to construction workers, professional engineering and environmental services and direct purchase of goods and services, such as equipment modules and structural steel elements.

Approximately 65% of the total expenditure is estimated to accrue to suppliers and workers within Alberta. In addition, 12% is estimated to accrue to suppliers in the rest of Canada and 23% to foreign suppliers. The expenditure accruing to foreign suppliers is related primarily to the purchase of machinery and equipment. An estimated $131 million (or about 22%) will accrue to the RSA, mainly in the form of wages for construction workers and income for contractors based in the Edmonton CMA.

Once operational, the Project will incur sustaining capital expenditures associated with:

- central plant facilities;
- construction of a further 40 wellpads; and
- ongoing drilling.

Sustaining capital outlays will begin in 2013 and are estimated to total $530 million between 2013 and 2038 (or an average of approximately $21 million per year). More than 80% of the sustaining capital expenditure is expected to accrue to Alberta suppliers, reflecting the supply capabilities of the Alberta drilling and pad and pipeline construction sectors.

Annual operations costs of the Project (excluding gas and electrical costs) are estimated to average $88 million (CR #8, Table 4-2). An estimated 65% of the expenditures accrue to Alberta, including the RSA, and an additional 12% to the rest of Canada. An estimated $19 million (or 22%) of annual operations spending will accrue to workers and contractors in the RSA, mostly in the form of wages and salaries.

The construction expenditure associated with the Project constitutes income for contractors, suppliers and workers. These recipients, in turn, spend part of this income on supplies and services, thus capital expenditures are circulating in the economy, compounding the income effect of the Project.

Table D.8.2.1 presents the Project's estimated direct, indirect, and induced impact in terms of Gross Domestic Product (GDP) and household income, based on published statistics (Alberta Finance 2009).

Table D.8.2.1 Project GDP and Income Effects

	Construction Phase	Operations Phase	Sustaining Capital Expenditure
	($ millions)		
Gross Domestic Product	560	83	20
Household Income	362	23	6

Through operations of its Pod One CPF and the construction of its Algar CPF, Connacher has developed a number of relationships with contractors in the RSA. Connacher intends to continue working with RSA based contractors to increase the share of local contractors in Project work.

In line with the general economic linkage between the Project and suppliers in the Edmonton CMA and beyond, most the Project's income effects in the RSA are likely to accrue to workers and suppliers in the Edmonton CMA.

Project Employment Effects

The Project will create on-site construction employment opportunities between Q1 2012 and Q2 2013. Taken together, the construction of the plant and field facilities and the drilling of the wells will create approximately 700 person-years of direct on-site employment.

The size of the on-site construction workforce, including drilling complements, is estimated to remain fairly constant in the range of 650 persons over the construction period.

Connacher's construction strategy includes the use of skid modules and overall construction modularization. This will create work an estimate 360 person-years of employment for construction workers in fabrication yards, primarily in the Edmonton and Calgary regions. The majority of this work will take place in the early part of the construction period.

The Project is expected to create an estimated 280 person-years of employment for engineering contractors. Most of this work will accrue to engineering firms in Edmonton and Calgary.

The Project is expected to be integrated with the Algar plant and in respect to product shipments with the Pod One CPF. Once fully operational, the Project is expected to increase the total operations workforce for the Algar and Pod One projects by 80 positions, from 125 to 215 persons. An estimated two-thirds of these full-time positions are expected to be direct employees of Connacher, with the balance consisting of contractors.

Ongoing drilling activity and associated replacement pad construction is estimated to require an average of between 20 and 25 workers per year during the operations phase of the Project. The work is expected to be done largely by RSA contractors.

The operations employment created by the Project will mirror that of the current operations. An estimated 50 full-time equivalent positions will be plant operators and maintenance workers. In addition, ongoing well pad and pipeline construction will require equipment operators and metal trades, while drilling of replacement wells will require the relevant crew complement.

Connacher's experience operating the Pod One plant reflects the challenge of the limited capacity in Fort McMurray in light of high demand for workers and services there. In line with this experience, most opportunities are expected to accrue to workers and contractors from communities in the southern part of the RSA and elsewhere in Alberta.

The company will continue to promote employment, contractor and supply opportunities for local and especially aboriginal contractors through efforts such as:

- procurement policies that consider degree of aboriginal participation;
- breakdown of the contract size for selected procurement items to reflect the size and capabilities of RMWB-based contractors; and
- use of the procurement promotion systems within RED Link and NAABA, as well as other RSA-based advertisements.

Project Fiscal Effects

The Project contributes property taxes to the RMWB, oil sands royalties to the provincial government, and corporate taxes to the provincial and federal government.

Once operational, the Project will add approximately $225 million to $250 million to the assessment base of the RMWB. The estimated total Project assessment represents roughly 1.2% of the current $19.6 billion assessment base of the RMWB (RMWB 2009b).

A preliminary estimate of the Project's municipal tax payment upon reaching full operation, using current tax rates as a proxy, is $3.5 million annually.

The municipal costs directly associated with the Project are expected to be few because most of the water, sewer and access road maintenance services are supplied by the Project. The Project will have effects on service providers, including policing and emergency services, and roadways.

The Project will contribute to the royalty income of the Alberta government. The royalty payment estimate presented here is subject to uncertainty regarding future values of key variables in the Provincial calculation formula.

It is estimated that the Project will pay a total of $978 million ($2009) over the 30 year operations phase. On a present value basis, assuming 2009 constant dollars and an 8% real discount rate, the value of the Project's royalty payments is estimated at $370 million. In addition approximately $175 million in corporate taxes accrue to Alberta and $350 million to Canada.

D.8.3.2 Population Effects

Application Case

The Project's population effect and the associated effect on service providers in the RSA is expected to be small. Many of the construction and operations workers that are expected to add marginally to the population in the northern part of the RSA are already resident in the RSA, especially in the Edmonton CMA.

The Project will use on-site operations and construction camps and institute worker commute systems, using private vehicles, busses, and a fly-in/fly-out program utilizing the Fort McMurray airport.

The temporary population increase of approximately 300 camp-based mobile workers during the construction phase and the roughly 80 camp-based operations workers for the life of the project will add to the demand for emergency, policing, and health services. This effect is expected to be small in view of the fact that the construction and operations workforces will not exceed 1.5% and 0.3%, respectively, of the estimated 20,000 camp-based workers counted in the RMWB in early 2009.

The Project is not expected to have a measurable effect on the population of and service providers in the small RSA communities.

Most of the construction and operations workers required for the Project are expected to be recruited from the Edmonton CMA and beyond. In addition, indirect and induced jobs created in the Edmonton CMA as a result of Project-related work being done off-site may encourage some in-migration. Under the very conservative case that all construction and operations workers for the Project are new to the Edmonton CMA, the population impact is expected to be less than 0.1% of the total population of the Edmonton CMA. The Project-related population growth is fully subsumed in the anticipated growth in the CMA.

In reality many of the Project construction and operations workers are likely to be residents of the Edmonton CMA, thus making the Project's population effect essentially zero.

Planned Development Case

Under the cumulative effects scenario the near and medium growth forecast discussed under the Application Case extends further into the future. The discussion under the Base Case remains relevant. As noted, population growth in Fort McMurray beyond 90,000 to 95,000 persons imply oil sands projects that currently do not have regulatory approval.

D.8.3.3 Social Infrastructure Effects

Application Case

Connacher is committed to hiring locally whenever possible and to fully use available local and provincial workforce. The residency patterns of the current Connacher workforce and the inclusion of a permanent on-site operations camp suggests that the majority of operations workers will live outside the Wood Buffalo region. The same holds for the temporary construction workforce.

The construction execution and approach to operations staffing will minimize any effects of the Project on the regional social infrastructure. In particular, the Project is expected to have minimal impacts on the regional population growth and thus, on housing, education, recreation, social, and municipal services and infrastructure. There will be some effects on policing, emergency services, and health services related to the construction and operations camps. These impacts are expected to be small relative to the overall impact of construction and operations camps in the region, which house 20,000 people or more.

Demand for health and other services in the small RSA communities is not expected to increase due to the Project. Demand for emergency response services along Highway 63 are expected to increase linked to Project related traffic.

Demand for health and other services in the Edmonton CMA is not expected to increase due to the Project. Most of the Project's construction and operations workers are already resident in the Edmonton CMA. The size of the police, emergency services, health and other social services systems in the Edmonton CMA is such that an increase in demand if all required construction and operations workforce were to be new to the region would be very small.

Planned Development Case

The main difference between the Application Case and the Planned Development Case is the inclusion in the analysis of projects without regulatory approval. Most of these projects are slated for construction in 2015 or beyond and contribute to population growth in 2018 and beyond.

In terms of service provider impacts, Planned Development Case implies a continued growth in service demands beyond 2018. This continued growth, in turn, will require a continued emphasis on planning and social infrastructure development for a more extended period than under the Base Case or Application Case assumptions. Most planning work already contemplates population levels beyond the 90,000 to 95,000 population level for Fort McMurray.

Demand for health and other services in the small RSA communities is expected to increase marginally with population. Demand for emergency response services along Highway 63 is expected to increase over time as traffic volumes increase. The demand for emergency services will be affected by the twinning of Highway 63, as divided highways have lower collision rates than two-lane secondary highways.

Demand for health and other services in the Edmonton CMA is expected to increase with population. Most of this demand is driven by general economic growth, which is expected to be positive but lower than experienced between 2001 and 2008. Growth-related pressures are expected to reflect the experience of the years prior to the onset of the 2008 recession.

D.8.3.4 Traditional Land and Culture

Additional land will be disturbed as approved and proposed oil sands projects are constructed in the region. The project will further intensify oil sands activities in the southern portion of the RMWB.

Further development will diminish the opportunities for traditional resource use in the Wood Buffalo region but increase wage employment opportunities for Aboriginal people, as well as commerce opportunities for Aboriginal-owned businesses.

The extent to which Aboriginal people in the area are able to take advantage of these opportunities depends on many factors, including:

- education level and job readiness; and
- interest in pursuing wage economy opportunities as compared to traditional pursuits.

D.8.3.5 Transportation Effects

Application Case

The Project will contribute to increased traffic along the Fort McMurray to Edmonton corridor. The effects are expected to be greatest during the peak construction phase of the Project, scheduled to occur between Q1 2012 and Q2 2013. During that time, an estimated 51 additional daily vehicle movements are expected. The total estimated 3,861 vehicle movements constitutes a 1.3% increase over Base Case traffic volumes near the project access road.

The estimated traffic volume, including Project activity, of 3,861 vehicle movements on Highway 63 near, the Project, including Project activity, of is below the peak volume of 5,400 average annual daily traffic (AADT) movements experienced in 2008 on two-lane segment of Highway 63 between the Edmonton CMA and the Project.

All but one of Connacher's current operations workers at Pod One make use of the fly-in/fly-out program and stay in camp for the duration of their shift. This pattern is expected to continue for operational employees of the Project.

The Project will expand the productive capacity of Algar and thus the number of trucks required to haul out the bitumen. Labour and supply movements to and from the Project are expected to generate an additional seven vehicle movements per day. In addition, the Project is expected to generate 342 vehicle movements per day for diluted bitumen to a sales hub in the Edmonton CMA, bringing the total operational traffic impact to approximately 349 vehicle movements. This represents a 9.0% increase in the vehicle movements near the intersection of Highway 63 and the Project access road.

There is planning ongoing regarding the feasibility of a bitumen pipeline from the Pod One CPF to Conklin. A bitumen pipeline would eliminate all of the bitumen truck related traffic from not only the Project, but also Pod One and Algar.

Planned Development Case

Based on all the projects included in the Cumulative Effects Assessment, traffic volumes on Highway 63 are expected to continue rising at the rate of 7% annually. Volumes south of the intersection with Secondary Highway 881 could reach an average of 8,500 vehicle movements by 2018. This average daily traffic volume would still be within the carrying capacity of the highway at its current level of service, but daily and weekly commuting would see higher volume peaks. As volumes increase on Highway 63, continued cooperation between oil sands developers on coordinating shift and over-dimensional load movements will be required. The twinning of Highway 63 will increase the roadway's capacity to handle the expected growth in traffic volumes.

D.8.4 Mitigation and Monitoring

D.8.4.1 Mitigation

Connacher will utilize the following mitigation measures in order to reduce potential impacts to socio-economic resources:

- utilize a camp to house construction and operations personnel;
- continue to evaluate constructing a pipeline to link Pod One, Algar, and the Project by pipeline to the Edmonton-area thereby offset product trucking;

- support the collection of traditional ecological knowledge on medicinal plants, wildlife and spiritual and cultural sites on Connacher leases prior to their development;
- work through the OSDG Aboriginal Affairs committee and with the IRCs to support cultural retention and other initiatives, where appropriate;
- implement a policy not allowing employees and contractors working on the Project site to access adjacent land or bring recreational vehicles with them to the camp;
- continue to build upon the practices and relationship developed for the Great Divide and Algar projects; and
- negotiate and consult with Aboriginal communities in the region and, where possible, use Aboriginal contractors that qualify on merit and are cost competitive for some products and services related to both the construction and operations of the Project.

D.8.4.2 Monitoring

Connacher will continue with periodic consultations with its main stakeholders. These consultations will include discussions about Project impacts. No formal monitoring program beyond these periodic stakeholder engagements is proposed.

D.8.5 Summary

Connacher has endeavoured to minimize the impact on the RMWB and through the fly/in fly/out program has mostly done that.

Connacher has build and is maintaining relationships with the Aboriginal communities to ensure that social and economic opportunities exist now and well into the future.

D.9 SOIL RESOURCES

D.9.1 Introduction and Terms of Reference

Connacher conducted an assessment of soil resources for the proposed Project. The following section is a summary of the Soil Assessment that was prepared by Millennium EMS Solutions Ltd. and included as Consultants Report #9 (CR #9). For full details of the assessment please refer to CR #9.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The specific requirements for the soil resource component are provided in Section 3.10 and are as follows:

3.10.1 Baseline Information

[A] Provide descriptions and maps of the terrain and soils conditions, including:

a) surficial geology and topography;
b) the soil types and their distribution. Provide an ecological context to the soil resource by supplying a soil survey report and maps to Survey Intensity Level 2 for the Project Area;
c) suitability and availability of soils within the Project Area for reclamation;
d) soils that could be affected by the Project with emphasis on potential acidification (by soil type); and
e) descriptions and locations of erosion sensitive soils.

3.10.2 Impact Assessment

[A] Describe Project activities and other related issues that could affect soil quality (e.g., compaction, contaminants) and:

a) indicate the amount (ha) of surface disturbance from plant, field (pads, pipelines, access roads), aggregate and borrow sites, construction camps, drilling waste disposal and other infrastructure-related construction activities;
b) provide an inventory of the pre- and predicted post-disturbance land capability classes for soils in both the Project Area and the LSA and describe Project impacts to land capability. Indicate the size and location of soil types and land capability classes that will be disturbed;
c) discuss the relevance of any changes for the local and regional landscapes, biodiversity, productivity, ecological integrity, aesthetics and future use resulting from disturbance for all stages of the Project;
d) identify the potential acidification impact on soils and discuss the significance of predicted impacts by acidifying emissions resulting from the Project;
e) describe potential sources of soil contamination;
f) describe the impact of the Project on soil types and reclamation suitability and the approximate volume of soil materials for reclamation. Discuss any constraints or limitations to achieving vegetation/habitat reclamation based on anticipated soil conditions (e.g. compaction, contaminants, soil moisture, nutrient depletion, erosion, etc.); and
g) discuss the potential for soil erosion for all stages of the Project;

[B] Discuss:
a) the environmental effects of proposed drilling methods on the landscape and surficial and bedrock geology;
b) the potential for casing and pipeline failures and their environmental effects; and
c) the potential for changes in the ground surface during steaming and recovery operations (e.g., ground heave and/or subsidence) and their environmental implications..
d) the potential impacts caused by the mulching and storage of woody debris considering, but not limited to vulnerability to fire, degradation of soil quality and increased footprint.

[C] Provide a mitigation plan to address:
a) possible measures to minimize surface disturbance including the use of existing clearings for the Project;
b) possible actions to address potential effects of acid deposition;
c) possible actions to mitigate effects of any constraint or limitation to habitat reclamation such as compaction, contaminants, soil moisture, erosion, nutrient regime, etc.;
d) possible measures to mitigate changes to ground surface (temperature, heave and subsidence) during operations;
e) possible actions to address impacts to land capability; and
f) any other measures to reduce or eliminate the potential impacts that the Project may have on soil capability and/or quality.

[D] Describe the residual effects of the Project on terrain and soils and Connacher's plans to manage those effects.

3.10.3 Monitoring

[A] Describe the monitoring programs proposed to assess Project impacts on terrain and soils and to measure the effectiveness of mitigation plans.

The local study area (LSA) for the soils and terrain baseline study is the Project Area and the RSA includes the LSA plus a 5 km buffer (CR#9, Figure 3).

Baseline soil data was collected in order to determine the potential environmental effects that the Project may have on soil resources, and to assist in preparation of a conceptual Conservation and Reclamation Plan with appropriate site mitigation and monitoring activities designed to achieve reclamation success.

The soil resource valued environmental components (VECs) chosen for the assessment include:

- soil quality and quantity;
- soil erosion;
- decreased soil biodiversity;
- accidental releases; and
- impacts to terrain

D.9.2 Baseline Conditions

Regional Study Area

The baseline soil map for the RSA was developed through the use of the following information sources:

- satellite imagery of the region;
- surficial geology maps of the region (Andriashek 2003);
- ecosite shape file data for the Project vegetation RSA prepared by GDC (GDC 2010); and
- soil mapping data available from other baseline soil surveys from within the region, including the adjacent *Soils Inventory of the Alberta Oils Sands Environmental Research Program – Study Area* (AOERP) (Turchenek and Lindsay 1982).

Nine dominant soil series were identified in the RSA (CR #9, Table 10, Figure 7). This naming convention for the regional soil map allows for an efficient application of soil sensitivity ratings to the large soil data set.

Local Study Area

Characterization of baseline soil conditions in the LSA included:

- a review of existing information with respect to the geology, surficial geology and soil correlation areas found in the area;
- a field investigation;
- soil classification to the series level;
- terrain classification;
- development of soil map units; and
- identification of baseline soil characteristics for each soil map unit.

A survey intensity level (SIL) 2 was completed over the majority of the LSA, with one inspection point for every 5 to 15 ha, and a SIL 1 for the Phase 1 footprint with one inspection for every 1 to 5 ha. A total of 977 inspection points were recorded in the LSA (CR #9, Figure 4). Survey guidelines were based on accepted methodologies used in Canada for baseline soil survey (MSWG 1981).

At each inspection site the soil profile was investigated to a depth of approximately 100 cm for upland soils, while organic soils were investigated to mineral contact or a maximum depth of 220 cm. Site and soil characteristics were observed and recorded, following accepted guidelines and classification systems (ECSS 1983 & 1987, SCWG 1998).

Samples of one or more soil horizons or layers were collected at 98 of the soil inspection sites (for lab analysis) located throughout the LSA. These ranged from "grab" samples collected to determine or check specific characteristics to detailed profile samples intended to represent the most common soils in the area (CR #9, Figure 4).

During the baseline assessment 22 soil series and variants were identified in the LSA (CR #9, Table 4) along with 11 terrain types (CR #9, Table 5). These were organized into 36 soil map units (SLMs) representing common soil patterns found in the Project LSA (CR #9, Table 7). The soil patterns were then mapped to a scale of 1:20,000 (CR #9, Figure 6a to f).

Baselne soil characteristics identified for each map unit include:

- thickness of soil layers;
- forest soil capability classification;
- reclamation suitability;
- baseline erosion risk; and
- soil sensitivity to acidification.

D.9.2.1 Thickness of Soil Layers

Litter material, topsoil, surface peat and subsoil layers were defined based on *The Canadian System of Soil Classification – Third Edition* (SCWG 1998). Topsoil, surface peat, and upper subsoil layers were defined as follows:

- topsoil (TS) – Ae, Ahe, AB, and in some instances BA horizons, including gleyed, and weakly gleyed versions of these horizons;
- surface litter/peat – under forested vegetation the surface litter is commonly comprised of an LFH horizon (L- litter, F – Fibric, and H – Humic) and in organic landscapes peat profiles are differentiated by degree of decomposition (Of, Om, and Oh); and
- upper subsoil (US) – all types of B horizons (Bm, Bt, Btg), plus gleyed (g) and juvenile (j) versions of them (as defined by CSSC 1998), were considered to be part of the upper subsoil for depth calculations.

All soil data collected within the LSA was analyzed to determine average thicknesses of soil layers for the soil map units. The results are listed in Table D.9.2.1 and shown in CR#9, Figure 8.

Table D.9.2.1 Soil layer thicknesses by SLM

Map Unit (SLM)	Thickness (cm)			
	Litter	Topsoil	Topsoil Lift Thickness[1]	Upper Subsoil
ANZ6/SC1l	20	10	30	35
EGSR9/H1l	10	10	20	45
EGSR9/H1m	5	10	15	45
EGSR9/HR2m	5	10	15	50
EGSR9/U1h	10	5	15	55
MLD1m/O3	70	--	--	20
MLD1m-G/O1	80	--	--	10
MLD1m-G/O3	60	--	--	15
MLD2m/O1	135	--	--	--
MLD2m/O3	145	--	--	--
MLD3/O1	205	--	--	--
MLD3/O3	205	--	--	--

Table D.9.2.1 Soil layer thicknesses by SLM

Map Unit (SLM)	Thickness (cm)			
	Litter	Topsoil	Topsoil Lift Thickness[1]	Upper Subsoil
MNS20/U1l	20	10	30	35
MNS21/U1l	40	5	45	35
MNSR20/U1h	15	10	25	45
MNSR20/U1l	10	15	25	45
MNWH21/U1l	20	15	35	40
MRN1m/O1	70	--	--	15
MRN1m/O3	95	--	--	10
MRN1m-G/O1	55	5	--	25
MUS2m/O1	140	--	--	--
MUS2m/O3	150	--	--	--
MUS3/O1	215	--	--	--
MUS3/O3	215	--	--	--
SRT2/H1l	15	10	25	40
SRT2/U1h	10	10	20	40
SRT2/U1l	10	10	20	45
SRT9/H1l	15	10	25	45
SRT9/H1m	10	10	20	40
SRT9/HP1m	10	10	20	40
SRT9/HR2m	10	10	20	35
SRT9/U1h	10	10	20	45
SRT9/U1l	10	15	25	40

[1] Topsoil Lift Thickness includes the mineral A horizon plus the litter/surface organic layer. In mineral soils this is the salvage depth for the topsoil material.

D.9.2.2 Forest Soil Capability Classification

Land capability for the LSA has been catalogued by rating the SLMs according to the Land Capability Classification System for Forest Ecosystems in the Oil Sands (LCCS) (CEMA 2006).

Forest soil capabilities were determined for SLMs. Within the LSA capability ratings ranged from Class 3 to Class 5 (CR #9, Table 12, Figure 9). The predominant limitations to the soils within the LSA include moderately acidic to acidic soil pH values throughout the soil profiles (subclass V), poor drainage (typically in the SLMs dominated by Organics or Peaty Gleysols) (subclass W), and/or poor nutrient regimes (Subclass F).

Distribution of final land capability classes within the LSA and Project Footprint are provided in Table D.9.2.2 and are shown on CR#9, Figure 9.

Table D.9.2.2 Soil Capability in the LSA and Project Footprint

Project Area	LCCS Ratings Classes				Totals (ha)
	Class 3 (ha)	Class 4 (ha)	Class 5 (ha)	Not Rated[1] (ha)	
LSA	5,481	1,541	7,737	506	15,265
Phase 1 footprint	99.3	-	46.0	0.2	145.5
Phase 2 footprint	132.0	1.3	55.8	-	189.1
Phase 3 footprint	99.6	7.5	78.9	0.3	186.3

1 Includes disturbed lands (ZDL) and open water (ZWA).

Classes 3 and 5 are most extensive within the LSA, accounting for 36% and 51% of the LSA area. Class 3 lands were the most common within the Project Footprint covering between 50 to 70% of the Project footprint depending on the Phase. Class 5 soils (poor drainage) accounted for 30 to 42% of the footprint, with Phase 3 containing the largest distribution of Class 5 soils.

D.9.2.3 Reclamation Suitability

Reclamation suitability ratings provide information that is useful for making soil handling recommendations, and guidance as to soil types that may present challenges for reclamation. Reclamation suitability was assessed for the topsoil (i.e. A horizons) and upper subsoil (i.e. B horizons), horizons for soils in the LSA. This assessment followed the *Soil Quality Criteria Relative to Disturbance and Reclamation* Guidelines as specified for the Northern Forest Region of Alberta (SQCWG 1987). Map unit ratings for the LSA are listed in CR #9, Table 15 and shown in CR#9, Figures 10 and 11.

The reclamation suitability for the topsoil materials ranged from poor to fair-good and the subsoils ranged from fair-poor to fair. The various SLMs had topsoil materials with the following reclamation suitability ratings, fair-good (1), fair (3), fair-poor (14), poor (1) and organic (14). The subsoil material was rated as fair (12), fair-poor (12) and organic (11).

D.9.2.4 Erosion Risk Assessment

Soil erosion by wind or water can affect soil profiles and distribution of soils in the landscape. In areas where vegetation has been cleared and the soil surface disturbed, the risk of erosion generally increases.

Soil erosion via wind and water was evaluated for the dominant or co-dominant soils of all Soil Models in the LSA (CR #9, Table 16, Figures 12 and 13). Wind erosion risk ratings are adapted from the *Wind Erosion Risk – Alberta* (Coote and Pettapiece 1989), and water erosion risk ratings were adapted from *Water Erosion Risk – Alberta* (Tejak and Coote 1985).

Within the study area the risk of water erosion is typically low to moderate as the soil surface is currently well protected by tree and understory cover. However the SRT9/HR2m and SRT9/H1m SLMs contain significant coarse textured soils and relatively steep slopes resulting in high water erosion risk.

Significant tree and understory cover and an extensive litter layer results in minimal exposure of surface soil material to wind throughout the study area. A majority of the soil series in the region have a low potential for soil erosion via wind (Pedocan, 1993).

D.9.2.5 Soil Sensitivity - Acidification

Soil sensitivity to acid deposition is the most commonly used system to rate the ability of soils to offset acidic inputs. Soils within the LSA and RSA were rated for sensitivity to acid deposition based on the following resources:

- Critical Loads of Acid Deposition on Soils in the Athabasca Oil Sands Region, Alberta (Abboud et al. 2002); and
- Recommendations for the Acid Deposition Management Framework for the Oil Sands Region of Northeastern Alberta (CEMA 2004).

Acid deposition values from the 50-Year critical loads for Mid-CV case were adapted from Abboud et al. (2002) to rate the soils within the RSA and LSA. Assigned acid deposition ratings for all dominant or co-dominant soils of the RSA and LSA are listed in CR #9, Table 17. Acid sensitivity ratings for the LSA and RSA are displayed in CR#9, Figure 14. The mid-CV case critical loads ranged from 0.4 to 1.1 Keq/ha/yr.

The potential for soil acidification on a soil type is assessed through comparison of the modelled PAI isopleths (generated in the air modeling report (MEMS 2010b) against the critical loads assigned to particular soil map units. Based on a review of the cumulative case PAI isopleths for the Project there are no PAI isopleths that contain values that trigger critical load exceedances for the soils within the LSA or the RSA (CR #9, Figure 14). The largest cumulative PAI isopleths (worst case) within the RSA is a point source location with a PAI of 0.29 Keq/ha/yr, the most sensitive soil recorded in the RSA contains a PAI critical load of 0.4 Keq/ha/yr. Soil acidification via atmospheric deposition is not expected to be a potential impact that will result in an environmental effect on the soil resources within the LSA or RSA.

The impact of the Project with respect to potential soil acidification is negligible at the local and regional scale for all assessment cases and not considered to pose a potential impact to soils in the Project Area.

D.9.3 Predicted Conditions

Project activities that may impact the soil resource VECs include:

- Soil salvage and handling – salvage of all required soil materials in the proposed disturbance areas as well as construction on (padding over); or salvage of organic materials may result in effects to soil quality.
- Soil stockpiling – stockpiling of salvaged soil materials during the construction of the Project, both short term and long term, results in potential for soil erosion issues and effects to soil productivity.
- Development of Project infrastructure – includes creation of well pads, roads, borrow pits that require site contouring and creation of padded areas may result in environmental effects to soil quality and terrain.
- Operational Activities – day to day operations that may result in effects to soil through accidental releases.
- Progressive Reclamation – activities including re-contouring, soil handling and replacement, and pad removal on organic landforms may result in effects to the reclaimed soil profiles and terrain.

D.9.3.1 Soil Quality and Quantity

Application Case

During Project construction potential impacts to the soil resource will be limited to the proposed areas of disturbance; specifically Phases 1 to 3 of the Project development (totalling 521 ha). Soil salvage, transport, storage (long term and short term) and replacement may have an environmental effect with respect to soil quality. Soil quality is evaluated through an assessment of soil quantity (soil thickness) and forested land capability (LCCS ratings assess soil productivity).

Topsoil thickness in the LSA is variable and dependent on terrain types. Topsoil lift material (mineral topsoil layer plus surface litter/shallow peat salvaged as one lift) will be salvaged within the project disturbance limits. During site construction, soils with peat thicknesses greater than 40 cm will be left intact and padded over with fill material or may be salvaged for use at reclamation. Salvaged soil material will be stockpiled for later use in reclamation.

Reclamation involves site conditioning (which may include re-contouring, decompaction, removal of fill over top organics), soil replacement, revegetation and reforestation. All reclaimed areas are expected to meet equivalent land capability as per the land capability classification system (LCCS).

The main goal for the reclamation program is to achieve forested land capability equivalent to pre-disturbance conditions. Only soil map units located in the Project footprint that are expected to be disturbed over the life of the Project were evaluated for post reclamation suitability. Table D.9.3.1 displays the reclaimed LCCS ratings for soil map units located in the Project footprint.

Table D.9.3.1 Baseline and Reclaimed Forest Land Capability Ratings for the Project Footprint (Phases 1 - 3)

Soil Map Unit[1]	Baseline Final Ratings Index	Baseline Land Capability Rating[2]	Reclaimed Final Ratings Index	Reclaimed Land Capability Rating[3]
ANZ6/SC1l	24	4WV	26	4WV
EGSR9/H1l	41	3V	41	3V
EGSR9/H1m	42	3V	41	3V
EGSR9/U1h	41	3V	41	3V
MLD1m-G/O1	5	5WF	5	5WF
MLD1m-G/O3	5	5WF	5	5WF
MLD1m/O3	0	5WF	0	5WF
MLD2m/O1	0	5WF	0	5WF
MLD2m/O3	0	5WF	0	5WF
MLD3/O3	0	5WF	0	5WF
MNS20/U1l	30	4WV	29	4WV
MNS21/U1l	18	5W	18	5W
MNSR20/U1h	36	4WV	35	4WV
MNSR20/U1l	35	4WV	34	4WV
MNWH21/U1l	18	5WV	18	5WV
MRN1m-G/O1	6	5WF	6	5WF
MRN1m/O1	0	5WF	0	5WF
MRN1m/O3	0	5WF	0	5WF
MUS2m/O1	0	5WF	0	5WF
MUS2m/O3	0	5WF	0	5WF
MUS3/O1	0	5WF	0	5WF

Table D.9.3.1 Baseline and Reclaimed Forest Land Capability Ratings for the Project Footprint (Phases 1 - 3)

Soil Map Unit[1]	Baseline Final Ratings Index	Baseline Land Capability Rating[2]	Reclaimed Final Ratings Index	Reclaimed Land Capability Rating[3]
MUS3/O3	0	5WF	0	5WF
SRT2/H1l	44	3VW	41	3VW
SRT2/U1h	42	3VW	41	3VW
SRT2/U1l	42	3VW	41	3VW
SRT9/H1l	41	3V	41	3V
SRT9/H1m	44	3V	42	3V
SRT9/HP1m	44	3V	42	3V
SRT9/HR2m	42	3V	41	3V
SRT9/U1h	44	3V	41	3V
SRT9/U1l	41	3VW	41	3V
ZDL	NR	NR	NR	NR

1 Soil map units listed include those identified in the Project footprint area
2 Subclass Notations:, F – Nutrient regime, V – soil reaction, W – wet moisture regime
3 Not meant to imply the precise soil unit was returned, this a comparison of the reclaimed land capability to the baseline LCCS calculations.

All of the SLMs contained the same final capability ratings for pre and post disturbance with the exception of three SLMs (Table D.9.3.1).

Within the Project footprint (Phase 1 to 3), LCCS ratings and percentage of the proposed development areas (ha) are as follows:

- Class 3 – pre-development 330.9 ha (63.5%); post reclamation 292 ha (56.1%);
- Class 4 – pre-development 8.8 ha (1.7%); post reclamation 8.8 ha (1.7%);
- Class 5 – pre-development 180.7 ha (34.7%); post reclamation 191.3 ha (36.7%); and
- Water – pre-development 0 ha (0%); post reclamation 28.1 ha (16.2%);

With proper soil salvage and handling, the impacts for the soil resource for the Application Case are expected to be insignificant.

Planned Development Case

It is expected that existing and potential future developments within the RSA that disturb (or have disturbed) the soil resource as a part of the development will be required to conserve topsoil and complete reclamation as per all regulatory and operating requirements. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize any impacts to soil quality by ensuring appropriate conservation and reclamation planning is in place that addresses soil handling, storage, replacement, and mitigation and monitoring post reclamation.

With effective mitigation, effective soil salvage and handling, the CEA Case (cumulative effects) on the soils resource are expected to be insignificant.

D.9.3.2 Erosion

Application Case

The loss of soil via erosion (wind and water) during soil salvage, soil storage, and after soil replacement is a potential impact. The risk of erosion to surface soils is greatest during the soil salvage and storage stages of site construction, and during the soil replacement phase of the reclamation process.

Salvaged soil material will be stored in stockpiles and graded to a maximum slope of 3:1. The topsoil stockpiles will be stabilized, and vegetated after placement.

Soil materials replaced during reclamation are at risk of erosion by wind and/or water during soil handling activities and immediately after replacement. The risk of erosion is higher as slopes increase. These areas need vegetation and other erosion control techniques to be implemented. Slopes and slope lengths will be similar to predisturbance conditions. Site re-contouring will provide similar landscapes and drainage patterns to pre-disturbance conditions. Within the Project footprint approximately 25% (131 ha) of the landscapes contain slopes > 10% that may be at risk of water erosion post reclamation (prior to vegetation establishment). Within these landscapes the potential effect of water erosion to the replaced soil resource (prior to vegetation establishment) is anticipated to be greater than the areas with < 10% slopes.

With appropriate revegetation and erosion control activities during the Project, it is expected that the soil loss due to erosion, will be minimal and have an insignificant effect on the soil resource.

Planned Development Case

The resultant environmental effects pertaining to soil erosion for the CEA Case are anticipated to be equivalent to the Application Case. Distribution of soil types and landforms within the RSA are similar to the LSA, however the RSA soil and landscape patterns are generally more subdued with respect to topography. A majority of the soils in the RSA (69%) have a low probability to wind or water erosion, the remaining 31% are comprised of soils that have a low wind erosion potential and variable water erosion potentials that are dependent on slope steepness (SRT and EGG series).

It is anticipated that similar mitigative measures and monitoring described to minimize erosion for the Application Case are currently being used for existing disturbances within the RSA and will be used in potential future projects (as required to ensure soil conservation). Minimization and mitigation of soil erosion is a regulatory requirement to ensure soil conservation and to protect water bodies. The resultant residual effects to the soil resource due to potential soil erosion for the CEA Case (RSA) are anticipated to be equivalent to the Application Case and will be insignificant.

D.9.3.3 Soil Biodiversity

Application Case

The potential effect to soil biodiversity will be discussed in terms of the effects of the Project on the spatial distribution of soil patterns removed as a result of the development of the Project and potential decrease in diversity. The Project will disturb approximately:

- 164 ha of organic soils, this equates to approximately 2% of the organic soils in the LSA and 0.3% of the estimated organic soils in the RSA;
- 334 ha of upland soils, this equates to approximately 5% of the upland soils in the LSA and 1.9% of the estimated upland soils in the RSA; and

- 21 ha of transitional mineral soils (Gleysols), this equates to approximately 2.8% of the transitional soils in the LSA and 0.4% of the estimated transitional soils in the RSA.

The removal and replacement of soil materials and alteration of terrain will result in less variable soil and terrain characteristics than found in the baseline assessment. Reclamation of soil and landscape patterns to provide similar forest soil capability will allow for the eventual formation of suitable habitat that meets desired end land use objectives.

Based on soil information for the RSA and LSA, there were no soil profiles or patterns found in the Project footprint that are not commonly found within the LSA and RSA. No loss of diversity with respect to soil types and landscape patterns is expected and the Project is expected to have insignificant effects.

Planned Development Case

In general, the soil types and distribution of soil and landscapes within the LSA are similar to that of the RSA as determined by the baseline RSA and LSA soil maps. With mitigation, the assessment of impacts to soil biodiversity for the CEA Case is anticipated to be equivalent to the Application Case.

D.9.3.4 Accidental Releases

Application Case

Impacts to the soil resource caused by accidental releases and operational incidents within the Project footprint have the potential to alter chemical and physical attributes of soils. Accidental release may occur as one time releases or as cumulative releases that occur over longer periods of time. With the appropriate environmental management plans in place, accidental releases and subsequent clean up, will result in insignificant effects on the soil resource.

Planned Development Case

It is anticipated that type, frequency, severity, and potential methods of accidental releases for existing and proposed future development is expected to be similar in nature to the Application Case, therefore, is anticipated to be equivalent to the Application Case. Projects currently operating in the RSA are similar to the proposed Project with respect to infrastructure, processes and in some cases chemicals handled. The resultant residual effects are insignificant.

D.9.3.5 Alteration of Terrain

Application Case

Development of the Project also results in disturbances to the terrain types within the Project footprint. After reclamation there will be a permanent loss of upland terrain to water bodies/shallow wetlands due to the development of the borrow pits. An estimated 28 ha of upland and transitional terrain will be lost to borrow pit development this is a loss of 0.3% of the mineral terrain in the LSA. Depending on the preferred method of organic material salvage for various Project components it is likely that various organic landform areas will be reclaimed to drier upland landscapes, offsetting the loss of mineral landscapes as a result of borrow pit development. However, a majority of the organic landforms will likely be padded over for Project development and pad removal would occur at reclamation. The alteration of terrain is expected to have an insignificant effect on the soil resource.

Planned Development Case

It is expected that existing and potential future developments within the RSA that disturb the soil resource as a part of the development will be required to complete reclamation as per all regulatory and operating requirements, this includes appropriate re-contouring to ensure reclaimed landscapes tie into adjacent undisturbed lands. Compliance with regulatory requirements for planning, construction, and reclamation of developments will minimize the impacts to terrain types in the RSA. Therefore, evaluation of the impact to altered terrain types is the same as for the Application Case.

D.9.4 Mitigation and Monitoring

D.9.4.1 Mitigation

Connacher will utilize the following measures to mitigate potential impacts to soil resources:

- utilize best management practices to salvage upland soils;
- supervision of soil salvage and placement by a qualified individual;
- salvage organic soil material in select areas for later use in reclamation;
- in areas where organic soils were padded over with clay fill, the clay fill is to be removed for final reclamation;
- topsoil stockpiles will be stored in a manner to minimize soil loss or degradation;
- seed topsoil stockpiles utilized as long term storage with a seed mix that establishes quickly;
- contour stockpiles to a gentle slope (less than or equal to 3:1) and contour with small ridges perpendicular to slope direction;
- de-compact replaced soil profiles;
- vegetate all reclaimed lands upon completion of soil placement;
- utilize erosion control in areas of increased potential for erosion by wind or water;
- reclaim soil landscape patterns similar to pre-disturbance conditions;
- implement measures for proper handling and containment of contaminating substances for the Projects various operating processes; and
- re-contour and reclaim landscapes to provide appropriate surface drainage, blend in with the adjacent undisturbed terrain (i.e. drainage, aspect) and remain stable.

D.9.4.2 Monitoring

Connacher's monitoring program will include:

- assessing landscape characteristics and features to ensure appropriate drainage is maintained;
- monitoring for potential soil erosion issues of stockpiled or recently replaced soil material;
- assessing reclaimed areas for topsoil quality (i.e. admixing) and quantity (depths); and
- assessing establishment of vegetation communities, after reclamation, to ensure stable sites that are capable of ecological succession exist.

D.9.5 Summary of VECs

A summary of potential environmental effects on the VECs along with the planned mitigation and residual effects for the Project presented in Table D.9.5.1. With mitigation, the effects of the Project on the soil and terrain VECs are considered insignificant.

Table D.9.5.1 Summary of Impact Significance on Soil Resource VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Soil Quality												
	Impact soil quality (via LCCS and soil quantity)	refer to Section D.9.4 and CR #9, Section 6.1.3	Application	LSA – Project Footprint	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially –Negative; Over time - Neutral	Moderate	Medium to High	Insignificant
			CEA (related Infrastructure outside the LSA)	Regional	Extended	Continuous, diminish with time	Reversible – long term	Moderate	Initially –Negative; Over time - Neutral	Moderate	Medium to High	Insignificant
2. Soil Erosion												
	Impact to soil quality	refer to Section D.9.4 and CR #9, Section 6.2.3	Application	LSA – Project Footprint	Short	Accidental	Irreversible	Moderate to Low	Neutral	Moderate	High during salvage and replacement: Low after veg. establishment	Insignificant
			CEA	Regional	Short	Accidental	Irreversible	Moderate to Low	Neutral	Moderate	High during salvage and replacement; Low after veg. establishment	Insignificant
3. Soil Biodiversity												
	Impact on soil diversity (distribution of soils)	refer to Section D.9.4 and CR #9, Section 6.3.3	Application	LSA – Project Footprint	Extended	Continuous	Reversible – long term	Low	Negative	High	High	Insignificant
			CEA	Regional	Extended	Continuous	Reversible – long term	Low	Negative	High	High	Insignificant
4. Accidental Releases												
	Impact to soil chemical and physical properties	refer to Section D.9.4 and CR #9, Section 6.4.3	Application	LSA – Project Footprint	Long	Accidental	Reversible – short term	Low	Neutral	High	Medium to Low	Insignificant
			CEA	Regional	Long	Accidental	Reversible – short term	Low	Neutral	High	Medium to Low	Insignificant
5. Alteration of Terrain												
	Impact on terrain types	refer to Section D.9.4 and CR #9, Section 6.5.3	Application	LSA – Project Footprint	Residual	Continuous	Irreversible	Low	Neutral	High	High	Insignificant
			CEA	Regional	Residual	Continuous	Irreversible	Low	Neutral	High	High	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.10 Vegetation, Wetlands and Rare Plants

D.10.1 Introduction and Terms of Reference

Connacher conducted an assessment of vegetation, wetlands and rare plants for the proposed Project. The following section is a summary of the Vegetation, Wetlands, Rare Plants, and Biodiversity Report that was prepared by Geographic Dynamics Corp. and included as Consultants Report #10 (CR #10). For full details of the assessment please refer to CR #10.

Alberta Environment issued the Terms of Reference (ToR) for the project on July 17, 2009. The specific requirements for the Vegetation, Wetlands, Rare Plants and Biodiversity are provided in Section 3.7 of the ToR and are as follows:

3.7.1 Baseline

[A] Describe and map the vegetation communities for each ecosite phase.
[B] Describe and map wetlands, and discuss their distribution and relative abundance.
[C] Identify, verify and map the relative abundance of species of rare plants and the ecosite phases where they are found.
[D] Identify key indicators and discuss the rationale for their selection. Identify composition, distribution, relative abundance, and habitat requirements. Address those species listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (Alberta Sustainable Resource Development) and all species listed in Schedule 1 of the federal Species at Risk Act.
[E] Discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution. Consider their importance for local and regional habitat, sustained forest growth, rare plant habitat and the hydrologic regime.
[F] Describe the regional relevance of landscape units that are identified as rare.
[G] Provide Timber Productivity Ratings for both the Project Area and the LSA, including identification of productive forested, non productive forested and non-forested lands.

3.7.2 Impact Assessment

[A] Identify the amount of vegetation and wetlands to be disturbed for all stages of the Project.
[B] Discuss any potential effects the Project may have on rare plants or endangered species, in The Status of Alberta Species (Alberta Sustainable Resource Development) and the Alberta Natural Heritage Information Centre (ANHIC).
[C] Discuss temporary (include timeframe) and permanent changes to vegetation and wetland communities and comment on:

- *a) the effects and their implications for other environmental resources (e.g., habitat diversity and quantity, water quality and quantity, erosion potential, recreation and other uses);*
- *b) the effects and their implications to recreation, aboriginal and other uses; and*
- *c) the sensitivity to disturbance (including acid deposition), as well as the techniques used to estimate sensitivity to disturbance and reclamation, of each vegetation community.*

[D] Describe the regional impact of any ecosite phase to be removed.
[E] Discuss from an ecological perspective, the expected timelines for establishment and recovery of vegetative communities and the expected differences in the resulting vegetative community structures.
[F] Provide an ELC map that shows the reclaimed vegetation. Comment on the importance of the size, distribution and variety of the reclaimed landscape units from both a local and regional perspective.
[G] Discuss the impact of any loss of wetlands, as well as how this will affect land use, fragmentation and biodiversity. Discuss measures and techniques that will be used to minimize the impact.
[H] Provide a mitigation strategy that will minimize Project impacts addressing:

a) mitigation of the adverse effects of site clearing on rare plants, plant communities and plants for traditional, medicinal and cultural purposes. Identify any setbacks proposed around environmentally-sensitive areas such as surface waterbodies, riparian areas and wetlands; and

b) measures and techniques that will be used to minimize the impact of loss of wetlands on land use, fragmentation and biodiversity.

[I] Discuss weeds and non-native invasive species and describe how these species will be assessed and controlled prior to and during operation and reclamation.

[J] Describe the residual effects of the Project on vegetation and Connacher's plans to manage those effects.

3.9.1 Biodiversity and Fragmentation Baseline Information

[A] Describe the terrestrial and aquatic biodiversity metrics that will be used to characterize the existing ecosystems and probable effects on the Project, and:

a) describe the process and rationale used to select biotic and abiotic indicators for biodiversity within selected taxonomic groups;

b) determine the relative abundance of species in each ecosite phase;

c) provide species locations, lists and summaries of observed and estimated species richness and evenness for each ecosite phase;

d) provide a measure of biodiversity on baseline sites that are representative of the proposed reclamation ecosites; and

e) rank each ecological unit for biodiversity potential. Describe the techniques used in the ranking process.

[B] Describe the Current level of Habitat Fragmentation.

3.9.2 Impact Assessment

[A] Describe the metrics that will be used to assess the probable effects of the Project. Discuss the contribution of the Project to any anticipated changes in regional biodiversity and the potential impact to local and regional ecosystems.

[B] Identify and evaluate the extent of potential effects from fragmentation that may result from the Project.

[C] Discuss the measures to minimize any anticipated changes in regional biodiversity.

[D] Describe the residual effects of the Project on biodiversity and fragmentation and Connacher's plans to manage those effects.

The Local Study Area (LSA) used for the vegetation assessment includes the Connacher lease boundaries (CR #10, Figure 1-1). The physical extent of the LSA is sufficient in size to capture potential project effects to valued environmental components (VECs) that will result from direct disturbance and also, changes to vegetation outside the Project footprint as a result of alterations to physical components such as water quantity (wetlands).

The regional study area (RSA) includes a 5 km buffer around the LSA (CR #10, Figure 1-1). The RSA was defined to ensure that it captured the furthest extent that project-specific effects are anticipated to act in combination with effects from other past, existing and anticipated future projects and activities.

The assessment of Project effects on vegetation and wetland resources was based on six valued environmental components; terrestrial vegetation (ecosites, rare plants, forest resources), wetlands, old growth forests, non-native and invasive species, traditionally used plants, and biodiversity.

The objectives of the assessment were to:

- describe and map the vegetation communities for each ecosite phase (after Beckingham and Archibald 1996);
- describe and map wetlands, and discuss their distribution and relative abundance (using Alberta Wetland Inventory Standards, Halsey and Vitt 1997);
- identify, verify and map the relative abundance of species of rare plants and the ecosite phases where they are found;
- identify composition, distribution, relative abundance, and habitat requirements for VECs;
- discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution;
- describe the regional relevance of landscape units that are identified as rare; and
- provide Timber Productivity Ratings for both the Project Area and the LSA, including identification of productive forested, non-productive forested and non-forested lands.

D.10.2 Baseline Conditions

D.10.2.1 Ecosite Phases

Before field surveys, preliminary maps were created depicting ecosite phase, based on interpretation of orthophotographs and aerial photographs of the area, as well as Alberta Vegetation Inventory (AVI) maps and database. Once this was complete field verification of many polygons was conducted in conjunction with field surveys. Vegetation surveys were conducted five different times between 2006 and 2009. The data collection protocols used for the vegetation surveys followed the guidelines outlined in the Ecological Land Survey Site Description Manual (AEP 1994).

A large portion of the LSA and RSA has been recently (1995) burned by wildfire (98% and 95%, respectively), and much of the vegetation is in early successional stages. In total, 635 plant species were found in the LSA. Of these, 329 were vascular plants, 135 were mosses and liverworts and 167 were lichens. Upland communities occupy 31% of the LSA, lowland communities occupy 64%, water 1% and existing disturbances 4%.

Twenty-four ecosite phases were mapped within the LSA and RSA (Table D.10.2.1; CR #10, Figure 5-1). The c1 and i2 ecosite phases occupy the largest portion of the LSA (21.8% and 20.1%, respectively). Fourteen of the 24 ecosite phases occupy less than 1% of the LSA, and these are considered to be of limited distribution, collectively representing 2.9% of the LSA (441.3 ha). Two of these ecosite phases (d1 and d2), while limited in distribution in the LSA, are not limited in the RSA.

Upland areas account for 27.2% of the RSA (15,633.8 ha), and lowland areas occupy 70.6% (40,555.1 ha) (Table D.10.2.1; CR #10, Figure 5-1). Shrubby bog (i2) and Labrador tea-mesic Jack pine-black spruce (c1) ecosite phases occupy the largest area in the RSA (20.2% and 18.8%, respectively). There are twelve ecosite phases of limited distribution (<1 %) in the RSA (Table D.10.2.1).

Table D.10.2.1 Distribution of Ecosite Phases

Ecosite phase	Project Footprint		LSA		RSA	
	Area (ha)[1]	Percent (%)	Area (ha)	Percent (%)	Area (ha)	Percent (%)
b1 - blueberry Pj-Aw	32.4	6.2	1,081.9	7.0	2,057.5	3.6
b2 - blueberry Aw(Bw)	0.0	0.0	18.9	0.1	96.4	0.2
b3 – blueberry Aw-Sw	0.0	0.0	3.1	<0.1	3.1	<0.1

Table D.10.2.1 Distribution of Ecosite Phases

Ecosite phase	Project Footprint		LSA		RSA	
	Area (ha)[1]	Percent (%)	Area (ha)	Percent (%)	Area (ha)	Percent (%)
b4 – blueberry Sw-Pj	0.0	0.0	6.1	<0.1	20.1	<0.1
c1 - Labrador tea-mesic Pj-Sb	146.6	28.1	3,357.8	21.8	10,824.1	18.8
d1 - low-bush cranberry Aw	0.6	0.1	74.6	0.5	1,547.8	2.7
d2 - low bush cranberry Aw-Sw	2.0	0.4	92.2	0.6	561.8	1.0
d3 - low bush cranberry Sw	4.3	0.8	82.3	0.5	313.4	0.5
e1 - dogwood Pb-Aw	0.0	0.0	16.6	0.1	52.8	0.1
e2 - dogwood Pb-Sw	0.0	0.0	20.4	0.1	37.3	0.1
e3 - dogwood Sw	0.0	0.0	7.6	<0.1	10.6	<0.1
f1 - horsetail Pb-Aw	0.0	0.0	11.9	0.1	66.2	0.1
f2 -horsetail Pb-Sw	0.0	0.0	17.6	0.1	31.6	0.1
f3 - horsetail Sw	0.0	0.0	10.9	0.1	11.2	<0.1
g1 - Labrador tea –subhygric Sb-Pj	132.9	25.5	2,355.7	15.3	6,774.7	11.8
h1 - Labrador tea/horsetail Sw-Sb	2.5	0.5	73.1	0.5	253.0	0.4
i1 - treed bog	50.3	9.7	1,002.8	6.5	3,939.3	6.9
i2 - shrubby bog	78.0	15.0	3,090.0	20.1	11,610.8	20.2
j1 - treed poor fen	9.2	1.8	501.9	3.3	2,827.8	4.9
j2 - shrubby poor fen	27.4	5.3	1,318.1	8.6	6,911.4	12.0
k1 - treed rich fen	2.9	0.5	413.8	2.7	2,155.4	3.8
k2 - shrubby rich fen	19.4	3.7	928.4	6.0	4,222.9	7.3
k3 - graminoid rich fen	2.8	0.5	210.5	1.4	1,841.6	3.2
l1 - marsh	0.1	0.0	6.0	<0.1	18.2	<0.1
Flooded	0.0	0.0	4.9	<0.1	12.6	<0.1
Ponds, Lakes	0.0	0.0	75.4	0.5	226.7	0.4
Pod One & Algar	0.0	0.0	217.6	1.4	217.6	0.4
AIG - Gravel and borrow pits	0.0	0.0	0.5	<0.1	42.3	0.1
AIH - Permanent right of way, roads, highways	0.3	0.1	76.3	0.5	196.9	0.3
AII - Industrial sites	0.2	0.0	1.7	<0.1	1.7	<0.1
CIP - Vegetated pipelines, transmission lines, airstrips	0.2	0.0	170.0	1.1	377.9	0.7
CIU - Unknown clearing	4.0	0.8	18.3	0.1	29.9	0.1
CIW - Vegetated well sites	4.9	0.9	104.6	0.7	163.8	0.3
Total	**520.8**	**100.0**	**15,371.4**	**100.0**	**57,458.4**	**100.0**

[1] – Total area in Project Footprint is a summary of all three Project phases together.

D.10.2.2 Rare Plants

Prior to the field survey, a list of potential rare plants and rare plant communities that could likely be found in the RSA was acquired from Alberta's Conservation Data Center – the Alberta Natural Heritage Information Centre (ANHIC 2010). Areas that were most likely to support rare plant species or rare communities were selected from the interpreted maps, and sample plots were then selected to incorporate the broadest range of habitatsin the Project footprint and LSA. The data collection protocols used for this survey followed those outlined in the Ecological Land Survey Site Description Manual (Alberta Environmental Protection 1994) and the ANPC (2000a) guidelines.

Fourty-three plants found on the Alberta Rare Plant Tracking and Watch Lists were found within the LSA (CR#10, Table 5-10, Figure 5-6). Of these, six were vascular plants (with 15 occurrences), 18 were bryophytes (with 35 occurrences), and 19 were lichens (with 102 occurrences). Also, 16 lichen species that do not appear on the ANHIC All Lichen Elements List were observed in the LSA (with 23 occurrences).

In order to predict where rare plant species may occur within Boreal Mixedwood ecological area, GDC has developed a predictive rare plant occurrence potential model based on plot data collected at 1,094 survey sites in the oil sands area. The model is designed to provide a direct association between each rare plant species and their associated habitat types.

It was determinded that the sites in the LSA with the highest rare plant potential are the d1, d2, g1, i1, i2, j1, k1, and k2 phases collectively occupying 55% of the LSA, while sites with the lowest rare plant potential are the b3, b4, and l1 phases (CR #10, Table 5.2). In the RSA the sites with the highest rare plant potential are the d1, d2, g1, i1, i2, j1, and k1 phases, and collectively occupy 51% of the RSA.

D.10.2.3 Wetlands

The extent of each Alberta Wetland Inventory Standards (AWIS) wetland type in the project footprint, LSA and RSA is listed in Table D.10.2.2 and shown in CR #10, Figure 5-5.

Wetlands constitute 49.8% of the LSA. Wooded bogs are the most dominant wetland type in the LSA (BTNN 26.6%), followed by rich wooded fens (FTNN 14.5%). Wetlands of limited distribution in the LSA are marshes (MONG <0.1%), wooded swamps (STNN 0.1%), and forested swamps (SFNN 0.6%).

Wetlands occupy 59% of the RSA. Wooded bogs were the most common wetland type (26.8%), followed by wooded fen (21.4%). Seven wetlands are limited in distribution within the RSA (<1%). In addition to the wetlands of limited distribution in the LSA, wooded bogs (BTNI 0.3%), patterned open fen (FOPN <0.1%), wooded fen with internal lawns (FTNI 0.2%), and deciduous swamps (SONS 0.4%) also occupy less than 1% of the RSA.

Table D.10.2.2 Wetland Distribution

Alberta Wetland Code	Project Footprint		LSA		RSA	
	Area (ha)[1]	Percent (%)	Area (ha)	Percent (%)	Area (ha)	Percent (%)
BTNI	0.0	0.0	0.0	0.0	158.4	0.3
BTNN	128.3	24.6	4,092.8	26.6	15,391.7	26.8
FONG	2.8	0.5	210.5	1.4	1,426.0	2.5
FONS	20.3	3.9	928.0	6.0	3,914.8	6.8
FOPN	0.0	0.0	0.0	0.0	5.5	<0.0
FTNI	0.0	0.0	0.0	0.0	109.1	0.2
FTNN	38.5	7.4	2,234.2	14.5	12,278.0	21.4
MONG	0.1	<0.0	6.0	<0.0	18.2	<0.0
SFNN	0.1	<0.0	91.9	0.6	112.0	0.2
SONS	0.0	0.0	0.0	0.0	225.7	0.4
STNN	0.0	0.0	16.0	0.1	29.2	0.1
Flooded	0.0	0.0	4.9	<0.0	12.6	<0.0
Ponds and Lakes	0.0	0.0	75.4	0.5	226.7	0.4
Wetland subtotal	**190.1**	**36.5**	**7,659.6**	**49.8**	**33,907.9**	**59.0**

Table D.10.2.2 Wetland Distribution

Alberta Wetland Code	Project Footprint		LSA		RSA	
	Area (ha)[1]	Percent (%)	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Non-wetland subtotal	330.7	63.5	7,711.8	50.2	23,550.5	41.0
Total	**520.8**	**100.0**	**15,371.4**	**100.0**	**57,458.4**	**100.0**

[1] Total area in Project footprint is a summary of all three Project phases together.

D.10.2.4 Biodiversity

Eleven ecosites and 24 ecosite phases were identified in the LSA. Biodiversity potential of all 24 ecosite phases was modeled separately for vascular, and nonvascular species based on both species richness and on Shannon diversity index (Table D.10.2.3).

Ecosite phase e1 had the highest species richness (CR #10, Table 5-13), followed by f2, f3, l1, d2, e2, and d1 all having more than 30 species on average. Graminoid rich fen k3 had the lowest species richness.

Table D.10.2.3 Biodiversity Potential by Ecosite Phase

Ecosite Phase	Vascular Plants		Non-vascular Plants	
	Richness Potential	Shannon's Diversity Index Potential	Richness Potential	Shannon's Diversity Index Potential
a1- lichen Pj	Low	Low	Moderate	Moderate
b1- blueberry Pj-Aw	High	High	Moderate	High
b2- blueberry Aw(Bw)	High	Moderate	Moderate	High
b3- blueberry Aw-Sw	Very high	Very high	Moderate	Very high
b4- blueberry Sw-Pj	Very high	Very high	Low	Low
c1- Labrador tea-mesic Pj-Sb	Moderate	Low	High	Very high
d1- low-bush cranberry Aw	Very high	High	Very low	Very low
d2- low bush cranberry Aw-Sw	Very high	Very high	Low	Moderate
d3- low bush cranberry Sw	Very high	High	High	High
e1- dogwood Pb-Aw	Very high	Very high	Very low	Very low
e2- dogwood Pb-Sw	Very high	Very high	Low	Moderate
e3- dogwood Sw	Very high	High	High	Very high
f1- horsetail Pb-Aw	High	High	Very low	Low
f2- horsetail Pb-Sw	Very high	High	Low	High
f3- horsetail Sw	Very high	High	High	High
g1- Labrador tea-subhygric Sb-Pj	Low	Very low	Very high	Very high
h1- Labrador tea-horsetail Sw-Sb	Very high	High	High	Very high
i1- treed bog	Very low	Very low	Very high	Very high
i2- shrubby bog	Very low	Very low	Very high	High
j1- treed poor fen	High	Moderate	Very high	Very high
j2- shrubby poor fen	Low	Moderate	Very high	Very high
k1- treed rich fen	Very high	Moderate	Very high	Very high
k2- shrubby rich fen	Moderate	Low	Moderate	High
k3- graminoid rich fen	Very low	Very low	Low	Moderate
l1- marsh	Moderate	Low	Low	Low

Table 10.2.4 shows the total area of all ecosite phases combined for each of the five biodiversity classes. For vascular species the majority of the LSA is classified as very low or low in biodiversity potential, while the opposite is true for non-vascular species where high and very high classes comprise the majority of the area.

Table D.10.2.4 Vascular and Non-Vascular Plant Biodiversity Potential in the LSA

Potential Class	Vasculars				Non-Vasculars			
	Richness		Diversity		Richness		Diversity	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Very high	813.3	5.3	138.4	0.9	8682.4	56.5	9033.9	58.8
High	1614.6	10.5	1700.6	11.1	3531.7	23	5230	34
Moderate	4292.2	27.9	1912	12.4	2032.3	13.2	323.1	2.1
Low	3673.8	23.9	4292.2	27.9	352.8	2.3	24	0.2
Very low	4303.3	28	6659	43.3	103.1	0.7	91.2	0.6

Table D.10.2.5 shows the total area of all ecosite phases combined for each of the five biodiversity categories within the RSA. Similar to the LSA, the majority of the RSA is classified as very low or low in biodiversity potential for vascular species, while the opposite is true for non-vascular species where high and very high classes comprise the majority of the area.

Table D.10.2.5 Vascular and Non-vascular Plant Biodiversity Potential in the RSA

Potential Class	Vasculars				Non-Vasculars			
	Richness		Diversity		Richness		Diversity	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Very high	4,998.1	8.7	675.1	1.2	34,219.4	59.6	33,699.4	58.7
High	5,047.9	8.8	6,193.7	10.8	11,412.3	19.9	18,343.8	31.9
Moderate	15,065.2	26.2	10,088.6	17.6	6,379.9	11.1	2,440.7	4.2
Low	13,686.1	23.8	15,065.2	26.2	2,510.6	4.4	104.5	0.2
Very low	17,391.7	30.3	24,166.4	42.1	1,666.8	2.9	1,600.6	2.8

A key element to biodiversity is the effects of fragmentation. Ecosystem fragmentation refers to the break-up of habitat expanses into smaller and more isolated units. Increased ecosystem fragmentation may result in a wide range of threats to biodiversity, such as an increase in invasive and non-native species, reduction or restriction of wildlife movement, reduction of genetic diversity and population viability. Fragmentation and biodiversity are co-dependent in that as fragmentation of natural landscapes increases, so does the loss of biodiversity. To assess biodiversity at the landscape level, the amount of fragmentation is considered including effects on the size, shape, number, and distribution of patches (ecosite phases) within the LSA and RSA.

Baseline fragmentation metrics for the LSA (Table D.10.2.6) show that ecosite phase c1 has the greatest number of patches (25 % of the LSA), while ecosite phase b1 has the largest mean patch size (6.8 % of the LSA). The highest perimeter-area ratios were found in ecosite phases j1, j2, k2, and k3, and this is due primarily to their often elongated shapes that follow areas of low topography such as riparian margins (combined 17.5 % of the LSA).

In the RSA shows that ecosite phase c1 has the largest number of patches (21.7 % of the RSA) and also the largest mean patch size of 37.9 ha (Table D.10.2.7).

Table D.10.2.6 Fragmentation Metrics for Ecosite Phases in the LSA

Ecosite Phase	Number of Patches			Patch area			Perimeter-Area Ratio			Nearest Neighbour Distance		
	Baseline	Application	Change	Baseline	Application	Change	Baseline	Application	Change	Baseline	Application	Change
b1	65	81	16	28.9	22.8	-6.2	487.4	554.8	67.4	568.1	450.9	-117.2
b2	20	20	0	4.9	4.9	0.0	407.6	407.6	0.0	853.5	853.5	0.0
b4	1	1	0	8.7	8.7	0.0	224.5	224.5	0.0	N/A	N/A	N/A
c1	329	402	73	38.0	30.6	-7.3	410.4	497.4	87.0	115.7	106.4	-9.3
d1	69	69	0	25.1	25.1	0.0	440.7	441.4	0.7	530.9	531.4	0.5
d2	53	54	1	10.1	9.9	-0.2	460.7	478.6	18.0	558.7	555.0	-3.6
d3	32	34	2	8.9	8.3	-0.7	430.0	509.8	79.7	603.2	575.9	-27.3
e1	11	11	0	5.3	5.3	0.0	577.3	577.3	0.0	1,423.9	1,423.9	0.0
e2	5	5	0	7.9	7.9	0.0	485.4	485.4	0.0	2,139.4	2,139.4	0.0
e3	6	6	0	2.1	2.1	0.0	522.2	522.2	0.0	1,616.1	1,616.1	0.0
f1	11	11	0	4.9	4.9	0.0	498.1	498.1	0.0	3,967.4	3,967.4	0.0
f2	9	9	0	2.9	2.9	0.0	572.3	572.3	0.0	424.2	424.2	0.0
f3	1	1	0	9.9	9.9	0.0	334.2	334.2	0.0	N/A	N/A	N/A
g1	366	426	60	16.1	13.5	-2.6	458.3	504.4	46.2	184.1	161.5	-22.6
h1	43	47	4	5.4	4.9	-0.5	503.7	522.6	18.9	834.7	772.0	-62.7
i1	389	413	24	10.1	9.4	-0.7	524.8	547.0	22.2	186.4	179.6	-6.8
i2	392	438	46	29.8	26.6	-3.3	480.6	519.9	39.4	136.5	125.7	-10.8
j1	259	262	3	10.4	10.2	-0.1	450.3	456.5	6.3	314.1	309.6	-4.5
j2	305	324	19	20.0	18.8	-1.3	488.2	520.3	32.1	194.0	186.4	-7.7
k1	135	140	5	16.3	15.7	-0.6	385.8	406.1	20.2	368.8	340.1	-28.6
k2	250	270	20	18.6	17.2	-1.5	583.4	587.8	4.4	204.7	190.1	-14.7
k3	186	188	2	8.4	8.3	-0.1	666.1	671.9	5.8	385.1	375.6	-9.5
l1	3	3	0	4.4	4.3	-0.1	521.1	547.7	26.7	7,025.1	7,025.1	0.0
Total	**2940**	**3215**	**275**	**297.2**	**272.1**	**-25.1**	**10,912.8**	**11,387.8**	**475.0**	**22,634.8**	**22,309.9**	**-324.9**

Table D.10.2.7 Fragmentation Metrics for Ecosite Phases in the RSA

Ecosite Phase	Number of Patches			Patch area			Perimeter-Area Ratio			Nearest Neighbour Distance		
	Baseline	Application	Change	Baseline	Application	Change	Baseline	Application	Change	Baseline	Application	Change
b1	39	52	13	26.7	19.4	-7.4	487.9	548.1	60.2	327.5	242.7	-84.8
b2	5	5	0	3.9	3.9	0.0	548.9	548.9	0.0	2,897.2	2,897.2	0.0
b4	1	1	0	8.6	8.6	0.0	231.9	231.9	0.0	N/A	N/A	N/A
c1	149	217	68	25.8	16.9	-8.9	514.2	615.2	-101.0	114.2	97.7	-16.5
d1	17	17	0	4.8	4.7	0.0	459.2	461.3	-2.1	777.3	779.9	2.6
d2	16	17	1	4.5	4.1	-0.4	512.7	544.2	-31.6	608.5	588.2	-20.3
d3	18	20	2	5.0	4.3	-0.7	471.0	607.8	-136.8	447.8	417.1	-30.7
e1	5	5	0	4.8	4.8	0.0	648.7	648.7	0.0	969.4	969.4	0.0
e2	5	5	0	4.7	4.7	0.0	710.9	710.9	0.0	681.7	681.7	0.0
e3	4	4	0	2.2	2.2	0.0	502.6	502.6	0.0	1,166.9	1,166.9	0.0
f1	1	1	0	4.1	4.1	0.0	332.3	332.3	0.0	N/A	N/A	N/A
f2	2	2	0	8.7	8.7	0.0	404.7	404.7	0.0	648.6	648.6	0.0
f3	1	1	0	9.8	9.8	0.0	331.2	331.2	0.0	N/A	N/A	N/A
g1	103	158	55	21.7	13.2	-8.4	491.7	576.3	-84.6	170.2	116.7	-53.5
h1	12	16	4	6.3	4.5	-1.8	388.3	449.2	-60.9	1,271.4	973.9	-297.5
i1	150	176	26	6.3	5.1	-1.2	566.4	620.3	-53.9	187.8	169.1	-18.7
i2	149	196	47	21.0	15.7	-5.3	507.1	585.6	-78.6	145.7	117.4	-28.4
j1	72	77	5	5.2	4.7	-0.4	587.8	608.3	-20.5	335.2	310.0	-25.2
j2	104	120	16	10.4	8.8	-1.6	581.5	627.6	-46.2	190.5	176.6	-13.9
k1	46	51	5	9.0	8.0	-0.9	435.2	477.9	-42.7	513.9	420.0	-93.9
k2	59	80	21	17.2	12.4	-4.8	531.2	565.5	-34.3	340.8	233.5	-107.3
k3	56	59	3	3.7	3.5	-0.2	761.2	787.9	-26.7	428.5	389.2	-39.3
l1	2	2	0	1.6	1.5	-0.1	461.0	502.0	-41.0	2,470.3	2,470.3	0.0
Total	**1,016**	**1,282**	**266**	**215.8**	**173.7**	**-42.2**	**11,467.5**	**12,288.7**	**-700.7**	**14,693.3**	**13,866.0**	**-827.3**

D.10.2.5 Forestry Resource

Using the Timber Damage Assessment tables and assigned cover classes, the volume of each commercialism class (stand type) was determined (CR 10, Table 5-3). Any stand with average tree height 12 m tall or greater and assigned a timber productivity rating (TPR) of good (G), medium (M), or fair (F) was considered merchantable, and stands less than 12 m tall or rated unproductive (U) were considered unmerchantable. The total volume of timber in the LSA is 98,609 m^3, and 58% of that is merchantable (56,788 m^3).

Forested areas represent 74% of the LSA with productive forested land representing 68% of the LSA and non-productive forested land representing 6% of the LSA (Table D.10.2.8).

Table D.10.2.8 Timber Productivity Rating

TPR	Project Footprint		LSA		RSA	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Good	329	63.1	7,195	46.8	15,224	26.5
Moderate	74	14.1	2,744	17.9	11,379	19.8
Fair	6	1.2	484	3.1	3,493	6.1
Unproductive	19	3.6	896	5.8	4,587	8.0
Non-forested	94	18.0	4,053	26.4	22,776	39.6
Total	**521**	**100**	**15,371**	**100**	**57,459**	100
Non-productive	19	3.6	896	5.8	4,587	8.0
Productive	409	78.4	10,423	67.8	30,096	52.4
Non-forested	94	18.0	4,053	26.4	22,776	39.6
Total	**521**	**100**	**15371**	**100**	**57459**	**100**

The dominant species found in the RSA is black spruce, followed by jack pine, tamarack, trembling aspen, white spruce, paper birch and a very small amount of balsam poplar. The total volume of timber within the RSA is 443,034 m^3, and 81% is coniferous, 13% is deciduous, and 6 % is a mixture of both. Of the total volume, the volume of merchantable timber in the RSA is 280,460 m^3. Of the total volume, the volume of merchantable timber in the RSA is 280,460 m^3. Forested areas represent 60% of the RSA. Productive forested land represents 52% of the RSA and non-productive forested land represents 8%.

D.10.2.6 Old Growth Forest

The area represented by old growth forests in the LSA is 30.7 ha. These areas are composed of small, scattered remnant patches of aspen, black spruce, tamarack, and birch that were not removed by either the 1995 fire or other disturbances (CR#10, Figure 5-2).

The area represented by old growth forests in the RSA is 257 ha. These areas are generally composed of small, scattered remnant patches of aspen, black spruce, tamarack and birch that were not removed by either wildfire or other disturbances (CR#10, Figure 5-2).

The potential for ecosite phases to support old growth forests has been assessed by accounting for the boreal forest disturbance regime, including wildfire and predictions of climate change, and the experience of vegetation ecologists (CR #10, Table 5-6).

Ecosite phases d1 and e1 both had high old growth potential, predicted with high confidence, and these areas occupy 0.6% of the LSA (91.2 ha). Ecosite phases with moderate potential and high confidence (b2, f3, j1, k1) occupy 6.2% of the LSA (945.5 ha).

D.10.2.7 Traditional Ecological Knowledge and Land Use

Fourty-nine vascular plant and lichen species with traditional values were identified during Aboriginal consultation for the proposed Project and a Traditional Land Use study conducted for lands north of the LSA (Axys 2000). Ecosite phases d1, d2, d3, e1, e2, and e3 were all found to have high potential to support traditionally used plants, and together occupy 1.8% of the LSA (CR #10, Table 5.7). However, as a result of the Aboriginal consultation, edible berry plants have been identified as having higher importance and can be used to indicate which ecosite phases may have a greater value for traditional plant use. Table D.10.2.9 presents a list of berry plants found in the LSA and the characteristic ecosite phases they are found within. While ecosite phases b4 and i2 have been classified as having low potential to support traditional plant species (CR #10, Table 5.7), both are characteristic habitats of valued berry plants. Rich fen ecosite phases (k1, k2, k3) and marsh (l1) do not support berry plants.

Table D.10.2.9 Berry species and Characteristic Ecosite Phases

Common Name	Scientific Name	Characteristic Ecosites
blueberry	*Vaccinium myrtilloides*	a1, b1, b2, b3, b4, c1, g1
bog cranberry	*Vaccinium vitis-idaea, Oxycoccus microcarpus*	b1, b2, b3, b4, c1, g1, i1, i2, j1, j2
chokecherry	*Prunus virginiana*	b1, b2, b3, b4, d1, d2, d3
cloudberry	*Rubus chamaemorus*	i1, i2, j1, j2
currants and gooseberry	*Ribes spp.*	e1, e2, e3, f1, f2, f3, g1, h1
hazelnut[1]	*Corylus cornutta*	d1, d2
low-bush cranberry	*Viburnum edule*	d1, d2, d3, e1, e2
pin cherry	*Prunus pensylvanica*	b1, b2, b3, d1, d2, f1, f2
saskatoon	*Amelanchier alnifolia*	d1, d2, e1
wild raspberry	*Rubus idaeus*	d1, d2, e1, e2, e3, f1, f2
wild strawberry	*Fragaria virginiana*	d1, d2, d3, e1, e2, e3, f1, f2, f3

D.10.2.8 Non-native and Invasive Species

The baseline field surveys identified 61 occurrences of non-native and invasive species within the LSA. These are designated agronomic invasive, nuisance, and noxious species, and many were observed in areas associated with existing development (Highway 63, well pads, access roads and seismic lines). These occurrences comprised the following 16 species:

- Noxious weeds: Chrysanthemum leucanthemum; Cirsium arvense; and Sonchus arvensis;
- Nuisance weeds: Erysimum cheiranthoides; Potentilla norvegica; and Taraxacum officinale; and
- Agronomic invasive species: Agropyron pectiniforme; Bromus inermis; Festuca rubra; Glyceria grandis; Medicago sativa; Melilotus alba; Phalaris arundinacea; Phleum pratense; Trifolium hybridum; and Trifolium pratense.

No restricted weeds were found in the LSA.

D.10.2.9 Potential Acid Input and Nitrogen Deposition

Acid deposition can generally be considered in terms of indirect effects of acid deposition, and direct effects from acidifying components including nitrogen and sulfur compounds. Acid effects on vegetation are not often considered directly because effects on soil and water occur earlier and are more easily measured (Clean Air Strategic Alliance 1999) and acid input usually affects vegetation indirectly through changes in soil or water chemistry. Plant communities on soils that are sensitive to potential acid input (PAI) may be affected depending on the rates of deposition and changes in soil chemistry. Therefore, this section focuses on direct effects from nitrogen, and indirect effects from acid deposition are considered in terms of effects on soil chemistry (Section D.9.2.5).

Baseline nitrogen deposition levels inside the RSA are expected to reach a maximum of 2 kg ha^{-1} yr^{--1}. The most conservative published critical loads for the most sensitive ecosite (bogs) is 5 kg ha^{-1} yr^{--1} (Bobbink and Roelofs 1995, WHO 2000). Therefore it is unlikely that baseline levels of nitrogen deposition will have an effect on vegetation or plant communities.

D.10.3 Predicted Conditions

The potential Project effects to vegetation and wetland resources are related to clearing natural vegetation and soils for Project facilities and infrastructure. Clearing natural vegetation will impact vegetation indicators directly through the reduction of communities and indirectly through changes to undisturbed vegetation and wetland resources resulting from changes to hydrology and habitat fragmentation. Other indirect effects considered in the assessment are effects to vegetation resulting from predicted climate change, natural disturbance (fire) and potential acid input (PAI). The potential effects of the Project have been assessed relative to each of the VECs.

Future and anticipated projects were reviewed for the assessment of the PDC. It was determined that the assessment of potential project effects is the same for both the Application Case and Planned Development (CEA) Case, for the following reasons:

- no developments other than what already exists within the study areas defined for the Project have been identified;
- the only future activities that could be reasonably expected to occur would be timber harvesting, however, forestry will not return to the RSA for decades due to the 1995 wildfire that removed almost all of the merchantable timber;
- the project is not located at or near the margins of the Boreal Forest Natural Region where potential effects due to climate change are expected to first appear and during the relatively short life span of the project climate change is not expected to impact vegetation and wetland resources; and
- fire is the single largest disturbance and has been included in the assessment of project effects on forest age class distribution and because of its stochastic nature it is not possible to spatially predict the effects of fire with any degree of accuracy.

D.10.3.1 Ecosite Phases

The area of ecosite phases and other land uses that will be disturbed in the LSA and RSA by the Project are summarized in Table D.10.2.1. Construction and operation of the Project will result in the removal of 3.3 % (511.4 ha) of the natural vegetation in the LSA (ecosite phases). Ecosite phases of limited distribution in the LSA that will be affected by the Project include d1, d2, d3, h1, and l1 (Table D.10.2.1).

Within the RSA, ecosite phases of limited distribution that will be affected by the Project include d3, h1 and l1. In total, ecosite phases of limited distribution currently occupy 2.9% of the LSA (441.3 ha) and 1.6 % of the RSA (913.9 ha). The Project will result in the removal of 2.2 % of this area from the LSA and 1 % of this area from the RSA. None of the ecosite phases of limited distribution will be completely removed from the LSA or RSA, and a proportion of each are expected to be re-established during reclamation (Part E).

With the exception of marsh (l1), ecosite phases identified as limited in distribution within the LSA and RSA and that will be affected by the Project are not rare in the Boreal Mixedwood ecological area, and the area that is to be removed is very small (2.2 % LSA and 1 % RSA). With mitigation, there is an opportunity to re-establish these ecosite phases as larger portions of the original polygons will remain intact, and natural ingress of native species from the adjacent undisturbed polygons is expected to occur. While the marsh ecosite phase (l1) may be regionally limited in distribution, it is expected that an additional area of marsh will be created after reclamation. In particular borrow areas will be reconfigured and contoured with 3:1 slopes surrounding a central pond (Part E). This will result in at least a 3 m emergent zone (less than 1 m deep) with some ponds being entirely marsh depending on depth and water permanence. Assuming only a 3 m wide marsh zone, then approximately 15.9 ha of marsh will be created following reclamation at Project closure.

Project-specific effects on terrestrial vegetation are expected to be minimal with mitigation. For both the LSA and RSA, Project effects for the Application case related to the reduction in area of individual ecosite phases are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is certain, and overall, the Project effect is insignificant.

D.10.3.2 Rare Plants

Construction and operation of the Project will result in the removal of 15 rare plants (25 occurrences) within the Project footprint; one vascular (two occurrences), five bryophytes (six occurrences), and nine lichens (17 occurrences). Of these, three are considered “critically imperiled” (S1) in Alberta, two are “most likely vulnerable” (S3?), one is “unrankable” (SU), two are “imperiled but most likely vulnerable” (S2S3) and five lichens are considered “imperilled” (S2). Globally, four are ranked “vulnerable but most likely secure” (G3G5), one is “most likely vulnerable” (G3?), one is “vulnerable” (G3), four are “not ranked” (GNR) or “unrankable” (GU), and five are globally “secure” (G5).

Also, four lichen species not previously described in Alberta were also identified within the Project footprint (five occurrences). None of these species are listed on the Alberta Preliminary Lichen Tracking List, and they have not yet been assessed provincially. Although these species are not considered rare in Alberta at this time, they do have conservation value in the respect that data on their abundance and distribution in the province is unknown. Because the ANHIC Preliminary Lichen Tracking List has not been updated since 2000, providing information about these new species to ANHIC will help update the list when revisions are made. Of the rare plants observed in the LSA, all but four species have been found outside of the Project footprint as well. No rare plant communities were observed during the survey.

All but the vascular species and a few of the rare bryophytes and lichens reported in the rare plant survey are not field identifiable species and require a microscope and special stains for positive identification. The involvement of a lichen specialist in the Project rare plant survey resulted in considerably more “rare” lichens being found than with similar surveys. Because the level of sampling used during this assessment is generally not done outside of academic studies, and the results are not consistently reported to tracking bodies (e.g., ANHIC), reports of abundance and distribution of these species is at best incomplete (Natureserve 2009). Also, because S-ranks are largely determined by the number of times a species is detected in the province, low profile and hard to identify species are more likely to be listed as rare (ABMI 2007). Therefore, it is impossible to determine if the species are in fact rare, are at the edge of their natural range and only appear to be rare, or are taxonomically uncertain having been previously misidentified or described as subspecies. Many of these species were found a number of times outside the Project footprint. The multiple occurrences of several of the species supports the conclusion that many of these small inconspicuous species present on the tracking lists are in fact not rare. Because it is not possible to identify these species in the field, and they often have specific microclimate requirements, transplanting is not an option. Modification of the project footprint is also not practical as subsequent rare plant searches, if conducted in the same way, would likely find more examples of these small inconspicuous and underreported species.

The only rare vascular species found in the survey was *Chrysosplenium iowense*. This species is provincially and globally ranked most likely vulnerable (S3?, G3?). Because this species was found eight times outside of the Project footprint, and is frequently found in saturated areas along seismic lines and other disturbances in the Boreal Mixedwood ecological area, no other mitigation is recommended for this species other than reporting these observations to ANHIC and minimizing disturbance outside of the Project footprint.

Also, it is recommended that all occurrences of non-vascular species be reported to ANHIC for updating of the tracking lists, and that disturbance to potentially suitable habitat adjacent to rare plant locations be minimized by making the Project footprint as small as is practical. Due to historical underreporting of bryophytes and lichens, reporting of these findings and others in the area, to ANHIC is likely to result in some reclassification of the species described here. No additional mitigation for these species is recommended.

Construction and operation of the Project will result in the removal and reduction of 3.3 % (476.1 ha) of ecosite phases with high and very high rare plant potential in the LSA, and 0.7% in the RSA. The majority of the rare species that characterize these sites as having high and very high rare plant potential are bryophyte and lichen species.

Reclamation activities at Project closure will focus on the re-establishment of ecosites c and g. In time, as these reclaimed ecosites begin to function like mature Labrador tea – mesic and hubhygric sites, it is expected that the potential for these sites to support rare plants will increase.

Project-specific effects on terrestrial vegetation are expected to be minimal with mitigation. For both the LSA and RSA, Project effects for the Application case related to the removal of rare plants and potential rare plant habitat are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is certain, and overall, the Project effect is insignificant.

D.10.3.3 Wetlands

Construction and operation of the project will result in the removal of 2.5 % (190.1ha) of the existing AWIS wetland types in the LSA and <0.1 % in the RSA (Table D.10.2-2). Project-specific effects on wetlands are expected to be minimal with mitigation. Both the MONG and SFNN are limited in distribution within the LSA and RSA and will be affected by the Project, and both are considered to be limited in distribution in the Boreal Mixedwood ecological area. Due to the very small area of disturbance proposed within these wetlands (0.2 ha), with mitigation it is expected that an equivalent area of each will be re-established at Project closure. It is also proposed that an additional 15.8 ha of MONG will be created during reclamation (Part E).

The Project will result in a small reduction of peatlands in the LSA and RSA (2.5 % and 0.6% respectively). With mitigation measures that include the maintenance of drainage patterns to wetlands and minimizing of the construction footprint, the effect of the reduction of peatland area as a result of the Project is expected to be negligible. During construction, peat and topsoil materials will be salvaged and stored for replacement during reclamation.

Within the LSA, Project effects on wetlands are related to the reduction in area of individual wetlands. Project effects are expected to be minimal with mitigation and monitoring. Application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is low because of the uncertainty in reclaiming peatlands, the probability of the effect is high, and overall, the Project effect is insignificant.

D.10.3.4 Biodiversity

The biodiversity VEC was assessed at three levels:

- species biodiversity - to address the effect of removing plant species from the LSA;
- community biodiversity - to address the effect of removing ecosite phases or biodiversity potential (based on ecosite phases) from the LSA; and
- landscape biodiversity - to address the effect of the Project on biodiversity in the RSA.

Species Diversity

Construction and operation of the Project will result in the removal of approximately 2.2 % (53.9 ha) of ecosite phases with very high and high vascular species biodiversity potential (based on species richness) from the LSA, and 0.9 % from the RSA. Based on non-vascular species richness, the Project will result in the removal of 3.7 % (454.1 ha) of habitat with very high and high biodiversity from the LSA and 1 % from the RSA. Within the LSA and RSA, most of the area with very high and high vascular species biodiversity potential is comprised of ecosite phases d1, d2, d3, and k1 (1.9 % of the Project footprint). The majority of the area with very high and high non-vascular species biodiversity potential is comprised of ecosite phases c1 and g1 (54 % of the Project footprint).

After closure, species richness is expected to be lower than naturally developing ecosites. The preferred revegetation method encourages natural recovery of vegetation. If this is not successful, the current Connacher reclamation practice is to seed a nurse crop that will stabilize reconstructed soils and to minimize sedimentation. Since these species are quick to establish and may form a dense turf layer, native species ingress and regeneration will be initially limited due to competition. Native species cover will increase over time.

Measures taken to mitigate for the reduction in area of terrestrial vegetation, wetlands, old growth forests, and non-native and invasive species will effectively mitigate for potential Project effects on species level biodiversity. In particular, the reestablishment of c and g ecosites means that the Project is expected to result in a negligible effect on biodiversity potential and overall species richness.

Potential Project effects are related to the reduction of species diversity resulting from vegetation clearing during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is high, and overall, the Project effect is insignificant.

Community & Landscape Diversity

The project will result in an increase in the number of patches and a decrease in patch area per ecosite phase in both the LSA and RSA. Ecosite phases with the highest level of fragmentation include b1, c1, d3, g1, h1, and i2 in the LSA (Table D.10.2.6). Within the RSA, ecosite phases with the highest level of fragmentation include those in the LSA as well as k1 and k2 ecosite phases (Table D.10.2.7). Of these, only ecosite phases d3 and h1 are of limited distribution. Neither of these is limited in distribution in the Boreal Mixedwood ecological area. Fragmentation of the LSA and RSA is due to the linear nature of the Project that bisect individual patches into smaller patches. None of the ecosite phases that will be fragmented by the Project will be completely removed from the LSA or RSA.

For the landscape as a whole the Shannon diversity index (calculated using patches not species) is 2.36 with the project (Application Case) and 2.28 without the Project (Baseline) for the LSA. For the RSA, the landscape level Shannon diversity index is 2.38 with the Project and 2.35 without the Project.

Construction and operation of the Project will result in the removal of 3.9 % (185.9 ha) of upland ecosites in the LSA (Table D.10.2-1) and 1.2 % in the RSA (Table D.10.2.1). The Project will also remove 4.2 % (331.2 ha) wetland ecosites in the LSA, and 1.0 % of wetland ecosite phases in the RSA (Table D.10.2.2). Regionally, the project will have a negligible impact on community level biodiversity as most of the ecosite phases that will be affected are common in the region. Although the Project will result in the removal of ecosite phases and AWIS wetlands that are locally and regionally limited in distribution, only marshes and forested swamps are limited in distribution within the Boreal Mixedwood ecological area. With mitigation (reclamation), it is expected that 15.8 ha of marsh (MONG) will be added and an equivalent area of SFNN will be restored at Project closure, and considering the limited amount of each wetland type that will be affected by the Project (0.2 ha), the magnitude of the effect will be ameliorated by reclamation at closure.

In the maximum disturbance scenario, Project effects related to the change in patch number and area within ecosite phases c1, g1, and i2 will increase in the LSA. This is due to the change in patch number that in turn impacts mean patch area and all other measures of fragmentation. However, following mitigation the Project will have a negligible impact on community and landscape level biodiversity within the LSA or RSA. No ecosite phase will be lost or added to the LSA or RSA as a result of the project. As well, because the Project will be developed in phases with sequential reclamation occurring throughout the life of the project (Part E) the impact is much less than predicted using the maximum disturbance scenario. The small size of the Project footpring (520.8 ha) relative to the RSA (57,458.4 ha) means that regional Project effects will also be minimal.

Project effects related to biodiversity will be addressed by measures taken to mitigate for the reduction in area of terrestrial vegetation, wetlands, old growth forests, non-native and invasive species, and traditionally used plants. In particular, the re-establishment of c and g ecosites (Part E) means that the Project will have a minimal effect on community and landscape level biodiversity.

Potential Project effects are related to the reduction of community diversity resulting from the removal of ecosite phases from the LSA during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is insignificant.

Potential Project effects are related to the removal of landscape diversity resulting from removal or alteration of ecostie phases in the RSA during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is insignificant.

D.10.3.5 Forestry Resource

The Project will result in the removal of 3.8% of forested land from the LSA, and 1.2 % from the RSA (Table D.10.2.8). Productive land (TPR – good, moderate, and fair) represents 96 % of the forested area in the Project footprint, and the merchantable timber volume is 2,714 m^3. Construction of the Project will remove all timber from the Project footprint. The volume of timber in the study areas is low relative to the productive area, and this is because the standing timber that remains is remnant patches that survived the 1995 fire, with the remaining forest area consisting of natural postfire regeneration. Due to the 1995 fire, Project effects on Annual Allowable Cut (AAC) will be minimal and confined to loss of growth only within the Project footprint. All merchantable timber salvaged from the Project will be made available to the FMA holder (Al-Pac).

Project-specific effects on Terrestrial Vegetation are expected to be minimal with mitigation. For both the LSA and RSA, Project effects for the Application case related to the removal of forest resources are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is certain, and overall, the Project effect is insignificant.

D.10.3.6 Old Growth Forest

The total amount of old growth forest is 30.7 ha in the LSA and 257 ha in the RSA. The Project will result in the removal of 2.0 % (0.6 ha) of old growth in the LSA, and 0.2 % of the RSA. The old growth in the project footprint is a small, open, remnant patch of aspen with less than 30% crown closure, which survived the 1995 fire. The predicted forest age class distribution 80 years into the future continues to show the effect of the 1995 wildfire that burned much of the RSA. The small size and short duration of the project, relative to the natural boreal forest disturbance regimes, results in an insignificant difference between the expected age distribution (modeled) with and without the project (CR #10, Figure 6-1). As expected, the amount of old growth within the RSA will remain low during the application case and well into the future as a result of the 1995 wildfire.

Within the LSA, construction and operation of the project will result in the removal of 0.7 % (0.6 ha) of ecosite phases with high potential to support old growth, and 1.3 % of ecosite phases with moderate potential. In the RSA, this will result in the removal of <0.1% of ecosite phases with high potential to support old growth, and 0.2 % with moderate potential. Reduction in area of ecosite phases with high and moderate potential within the Project study areas will be negligable.

The amount of old growth and ecosite phases with the potential to support old growth forests that are to be removed from the LSA is negligible and will not have an effect on the ability for these forests to regenerate after Project closure. As the model of future age class distribution shows, there will be no difference in the development of old age class forests with or without the Project.

Within the LSA, Project effects on old growth stands are related to the reduction in area of old growth, and a reduction in ecosite phases with the potential to support the development of these stands. Due to the wildfire history in the Project study areas, the Project is expected to have a negligible effect on old growth forests. Application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is insignificant.

D.10.3.7 Traditional Ecological Knowledge and Land Use

Construction and operation of the project will result in the removal of 2.3% (6.9 ha) of ecosite phases with high traditional plant potential from the LSA and 0.3 % from the RSA. Also, 3.4 % (454.2 ha) of ecosite phases with moderate potential will be removed from the LSA and 0.9% from the RSA. The total area of ecosite phases with high and moderate potential to support traditionally used plants that will be removed is 3.4% (461.1 ha) from the LSA and 0.9 % from the RSA. The total area of ecosite phases with the potential to support berry communities that will be removed is 3.7 % (486.2 ha) from the LSA and 1.0 % from the RSA.

Ecosite phases with the potential for blueberries, bog cranberries, chokecherry, currants, gooseberries, low-bush cranberries, pin cherries, saskatoons, raspberries, and strawberries are upland sites and will be reclaimed to upland sites similar to baseline conditions (Part E). Overall, the amount of ecosite phases with the potential to support traditionally used plants (including berry habitat) that will be removed as a result of the Project is very low relative to the amount that will still be accessible in the LSA and RSA. With mitigation, the Project is not expected to have a lasting local or regional effect on traditional plants.

Potential Project effects are related to the removal of traditionally used plants resulting from construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is insignificant.

D.10.3.8 Non-native and Invasive Species

Although non-native and invasive species are already prevalent within the study areas, construction and operations activities may increase the spread and establishment of these species into areas adjacent to disturbed sites. With mitigation (including a weed management and monitoring program), the Project is not expected to have a local or regional effect on the establishment and spread of non-native and invasive species.

Potential Project effects are related to the establishment and spread of non-native and invasive species resulting from construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, periodic in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is insignificant.

D.10.3.9 Potential Acid Input and Nitrogen Deposition

Application case scenario nitrogen deposition ranges from 0.65 kg ha^{-1} yr^{-1} to 2 kg ha^{-1} yr^{-1}. Nitrogen deposition is predicted to remain well below even the most conservative critical deposition rates for sensitive ecosystems (Bobbink and Roelofs 1995, WHO 2000), and is not expected to have an effect on vegetation or plant communities. Similarly, PAI was not found to significantly affect soils (Section D.9.2.5), and therefore no indirect effects on vegetation or plant communities is expected.

D.10.4 Mitigation and Monitoring

D.10.4.1 Mitigation

In order to minimize the potential impacts to vegetation resources Connacher will undertake the following:

- develop revegetation plans that will promote the long term establishment of healthy ecosystems and ingress of native species;
- preserve adjacent habitat by minimizing the area required for construction and operation of the Project;
- when possible, utilize coarse woody debris to amend soils to provide mycorrhizal and microbial inoculum;
- conduct re-vegetation according to the reclamation guidelines prepared by the Oil Sands Vegetation Reclamation Committee (OSVRC, 1998), CEMA, or updates;
- report the findings of rare and unranked species to ANHIC for updating provincial All Element Lists;
- salvage all merchantable timber;
- plant pine and white and black spruce seedlings in select areas 2 to 4 years after seeding reclaimed lands;
- where possible, plant aspen and white spruce to increase the diversity of ecosite phases, versus the standard planting of mainly pine.
- maintain drainage patterns and preserve the integrity of wetland areas outside the Project footprint;
- create wetland "transition areas" between reclaimed sites and natural uplands and wetlands;
- when possible, remove fill material placed over organics to reestablish wetlands;
- where possible, reclaim borrow areas to wetlands,
- when possible, direct place salvaged surface material;
- plant mixed species, including some aspen, particularly if post-reclamation observations do not detect natural aspen ingress from adjacent habitat or establishment from replaced stockpiled topsoil; and
- where suitable, introduce woody species typical of b1, b2, c1, d1, and g1 ecosite phases.
- minimize areas of bare ground during Project construction and operation;
- use a non-invasive seed-mix for erosion control, and use approved revegetation species that are compatible with the intended end land use; and
- implement a weed control program during construction, operations and reclamation.

D.10.4.2 Monitoring

Connacher will undertake the following activities:

- monitor reclaimed sites to assess the development of healthy ecosystems that will support natural vegetation an be capable of ecological succession;
- monitor timber harvesting activities to ensure all merchantable timber is salvaged;
- perform survival, growth and health assessments to monitor the success of revegetation efforts;
- conduct a rare plant survey on any new development areas not previously assessed;
- monitor and maintain drainage control structures regularly to ensure water flow and flow patterns are maintained during the construction, operation, and closure phases of the Project;
- monitor reclaimed wetlands after closure to ensure healthy wetlands are being created; and
- conduct regular site inspections during the life of the Project to identify if invasive species are becoming established.

D.10.5 Summary of VECs

Environmental effects on terrestrial vegetation, wetland resources, old growth forests, non-native and invasive species, traditionally used plants, and biodiversity were assessed after accounting for relevant mitigation measures. In all components the effects were reversible over the longterm and, with mitigation, the effect of the Project on the valued environmental component was insignificant. Table D.10.5.1 summarizes the effects to the vegetation, wetlands, old growth forests, wetlands and rare plants.

Table D.10.5.1 Summary of Impact Significance on Vegetation, Wetland and Rare Plant VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1. Terrestrial Vegetation												
	Reduction in area	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
2. Wetlands												
	Reduction in Area	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
	Disturbance of Patterned Fen	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	None [10]	None	None	None	None	None	None	None	None
			Cumulative	None [10]	None	None	None	None	None	None	None	None
3. Old Growth Forests												
	Removal of Old Growth forests	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
4. Non-native and invasive species												
	Invasions into cleared areas in the PF	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
5. Traditionally Used Plants												
	Removed from PF	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
6. Biodiversity												
	Reduction in Genetic-	refer to Section	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant

Table D.10.5.1 Summary of Impact Significance on Vegetation, Wetland and Rare Plant VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
	Species Diversity	D.10.4.1 and CR #10, Section 7.0	Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
	Reduction of Community Diversity	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
	Reduction of Landscape Diversity	refer to Section D.10.4.1 and CR #10, Section 7.0	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
			Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.11 WILDLIFE

D.11.1 Introduction and Terms of Reference

Connacher conducted an assessment of wildlife resources for the proposed Project. The following section is a summary of the Wildlife Baseline Report and Assessment that was prepared by Stantec and included as Consultants Reports #11a & b (CR #11 a & b). For full details of these reports please refer to CR #11 a & b.

Alberta Environment issued the Terms of Reference (ToR) for the project on July 17, 2009. The specific requirements for wildlife are provided in Section 3.8 of the ToR and are as follows:

3.8.1 Baseline Information

[A] Describe and map existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals) and their use and potential use of habitats.
[B] Identify key indicator species and discuss the rationale for their selection. Identify composition, distribution, relative abundance, seasonal movements, movement corridors, habitat requirements, key habitat areas, and general life history. Address those species listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (Alberta Sustainable Resource Development) and all species listed in Schedule 1 of the federal Species at Risk Act and those listed as "at risk" by COSEWIC.
[C] Quantitatively describe and map existing habitat disturbance (including exploration activities) and identify those habitat disturbance that are related to the Project.

3.8.2 Impact Assessment

[A] Describe Project components and activities that may affect wildlife and wildlife habitat.
[B] Describe and assess the potential impacts of the Project on wildlife populations and wildlife habitat addressing:

- *a) how the project will affect wildlife relative abundance, movement patterns, distribution, reproductive potential, population and community dynamics and recruitment into regional populations for all stages of the Project;*
- *b) how improved or altered access may affect wildlife including potential obstruction of daily and seasonal movements, increased vehicle-wildlife collisions, and increased hunting pressure;*
- *c) how increased habitat fragmentation may affect wildlife considering edge effects, the availability of secure core habitat, and the influence of linear features and infrastructure on wildlife movements and other population parameters;*
- *d) the spatial and temporal changes to habitat availability and habitat effectiveness (type, quality, quantity, diversity, availability, and distribution) and relate those changes to potential changes in wildlife populations;*
- *e) potential effects on wildlife as a result of changes to air and water quality including both acute and chronic effects on animal health;*
- *f) potential effects on wildlife from increased light from the Project;*
- *g) potential effects on wildlife from Connacher's proposed and planned exploration, seismic and core hole activities, including monitoring/4D seismic;*
- *h) the resilience and recovery capabilities of wildlife populations and habitat to disturbance; and*
- *i) the potential for the Project Area to be returned to its pre-disturbed state with respect to wildlife population and their habitats.*

[C] Comment on the availability of species for traditional use considering habitat loss, habitat avoidance, vehicle-wildlife collisions, increased non-aboriginal hunting pressure and other Project related effects on wildlife populations.

[D] Provide a strategy and mitigation plan to minimize impacts on wildlife and wildlife habitat for all stages of the Project and to return productive wildlife habitat to the area, considering:

- *a) consistency of the plan with applicable regional, provincial and federal wildlife habitat objectives and policies;*
- *b) a schedule for the return of habitat capability to areas impacted by the Project;*
- *c) the use of setbacks to protect riparian habitats, interconnectivity of such habitat and the unimpeded movement by wildlife species using that habitat;*
- *d) the need for access controls or other management strategies to protect wildlife during and after Project operations;*
- *e) measures to prevent habituation of wildlife minimize the potential for human-wildlife encounters and consequent destruction of wildlife, including any staff training program, fencing camps, garbage containment measures or regular follow-up;*
- *f) measures to mitigate habitat fragmentation considering impacts to habitat connectivity and wildlife movements resulting from linear features (e.g., above ground pipelines, roads etc.) and other Project infrastructure and activities; and*
- *g) measures to minimize the effects of light on wildlife.*

[E] Describe the residual effects of the Project on wildlife and wildlife habitat and Connacher's plans to manage those effects.

3.8.3 Monitoring

[A] Describe the monitoring programs proposed to assess any Project impacts to wildlife and to measure the effectiveness of mitigation plans, giving special attention to those species:

- *a) listed as "at Risk, May be at Risk and Sensitive" in The Status of Alberta Species (Alberta Sustainable Resource Development);*
- *b) listed in Schedule 1 of the federal Species at Risk Act; and*
- *c) listed as "at risk' by COSEWIC.*

The local study area (LSA) used for the wildlife baseline data collection and assessment included the Connacher lease area (CR #11b, Figure 1-1). The regional study area (RSA) was defined as the land within 5 km of the LSA (CR #11b, Figure 1-1), which represents the approximate diameter of a moose range in north-eastern Alberta. The RSA overlaps both the Egg-Pony and Algar Caribou Management Zones. With the exception of caribou, cumulative effects on habitat availability for all VECs were assessed at the scale of the RSA. Cumulative effects for caribou were assessed at the scale of the East Side of the Athabasca River caribou range. This large area was considered most appropriate for caribou because management typically occurs at the range level.

Information sources used to provide baseline wildlife information include:

- sources of existing information such as Alberta Sustainable Resource Development, Fish and Wildlife Management Information System, Alberta Natural Heritage Information Centre, and Alberta Caribou Committee;
- experts and local residents;
- environmental assessments and associated baseline reports previously conducted in the area;
- field surveys conducted in the LSA for amphibians, breeding birds, nocturnal owls, raptors, waterbirds, ungulates and bats; and
- results of long-term wildlife monitoring program currently undertaken by Connacher on the lease.

The wildlife assessment focused on eight species selected as Valued Environmental Components (VECs) including:

- bird species - Northern goshawk, Cape May warbler, Sandhill crane
- ungulates - woodland caribou and moose;
- beaver; and
- predators - Canada lynx and Fisher.

An additional 33 special status species whose ranges overlap with the Project, and for which there was suitable habitat, were also considered.

Project development has the potential to interact with wildlife in different ways. The Project may alter wildlife habitat availability and connectivity, movement, as well as wildlife health and mortality rates, all of which may affect the abundance of wildlife in the LSA and beyond.

Quantitative assessments were conducted for the application and planned development cases and included habitat modelling, habitat patch metrics, core security and movement analysis, and linear disturbance and density analysis. Construction, although potentially disruptive, will occur over a relatively short period, and was therefore addressed qualitatively only.

D.11.2 Baseline Conditions

D.11.2.1 Wildlife Habitat

Ecosite phases for the LSA were grouped into broader wildlife habitat classes based on their vegetation species composition, moisture regime, topographic position, and general value to wildlife. Because of the varying importance of young and mature/old forests for wildlife, stand age was also incorporated into the habitat classes.

Young mixed coniferous and young shrubby bog/fen habitats were the most abundant, representing 30.9% and 25.1% of the LSA, respectively (Table D.11.2.1, CR #11, Figure 2-2). Deciduous forest, marsh and waterbody habitat types were relatively uncommon in the LSA.

As in the LSA, young shrubby bog/fen and young mixed coniferous were the dominant habitat types, collectively accounting for 54% of the RSA (Table D.11.2.1). Old treed bog/fen habitat, which is important habitat for woodland caribou, was twice as abundant as young treed bog/fen. The disturbance type accounted for just 1.8% of the RSA under existing conditions.

The habitat availablility in the LSA and RSA for each VEC is provided in Table D.11.2.2.

Table D.11.2.1 Wildlife Habitat Availability

		LSA				RSA			
Habitat Type	**Age**	**Baselineg Area (ha)**	**Application Area (ha)**	**Change (ha)**	**Change (%)**	**Baseline Area (ha)**	**Application Area (ha)**	**Change (ha)**	**Change (%)**
Treed bog/fen	Young	716	678	-37.8	-5.3	2,870	2,832	-38	-1.3
	Old	1,016	998	-18	-1.8	5,938	5,920	-18	-0.3
Shrubby bog/fen	Young	3,855	3,774	-81.8	-2.1	15,796	15,714	-82	-0.5
	Old	1,421	1,397	-24.1	-1.7	6,727	6,703	-24	-0.4
Mixed coniferous	Young	4,744	4,453	-291.5	-6.1	15,353	15,062	-291	-1.9
	Old	1,467	1,446	-20.4	-1.4	3,515	3,494	-20	-0.6

Table D.11.2.1 Wildlife Habitat Availability

Habitat Type	Age	LSA Baselineg Area (ha)	LSA Application Area (ha)	LSA Change (ha)	LSA Change (%)	RSA Baseline Area (ha)	RSA Application Area (ha)	RSA Change (ha)	RSA Change (%)
Mixedwood	Young	830	800	-30.2	-3.6	1,706	1,676	-30	-1.8
	Old	325	320	-4.8	-1.5	776	772	-5	-0.6
Deciduous	Young	66	66	0	0	1,670	1,670	0	0
	Old	62	61	-0.6	-1	273	272	-1	-0.2
Sedge meadow	n/a	208	205	-2.5	-1.2	1,563	1,561	-2	-0.1
Marsh	n/a	3	3	-0.1	-3.3	13	13	0	0
Waterbody	n/a	76	76	0	0	236	236	0	0
Disturbance	n/a	581	1,092	511.2	88	1,023	1,534	511	50
Totals		**15,370**	**15,370**	**0**	**0**	**57,458**	**57,458**	**0**	**0**

Table D.11.2.2 Habitat Availability for each VEC

Species	Habitat Quality	LSA Baseline (ha)	LSA Application (ha)	LSA Change (ha)	LSA % Change	RSA Baseline (ha)	RSA Application (ha)	RSA Change (ha)	RSA % Change
Northern goshawk	High	22	22	0	0	85	85	0	0
	Moderate	113	108	-5	-4.4	525	520	-5	-1.0
	Low	2,658	2,289	-369	-13.9	8,756	8,387	-369	-4.2
	Nil	12,577	12,951	+374	+3.0	48,092	48,467	+375	+0.8
	Effective	**135**	**130**	**-5**	**-3.7**	**610**	**605**	**-5**	**-0.8**
Cape May warbler	High	80	74	-6	-7.5	270	263	-7	-2.6
	Moderate	913	823	-90	-9.9	4,858	4,768	-90	-1.9
	Low	4,673	3,917	-756	-16.2	13,806	13,050	-756	-5.5
	Nil	9,704	10,556	+852	+8.8	38,524	39,377	+853	+2.2
	Effective	**993**	**897**	**-96**	**-9.7**	**5,128**	**5,031**	**-97**	**-1.9**
Sandhill crane	High	5,533	4,918	-615	11.1	25,429	24,814	-615	-2.4
	Moderate	2,188	2,321	+133	6.1	9,694	9,827	+133	+1.4
	Low	6,361	5,581	-780	12.3	20,176	19,396	-780	-3.9
	Nil	1,288	2,550	+1,262	98.0	2,159	3,421	+1,262	+58.5
	Effective	**7,721**	**7,239**	**-482**	**6.2**	**35,123**	**34,641**	**-482**	**-1.4**
Woodland caribou	High	776	626	-150	-19.3	3,359	3,208	-151	-4.5
	Moderate-high	740	705	-35	-4.7	4,150	4,121	-29	-0.7
	Moderate	2,889	2,545	-372	-12.9	13,458	13,107	-351	-2.6
	Low	3,495	2,912	-583	-16.6	13,324	12,741	-583	-4.4
	Very low	4,538	4,061	-477	-10.5	16,933	16,458	-475	-2.8
	Nil	2,932	4,521	+1,589	+54.2	6,234	7,823	+1,589	+25.5
	Effective	**4,405**	**3,876**	**-529**	**-12.0**	**20,967**	**20,436**	**-531**	**-2.5**
Moose	High	427	353	-74	-17.2	2,661	2,587	-74	-2.8
	Moderate-high	762	742	-21	-2.7	3,353	3,332	-21	-0.6
	Moderate	3,196	2,626	-570	-17.8	11,556	10,986	-570	-4.9
	Low	5,961	5,694	-267	-4.5	26,023	25,755	-267	-1.0

Table D.11.2.2 Habitat Availability for each VEC

Species	Habitat Quality	LSA				RSA			
		Baseline (ha)	Application (ha)	Change (ha)	% Change	Baseline (ha)	Application (ha)	Change (ha)	% Change
	Very low	3,565	3,874	+309	+8.7	11,164	11,472	+309	+2.8
	Nil	1,459	2,082	+623	+42.7	2,702	3,325	+623	+23.1
	Effective	**4,385**	**3,721**	**-664**	**-15.1**	**17,570**	**16,906**	**-664**	**-3.8**
Beaver	High	306	302	-4	-1.3	1,188	1,184	-4	-0.3
	Moderate	1,454	1,425	-29	-2.0	3,638	3,610	-28	-0.8
	Low	4,062	3,915	-147	-3.6	9,006	8,860	-146	-1.6
	Nil	9,549	9,728	+179	+1.9	43,626	43,804	+178	+0.4
	Effective	**1,760**	**1,727**	**-33**	**-1.9**	**4,826**	**4,794**	**-32**	**-0.7**
Fisher	High	49	46	-3	-6.1	322	319	-3	-0.9
	Moderate	1,212	1,187	-25	-2.1	3,037	3,011	-26	-0.9
	Low	5,180	4,552	-628	-12.1	19,098	18,471	-627	-3.3
	Nil	8,930	9,585	+655	+7.3	35,002	35,657	655	+1.9
	Effective	**1,260**	**1,233**	**-28**	**-2.2**	**3,358**	**3,330**	**-28**	**-0.8**
Canada lynx	High	6,237	5,231	-1,006	-16.1	25,275	24,270	-1,005	-4.0
	Moderate-high	4,225	3,512	-713	-16.9	17,623	16,910	-713	-4.0
	Moderate	1,873	2,540	+666	+35.6	5,660	6,326	+666	+11.8
	Low	1,543	1,963	+420	+27.2	5,036	5,456	+420	+8.3
	Very low	560	599	+39	+7.0	1,368	1,407	+39	+2.9
	Nil	932	1,525	+593	+63.6	2,496	3,089	+593	+23.7
	Effective	**12,335**	**11,283**	**-1052**	**-8.5**	**48,558**	**47,506**	**-1,052**	**-2.2**

D.11.2.2 Biodiversity

Biodiversity of the existing LSA landscape was assessed (CR #11a, Section 2.6). Habitat types with high biodiversity, based on the total number of potential species that could occur within each ecosite phase and stand age, were relatively uncommon in the LSA under existing conditions (Table D.11.2.3, CR #11b, Figure 2-2). This likely reflects the early seral stage of most of the LSA. Waterbodies had the highest biodiversity ranking, with 112 species potentially occurring in or near them (i.e., riparian habitats). Other habitats with high biodiversity included old mixedwood forests with spruce, aspen and balsam poplar which support a range of listed species, such as black-throated green warbler and Canada warbler.

Table D.11.2.3 Biodiversity Ranking in the LSA

Biodiversity Ranking	Area (ha)			% Change
	Baseline	Planned	Change	
High	73	73	0.0	0.0
Moderate-high	746	734	-12	-1.6
Moderate	2,847	2,798	-49	-1.7
Moderate-low	11,122	10,672	-450	-4.0
Low	583	1,094	+511	+87.7
Totals	**15,370**	**15,370**	**0**	**0.0**

D.11.2.3 Birds

Northern goshawk

The northern goshawk, considered "Sensitive" in Alberta. Optimal nesting and cover habitats have been described as mature to old deciduous-dominated mixedwood stands, characterized by well-developed, complex canopies and open understories.

According to the habitat suitability model, there is very little effective habitat (135 ha) for northern goshawks in the LSA under existing conditions (Table D.11.2.2). The majority of high and moderate quality habitat is located west of Highway 63. Effective habitat is similarly rare in the RSA (610 ha), and located mostly in the northern and western regions.

There is only one patch of effective habitat in the LSA large enough to support a nesting site (Table D.11.2.4, CR #11b, Figure 2-4). In comparison, the RSA provides six potential nest site patches under existing conditions. These results confirm the results of field surveys suggesting that northern goshawks are relatively rare in the LSA.

Table D.11.2.4 Effective Habitat Patches

Metric	LSA				RSA			
	Existing	Predicted	Change	% Change	Existing	Predicted	Change	% Change
Northern Goshawk								
Number of Effective Habitat Patches (≥24 ha)	1	1	0	0	6	6	0	0
Total Area (ha)	26	26	0	0	273	273	0	0
Cape May warbler								
Number of Effective Habitat Patches (≥10 ha)	19	17	-2	-10.5	100	98	-2	-2
Total Area (ha)	578	508	-70	-12.1	3,765	3,695	-70	-1.9

Cape May Warbler

Although the Cape May warbler has been recorded in low numbers across northern and central Alberta, this species was not detected in the LSA. Cape May warblers prefer to nest in mature and old-growth, white spruce-dominated forests, although black spruce forests may also be used. Cape May warblers tend to select spruce forests over 10 m in height, with a number of very tall conifers rising above the canopy. These tall conifers are likely used as singing posts to attract mates and defend territories. Tree density does not appear to be an important factor in habitat selection by the Cape May warbler.

Under existing conditions, the LSA contains 993 ha (6.4%) of effective habitat for Cape May warblers (Table D.11.2.2, CR #11b, Figure 2-5). Most of this habitat is located between the transmission line and Highway 63, and in the southern section of the LSA. In comparison, 9% of the RSA is considered effective habitat for Cape May warblers under existing conditions (Table D.11.2.2). Most of this high and moderate quality habitat is located in the southwest corner of the RSA.

Although Cape May warbler breeding territories typically encompass up to 1 ha of effective habitat, there is evidence that songbird territories need to be surrounded by a contiguous habitat patch of at least 10 ha in size. Therefore, habitat patches need to be ≥10 ha in size to be considered effective for Cape May warblers.

The habitat model predicted that the LSA contains 19 patches of effective habitat (578 ha) large enough to support breeding Cape May warblers (Table D.11.2.4). The RSA contains 100 habitat patches for a total area of 3,765 ha. Therefore, the LSA can support an estimated 40 pairs of Cape May warblers under existing conditions, while the RSA can support approximately 264 pairs.

Sandhill Crane

Sandhill cranes nest in isolated bogs, marshes, swamps, meadows and other secluded freshwater wetlands. High and moderate quality sandhill crane habitat is widely distributed throughout the study areas, except for the area west of Highway 63 in the LSA (CR #11b, Figure 2-7). Over one-half of the RSA and LSA provide effective habitat for sandhill cranes under existing conditions (Table D.11.2.2). Thus, sandhill crane breeding habitat is unlikely to be limiting in either the LSA or RSA prior to Project development.

D.11.2.4 Ungulates

Woodland caribou

The LSA overlaps with the Egg-Pony Caribou Management Zone within the East Side of the Athabasca caribou range (ESAR). The caribou population in this range is approximately 250 animals and is currently declining at a rate of about 6% per year (Athabasca Landscape Team 2009). Caribou are designated as a "Threatened" species federally under the *Species at Risk Act* and provincially under the *Wildlife Act*. Caribou and their sign (i.e., tracks and scat) have been recorded during many of the wildlife surveys throughout the LSA. Recent data collected during the Algar and expansion monitoring programs has confirmed caribou use of the LSA.

Almost 29% of the LSA is considered as effective habitat for caribou, although 66% of this is only rated as moderate quality (Table D.11.2.2). Most of the high quality habitat is located in the northern and central portions of the LSA southeast of the Algar Project (CR #11b, Figure 2-8). Similarly, over 35% of the RSA is considered effective for caribou, with only 16% of this rated high quality. Much of the high and moderate-high quality habitat is located at the southern end of the RSA.

Core Security and Movement Analyses

Core security habitat was defined as effective habitat (i.e., high, moderate-high or moderate quality habitat) located outside of the disturbance zones of influence (ZOIs). Patches of all sizes ≥0.005 ha were considered to be potential core habitat. It was assumed that although large habitat patches are best because animals can save energy by foraging in one location for an extended period, caribou can use even very small patches of effective habitat, provided they are secure from predation and human disturbance.

Results of the core security and movement analysis indicate that there are 301 core habitat patches in the LSA and 861 patches in the RSA (Table D.11.2.5). Most patches are less than 20 ha in size, with only 45 core habitat patches > 100 ha in area within the RSA. Core winter habitat is highly fragmented under existing conditions (CR #11b, Figure 2-9), emphasizing the need for caribou to move safely about the landscape among core patches. Within the LSA, larger patches of core habitat tend to be concentrated in the north lease extension, south of the Algar Project and in the extreme south end of the LSA. Permeability of the landscape is anticipated to be affected by disturbance features within the RSA (CR #11b, Table 2-11). Highway 63 represents the greatest barrier to caribou movement under existing conditions, with plants, gravel pits and active well pads also considered impermeable. Winter access routes and larger seismic lines within the RSA were rated as moderately permeable during the winter because of human and predator presence. Permeability of portions of the Algar Project is expected to increase with the recent completion of wildlife crossing structures over aboveground pipelines.

Table D.11.2.5 Caribou core security habitat patch metrics in the LSA

Patch Size	Number			Total Area (ha)		
	Existing	Project	Change	Existing	Project	Change
<1 ha	101	81	-20	40.3	35.4	-5.4
1-20 ha	157	106	-51	841.1	607.3	-233.8
21-40 ha	15	16	+1	429.8	465.7	+35.9
41-60 ha	11	7	-4	521.7	342.0	-179.7
61-80 ha	5	3	-2	357.4	218.6	-138.8
81-100 ha	2	3	+1	165.7	249.4	+83.6
>100 ha	10	8	-2	1,480.4	1,195.7	-284.7
Totals	**301**	**243**	**-77**	**3,836.6**	**3,114.0**	**-723.2**

Linear Density and Disturbance Analysis

Linear feature densities within the LSA and RSA were calculated with and without low impact seismic (LIS) lines (Table D.11.2.6) The impact of LIS on caribou is still uncertain (Athabasca Landscape Team 2008), and therefore density calculations considered both scenarios.

Table D.11.2.6 Density of linear features in the LSA and RSA

Study Area	Existing		Project		Change		% Change	
	Length (km)	Density (km/km^2)	Length (km)	Density (km/km^2)	Length (km)	Density (km/km^2)	Length (km)	Density (km/km^2)
LSA								
Excluding LIS	247.0	1.6	-	-	-	-	-	-
Including LIS	4,678	30.4	-	-	-	-	-	-
RSA								
Excluding LIS	748	1.3	791.6	1.4	43.6	0.1	5.8	7.7
Including LIS	5,455	9.5	3481.1	6.1	43.6	0.1	1.3	1.7

The density of linear features without LIS is close to or over the lower thresholds at which caribou are predicted to decline (Table D.11.2.7). If LIS is considered as a linear feature that might affect caribou, the density of features is far beyond any predicted thresholds. Further research is required to confirm the effects of LIS on caribou, their predators, and alternate prey.

Table D.11.2.7 Guideline or Threshold Values for Cumulative Effects Indicators for Woodland Caribou

Indicator	Guideline or Threshold	Comments
Total Corridor Density(>3 m wide)	>1.8 km/km^2 (Francis et al. 2002)	Boreal caribou populations decline above threshold
	>3km/km^2 (Stelfox *in* Salmo Consulting 2004)	Boreal caribou populations do not persist above threshold
	2.04 km/km^2 (Dzus 2001)	Linear corridor density associated with declining caribou populations in ESAR caribou range, Alberta
	>1.2 km/km^2 (Weclaw and Hudson 2004)	Caribou may be extirpated from northern Alberta in 40 years if linear densities exceed threshold
Road Density	1.0 – 1.3 km/km^2 (Dyer et al. 2002)	Density in caribou seasonal home ranges in Alberta
	<0.6 km/km^2 (Stelfox *in* Salmo Consulting 2004)	Road densities in mountain ecotype caribou range

Moose

Moose are widely distributed throughout the forested portion of the province, and appear to be one of the most common ungulates in the LSA. Moose occur in a variety of habitats often in close association with deciduous, shrub, riparian and especially with wetland habitats. The habitat suitability model predicts that approximately 30% of the LSA and RSA functions as effective habitat for moose during the winter (Table D.11.2.2). Effective habitat is widely scattered throughout the study areas (CR #11b, Figure 2-10), with relatively large patches of high quality habitat located on the western side of the RSA.

Core Security and Movement Analysis

As with caribou, core security habitat for moose was considered as all effective habitat (high, moderate-high and moderate quality) located outside of the disturbance ZOIs. This core habitat is of high value for moose because it provides adequate forage in areas safe from human disturbance and potentially predation.

Core security habitat was mapped for the winter only, when forage availability is most limiting. Core security habitat is distributed throughout the LSA, although it is relatively scarce around Highway 63 and the Algar Project, and in the south end of the LSA (CR #11b, Figure 2-11). Two-hundred forty-six core habitat patches were identified in the LSA, most of which were <21 ha in size (Table D.11.2.8). Core habitat represented 27% of the LSA for moose, and 29% of the RSA. Although core habitat in the RSA is also composed mostly of small patches, there are 32 patches >100 ha in size, located primarily on the northwest side of the RSA.

Highway 63 and existing SAGD projects are predicted to reduce the permeability of the LSA to moose (CR #11b, Figure 2-11). In addition, habitat located around the Algar Project and along Highway 63 may be relatively inaccessible with the concentration of impermeable and semi-permeable disturbance features. The RSA landscape, away from existing disturbances, is anticipated to be relatively permeable to moose moving among core habitat patches.

Table D.11.2.8 Moose core security habitat patch metrics

Patch Size	LSA						RSA					
	Number			Total Area (ha)			Number			Total Area (ha)		
	Baseline	Planned	Change	Baseline	Planned	Change	Baseline	Planned	Change	Baseline	Planned	Change
<1 ha	67	73	+6	23.6	26.9	+3.3	243	247	+4	95.8	98.4	+2.6
1-20 ha	135	145	+10	778.1	945.9	+167.8	437	438	+1	2,464.6	2,523.0	+58.4
21-40 ha	18	19	+1	502.6	565.3	+62.6	47	48	+1	1,402.1	1,464.4	+62.2
41-60 ha	7	8	+1	364.5	418.3	+53.8	31	31	0	1,541.6	1,541.8	+0.2
61-80 ha	7	5	-2	512.0	368.9	-143.1	18	16	-2	1,255.1	1,116.5	-138.7
81-100 ha	3	1	-2	255.3	87.7	-167.6	12	10	-2	1,087.1	911.9	-175.1
>100 ha	9	6	-3	1,652.4	987.4	-664.9	32	30	-2	8,964.5	8,466.8	-497.6
Totals	**246**	**257**	**+11**	**4,088.5**	**3,400.6**	**-687.7**	**820**	**820**	**0**	**16,810.7**	**16,122.8**	**-688.0**

Linear Features Density Analysis

The density of linear features in the RSA (Table D.11.2.6) will not likely affect moose, primarily because most of the linear features are winter access routes that do not pose major barriers to movement. Seismic lines may actually benefit moose by providing forage, although these benefits are likely offset by improved access for wolves and hunters.

Although moose do not typically exhibit such a negative response to disturbance as caribou, development is still expected to affect the distribution and movement of moose across the RSA. Linear features most likely affect moose through increased levels of sensory disturbance, and mortality risk associated with vehicular collisions on access routes.

D.11.2.5 Beaver

Beaver are widespread and not considered "Sensitive" at either the provincial or federal levels. The beaver is considered a keystone species for its ability to alter hydrological processes and landscape structure to benefit many other species. Beaver are associated with streams, lakes, ponds and marshes in forested areas. Waterbodies at least 1.5 m deep are preferred and stable shorelines are required for dam, lodge or burrow construction. Areas with abundant deciduous vegetation, including aspen, poplar, willow and alder, within 200 - 250 m of a waterbody are generally considered high quality habitat for beaver.

Potential beaver habitat is restricted to riparian areas, and as such, effective habitat represents less than 12% of the study areas (Table D.11.2.2). High quality foraging habitat is relatively uncommon, with waterbodies comprising much of the 306 ha and 1,188 ha in the LSA and RSA, respectively (CR #11b, Figure 2-12).

D.11.2.6 Predators

Fisher

The fisher is classified as "Sensitive" in Alberta because of uncertainty in population trends, potential reduction in preferred habitat, and declines in harvest since 1985. Fisher were relatively uncommon in the LSA, but have been detected on wildlife cameras used in the monitoring program and during track surveys. Fishers exhibit seasonal variation in their use of habitats with the most important habitat component being mature to old-growth forest, which is used for foraging, resting and denning.

Effective fisher habitat, old mixedwood and coniferous forest, is relatively uncommon within the LSA under Existing conditions (Table D.11.2.2, CR #11b, Figure 2-13). Based on these results, fisher are expected to be relatively uncommon in the LSA.

Canada lynx

The Canada lynx occurs at low densities throughout the boreal forest of Alberta (Pattie and Fisher 1999). While the lynx is designated as "Not at Risk" of extinction at the federal level, it is considered "Sensitive" in Alberta because of recent population declines, and concerns over habitat loss and fragmentation. Lynx were detected during early winter track surveys and by wildlife cameras deployed throughout the LSA as part of the Algar and expansion monitoring programs.

Effective lynx habitat was very common and widespread in the LSA, accounting for over 80% of the study area (Table D.11.2.2, CR #11b, Figure 2-14). These results reflect the abundance of early-successional forest, considered good snowshoe hare habitat, resulting from the 1995 Mariana fire. High quality habitat represents 41% of the LSA under existing conditions, and therefore lynx are anticipated to be relatively common when they are at the peak of their ten-year cycle. Similarly in the RSA, effective habitat accounted for almost 85% of the total area. These results are consistent with the remote camera data, which indicate that lynx are relatively common and widespread throughout the LSA.

D.11.3 Predicted Conditions

D.11.3.1 Wildlife Habitat

Application Case

The footprint of the expansion Project is anticipated to increase disturbance by 511 ha, or 88% (Table D.11.2.1). The total expansion project footprint is 520.8 ha, but overlaps with some existing disturbance, and therefore the relative increase in disturbance is lower. The largest proportional decreases will occur in young mixed coniferous (6.1%) and young treed bog habitats (5.3%). Only 1.0 to 1.8% of older habitat types is anticipated to be lost following Project development. The change in habitat availablility in the LSA for each VEC is provided in Table D.11.2.2.

Planned Development Case

At the RSA scale, changes in wildlife habitat types are predicted to be relatively small and likely insignificant (Table D.11.2.1). Although total disturbance within the RSA is anticipated to increase by 50% with the Project, the largest proportional changes in natural habitat availability will be 1.9% for young mixed coniferous and 1.8% for young mixedwood. Very small proportions of older habitat types will be affected by Project development. The change in habitat availablility in the LSA for each VEC is provided in Table D.11.2.2.

D.11.3.2 Special Status Wildlife Species

Special status species that potentially occur in the LSA were identified using a variety of resources, including The General Status of Alberta Wild Species (AE/ASRD 2005), the Cumulative Environmental Management Association, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007) and published range maps and species accounts. A total of 56 listed species may occur within the LSA (CR #11a, Table 3-3).

Species of concern are often considered in wildlife assessments because of their status and sensitivity to changes in habitat. By managing the landscape for species of concern, habitat may also be conserved for other less sensitive species.

Waterbodies, marshes and sedge meadows will be largely unaffected by the Project (-1% loss), and therefore impacts are anticipated to be negligible for species such as garter snake, western toad, Canadian toad, lesser scaup, green-winged teal, northern pintail, yellow rail, sora, northern harrier, and short-eared owl. Because Connacher will mitigate effects on riparian species by buffering watercourses and waterbodies, rusty blackbird, barred owl, common yellowthroat, eastern phoebe, broad-winged hawk, and Canada warbler are unlikely to be affected by the Project. Several species at risk could use old mixedwood and/or deciduous forests in the LSA, including black-throated green warbler, northern long-eared bat, silver-haired bat, and least flycatcher. The Project will result in the loss of 4.8 ha (-1.5%) of old mixedwood and 0.6 ha (-1%) of old deciduous habitats, and therefore, effects are anticipated to be minimal for wildlife using these habitats. Similarly, wildlife using old mixed coniferous habitat, such as hoary bat, bay-breasted warbler, blackburnian warbler, brown creeper, and pileated woodpecker will not be greatly affected by direct habitat loss (-1.4%). Approximately 56 ha (-3%) of treed bog/fen will be lost, potentially affecting olive-sided flycatcher, great gray owl, northern hawk owl, and possibly sharp-tailed grouse. Western tanager can use a variety of coniferous and mixedwood stands, 347 ha (-4.7%) of which will be affected by Project development. Sharp-tailed grouse and common nighthawk are anticipated to use reclaimed Project sites, such as well pads and rights-of-way (RoWs), and may benefit in the long-term. Although wolverine are habitat generalists and are unlikely to be affected by direct habitat loss, this species may avoid the area because of increased human activity and development. In general, Project-related habitat losses are considered unlikely to significantly affect special status wildlife species.

D.11.3.3 Biodiversity

The Project is anticipated to have relatively little effect on biodiversity in the LSA or RSA, both of which are dominated by habitats that are characterized by moderate-low biodiversity (CR #11b, Figure 3-2). The Project is not predicted to affect any high biodiversity habitats (Table D.11.2.3), primarily because the footprint avoids waterbodies and riparian areas. Therefore, the Project is unlikely to have a significant effect on biodiversity or habitats with the potential for having high biodiversity within the LSA or RSA.

D.11.3.4 Traditional Land Use and Ecological Knowledge

Interviews were conducted with a number of traditional land users, including members of the Fort McMurray Métis Local 1935, Willow Lake Métis Local 780, Chipewyan Prairie Dene First Nation (CPDFN), Heart Lake First Nation, Fort McMurray First Nation, and Chard Métis Local 214. Participants confirmed that a broad diversity of wildlife use the LSA, including moose, caribou, lynx, fox, coyote, marten, mink, black bear, fisher, grizzly, otter, rabbit, beaver, muskrat, deer, ducks, geese, grouse, and bats. There is concern that caribou trails are being disrupted by seismic lines and roads, and lichen lost with development. Participants also indicated that caribou are much less common in the area than in the past, and suggested wildlife are avoiding the area because of increased traffic and noise. Predators, including black bears, grizzly bears, lynx, wolves and cougars, are abundant in the LSA. There is concern regarding loss of wildlife and declining populations, as well as the cumulative effects of development on wildlife, particularly for caribou.

D.11.3.5 Birds

<u>Application Case</u>

<u>Habitat Availability</u>

Because both Cape May warbler and northern goshawk are dependent upon mature or old forest stands, they are predicted to occur at low densities within the LSA. The operations phase of the Project is anticipated to result in the loss of 5 ha (4%) and 96 ha (10%) of effective habitat for northern goshawk and Cape May warbler, respectively (Table D.11.2.2, CR #11b, Figures 3-3 & 3-5). It is important to note that the LSA provides only 135 ha of effective habitat for northern goshawk under existing conditions, and 993 ha for Cape May warbler. The number of patches of suitable nesting habitat will also decrease with the Project as a result of habitat loss and fragmentation. The Project is predicted to eliminate two smaller (2 to 23 ha) habitat patches (potential nest sites) for northern goshawks, but will not intersect the larger habitat patch (potential nest area) available in the LSA (Table D.11.2.4, CR #11b, Figure 3-4). Similarly, the number of effective habitat patches suitable for nesting Cape May warblers is anticipated to decrease by two (10.5%) with Project development, representing a loss of 70 ha (Table D.11.2.4, CR #11b, Figure 3-6).

Effective sandhill crane breeding habitat is far more abundant than habitat for the forest-dependent VECs, and accounts for almost 50% of the LSA under predicted conditions (Table D.11.2.2). The Project development will result in the loss of 482 ha (6%) of effective sandhill crane habitat; however, almost half of the LSA (47%, 7,239 ha) is still considered effective under predicted conditions. Unlike the other avian VECs, patch size is not considered important for sandhill crane (Cooper 1996), and since most of the effective habitat occurs outside of the disturbance ZOIs, all of this effective habitat will be available to sandhill cranes. Decommissioning and reclamation will create habitat for sandhill crane in the short-term.

Wildlife Movement

Effects of the Project on bird movement will be most pronounced for forest songbirds, such as Cape May warbler, particularly along cleared RoWs and well pads. Although breeding songbirds can incorporate narrow (<6 m) RoWs into their territories (Machtans 2006), wider (≥8 m) corridors may be used as territorial boundaries and crossed less frequently (Bayne et al. 2005), possibly because of increased predation risk (Lima and Dill 1990). Although Bélisle and St. Clair (2001) noted that movement of yellow-rumped warblers was delayed when crossing multiple linear corridors, including a 60 to 100 m wide highway, most individuals (86%) were still able to cross, indicating that even wide gaps in vehicular traffic are not impermeable barriers to movement. Effects on movement were assumed to be higher, but not significant, during construction when human activity will be most intense. The Project is not anticipated to have significant effects on movements of Cape May warbler or other forest songbirds.

Openings and RoWs may be used for hunting by northern goshawk, particularly after reclamation, and are unlikely to reduce permeability of the LSA for this species. Similarly, sandhill crane movement is unlikely to be significantly affected by the Project during either the construction or operations phases. In fact, sandhill cranes are likely to use the reclaimed footprints, which will initially resemble meadows and early seral stands, as sources of forage and possibly movement corridors..

Wildlife Health and Mortality

The primary mechanism through which the Project could affect avian health and mortality is through vegetation clearing and consequent destruction of nests. Since vegetation clearing is scheduled for the winter, no birds or nests will be directly affected. Sensory disturbance has the potential to cause nest abandonment and reduced mating success immediately adjacent to continuously noisy features. Disturbance will be mitigated for all birds by clearing vegetation outside of the breeding season and using noise-reducing technology where possible to minimize noise levels. For northern goshawk, nests will be identified and any Project-related activities near the nests will be avoided from March 1 to August 15.

Avian health could be affected by pollutants released into the air as emissions or onto the ground as accidental spills. Contaminants which enter the food chain via vegetation or insects could then be consumed by birds, potentially leading to reduced fitness and health. Project emissions, however, are anticipated to be too low to affect vegetation or aquatic systems, and should affect avian health. Accidental spills will be mitigated by restricting refueling activities to areas set away from waterbodies and that are protected by berms. Further, an Emergency Spill Response Plan will be provided to all

Project employees. A Screening Level Wildlife Risk Assessment has been completed and is summarized in Section D.5 and included as CR #5b. It was determined that the Project would not adversely impact wildlife health in the region.

Other potential sources of mortality include hunting/poaching and vehicular collisions, but these are not anticipated to be major Project-related issues from a wildlife perspective. Health and mortality of Cape May warbler, northern goshawk and sandhill crane are not anticipated to be significantly affected by the Project.

Abundance

Project-related changes in abundance were calculated based on average density of birds in effective habitat as follows: Cape May warbler 0.07 birds/ha (Kirk et al. 1996, 1997); northern goshawk 1 pair/nest area (Mahon and Doyle 2005); and sandhill crane 0.04 birds/ha (Armbruster 1987). Results indicate that <0.10% of provincial populations will be affected by the Project (CR #11b, Table 3-6), suggesting that regional populations of Cape May warbler, northern goshawk or sandhill crane will not be affected by Project development. Birds displaced by the Project will likely move into other unoccupied habitats, assuming that populations are not at carrying capacity. Therefore, Project-related changes in habitat availability and abundance are not considered significant for the three avian VECs.

Planned Development Case

Cumulative effects on birds were assessed at the scale of the RSA. Habitat affected by the Project, either directly or indirectly, represents a very small proportion of that available in the RSA for all avian VECs (Table D.11.2.3). The number of nest areas should remain the same for northern goshawk and decrease by only 2% for Cape May warbler (Table D.11.2-4). Because almost 85% of the RSA was burned in 1995, there is currently very little mature forest available for obligates such as Cape May warbler and northern goshawk. Because no forest harvesting is planned for the RSA, this remaining mature forest should be undisturbed for at least the life of the Project. By Project closure in approximately 2036, forest stands, particularly deciduous-leading, will have matured sufficiently to be used by some mature forest bird species. Therefore, habitat availability may actually increase over time for Cape May warbler and northern goshawk even with Project development. While sandhill crane habitat will decrease by only 1.5% with the Project, it is abundant in the RSA.

Cumulative effects are not likely to be significant for Cape May warbler, northern goshawk or sandhill crane, nor does the Project contribute significantly to cumulative effects.

D.11.3.6 Ungulates

Application Case

Habitat Availability

Sensory disturbance is anticipated to significantly affect ungulates (Jalkotzy et al. 1997), particularly caribou (Dyer et al. 2001). Construction activities will likely lead to the highest levels of avoidance for moose, deer and caribou, but based on results of the expansion Project monitoring program, this avoidance is anticipated to be temporary.

Operations activities will have the longest-term impact on ungulates and so this is the period assessed. Availability of effective habitat during the winter, considered the most restrictive period for ungulates, is predicted to decrease by 12% for caribou and 15% for moose (Table D.11.2.2, CR #11b, Figures 3-8 & 3-10). The slightly higher habitat loss for moose reflects the routing of the footprint through younger stands rather than mature stands that provide habitat for caribou. Under predicted conditions, approximately 25% of the LSA represents effective habitat for moose and caribou.

The distribution of effective habitat in the LSA is also anticipated to change with Project development. The total area of core security habitat is predicted to decrease by 723 ha (5%) for caribou, with most of this reduction occurring in 1 – 20 ha patches and patches >100 ha (Table D.11.2.5, CR #11, Figure 3-9). This equates to a loss of 71 core habitat patches ≤20 ha and two of the 10 patches >100 ha in size. For moose, Project development will fragment core habitat into smaller patches, with an overall loss of 688 ha (4%) of core security habitat (Table D.11.2.5, CR #11, Figure 3-11). Although loss of larger habitat patches could lead to greater energy expenditures for foraging, the areal loss of core habitat is relatively small for both caribou and moose.

The Project is not anticipated to have significant effects on habitat availability for either caribou or moose. Caribou appear to be relatively resilient to changes in habitat structure (e.g., wildfire, Dalerum et al. 2007), while moose will see almost immediate benefits from progressive reclamation (i.e., effects of Project are easily reversible). Most of the habitat loss will occur indirectly through sensory disturbance, although once operations have ceased and the areas have been reclaimed, these habitats will become functional again. For caribou, residual effects associated with the Project footprint will occur for >40 years after closure because of the preference of this species for forest stands >50 years old (Dalerum et al. 2007).

Wildlife Movement

The ability of ungulates to access core habitat is believed to be just as important as the availability of such habitat. Permeability of the LSA will be reduced by the Project footprint, particularly by road and utility corridors with adjacent aboveground pipelines. Connacher intends to mitigate the barrier effect of aboveground pipelines by using ramp-style wildlife crossing structures, which have been found successful for moose (Dunne 2007) and barren-ground caribou (Cronin et al. 1994).

The Project has only 43.6 km of linear features (0.3 km/km^2) (Table D.11.2.6), which is far below the thresholds of 1.8 km/km^2 and 1.2 km/km^2 identified for caribou (Table D.11.2-7). Therefore, linear feature densities associated with the Project alone (i.e., not considering existing features) is not anticipated to be significant for moose, which are typically less sensitive than caribou. Because of the relatively small Project footprint and the use of mitigation measures to maintain overall permeability, the Project should not significantly affect ungulate movements in the LSA.

Wildlife Health and Mortality

Potential effects of the Project on ungulate health and mortality include:

- increased access could increase the risk of mortality associated with hunting and poaching, and potentially even predation;
- vehicular collisions could result in injury or mortality of ungulates; and
- consumption of contaminated vegetation.

With the mitigation program proposed the Project effects on health and mortality of ungulates are anticipated to be negligible.

Further information regarding wildlife health is provided in Section D.5 and CR #5b.

Wildlife Abundance

Changes in habitat availability, movement corridors and mortality and health have the potential to affect ungulate populations in the LSA. However, since changes in habitat availability, movement and health are not anticipated to be significant, ungulate abundance should not decline significantly with Project development. In fact, moose abundance may increase initially after Project closure in response to reclamation and increased availability of forage. Habitat losses for caribou are likely to persist for at least 50 years following project decommissioning, although the total area affected by this project is not considered large enough to cause a measureable change in the regional population

Planned Development Case

Woodland Caribou

As outlined in the recent Athabasca Caribou Management Options Report (Athabasca Landscape Team 2009), all of the monitored caribou populations in this management region are in decline. The most recent population data available for caribou in the ESAR herd indicate that approximately 250 animals remain in the herd, with a rate of population decline of 6% per year (Athabasca Landscape Team 2009). If present rates of decline are not halted, there is concern that the population could become so small that stochastic events or inbreeding could place the herd at risk of extinction (McLoughlin et al. 2003). The reasons for declining caribou populations in the region are complex and are still not completely understood. Although predation is thought to be the primary cause of recent population declines, habitat changes that have resulted from land use development (timber harvesting, petroleum, agriculture, residential and infrastructure) are believed to have contributed to this problem (Athabasca Landscape Team 2009). It is apparent that the loss of mature forest and increased fragmentation resulting from these various forms of development has increased populations of deer and moose within and around caribou ranges, thereby increasing predator populations and predation pressure on caribou.

Although future levels of development within the ESAR caribou range are difficult to predict, new or expansion SAGD projects have been proposed within this area. Most of the SAGD development is expected to take place in the so-called “Bitumen Fairway”, which the Caribou Management Options Report identifies as a high risk zone for caribou. Expansion of other types of resource development is also expected in the future. Most of the ESAR caribou range falls within Alberta-Pacific Forest Industries Inc. Forest Management Agreement Area. Harvest blocks are scattered throughout the ESAR range and future timber harvesting will cause further changes to the boreal forest which could be detrimental to caribou. At the same time, agricultural expansion continues to affect caribou habitat along the southern portion of the herd’s range, and activities such as peat harvesting and aggregate removal are expected to contribute to future loss of habitat in the region.

Cumulative effects on caribou are most appropriately assessed at the scale of the caribou range, rather than the RSA. Such an analysis was conducted by Sorensen et al. (2008) where all disturbance features (dated 1998-2000) within caribou ranges were mapped, including the ESAR range. All of the disturbance features were buffered by 250 m to account for avoidance and loss of functional (effective) habitat. These disturbance features were also assumed to act as barriers to movement, with increased mortality rates associated with poaching, vehicular collisions and predation. Results indicated that 54.1% of the ESAR caribou range was within 250 m of disturbance. The Project’s contribution to areas within 250 m of disturbances represents just 0.2% of the ESAR caribou range, and is therefore negligible by itself. Sorensen et al. (2008) also considered natural disturbances in their calculation of cumulative effects on caribou, and estimated that 20% of the ESAR range had been burned in the past 50 years, with a large proportion of that (70%) occurring during the 1995 Mariana Lake fire. Effects of the 1995 Mariana Lake fire on caribou habitat will lessen over time as the regenerating forest matures, however, future fires within the ESAR range could further reduce habitat effectiveness for caribou, particularly if they are widespread and occur before the previously burned forest recovers.

In addition to habitat loss, habitat connectivity is being affected by development in the region. There is a relatively high potential for major roads, such as Highway 63, to affect caribou movements. High traffic roads act as barriers to caribou movement (Dyer et al. 2002), and a potential source of mortality for those animals that attempt to cross. Twinning of Highway 63 will likely increase the barrier effect of the existing two lane highway, which is likely already significant. Because of the need for aboveground pipeline networks to transport steam and bitumen between processing plants and well pads, SAGD type oil sands developments also have potential to disrupt movements of caribou and other ungulates. Recent research on the effectiveness of well-designed, wildlife overpasses appears encouraging, although it is too soon to know how these projects will affect caribou movements and habitat use over the longer term.

As the number of developments increase on the Athabasca landscape, traffic will also increase, increasing the risk for caribou-vehicle collisions. Under existing conditions, caribou were rarely involved in vehicular collisions between 2001 and 2005 (0.1% of all collisions, Alberta Infrastructure and Transportation Driver Safety and Research 2007). These data suggest that few caribou attempt to cross the highway, which may indicate the barrier effect of the highway. All of these disturbance factors were used by Sorensen et al. (2008) to calculate a 2%/year rate of decline for the ESAR caribou population, although as noted above, the Athabasca Landscape Team (2009) has suggested that this herd might be declining at a rate of 6%/year. The Athabasca Landscape Team has suggested that a range of measures are required to protect the herd, including wolf control, reclamation of linear disturbance, land use planning/zoning, control of alternate prey and best practices.

Although the Great Divide Expansion Project will also affect a portion of the ESAR caribou herd, the Project's contribution is expected to be relatively small. Direct and indirect habitat losses are estimated to comprise just 0.2% of the herd's range. Because of its fire history and proximity to Highway 63, the Great Divide project area is not considered core habitat for caribou, although limited numbers of caribou have been documented in the LSA, particularly during the snow-free period. Connacher believes that the mitigation measures being proposed reflect a substantial improvement over earlier industrial practices, which should lessen the long-term effects of the project on caribou. In addition, Connacher has made a commitment to begin reclaiming existing linear disturbances in an effort to reverse some of the negative consequences of habitat fragmentation. Connacher is committed to monitoring the effects of its operations on caribou and other wildlife and to working with provincial resource managers in implementing new mitigation techniques as they become available. For these reasons, it is predicted that the proposed Project will not make a significant contribution to regional cumulative effects on the ESAR herd.

Moose

Cumulative effects were assessed at the scale of the RSA for moose. The Project will likely have minimal effects on habitat availability within the RSA, with a loss of <4% of effective winter habitat (Table D.11.2.2). Similarly, change in the characteristics of core habitat patches was relatively small compared to what is available in the entire RSA (Table D.11.2.8). The density of linear features in the RSA (Table D.11.2.6) will not likely affect moose, primarily because most of the linear features are winter access routes that do not pose major barriers to movement.

Although hunting pressure is believed to be relatively low in the RSA at present, it is uncertain whether hunting will become a more significant factor in the future. Non-subsistence moose harvests are regulated through the provincial licensing system by Alberta Sustainable Resource Development (ASRD). Therefore cumulative effects on health and mortality of moose are not considered significant, nor are effects on moose abundance. Overall, the cumulative effects of disturbance, including the Project, are not anticipated to be significant for moose.

D.11.3.7 Beaver

Application Case

Habitat Availability

Potential habitat for beaver is limited to riparian areas within 200 m of watercourses and waterbodies, and is therefore relatively uncommon in the LSA under existing conditions. The Project is anticipated to result in a maximum direct loss of 33 ha (2%) of effective habitat (Table D.11.2.2, CR #11b, Figure 3-12). Most of the foraging occurs close to watercourses therefore habitat loss will be mitigated by leaving at least a 30 m buffer around permanent watercourses. Beaver typically have low sensitivity to disturbance, and therefore, indirect habitat loss is likely negligible. Overall, Project effects on habitat availability for beaver are anticipated to be of low magnitude and insignificant following mitigation.

Movement

Although beaver typically remain close to their lodge for most of year, kits disperse in spring and travel along streams or through upland areas. The Project will affect two moderately-sized watercourses over which bridges will be constructed. These bridges will be constructed so as to accommodate movement of wildlife, including beaver. The Project is not anticipated to significantly affect beaver movement in the LSA.

Wildlife Health and Mortality

The Project has the potential to affect health and mortality of beaver through vehicular collisions along road and utility corridors. Contamination of air or water from emissions or accidental spills has the potential to affect beaver health. However, because emissions are predicted to be too low to contaminate water or vegetation, and spills will be controlled by restricting refueling activities to designated areas away from watercourses, effects on health and mortality of beaver are unlikely to be significant.

Wildlife Abundance

The Project is not likely to have significant effects on beaver habitat availability, movement or health and mortality, and therefore abundance of beaver should not be significantly affected.

Planned Development Case

At the RSA scale, only a very small proportion (0.7%) of effective beaver habitat will be affected by the Project (Table D.11.2.2). This amount will be further reduced with the application of riparian buffers. Because beavers are limited to riparian areas and prefer deciduous vegetation, effective habitat represents only 8% of the RSA under cumulative conditions. Beaver are considered relatively tolerant of human disturbance; therefore, additional habitat loss through sensory disturbance is unlikely.

Overall, cumulative effects on beaver are considered to be negligible.

D.11.3.8 Predators

Application Case

Habitat Availability

Availability of effective habitat is anticipated to decrease following Project development by 28 ha (2%) for fisher, and 1,052 ha (9%) for lynx (Table D.11.2.2). Fisher habitat is relatively rare in the LSA, and located primarily in the northern portion of the lease and in remnant stands of unburned forest around

Highway 63. Habitat fragmentation is not a concern for fisher because this species uses patches of almost any size within their home range (Olsen et al. 1999).

Lynx habitat is common and widespread throughout the LSA, so despite a relatively high degree of interaction with the Project, 73% of the LSA should still provide effective foraging habitat during operations (Table D.11.2.2). Distribution of lynx may be temporarily affected by aspects of the Project, but these effects are anticipated to be short-term and will likely have no long-term effects on lynx recruitment or reproduction.

Wildlife Movement

Fishers occupy relatively large home ranges and therefore, the ability to move about the landscape is important. Although fisher prefer mature forests, they move through shrub patches, marsh and grasslands (Proulx et al. 1994), suggesting that reclaimed habitats will not act as barriers to fisher movements. The Project is not predicted to have a significant effect on fisher movement.

Lynx also have large home ranges and typically travel 5 to 15 km/night along traditional routes. As with fisher, road and utility corridors are not likely to impede lynx movement. Lynx movement in the LSA is unlikely to be affected significantly by the Project.

Wildlife Health and Mortality

As with the other wildlife VECs, the health and mortality of predators could be affected by the Project in several ways including:

- exposure to pollutants;
- increased hunting and trapping
- vehicular collisions, and
- vegetation clearing.

Since vegetation clearing is scheduled for the winter and will follow the “early-in, early-out” principle, denning animals such as fisher and lynx are unlikely to be disturbed. Connacher will undertake a number of mitigation measures to reduce the potential impacts to the health and mortality of wildlife, therefore the Project is not anticipated to have significant effects on health and mortality of lynx or fisher.

Wildlife Abundance

Because the Project is not anticipated to have significant effects on habitat availability, movement or health and mortality of lynx or fisher, abundance of these two wildlife VECs is also unlikely to be affected.

Planned Development Case

A very low proportion of predator habitat will be affected by the Project at the scale of the RSA, with losses of just 1% and 2% of the effective habitat for lynx and fisher, respectively (Table D.11.2.2). Although fisher habitat may be limiting because of the paucity of mature forest, 85% of the RSA contains effective habitat for lynx at the cumulative case.

With the exception of Highway 63, linear features in the RSA will have a relatively low impact on lynx and fisher. The highway presents a potentially high mortality risk for mammals, but traffic records do not indicate vehicular collisions with lynx or fisher. Traffic levels are typically lighter at night when lynx and fisher are most active, thereby reducing the chance of collisions.

Trapping is another potential source of mortality for lynx and fisher in the RSA, but is unlikely to increase with the Project. Predators are unlikely to be affected by changes to air or water quality because cumulative emissions from developments in the RSA are predicted to be too low to contaminate air or water.

Given the predominance of regenerating forest, lynx are likely abundant (and currently at or near the peak of a population cycle) and fisher are relatively rare. The Project is unlikely to have any significant effects on abundance of these predators.

Overall, cumulative effects on fisher and lynx are anticipated to be insignificant.

D.11.4 Mitigation and Monitoring

D.11.4.1 Mitigation

Connacher will undertake the following mitigation measures in order to reduce the potential impacts to wildlife:

- vegetation clearing will follow the "early-in, early-out" principle;
- clearing will be timed, where practicable, to avoid disruption of nesting birds and the sensitive calving period for caribou;
- the footprint will avoid mature and old forest, as much as possible, to minimize impacts on species dependent on this habitat, including woodland caribou and old-growth forest birds;
- development in riparian areas and waterbodies will be avoided, where possible, to preserve habitat for amphibians, waterbirds and many other species, as well as to reduce the chance of contaminating waterbodies;
- treed buffers will be retained around watercourses and waterbodies;
- development of an Access and Recreation Management Plan within the LSA;
- participation in the Alberta Biodiversity Monitoring Initiative (ABMI) to assist with monitoring regional cumulative effects on biological resources;
- development of a Waste Management Plan to minimize the attraction of bears and other predators to the area;
- adherence to the Best Management Practices for Camps, Fences and Barriers as described in the BearSmart: Best Management Practices for Camps;
- development of an Emergency Spill Response Plan;
- restriction of fuel storage and use to designated areas at least 100 m from waterbodies and watercourses;
- installation of wildlife crossing structures to facilitate wildlife movement through the LSA;
- marking of wildlife crossings to prevent wildlife-vehicular collisions, and winter plowing or grading will be conducted in a manner that does not result in creation of snow berms at wildlife crossings;
- monitoring of the wildlife crossing structures using remote cameras and snow tracking for up to 10 years following construction, and undertaking further mitigation measures if monitoring results indicate they are required; and
- becoming a member of the Alberta Caribou Committee, and will provide the ACC with any pertinent data collected during the monitoring program.

D.11.4.2 Monitoring

Monitoring for the Project will include:

- a continuation of the existing on-going pre-disturbance long-term wildlife monitoring program for the Project (which is described in detail in CR #11, Section 4.2.1) including:
  - at least 33 cameras with ten of these shared with the Algar Monitoring Program.
  - monitoring for the first five years of each Phase of the Project, including the construction period associated with each Phase.
  - Installation of all wildlife cameras at wildlife crossings associated with active Phases.
  - Conduct winter snow tracking surveys and use remote cameras to determine the response of wildlife to the above-ground pipeline and crossing structures.

D.11.5 Summary of VECs

Table D.11.5.1 provides a summary of the net impacts of the Great Divide SAGD Expansion Project on wildlife habitat availability, wildlife movement, wildlife health and mortality, wildlife abundance for the VECs after mitigative measures have been implemented. For the Project Case and Cumulative Effects Case, with mitigation, there was no significant effects.

Table D.11.5.1 Summary of Impact Significance on Wildlife VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
1 Northern goshawk												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Residual	Continuous	Long-term	Low	Negative	High	High	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Residual	Continuous	Long-term	Low	Negative	High	Moderate	Insignificant
2 Cape May warbler												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Residual	Continuous	Long-term	Low	Negative	High	High	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Long-term	Low	Negative	High	Low	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Residual	Continuous	Long-term	Low	Negative	High	Moderate	Insignificant
3 Sandhill crane												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Extended	Continuous	Short-term	Low	Negative	High	High	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Long	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
4 Woodland caribou												
	Habitat	refer to	Application	Local	Residual	Continuous	Long-term	Moderate	Negative	High	High	Insignificant

Table D.11.5.1 Summary of Impact Significance on Wildlife VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
	Availability	Section D.11.4 and CR #11, Section 4.0										
	Wildlife Movement		Application	Local	Long	Continuous	Long-term	Low	Negative	Moderate	Moderate	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	Moderate	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	Moderate	Moderate	Insignificant
	Cumulative Effects		Cumulative	Regional	Residual	Continuous	Long-term	High	Negative	High	Moderate	Insignificant
5 Moose												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Extended	Continuous	Short-term	Low	Negative	High	High	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Residual	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
6 Beaver												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Extended	Continuous	Long-term	Low	Negative	High	Moderate	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Long	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
7 Canada lynx												
	Habitat Availability	refer to Section D.11.4 and	Application	Local	Extended	Continuous	Short-term	Low	Negative	High	High	Insignificant
	Wildlife		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant

Table D.11.5.1 Summary of Impact Significance on Wildlife VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Effect	Geographic Extent[1]	Duration[2]	Frequency[3]	Reversibility[4]	Magnitude[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Occurrence[8]	Significance[9]
	Movement	CR #11, Section 4.0										
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Long	Continuous	Short-term	Low	Negative	High	Moderate	Insignificant
8 Fisher												
	Habitat Availability	refer to Section D.11.4 and CR #11, Section 4.0	Application	Local	Residual	Continuous	Long-term	Low	Negative	High	High	Insignificant
	Wildlife Movement		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Health and Mortality		Application	Regional	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Wildlife Abundance		Application	Local	Long	Continuous	Short-term	Low	Negative	High	Low	Insignificant
	Cumulative Effects		Cumulative	Regional	Residual	Continuous	Long-term	Low	Negative	High	Moderate	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible – rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

D.12 Greenhouse Gas and Climate Change

D.12.1 Introduction and Terms of Reference

A greenhouse gas (GHG) is any gas that contributes to potential climate change. Common GHGs include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHGs absorb heat radiated by the earth and subsequently warm the atmosphere, leading to what is commonly known as the greenhouse effect. This section has been prepared to discuss the GHGs and climate change potential for the Project.

Alberta Environment issued the Terms of Reference for the project on July 17, 2009. The requirements for the greenhouse gas and climate cahnge components are provided in Section 2.7 and 3.2 and are as follows:

2.7 Air Emissions Management

[A] Provide emission profiles (type, rate and source) for the Project's operating and construction emissions including point and non-point sources and fugitive emissions. Consider both normal and upset conditions. Discuss:

a) annual and total greenhouse gas emissions during all stages of the Project. Identify the primary sources and provide examples of calculations;
b) the intensity of greenhouse gas emissions per unit of bitumen produced and discuss how it compares with similar projects;
c) the Project's contribution to total provincial and national greenhouse gas emissions on an annual basis;
d) Connacher's overall greenhouse gas management plans;
e) amount and nature of Criteria Air Contaminants emissions;

3.2 Air Quality, Climate and Noise

[B] Identify stages or elements of the Project that are sensitive to changes or variability in climate parameters, including frequency and severity of extreme weather events. Discuss what impacts the change to climate parameters may have on elements of the Project that are sensitive to climate parameters.

D.12.2 Greenhouse Gas

D.12.2.1 Project GHG Emissions

Table D.12.2.1 summarizes the annual greenhouse gas (GHG) emissions for the Project. The emission estimates of CO2, CH4, and N2O are based on emission factors and the estimated fuel consumption rates. The GHG emission estimates conservatively assume all fired equipment is operating continuously. At full operation, the entire Connacher operation will be generating 1.27 MT/yr of CO2e, with the Project contributing 0.72 Mt/yr.

Table D.12.2.1 Summary of Annual Greenhouse Gas Emissions

Emissions	Direct Emission Rates[1] [t/year]				Indirect Emission Rates[2] [t/year]	Overall Total [t/year]
	CO_2	CH_4	N_2O	CO_{2e}[3]	CO_2e[3]	CO_2e[3]
Approved Algar Facility	331,815	0.66	14.9	336,458	0	336,458
Existing Pod One Facility	216,853	0.40	9.6	219,833	0	219,833

Table D.12.2.1 Summary of Annual Greenhouse Gas Emissions

Emissions	Direct Emission Rates[1] [t/year]				Indirect Emission Rates[2] [t/year]	Overall Total [t/year]
	CO_2	CH_4	N_2O	CO_{2e}[3]	CO_2e[3]	CO_2e[3]
Total Existing and Approved	548,669	1.1	24.5	556,291	0	556,291
Expanded Algar Facility	1,038,006	1.96	46.1	1,052,345	0	1,052,345
Expansion Only	**706,191**	**1**	**31**	**715,887**	**0**	**715,887**
Total with Expansion	1,254,859	2.4	55.7	1,272,178	0	1,272,178

[1] – Annual direct GHG emission rates are based on 98% plant availability
[2] – Emissions from purchased electricity
[3] – CO_{2e} = carbon dioxide equivalent

Table D.12.2.2 summarizes the total greenhouse gas emissions for the Project, based on an estimated project life of 25 years, with the Project alone contributing an estimated lifetime 17.9 Mt.

Table D.12.2.2 Summary of Total Greenhouse Gas Emissions

Emissions	Total GHG Emissions[1] [kt]			Overall Total [kt]
	CO_2	CH_4	N_2O	CO_2e[2]
Approved Algar Facility	8,295	0.02	0.37	8,411
Existing Pod One Facility	5,421	0.01	0.24	5,496
Total Existing and Approved	13,717	0.03	0.61	13,907
Expanded Algar Facility	25,950	0.05	1.15	26,309
Expansion Only	**17,655**	**0**	**1**	**17,898**
Total with Expansion	31,371	0.06	1.39	31,804

[1] – Based on a average plant availability of 98% during life of Project
[2] – CO_{2e} = carbon dioxide equivalent

GHG emissions, as a result of construction activities, were also considered but were assumed to be negligible when compared to emissions during the operational phase of the Project. Since Connacher is proposing to expand an already existing development and because the expanded portion will use the existing infrastructure and access roads, the GHG emissions with the construction activities for the Project were assumed to be negligible for assessment purposes.

Table D.12.2.3 shows the contribution of the expansion to the total provincial and national GHG emissions on an annual basis.

Table D.12.2.3 Contribution of Connacher Expansion to Provincial and National GHG Emission Inventory

GHG Emissions	GHG Emissions [Mt CO_{2e}/year]	% of Alberta Total	% of Canada Total
Connacher Expansion	0.72	0.29%	0.10%
Alberta Total	246[1]		33%
Canada Total	747[1]		

[1] – Taken from Environment Canada (2009) National Inventory Report of 2007 GHG Emissions

D.12.2.2 Greenhouse Gas Management Strategy

Connacher's business success is contingent on responsible resource development which requires dedicated stewardship of air issues and air emissions. Connacher is committed to responsible environmental management and continues to do their part to minimize potential impact. Connacher will continue to develop effective management and operational approaches to comply with regulations designed to reduce GHG emissions. Connacher's greenhouse gas emission goals are:

- to continually improve efficiencies in energy use, thus reducing the GHG footprint; and
- to deliver on a long term plan that meets industry standards.

Connacher believes that execution of their GHG management programs can be achieved with proactive preparation, planning and continued cooperation with industry regulators and in the communities where they operate.

Connacher's long-term GHG management options fall into four broad categories. These are:

- continuous improvement in technologies (particularly combustion technologies) during the operational phase;
- carbon injection and storage;
- trading of GHG offsets; and
- contribution to the Climate Change and Emissions Management Fund.

Continuous Improvement

Connacher is continually considering opportunities for GHG reductions. Their approach to managing GHG emissions includes:

- continuous improvement to address direct emissions from their facilities
- monitor and measure performance, identify design gaps, and identify improvement opportunities;
- review corporate and project goals for GHG reductions; and
- continue to improve corporate and operational knowledge of technologies that lead to emission reduction and policy development.

Design measures to reduce GHG emissions in the Project include:

- optimizing and continuously improving energy efficiency in the design and operation of processes and facilities;

- using natural gas to produce steam, which is the most economical fossil fuel energy source with the lowest GHG emissions;
- using a vapor recovery unit (VRU) to reduce the loss of hydrocarbon vapours;
- continuing to improve the efficiency of the thermal recovery process in the reservoir, thereby reducing the SOR and fuel consumption;
- replacing the fleet of vehicles transporting bitumen and diluent with a pipeline system;
- incorporating cogeneration of steam and electricity at the central plant; and
- minimizing fugitive emissions.

Other measures may include optimizing piping systems to reduce pumping energy requirements, optimizing motor sizes and insulating piping to conserve energy.

Carbon Injection and Storage

Existing carbon capture technologies are not viable for projects the size of Great Divide SAGD Expansion Project with low pressure and low concentration CO_2 emissions. However, Connacher will continue to monitor ongoing developments in carbon capture technology and evaluate options as they develop.

Offsets

The *Alberta Climate Change and Emissions Management Act* establishes offset trading as one of a range of mechanisms for achieving compliance with GHG emission reduction obligations. Connacher will evaluate offset trading opportunities.

Contribute to the Climate Change and Emissions Management Fund

The Province has established a Climate Change Fund contribution price of $15 per tonne CO2e. Connacher will evaluate offset purchases and, where appropriate, may use offsets to achieve compliance with their GHG emission reduction targets.

D.12.3 Climate Change

This section defines the existing climate setting in and around the Project area and identifies impacts on all stages of the Project from projected changes in climate factors. Climate change may affect construction, operation, decommissioning and reclamation stages of the development.

Assessment of climate change impacts is facilitated by the accuracy of climate change predictions. The effect of global warming on climate variables in Alberta have been assessed by the Prairie Adaptation Research Collaborative (PARC) using IPCC growth scenarios and various international global climate models (GCMs)

Barrow and Yu (2005) assembled a series of climate projections from the GCM experiments for PARC in cooperation with AENV. Predictions include projections for climate change between the baseline period (1961-1990) and the 2020s, the 2050s and the 2080s using median GCM/emissions scenarios. Barrow and Yu selected five scenarios for the Alberta model that represented futures: cooler and wetter, cooler and drier, warmer and wetter, warmer and drier, and the median.

The climate change assessment for the Project included the following elements:

- determine projections for climate parameters during the Project lifetime;
- identify potential effects of climate change on Project stages; and

- identify implications that climate change may have on the Project.

The existing and projected changes to the selected climate parameters are provided for the region near Project. The selected parameters are: mean annual temperature, annual precipitation, degree days, and moisture index.

Predicted changes in the 2050s, near the expected end of the Project lifetime, for these parameters are listed in Table D.12.3.1.

Table D.12.3.1 Projected Climate Parameters near Fort McMurray based on the median change scenario (Barrow and Yu 2005)

Parameter	Baseline Value (1961-1990)	Median Prediction, 2050s	Change (%)
Mean Annual Temperature (°C)	0.1	2.4	0.8
Annual precipitation (mm)	473	525	11
Degree Days > 5°C	1311	1781	36
Annual Moisture Index	2.7	3.3	22

Mean annual temperatures are projected to increase over the life of the Project by about 2.4°C (Barrow and Yu 2005). January (coldest month) mean temperatures are projected to increase by 1.9°C (GCM experiments) although the observed rate of warming appears to have been greater than that predicted by model projects considered by Barrow and Yu. Projected precipitation increases are approximately 11%.

D.12.3.1 Construction and Decommissioning

Changes in air temperature and precipitation may have an impact on construction techniques and timing during the initial development and the decommissioning stages. Warmer temperatures may shorten the length of time the ground is frozen which may impact clearing. Increases in precipitation may worsen access or aggravate construction. These projected temperature increases over the Project life will have negligible impact during the initial construction stage, but could affect construction techniques and timing during later stages of development. However, impacts are considered negligible and can be mitigated by using appropriate construction methods.

Precipitation changes could increase surface runoff. The design of storage ponds, culverts and bridge openings needs to consider the increased flow, which is within normal inter-annual variation.

D.12.3.2 Operations

Changes in temperature within the ranges identified above will have no impact on operations. An increase in average annual precipitation (runoff) of 11% could increase sediment loading in watercourses that may require somewhat more frequent monitoring and cleanout at crossings.

D.12.3.3 Reclamation

The projected increase in degree-days greater than 5°C of about 36% would result in a potentially warmer and longer growing season. The projected increase in precipitation index may increase soil moisture stress. The combined effect is considered to be a negligible risk to the Project as the selection of reclamation plant species would be adapted to the climate conditions at the time of reclamation.

D.13 LAND AND RESOURCE USE

D.13.1 Introduction

This section identifies baseline conditions including current land uses, crown land and crown reservations, and unique sites and special features within the Project area. Potential impacts of the Project on identified land uses are discussed. Where required, potential mitigation techniques and strategies are proposed.

The local study area (LSA) for the landuse assessment includes the Connacher lease area and is shown on Figure D.13.2-1.

D.13.2 Baseline Conditions

The Project is located outside the boundaries of the existing sub-regional integrated resource plans (IRP); therefore, no specific IRP has been referenced. However, Connacher has considered the development philosophies described for adjacent IRPs (i.e. The Fort McMurray-Athabasca Oil Sands Sub-regional Integrated Resource Plan and the Cold Lake Sub-regional Integrated Resource Plan).

D.13.2.1 Oil Sands Leases

There are 11 Oil Sands Leases (OSLs) within the LSA which are all held by Connacher (Table D.13.2.1). The existing Algar Project falls within the OSL No. 7404010459 and the existing Great Divide (Pod One) Project falls within OSL No. 7404010460. The existing OSL within the LSA are shown on Figure D.13.2-1.

Table D.13.2.1 Oil Sands Leases

Disposition	Disposition Holder	Location
074 7404010456	Connacher	27 to 34-081-11W4 03 to 06-082-11W4
074 7404010459	Connacher	07, 08, 17 to 20, 29 to 32-082-11W4 11 to 14, 23 to 26, 35, 36-082-12W4
074 7404010460	Connacher	08 to 10,15 to 17, 20 to 22, 27 to 29, 32 to 34-082-12W4 02 to 04-083-12W4
074 7405070553	Connacher	09-083-12W4
074 7405070554	Connacher	10-083-12W4
074 7405070555	Connacher	14-083-12W4
074 7405070556	Connacher	15-083-12W4
074 7406010664	Connacher	23-083-12W4
075 7406010665	Connacher	26-083-12W4
074 7406010666	Connacher	35-083-12W4
074 7407010531	Connacher	11-083-12W4

D.13.2.2 Petroleum and Natural Gas Licenses and Leases

Iteration Energy Inc. (Iteration) & Chair Resources Inc. (Chair Resources) jointly hold five Petroleum and Natural Gas (PNG) Licences within the LSA. Rife Resources Ltd. (Rife Resources), Husky Oil Operations Limited (Husky), and Canadian Natural Resources Limited (CNRL) each hold one PNG licence within the LSA (Table D.13.2.2, Figure D.13.2-1).

These licences are managed by Alberta Department of Energy, Mineral Development and Strategic Resources, and do not expire.

Table D.13.2.2 Petroleum And Natural Gas Licenses

Disposition	Disposition Holder	Location
054 5496080043	Iteration Energy Ltd. & Chair Resources Inc.	31 to 33-082-12W4 03 to 05-083-12W4
054 5497030066	Iteration Energy Ltd. & Chair Resources Inc.	34 to 36-082-12W4 02,11-083-12W4
054 5496020050	Rife Resources Ltd.	21, 22, 26 to 28-082-12W4
054 5496060067	Husky Oil Operations Limited	08,18-082-12W4 13, 22, 23-082-13W4
054 5496060068	Canadian Natural Resources Limited	19, 20, 29, 30-082-12W4 28-082-13W4
054 5497060049	Iteration Energy Ltd. & Chair Resources Inc.	18 to 20, 29, 30-082-11W4 25-082-12W4
054 5497030065	Iteration Energy Ltd. & Chair Resources Inc.	31 to 33-082-11W4 03, 04-083-11W4
054 5497060172	Iteration Energy Ltd. & Chair Resources Inc.	16, 21, 22, 27, 28-081-11W4

Iteration and Chair Resources jointly hold seven Petroleum and Natural Gas (PNG) Leases within the LSA, CNRL has two leases and Connacher has three leases within the LSA (Table D.13.2.3). Lease 587070183 located in Section 16 straddles Highway 63 and contains most of the existing infrastructure for the Great Divide SAGD Project (plant site, access road, other facilities). The PNG leases are shown on Figure D.13.2-1.

Table D.13.2.3 Petroleum and Natural Gas Leases

Disposition	Disposition Holder	Location
005 0587070183	Connacher	16,17-082-12W4
005 0587090229	Connacher	04, 09-082-12W4
005 0597080512	Canadian Natural Resources Limited	31-081-11W4 34 to 36-081-12W4 01 to 03,10 to 15, 23, 24-082-12W4
005 0594070209	Connacher	07-082-11W4
005 0594070213	Iteration Energy Ltd. & Chair Resources Inc.	17-082-11W4
005 0594110285	Iteration Energy Ltd. & Chair Resources Inc.	03-082-11W4
005 0594110286	Iteration Energy Ltd. & Chair Resources Inc.	04-082-11W4
005 0595100513	Iteration Energy Ltd. & Chair Resources Inc.	05-082-11W4
005 0595110173	Iteration Energy Ltd. & Chair Resources Inc.	06-082-11W4
005 0596060271	Iteration Energy Ltd. & Chair Resources Inc.	32 to 34-081-11W4 08-082-11 W4
005 0595100512	Iteration Energy Ltd. & Chair Resources Inc.	29-081-11W4
005 0597080511	Canadian Natural Resources Limited	30-081-11W4

D.13.2.3 Forestry

The entire LSA is located within Forestry Management Area (FMA) 9100029 (Table D.13.2.4, Figure D.13.2-2). The FMA, in total, is 5,545,804.1 ha (13,703,981.39 acres) in size and is held by Alberta-Pacific Forest Industries Incorporated (Al-Pac).

Table D.13.2.4 Timber Allocations

Disposition	Disposition Holder	Location
FMA 9100029	Alberta Pacific Forest Industries Inc.	081-11W4 082-11W4 082-12W4 083-12W4

D.13.2.4 Mineral Surface Lease and Miscellaneous Leases

Within the LSA, there are ninety Mineral Surface Leases (MSL) held by Connacher, Iteration, Nexen Inc. (Nexen), AltaGas Ltd. (AltaGas), CNRL, Compton Petroleum Corporation (Compton), Devon Canada Corporation (Devon) and Husky (Table D.13.2.5). The Algar SAGD plant site is MSL 082357 and the Great Divide SAGD plant site is MSL 060765. There are also seventeen Miscellaneous Leases (MLL) of which thirteen are held by Connacher (Table D.13.2.5). Tele-Mobile Company (Tele-Mobile), Nexen, Atco Electric Ltd (Atco), and Rogers Communication Inc (Rogers)/Fido Solutions Inc (Fido) hold the remaining four MLLs. These dispositions are shown on Figure D.13.2-3a, 3b & 3c.

Table D.13.2.5 Mineral Surface Leases and Miscellaneous Leases

Disposition	Disposition Holder	Location
MLL 000044	Tele-Mobile Company	SW;16-082-12W4
MLL 060146	Connacher	SW;21-082-12W4
MLL 060148	Connacher	NW;16-082-12W4 NE;17-082-12W4
MLL 060152	Connacher	SW;16-082-12W4
MLL 070021	Connacher	NE;17-082-12W4 SE;20-082-12W4
MLL 080068	Connacher	NW;14-082-12W4
MLL 080069	Connacher	NW;15-082-12W4 NE;16-082-12W4
MLL 080114	Nexen Inc.	NW,NE;31-082-11W4
MLL 080167	Connacher	NW;18-082-11W4
MLL 080168	Connacher	NE;13-082-12W4
MLL 080174	Connacher	NW;13-082-12W4
MLL 080180	Connacher	SE,NE;22-082-12W4
MLL 080188	Connacher	SE,NE;17-082-12W4
MLL 080203	Connacher	NW,NE;13-082-12W4 SE,SW;24-082-12W4
MLL 080204	Connacher	NW;13-082-12W4 SW;24-082-12W4
MLL 950066	Atco Electric Ltd	SW;08-082-12W4
MLL 990030	Rogers Communication Inc. Fido Solutions Inc.	SW;08-082-12W4
MSL 003864	Iteration Energy Ltd.	SW,NW-31-082-11W4

Table D.13.2.5 Mineral Surface Leases and Miscellaneous Leases

Disposition	Disposition Holder	Location
MSL 003865	Iteration Energy Ltd.	NE-30-082-11W4
MSL 004151	Iteration Energy Ltd.	NW-29-082-11W4
MSL 004618	Connacher	SW-21-082-12W4
MSL 004780	Iteration Energy Ltd.	NE-02-083-12W4
MSL 004781	Iteration Energy Ltd.	SE-11-083-12W4
MSL 005043	Iteration Energy Ltd.	SW-27-082-12W4
MSL 014645	Iteration Energy Ltd.	NE-32-081-11W4
MSL 014646	Iteration Energy Ltd.	NE-28-081-11W4
MSL 014983	Iteration Energy Ltd.	NE-05-082-11W4
MSL 015171	Iteration Energy Ltd.	NE-27-081-11W4
MSL 015278	Iteration Energy Ltd.	SW-40-082-11W4
MSL 015291	Iteration Energy Ltd.	NE-30-082-11W4
MSL 020337	Iteration Energy Ltd.	NW-32-082-12W4
MSL 020455	Iteration Energy Ltd.	NE-33-081-11W4
MSL 024217	Canadian Natural Resources Limited	SE-20-082-12W4
MSL 030002	Iteration Energy Ltd.	NW-34-081-11W4
MSL 040872	Connacher	NE-17-082-12W4
MSL 045658	Connacher	SE-16-082-12W4
MSL 045659	Connacher	NE-17-082-12W4
MSL 045660	Connacher	NE-17-082-12W4
MSL 045661	Connacher	SE-20-082-12W4
MSL 045662	Connacher	SE-20-082-12W4
MSL 045789	Connacher	NW-09-082-12W4
MSL 045790	Connacher	SW-16-082-12W4
MSL 045882	Connacher	SE-17-082-12W4
MSL 045883	Connacher	NE-16-082-12W4
MSL 045884	Connacher	SE-21-082-12W4
MSL 045886	Connacher	NE-21-082-12W4
MSL 045887	Connacher	NE-21-082-12W4
MSL 060080	Connacher	SE-16-082-12W4
MSL 060348	Nexen Inc.	SW-16-082-12W4
MSL 060659	Connacher	SE-17-082-12W4
MSL 060660	Connacher	NE-28-082-12W4
MSL 060765	Connacher	NW-16-082-12W4 SW-21-082-12W4
MSL 063977	Connacher	NW-16-082-12W4 SW-21-082-12W4
MSL 064009	Connacher	SE,SW-21-082-12W4
MSL 064241	Connacher	SW-21-082-12W4
MSL 065654	Connacher	SE,NE-09-082-12W4
MSL 070517	Connacher	NE-30-082-11W4
MSL 070786	Connacher	SW;21,22-082-12W4
MSL 070866	Connacher	SW-22-082-12W4
MSL 071606	Connacher	NE-19-082-11W4
MSL 071607	Connacher	NW-20-082-11W4

Table D.13.2.5 Mineral Surface Leases and Miscellaneous Leases

Disposition	Disposition Holder	Location
MSL 071608	Connacher	NW-32-082-11W4
MSL 071610	Iteration Energy Ltd.	SE-06-082-11W4
MSL 071612	Connacher	SE-31-082-11W4
MSL 072788	Connacher	SE-16-082-12W4
MSL 072790	Connacher	NE-34-082-12W4
MSL 080406	Connacher	NE-30-082-11W4
MSL 080407	Connacher	SE-24-082-12W4
MSL 080408	Connacher	SW-19-082-11W4
MSL 080593	Connacher	SW-08-082-12W4
MSL 080787	Connacher	NE-13-082-12W4
MSL 080796	Connacher	NE-13-082-12W4
MSL 081267	Connacher	NE-13-082-12W4
MSL 082357	Connacher	NW,NE-18-082-11W4 SE,SW-19-082-11W4
MSL 082487	Connacher	SE,NE-22-082-12W4
MSL 083111	Connacher	NE-02-083-12W4
MSL 083191	Connacher	NW-18-082-11W4 SW-19-082-11W4 NE-13-082-12W4
MSL 083220	Connacher	NW-18-082-11W4 SW,NW-19-082-11W4 NE-13-082-12W4 SE-24-082-12W4
MSL 083237	Connacher	NE-13-082-12W4 SE-24-082-12W4
MSL 090349	Connacher	SE-19-082-11W4
MSL 090453	Connacher	SW-19-082-11W4
MSL 090703	Connacher	SE,NW,NE-18-082-11W4
MSL 091401	Connacher	SE,SW-33-082-12W4
MSL 870912	Connacher	SW,NW-16-082-12W4
MSL 871332	Connacher	SW-08-082-12W4
MSL 871918	Connacher	SE-09-082-12W4
MSL 872042	Iteration Energy Ltd.	NE-29-082-12W4
MSL 871917	Connacher	06-08-082-12W4
MSL 871920	Connacher	08-04-082-12W4
MSL 871921	Connacher	SW/4-03-082-12W4
MSL 880085	AltaGas Ltd.	NE,SE-08-082-12W4
MSL 880155	Canadian Natural Resources Limited	SW-08-082-12W4
MSL 932546	Canadian Natural Resources Limited	SW,NW-13-082-12W4
MSL 932547	Canadian Natural Resources Limited	NE-14-082-12W4
MSL 941074	Compton Petroleum Corporation	NW-26-082-12W4
MSL 943609	Devon Canada Corporation	SW-03-082-11W4
MSL 960808	Connacher	SW,NW-21-082-12W4
MSL 962580	Husky Oil Operations limited	NE-08-082-12W4
MSL 962583	Iteration Energy Ltd.	SE-34-081-11W4
MSL 973818	Connacher	SE,NE-17-082-12W4

Table D.13.2.5 Mineral Surface Leases and Miscellaneous Leases

Disposition	Disposition Holder	Location
MSL 974308	Devon Canada Corporation	NW-04-082-11W4
MSL 974592	Iteration Energy Ltd.	SW-10-082-12W4
MSL 974610	Iteration Energy Ltd.	SE,SW-04-082-11W4
MSL 974905	Iteration Energy Ltd.	NW-27-081-11W4
MSL 982868	Iteration Energy Ltd.	SE-04-083-12W4
MSL 993374	Iteration Energy Ltd.	SE-28-082-12W4

D.13.2.5 Pipeline Agreements

There are forty eight Pipeline Agreements (PLA) for pipelines located in the LSA along with thirteen Pipeline Installation Leases (PIL) (Table D.13.2.6, Figure D.13.2-3a, 3b, 3c). Of these, Connacher holds two PILs and eleven PLAs and Great Divide Pipeline Limited (Connacher) holds four PLAs.

Table D.13.2.6 Pipeline Installation Leases and Pipeline Agreements

Disposition	Disposition Holder	Location
PIL 010045	AltaGas Ltd	NW;31-082-11W4
PIL 010209	Inter Pipeline (Corridor) Inc.	NW;16-082-12W4
PIL 020036	Iteration Energy Ltd.	SE;05-082-11W4
PIL 020231	AltaGas Ltd	SE;08-082-12W4
PIL 030061	Alberta Oil Sands Pipeline Ltd.	NW;26-082-12W4
PIL 060706	Nova Gas Transmission Ltd	SW,NW;16-082-12W4
PIL 070970	Inter Pipeline (Corridor) Inc.	NW;16-082-12W4
PIL 090397	Connacher	NW;16-082-12W4
PIL 090402	Connacher	NW;18-082-11W4
PIL 870066	AltaGas Ltd	SE,NE;09-082-12W4
PIL 970029	Husky Oil Operations Limited	NW;09-082-12W4
PIL 970047	Husky Oil Operations Limited	SE;17-082-12W4
PIL 970052	Suncor Energy Inc.	NW;09-082-12W4
PLA 002317	Inter Pipeline (Corridor) Inc.	SW,NW,NE;08,16-082-12W4 SE;17,21-082-12W4 SW,NW;22-082-12W4 NW;26-082-12W4 SE,SW,NE;27-082-12W4 SE;35-082-12W4 SW,NE;35-082-12W4 NW;36-082-12W4
PLA 002464	Suncor Energy Inc.	SW,NW,NE;08-082-12W4 16-082-12W4 SE;21-082-12W4 SW,NW;22-082-12W4 NW;26,36-082-12W4 SE,SW,NE;27,35-082-12W4

Table D.13.2.6 Pipeline Installation Leases and Pipeline Agreements

Disposition	Disposition Holder	Location
PLA 003085	Suncor Energy Inc.	SW,NW,NE;08-082-12W4 16-082-12W4 SE;21-082-12W4 SW,NW;22-082-12W4 NW;26,36-082-12W4 SE,SW,NE;27,35-082-12W4
PLA 006055	Alberta Oil Sands Pipeline Ltd.	SW,NW,NE;08-082-12W4 16-082-12W4 SE;21-082-12W4 SW,NW;22-082-12W4 NW;26,36-082-12W4 SE,SW,NE;27,35-082-12W4
PLA 010491	AltaGas Ltd.	NW,NE;31,32-082-11W4
PLA 010706	AltaGas Ltd.	NW;31-082-11W4
PLA 010708	AltaGas Ltd.	NW,NE;30-082-11W4 SW,NW;31-082-11W4
PLA 011337	Connacher	NW;16-082-12W4 SW;21-082-12W4
PLA 013922	Iteration Energy Ltd.	SE,NE;05-082-11W4
PLA 013924	Iteration Energy Ltd.	NE;32-081-11W4 SE;05-082-11W4
PLA 013958	Iteration Energy Ltd.	SE,SW;05,06-082-11W4
PLA 020199	Iteration Energy Ltd.	SW;04-082-11W4 SE;05-082-11W4
PLA 020464	Iteration Energy Ltd.	SE,SW;04,34-082-11W4 SE,NE;33-081-11W4
PLA 020525	Iteration Energy Ltd.	NE;27-081-11W4 SE;34-081-11W4
PLA 020624	Iteration Energy Ltd.	NW;29-082-11W4 NE;30-082-11W4
PLA 030174	Iteration Energy Ltd.	NE;33-081-11W4 NW;34-081-11W4
PLA 040732	Connacher	SW;16-082-12W4 SE,NE;17-082-12W4
PLA 061545	Inter Pipeline (Corridor) Inc.	SW,NW,NE;08,16-082-12W4 SE,NE;17,21-082-12W4 NW;22,26,36-082-12W4 SE,SW,NE;27,35-082-12W4
PLA 062279	AltaGas Ltd.	SW,NW;16,21-082-12W4 NE;17-082-12W4 SE;20-082-12W4 SW;27-082-12W4 SE,SW;28-082-12W4
PLA 065023	Connacher	SW,NW;16-082-12W4 SE,NE;09-082-12W4
PLA 065223	Connacher	E9-082-12W4
PLA 070030	Connacher	NW;16-082-12W4 SE,NE;17-082-12W4 SW;21-082-12W4
PLA 070971	Connacher	NW;16-082-12W4 NE;17-082-12W4

Table D.13.2.6 Pipeline Installation Leases and Pipeline Agreements

Disposition	Disposition Holder	Location
PLA 071961	Connacher	SE,NE;09-082-12W4 SW;10-082-12W4 SE,SW,NW;16-082-12W4
PLA 071962	Connacher	SE,SW;04 to 06-082-11W4
PLA 071963	Connacher	NW,NE;27-081-11W4 NE;28-081-11W4 SE,NE;33-081-11W4
PLA 080687	Iteration Energy Ltd.	SE;06-082-11W4
PLA 082787	Connacher	NW;18-082-11W4 NW,NE;13,15-082-12W4 NW;14-082-12W4 16-082-12W4
PLA 082791	Connacher	NW;16-082-12W4
PLA 082906	Connacher	NW;8-082-11W4 SE;24-082-12W4
PLA 083006	Connacher	SE; 24-082-12W4
PLA 083009	Connacher	NE;18-082-11W4 SE,SW;19-082-11W4
PLA 090787	William Energy (Canada) Inc.	SW,NW,NE;08-082-12W4 NW,NE;16-082-12W4 SE,NE;17,21-082-12W4 NW;22,26,36-082-12W4 SE,SW,NE;27,35-082-12W4
PLA 091029	Connacher	NW;13-082-12W4 SE,SW;24-082-12W4
PLA 760302	Nova Gas Transmission Ltd.	SW,NW,NE;08,16-082-12W4 SE;17,21-082-12W4 SW,NW;22-082-12W4 NW;26,36-082-12W4 SE,SW,NE;27,35-082-12W4
PLA 870861	AltaGas Ltd.	NW,NE;09-082-12W4 SW;16-082-12W4
PLA 880013	AltaGas Ltd.	SE,NE;09-082-12W4
PLA 880014	Devon Canada Corporations	SE;09-082-12W4 SE,SW;10,11-082-12W4
PLA 880015	AltaGas Ltd.	SE;09-082-12W4
PLA 880076	AltaGas Ltd.	SE,SW,NE;08-082-12W4 SW;16-082-12W4 SE;17-082-12W4
PLA 890152	AltaGas Ltd.	SE;08-082-12W4
PLA 960069	Iteration Energy Ltd.	SE;09-082-12W4 SW;10-082-12W4
PLA 970477	Husky Oil Operations Limited	SE,NE;08-082-12W4 NW,NE;09-082-12W4
PLA 970478	Husky Oil Operations Limited	SW,NW,NE;08-082-12W4 SE,SW;17-082-12W4
PLA 970598	AltaGas Ltd.	SW;08-082-12W4

Table D.13.2.6 Pipeline Installation Leases and Pipeline Agreements		
Disposition	**Disposition Holder**	**Location**
PLA 980303	Iteration Energy Ltd.	NW;27-081-11W4 SE,NE;28,33-081-11W4 SE,SW;04 to 06-082-11W4 SE;09-082-12W4 SE,SW;10-082-12W4
PLA 981863	AltaGas Ltd.	SE;08-082-12W4
PLA 990659	AltaGas Ltd.	SW,NW;16-082-12W4 NW,NE;17-082-12W4 SW;20-082-12W4

D.13.2.6 Surface Material Leases, Licenses, and Exploration Disposition

Connacher holds seven Surface Material Licenses (SMC) and six Surface Material Leases (SML) within the LSA (Table D.13.2.7, Figure D.13.2-3a, 3b, 3c). Connacher is currently applying for SMLs for several of the SMC dispositions. Bilsky Contracting Ltd. holds one Surface Material Exploration (SME) disposition and LF Consulting Services Ltd (LF Consulting) holds one SML within the LSA.

Table D.13.2.7 Surface Material Leases and Licenses		
Disposition	**Disposition Holder**	**Location**
SMC 060032	Connacher	SE;16-082-12W4
SMC 080026	Connacher	NW;17-082-12W4
SMC 080059	Connacher	NE;13-082-12W4
SMC 080060	Connacher	NW;13-082-12W4
SMC 090036	Connacher	NW;14-082-12W4 SW;23-082-12W4
SMC 090037	Connacher	NE;16-082-12W4
SMC 090071	Connacher	NW;13-082-12W4
SME 090245	Bilsky Contracting Ltd.	22-082-12W4 SW;24-082-12W4 NW,NE;26-082-12W4 SW;36-082-12W4
SML 060028	LF Consulting Services Ltd.	NW;36-082-12W4
SML 090068	Connacher	NE;13-082-12W4
SML 090069	Connacher	NE;16-082-12W4
SML 090070	Connacher	NW;14-082-12W4 SW;23-082-12W4
SML 090071	Connacher	NW;13-082-12W4
SML 090068	Connacher	NW;18-082-11W4
SML 090072	Connacher	NW;18-082-11W4

D.13.2.7 Major Roads

Alberta Infrastructure and Transportation owns and operates two roadways and one Registered Roadway within the northwest corner of the LSA LSA (Table D.13.2.8, Figure D.13.2-3a, 3b, 3c); these are dispositions held for Highway 63.

Table D.13.2.8 Roads

Disposition	Disposition Holder	Location
RDS 050048	Transportation	Four lanes of highway 63 S/Marianna Lake to S/Handingstone River
RDS 890026	Transportation	Highway 63:08, N of Mariana Lake- N of Alger tower road is in existence. Land are administered by transportation and the management direction and control are with the local municipal authority
RRD 154PX	Transportation	SW, NW, NE; 08, 16, 22, 36-082-12W4 SE; 17, 27, 35-082-12W4 SW; 24-082-12W4 NW, NE; 26-082-12W4

D.13.2.8 Area Operating Agreement

Talisman Energy Inc. (Talisman) holds an Area Operating Agreement (AOA 60009) with Alberta Sustainable Resource Development within 81 and 82-11W4 and 82 and 83-12W4M; it covers the LSA (Table D.13.2.9, Figure D.13.2-3a, 3b, 3c)

Table D.13.2.9 Area Operating Agreement

Disposition	Disposition Holder	Location
AOA 060009	Talisman Energy Inc.	082-12W4 081-11W4 082-11W4 083-12W4

D.13.2.9 Easements

Within the LSA there are twenty easements (EZE) including vegetation easements (VCE). Atco holds fourteen of these dispositions, Connacher holds four, and Shaw Cable and Rogers each hold one (Table D.13.2.10, Figure D.13.2-3a, 3b, 3c).

Table D.13.2.10 Easements

Disposition	Disposition Holder	Location
EZE 080248	Connacher	NW; 18-082-11W4
EZE 080251	Atco Electric Ltd.	NW, NE; 18-082-11W4
EZE 080265	Connacher	NE, SE; 18-082-11W4 SW; 19-082-11W4
EZE 090244	Atco Electric Ltd.	NW; 18-082-11W4 SW; 19-082-11W4
EZE 090251	Atco Electric Ltd.	SE, SW; 19-082-11W4

Table D.13.2.10 Easements

Disposition	Disposition Holder	Location
EZE 30188	Atco Electric Ltd.	SW, NW, NE; 08, 16, 27, 35-082-12W4 SE; 17-082-12W4 SE, NE; 21-082-12W4 NW; 22, 26, 36-082-12W4
VCE 030038	Atco Electric Ltd.	SW, NW, NE; 08, 16, 27, 35-082-12W4 SE; 17-082-12W4 SE, NE; 21-082-12W4 NW; 22, 26, 36-082-12W4
VCE 980005	Atco Electric Ltd.	SW, NW, NE; 08, 16, 27, 35-082-12W4 SE; 17, 21-082-12W4 SW, NW; 22-082-12W4 NW; 26, 36-082-12W4
EZE 40130	Atco Electric Ltd.	SW; 16-082-12W4
EZE 60269	Connacher	SW, NW; 16-082-12W4 SE; 17-082-12W4
EZE 60412	Atco Electric Ltd.	SW, NW, NE; 08-082-12W4 SW, NW; 16-082-12W4 SE; 17-082-12W4 SW; 21-082-12W4
EZE 80026	Atco Electric Ltd.	NW; 16-082-12W4 SE, NE; 17-082-12W4 SE; 20-082-12W4
EZE 80044	Atco Electric Ltd.	SW, NW; 16-082-12W4
EZE 80248	Connacher	NW, NE; 13 to15-082-12W4 6-082-12W4 SE; 22-082-12W4 SW; 23, 24-082-12W4
EZE 80251	Atco Electric Ltd.	NW, NE; 13 to15-082-12W4 16-082-12W4
EZE 90232	Atco Electric Ltd	NW; 13-082-12W4
EZE 90244	Atco Electric Ltd.	NE; 13-082-12W4 SE; 24-082-12W4
EZE 980247	Atco Electric Ltd	NW, NE, SW; 08,16-082-12W4 SE; 17, 21-082-12W4 SW, NW; 22-082-12W4 NW; 26-082-12W4 SE, SW, NE; 27, 35-082-12W4 NW; 36-082-12W4
EZE 990030	Shaw Cable Systems Limited	NW, NE, SW; 08, 16-082-12W4 SE; 17, 21-082-12W4 SW, NW; 22-082-12W4 NW, SE; 26-082-12W4 NE; 27-082-12W4 SE, SW, NE; 35-082-12W4 NW; 36-082-12W4
EZE 990067	Rogers Communications Inc.	SW; 08-082-12W4

D.13.2.10 License of Occupation

There are eightly six License of Occupation (LOC) dispositions within the LSA of which Connacher holds fifty six (Table D.13.2.11, Figure D.13.2-3a, 3b, 3c). The main access road from Highway 63 to the Algar Plant site is LOC 080437 and to the Great Divide Plant site is LOC 062120.

Table D.13.2.11 Licence of Occupation

Disposition	Disposition Holder	Location
LOC 002672	Iteration Energy Ltd.	NE; 32-082-11W4
LOC 002715	Iteration Energy Ltd.	NW; 31-082-11W4
LOC 002716	Iteration Energy Ltd.	NW, NE; 30-082-11W4 SW; 31-082-11W4
LOC 002933	Iteration Energy Ltd.	NW; 29-082-11W4 NE; 30-082-11W4
LOC 003345	Iteration Energy Ltd.	NE; 02-083-12W4 SE; 11-083-12W4
LOC 013299	Iteration Energy Ltd.	NE; 32-081-11W4 SE; 05-082-11W4
LOC 013506	Iteration Energy Ltd.	SE, NE; 05-082-11W4
LOC 013672	Iteration Energy Ltd.	NW, NE; 27-081-12W4
LOC 020312	Iteration Energy Ltd.	NE; 33-081-11W4 NW; 34-081-11W4
LOC 063769	Total E&P Canada Ltd.	NE; 27-081-1W4
LOC 071095	Connacher	NW; 18-082-11W4 SE, NE; 19-082-11W4
LOC 071096	Connacher	NW; 20-082-11W4 SW, NW; 29-082-11W4
LOC 071097	Connacher	NW; 32-082-11W4
LOC 071100	Connacher	SE, NW, NE; 31-082-11W4
LOC 071914	Connacher	SE; 02-083-12W4
LOC 080262	Connacher	NE; 30-082-11W4
LOC 080263	Connacher	SE, SW; 19-082-11W4
LOC 080400	Connacher	SW, NW; 05-082-11W4 SW; 08-082-11W4
LOC 080437	Connacher	NW; 18-082-11W4
LOC 080572	Connacher	SW, NW; 18-082-11W4
LOC 080582	Connacher	NW; 05-082-11W4 NE; 06-082-11W4
LOC 080589	Connacher	SE; 05-082-11W4
LOC 080591	Connacher	SE; SW; 29-082-11W4
LOC 081226	Connacher	SE, SW; 19-082-11W4
LOC 081227	Connacher	SW; 19-082-11W4
LOC 081228	Connacher	SW; 19-082-11W4
LOC 082506	Connacher	SW; 19-082-11W4
LOC 20240	Iteration Energy Ltd.	SW, NW; 32-082-12W4
LOC 30526	Alberta Oil Sands Pipeline Ltd.	NW; 26-082-12W4
LOC 3131	Iteration Energy Ltd.	NE; 29-08-12W4 SE, SW; 32-082-12W4
LOC 3231	Connacher	SW; 21-082-12W4
LOC 3522	Iteration Energy Ltd.	SW; 27-082-12W4 SE; 28-082-12W4
LOC 43643	Connacher	SE; 16-082-12W4
LOC 43644	Connacher	NE; 17-082-12W4

Table D.13.2.11 Licence of Occupation

Disposition	Disposition Holder	Location
LOC 43645	Connacher	NE; 17-082-12W4
LOC 43646	Connacher	NE; 17-082-12W4 SE; 20-082-12W4
LOC 43730	Connacher	SW; 16-082-12W4
LOC 43780	Connacher	SW, NE; 16-082-12W4
LOC 43781	Connacher	SE, SW; 21-082-12W4
LOC 43782	Connacher	NE; 21-082-12W4
LOC 43783	Connacher	NW; 16-082-12W4 SW, NW; 21-082-12W4 SW; 28-082-12W4
LOC 43801	Connacher	NE; 21-082-12W4 SE, SW; 28-082-12W4
LOC 60495	Connacher	SW; 16-082-12W4 SE; 17-082-12W4
LOC 61846	Connacher	SW; 16-082-12W4 SE; 17-082-12W4
LOC 62120	Connacher	NW; 16-082-12W4
LOC 64281	Connacher	SE; 09-082-12W4
LOC 70430	Connacher	NW; 14-082-12W4 SE, NE; 22-082-12W4 SW, NW; 23-082-12W4
LOC 70592	Connacher	SW; 21-082-12W4
LOC 70616	Connacher	NW; 16-082-12W4
LOC 70659	Connacher	SW, NW; 15-082-12W4 SW; 22-082-12W4
LOC 71092	Iteration Energy Ltd.	SE; 09-082-12W4 SW; 10-082-12W4
LOC 71095	Connacher	SW, NE, NW; 13-082-12W4
LOC 71862	Atco Electric Ltd.	SE; 08-082-12W4
LOC 71914	Connacher	NE; 34-082-12W4
LOC 770347	Canadian Natural Resources Limited	SE, NE; 28-081-11W4 SE; 33-081-11W4 SW, NW; 34-081-11W4 SW, NW; 03-082-11W4
LOC 80363	Connacher	SE; 24-082-12W4
LOC 80437	Connacher	NW, NE; 13 to15-082-12W4 SE, SW, NE; 16-082-12W4
LOC 80439	Connacher	NE; 15-082-12W4 SE; 22-082-12W4 SW; 23-082-12W4
LOC 80562	Connacher	SE, SW, NE; 34-082-12W4
LOC 80565	Connacher	SE; 10-082-12W4 SW; 11-082-12W4
LOC 80572	Connacher	SW, SE; 13-082-12W4
LOC 80573	Connacher	NE; 10-082-12W4 NW, NE; 11-082-12W4 NW; 12-082-12W4
LOC 80574	Connacher	NE; 09-082-12W4 NW; 10-082-12W4
LOC 80595	Connacher	SE; 32-082-12W4 SE, SW; 33-082-12W4 SW; 34-082-12W4

Table D.13.2.11 Licence of Occupation

Disposition	Disposition Holder	Location
LOC 80597	Connacher	SE, SW, NW; 23-082-12W4
LOC 80627	Connacher	SE, NE; 13-082-12W4
LOC 80660	Connacher	NE; 13-082-12W4
LOC 80952	Connacher	SE, NE; 13-082-12W4
LOC 81522	Connacher	SE, NE; 17-082-12W4
LOC 82324	Connacher	SE; 22-082-12W4
LOC 871062	AltaGas Ltd.	SE; 08-082-12W4
LOC 871185	AltaGas Ltd.	NW, NE; 09-082-12W4 SW; 16-082-12W4
LOC 871279	Connacher	SE, NE; 17,20,29-082-12W4
LOC 871336	Husky Oil Operations Limited	SE, SW; 17-082-12W4
LOC 900010	Iteration Energy Ltd.	NW, NE; 28-082-12W4 NE; 29-082-12W4
LOC 90399	Connacher	SE; 24-082-12W4
LOC 931731	Canadian Natural Resources Limited	SW; 15-082-12W4 16-082-12W4
LOC 931732	Canadian Natural Resources Limited	SW; 13-082-12W4 14-082-12W4 SE, SW; 15-082-12W4
LOC 942718	Devon Canada Corporation	SE, SW; 31 to 33-081-11W4 SW; 34-081-11W4
LOC 960641	Connacher	SE; 20-082-12W4 SW; 21-082-12W4
LOC 961943	Iteration Energy Ltd.	SE, SW; 34-081-11W4
LOC 970874	Husky Oil Operations Limited	SW; 16-082-12W4 SE; 17-082-12W4
LOC 972919	Devon Canada Corporation	SW, NW; 04-082-11W4
LOC 973101	Iteration Energy Ltd.	SE, SW; 10-082-12W4
LOC 973119	Iteration Energy Ltd.	SW; 03, 04-082-11W4 SE, SW; 05, 06-082-11W4
LOC 973333	Iteration Energy Ltd.	NW; 27-081-12W4 NE; 28-081-11W4
LOC 991990	Iteration Energy Ltd.	SE, SW; 02, 03-083-12W4 SE; 04-083-12W4
LOC 992322	Iteration Energy Ltd.	SE, NE; 28-082-12W4
LOC 974	Devon Canada Corporation	NW, NE; 31-082-11W4 NW, NE, SE; 32-082-11W4
LOC 760309	Canadian Natural Resources Limited	NW, NE; 02-083-12W4 SE, NW, NE; 09-083-12W4 SE, SW; 10-083-12W4 SW; 11-083-12W4
LOC 974	Devon Canada Corporation	NW, NE; 31-082-11W4 NW, NE, SE; 32-082-11W4
LOC 760309	Canadian Natural Resources Limited	NW, NE; 02-083-12W4 SE, NW, NE; 09-083-12W4 SE, SW; 10-083-12W4 SW; 11-083-12W4

D.13.2.11 Industrial Sample Plot

Alberta Pacific Forest Industries Inc. has industrial sample plots established on 06-26-082-12W4 (Table D.13.2.12, Figure D.13.2-2).

Table D.13.2.12 Industrial Sample Plot

Disposition	Disposition Holder	Location
ISP 010137	Alberta Pacific Forest Industries Inc.	06-26-082-12W4

D.13.2.12 Government Holdings

The Office of Alberta Sustainable Resource Development holds a Protective Notation (PNT 742815) in the north central area of the LSA (Table D.13.2-13, Figure D.13.2-3a, 3b, 3c).

Table D.13.2.13 Government and Municipal Dispositions

Disposition	Disposition Holder	Location
PNT 742815	Fort McMurry Office- Land Use Area-Land Division	31-082-11W4 SE, SW; 36-082-12W4 9-36-082-12W4 11 to 14-36-082-12W4 16-36-082-12W4

D.13.2.13 Miscellaneous Dispositions

Other miscellaneous dispositions include Disposition Reservations (DRS) which authorizes the government use of the public lands within the LSA for any public works and a reservation for Drilling Waste Disposal (DWD) (Table D.13.2.14, Figure D.13.2-3a, 3b, 3c).

Table D.13.2.14 Miscellaneous Disposition

Disposition	Disposition Holder	Location
DRS 537	Transportation	NW;36-082-12W4
DRS 830078	Lac La Biche Regional Office	09-22-082-12W4
DRS 890036	Transportation	SE, SW, NW;25-083-12W4 SE, NW, NE; 35-083-12W4
DWD 040314	Connacher	NE; 17-082-12W4

D.13.2.14 Trapping Areas

There are four Trapping Area (TPA) dispositions within the LSA. These dispositions are held by Donald Huppie (TPA 2277), Jason McKenzie (TPA 1842), Norman Dube (TPA 2867) and Romeo Gauthier (TPA 2945) (Table D.13.2.15, Figure D.13.2-2). There is a cabin located on TPA 2945.

Table D.13.2.15 Trapping Areas

Disposition	Disposition Holder	Location
TPA 1842	Jason McKenzie	03, 04, 09,10,13 to 16; 35-083-12W4
TPA 2277	Donald Huppie	29 to 32-082-11W4 25 to 29; 32 to 36-082-12W4 02,11,14, 23-083-12W4
TPA 2867	Norman Dube	08,16,17,21-082-12W4 (W/HWY 63) 20-082-12W4
TPA 2945	Romeo Gauthier	27 to 34; 081-11W4 03 to 08-082-11W4 08, 16, 17, 21-082-12W4 (E/HWY 63) 09 to 15-082-12W4

D.13.2.15 Unique Sites and Special Features

There are no unique sites or special features such as Parks and Protected Areas, Heritage Rivers, Environmentally Significant Areas, culturally significant sites, or other designations.

D.13.2.16 Recreation and Tourism

There are no significant recreation and tourism features or operations identified within the LSA.

D.13.3 Potential Impacts and Mitigation

The following section outlines the potential impacts of the Project may have on land and resource use and provides mitigation strategies where required.

D.13.3.1 Oil Sands Leases

The Project will not impact other oil sands users. Connacher holds all the OSLs within the LSA.

D.13.3.2 Petroleum and Natural Gas Licences and Leases

PNG Licenses and Leases within the LSA are held by Iteration and Chair Resources, Rife Resources, Husky and CNRL. Connacher will consult with these companies to ensure any potential resource use conflicts are resolved.

D.13.3.3 Forestry

The LSA and Project footprint is located completely within the confines of Al-Pac's FMA. The Project footprint falls within an area that was burned in 1995 that has naturally regenerated. The estimated total volume of timber to be impacted by clearing activities within the Project footprint is 3,565 m^3, of that 2,714 m^3 is merchantable. All merchantable timber salvaged from the Project will be made available to the FMA holder (Al-Pac). Connacher will contact Al-Pac regarding project developments and work with Al-Pac on mitigation strategies if required.

D.13.3.4 Mineral Surface Leases and Miscellaneous Leases

The Mineral Surface Leases and Miscellaneous Leases in the LSA are held by Iteration, Nexen, CNRL, Devon, Husky, Atco, Alta Gas, Compton, Tele-mobile, and Rodgers/Fido. If the Project footprint encroaches on any of these dispositions, Connacher will contact these companies in order to address any potential land use conflicts.

D.13.3.5 Pipeline Agreements

Pipeline Installation Leases and Pipeline Agreements are held by Alta Gas, Interpipeline, Iteration, Alberta Oil Sands, Nova, Husky, Suncor, Great Divide, Williams, and Devon. If the Project footprint encroaches on any of these dispositions, Connacher will contact these companies to ensure that development activities will address potential conflicts.

D.13.3.6 Surface Material Leases, Licences, and Exploration Dispositions

Connacher holds the majority of the SML and SMC dispositions in the LSA. Bilisky Contracting Ltd. (Bilisky) has an SME application near the Project footprint. Should land use conflicts ensue Connacher will work with Balisky to develop mitigation strategies.

Gravel resources are highly sought after in the local vicinity and will be conserved and used in all instances for construction activities.

D.13.3.7 Major Roads

Highway 63 runs through the LSA. Connacher is working with Alberta Infrastructure and Transportation on road use and access to the existing Algar and Great Divide operations. No additional access will be required for the Project.

D.13.3.8 Area Operating Agreement

Connacher will contact Talisman to discuss development activities within Talismans Area Operating Agreement.

D.13.3.9 Easements

Atco, Shaw Cable, and Rogers holds dispositions within the LSA. If the Project footprint encroaches on any of these dispositions, Connacher will contact these companies to determine if there is any land use conflicts and work jointly mitigate any conflicts.

D.13.3.10 License of Occupation

There are nine companies (Iteration, Total, Alberta Oil Sands, Atco, Alta Gas, Husky, CNRL, Devon) other than Connacher that hold LOC’s throughout the LSA. If the Project footprint encroaches on any of these dispositions, Connacher will contact these companies regarding the potential for shared use of these roads/dispositions.

D.13.3.11 Industrial Sample Plot

Alberta Pacific Forest Industries Inc. has an industrial sample plots established on 06-26-082-12-W4M. The sample plot location does not overlap with the development footprint; therefore no additional mitigation is required.

D.13.3.12 Government/Municipal Holdings

Alberta Sustainable Resource Development holds a PNT on a localized portion of the LSA that requires contact prior to any disturbance. The project footprint does not encroach on this area.

D.13.3.13 Miscellaneous Dispositions

AT and ASRD hold Disposition Reservations within the vicinity of and adjacent to Project footprint. These agencies will be contacted as part of the application review process.

D.13.3.14 Trappers

Donald Huppie, Romeo Gauthier, Jason McKenzie, and Norman Dube all hold trapping agreements within the LSA and may be affected by development. Connacher will discuss compensation program with the disposition holders to minimize the effect of the Project on the trapping resource. The cabin is associated with the Romeo Gauthier's trapping area and mitigation will be discussed with Mr. Gauthier.

D.13.4 Summary and Conclusions

The Project will have an insignificant impact on land and resource use. Connacher identified potential land and resource users within the LSA area and through their ongoing Stakeholder Consultation Program will ensure impacts to these users are minimized. Connacher will work cooperatively and jointly with other land use resource users to minimize and mitigate any land use conflicts.

D.14 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, baseline information is collected for all the major environmental disciplines and areas of sensitivity, environmental (biophysical) and cultural are identified. Constraints mapping compiles and spatially presents all potential constraints associated within the identified sensitivities within a development area. Figure D.14.0-1shows potential constraints associated with the environmental, social, cultural, and resource development sensitivities identified for the Project.

The Project has a total surface disturbance footprint of 520.7 ha staged over three development phases. The following provides a summary of the total disturbance footprint for the Project.

- well pads – 163.9 ha;
- access corridors – 223.0 ha; and
- additional site infrastructure (camps, laydown area, airstrip, sumps, borrow pits) – 133.8 ha.

The proposed footprint for these development activities forms the basis of constraints mapping. The existing Algar and Pod One Projects and associated facilities are not included in the areas above.

D.14.1 Approach

The environmental and cultural sensitivities and operational resource development requirements were identified early in the Project design stages. Based on the identified sensitivities, the Project was designed to minimize environmental impacts and maximize resource recovery. Constraints were then applied through the use of "constraints mapping' to ensure identified sensitivities are managed or mitigated during the development phases. The following approach was followed to ensure sensitivities were identified and integrated into the Project design:

- collecting comprehensive environmental and cultural information for the Project development area;
- defining and mapping the environmental and cultural constraints;
- addressing each constraint “individually’, or ‘collectively” in areas of overlapping sensitivities/constraints, and applying a constraint that meets the protection and management requirement of the sensitivity; and
- demonstrating that operational planning and design considered the constraints while optimizing resource recovery.

The following tiered decisions were applied to constraints or sensitive areas identified within the Project development area;

- the environmental or cultural sensitivity (spatial) would be avoided; and
- impact would be minimized through appropriate mitigation and monitoring.

The constraints mapping approach assists in the validation of the environmental assessment conclusions. Results include mitigation and monitoring programs to neutralize effects.

D.14.2 Constraints Criteria – Environmental Considerations

Constraints were identified as environmental or cultural sensitivities that exist within the Project development area as identified by the Consultants’ Reports that support the application. Constraints that were non-spatial in nature and could not be mapped were not included in this exercise. Table D.14.2.1 identifies sensitivities and applied constraint.

D.14.2.1 Aquatic Resources (CR #2)

Potential impacts to surface water quality and fisheries resources occur primarily from introduction of foreign substances into the water courses. Substance of concern would be the introduction of suspended solids through surface runoff and introduction of contaminants due to product spills. The maintenance of a 50 m buffer along permanent watercourses would provide sufficient watershed protection along with erosion control measures including revegetation activities. Spill prevention and emergency response plans mitigate the product spill potential.

- Mapping Constraint
  - 50 m buffer along watercourses

D.14.2.2 Hydrology (CR # 6)

Potential impacts to runoff volumes and streamflows, water levels and surface areas, and channel morphology and sediments concentrations were assessed. The natural landscape will tend to buffer the effects of runoff volume, streamflow effects, effects on water levels and surface areas, and channel morphology and sediment concentrations. Identification of a 50 m buffer along all waterbodies and watercourses with a defined channel is expected to be sufficient protection from surface runoff and potential sedimentation.

- Mapping Constraint
  - 50 m buffer along waterbodies and watercourses

D.14.2.3 Vegetation and Wetlands (CR #10)

There are four potential constraints related to vegetation and wetlands:

- uncommon or sensitive ecosites;
- uncommon or sensitive wetlands;
- rare plants or communities; and
- old growth forests.

Rare plants were found in the project footprint and LSA. Rare plant occurrences are identified on the constraints map for reference purposes only as mitigation for disturbance of these species is not required as stated in Section D.10.3.2. No rare plant communities were identified.

Ecosites phases (d1, d2, d3, h1) are of limited distribution in the LSA but are common in the Boreal Mixedwood ecological area, therefore, are not considered uncommon for this exercise. The marsh ecosite (l1) is uncommon in the LSA and may be limited regionally. If possible, avoidance of this ecotype is suggested.

There are two wetland types (MONG and SFNN) of limited distribution in the LSA. If avoidance is not possible, mitigation is to be addressed.

Old growth forests include remnant patches from the 1995 fire and are of wildlife value.

- Mapping Constraints
  - old growth forest – reminant patches
  - uncommon ecosites – marsh ecosite (l1)
  - rare plants – mapped for reference but mitigation is not required
  - uncommon wetlands – MONG and SFNN

D.14.2.4 Soils and Terrain (CR #9)

The main constraint for soils and terrain includes:

- riparian areas.

Maintenance of a 50 m buffer along water courses will protect the riparian areas.

Mapping Constraints

- riparian areas maintain a 50 m buffer along waterbodies and watercourses

D.14.2.5 Wildlife (CR #11)

The wildlife discipline is one which is difficult to spatially reference. In an attempt to include this in the constraints mapping process, Connacher has chosen to focus on wildlife habitat for sensitive species. Connacher has identified riparian areas as a potential constraint as it adds high quality habitat for a number of species. A 50 m buffer along waterbodies and watercourses with a defined channel will address wildlife sensitivities in conjunction with other values such as water quality. As well the project footprint is to avoid mature and old growth forests to minimize impacts on species dependent on this habitat, including woodland caribou and old-growth forest birds.

The majority of the Project development area is within a designated caribou zone. This zone has been included on the constraints map. Impacts to caribou will be mitigated with the development and implementation of a Caribou Protection Plan. Above ground pipeline crossing will also be constructed in the caribou zone to promote movement around the development.

- Mapping Constraint
  - 50 m buffer along waterbodies and watercourses
  - old growth forest
  - egg pony caribou zone

D.14.2.6 Historical (CR #4)

The historical resource assessment included a file search literature and development of archaeological potential model. Constraints include known historical and archaeological sites and areas of moderate and high archaeological potential.

No known historical sites were identified in the HRIA assessment for Phase 1 development and Connacher is seeking clearance from ACCS for the Phase 1 development. The Phase 2 and 3 footprints both contain areas with moderate to high archaeological potential that have not been assessed and a HRIA is recommended for these areas prior to development. If a historical resource is found, suitable mitigation will be implemented.

- Mapping Constraint
  - 50 m buffer around known historical or archaeological sites – currently, none identified
  - areas of moderate and high archeological potential

D.14.2.7 Land Use (Sec. D.13)

Alberta Pacific Forest Industries Inc. has an industrial sample plot disposition on 06-26-082-12-W4M. The sample plot location does not overlap with the development footprint; however, any possible development adjacent to the disposition is subject to a 50 m buffer for protection purposes. As well there is a trappers cabin (active) identified outside the project footprint.

Table D.14.2.1 Environmental and Resource Utilization Constraints

Constraint	Identifier
Surface Water Quality	
Watercourses and waterbodies	50 m buffer
Hydrology	
Watercourses and waterbodies	50 m buffer
Vegetation	
Old Growth Forest	Location of reminant patches
Uncommon Ecosites	Marsh ecosite phae (l1)
Rare Plants	Location, no mitigation required
Uncommon Wetlands	MONG and SFNN
Soil Resources	

Table D.14.2.1 Environmental and Resource Utilization Constraints

Constraint	Identifier
Riparian areas	50 m buffer on all waterbodies and watercourses
Wildlife	
Habitat – riparian areas	50 m buffer on all waterbodies and watercourses
Caribou zone	Caribou zone boundary
Historical Resources	
Identified historical sites	50 m buffer around known sites
Algar Tower historic site	No constraint, tower moved outside LSA
High and Moderate Potential for occurrence	HRIA prior to development of Phase 2 & 3
Land Use	
ISP disposition	Location of ISP
Trappers cabin	Location of cabin
Resource Utilization	
Developable Bitumen	15 m Net Process Pay Isopach

D.14.3 Constraints Criteria – Resource Considerations

D.14.3.1 Resource Utilization and Bitumen Recovery

The key consideration during the site selection process is to maximize resource utilization. Bitumen reservoir target areas for the proposed SAGD developments are shown on Figure D.14.0-1. The bitumen reservoirs that Connacher is proposing to develop are irregular in shape and not continuous providing significant challenges in resource optimization. There is often little flexibility with regards to shifting and adjusting well pads, and subsequently, access and other infrastructure locations.

During site selection for the Phase 1 development several options were considered to maximize the bitumen reservoir while considering the environmental and other constraints. Phase 2 and 3 developments generally considered the constraints but are subject to a more detailed evaluation of the resources and design changes are expected.

D.14.3.2 Project Costs

Capital and operating costs are important considerations in project development and are a significant factor into siting the locations of the SAGD development activities. Each of the three main components considered were rated based on projected costs:

- construction;
- drilling; and
- reclamation.

D.14.3.3 Footprint

The selection of access/utility corridors and other facilities satisfies current needs and provides flexibility for long term lease development requirements. The following concepts were incorporated into the Project design:

- minimize resource conflict;
- use of common corridors; and

- minimize new clearing.

This resulted in phase development utilizing existing corridors and disturbances, to the extent possible, and minimization of the Project's disturbance footprint. Well pad location was primarily driven by operational constraints; however, minimizing access routes and disturbances of associated facilities was incorporated into the design as well.

D.14.3.4 Constraints Evaluation

The 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:

0. No Activity
1. Fair – meets few objectives
2. Good – meets some objectives
3. Best – meets most objectives

The rating system used for each of the major environmental disciplines was presence or absence of a sensitive feature. Table D.14.2.2 summarizes the ratings for both environmental and non-environmental based criteria for Phase 1 of the Project. With the subsequent phases, Connacher has less confidence that the development will occur as shown.

Table D.14.2.2 Constraints Evaluation (Phase 1)

Facility Component	Breakdown		Bitumen Recovery	Costs			Footprint			Rating	Environmental Constraints (Present or Absent)								Mitigation Required
				Drilling	Construction	Reclamation	Minimize Resource Conflict	Common Corridor	Minimize New Clearing	Total	*Hydrology*	*Surface WQ*	*Vegetation & Wetlands*	*Rare Plants*	*Soils and Terrain*	*Wildlife*	*Historical*	*Traditional*	
Well Pad 104	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	P	A	A	A	A	N
		Alternate	2	3	3	3	3	3	3	20	A	A	A	A	A	A	A	A	N
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	3	1	1	9	A	A	A	A	A	A	A	A	N
Well Pad 110	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	A	A	A	A	A	N
		Alternate	2	3	3	3	3	1	2	17	A	A	A	A	A	A	A	A	N
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	3	1	1	9	A	A	A	A	A	A	A	A	N
Well Pad 111	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	A	A	A	A	A	N
		Alternate	3	3	2	2	3	3	3	19	A	A	A	A	A	A	A	A	N
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	3	3	3	3	2	14	A	A	A	A	A	A	A	A	N
Well Pad 112	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	A	A	A	A	A	N
		Alternate	2	3	3	3	3	3	2	19	A	A	A	A	A	A	A	A	N
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	3	3	2	12	A	A	A	A	A	A	A	A	N
Well Pad 231	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	A	A	A	A	A	Y
		Alternate	2	2	3	3	3	2	2	17	A	A	A	A	A	A	A	A	Y
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	Y
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	P	A	A	A	A	Y
Well Pad 232	Pad	Proposed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**21**	A	A	A	P	A	A	A	A	Y
		Alternate	2	2	3	3	3	2	2	17	A	A	A	P	A	A	P	A	Y
	Access Road and Corridor	Proposed	**NA**	**NA**	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	P	A	A	A	A	Y
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	P	A	A	A	A	Y

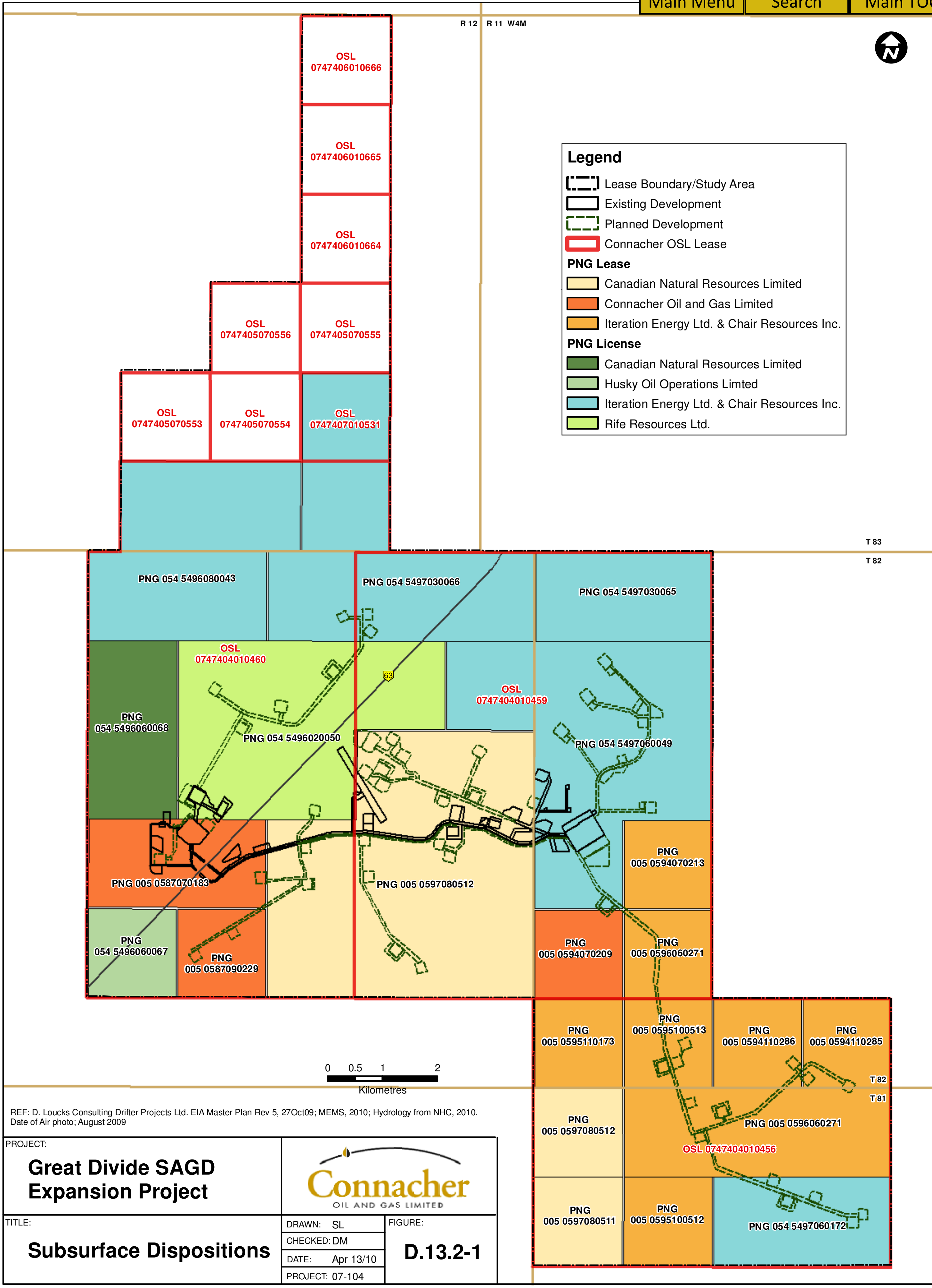
Table D.14.2.2 Constraints Evaluation (Phase 1)

Facility Component	Breakdown		Bitumen Recovery	Costs			Footprint			Rating	Environmental Constraints (Present or Absent)								Mitigation Required
				Drilling	Construction	Reclamation	Minimize Resource Conflict	Common Corridor	Minimize New Clearing	Total	Hydrology	Surface WQ	Vegetation & Wetlands	Rare Plants	Soils and Terrain	Wildlife	Historical	Traditional	
Well Pad 233	Pad	Proposed	3	3	3	3	3	3	3	21	A	A	A	P	A	A	A	A	Y
		Alternate	3	3	2	2	3	2	2	17	A	A	A	A	A	A	A	A	Y
	Access Road and Corridor	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	P	A	A	A	A	Y
		Alternate	NA	NA	1	1	3	1	1	7	A	A	A	A	A	A	A	A	Y
Well Pad 234	Pad	Proposed	3	3	3	3	3	3	3	21	A	A	A	A	A	A	A	A	N
		Alternate	3	3	3	3	3	2	1	18	A	A	A	A	A	A	A	A	Y
	Access Road and Corridor	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	P	A	A	A	A	N
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	P	A	A	A	A	Y
Well Pad 235	Pad	Proposed	3	3	3	3	3	3	3	21	A	A	A	A	A	A	A	A	Y
		Alternate	2	2	2	3	3	2	2	16	P	A	A	P	A	A	A	A	Y
	Access Road and Corridor	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	P	A	A	A	A	Y
		Alternate	NA	NA	3	3	3	3	2	14	P	A	A	P	A	A	A	A	Y
Borrow Pit 21-82-12W4	Site	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	A	A	A	A	A	N
	Access Road	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	A	A	A	A	A	N
Borrow Pit 24-82-12W4	Site	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	P	A	P	A	A	Y
		Alternate	NA	NA	3	3	3	3	3	15	A	A	A	A	A	P	A	A	Y
	Access Road	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	A	A	P	A	A	N
		Alternate	NA	NA	2	2	3	2	2	11	A	A	A	A	A	P	A	A	N
Borrow Pit N23-82-12W4	Site	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	3	2	3	3	13	A	A	P	P	A	A	A	A	Y
	Access Road	Proposed	NA	NA	3	3	3	3	3	15	A	A	A	A	A	A	A	A	N
		Alternate	NA	NA	2	2	2	2	2	10	A	A	A	A	A	A	A	A	N

Table D.14.2.2 Constraints Evaluation (Phase 1)

Facility Component	Breakdown		Bitumen Recovery	Costs			Footprint			Rating	Environmental Constraints (Present or Absent)								Mitigation Required
				Drilling	Construction	Reclamation	Minimize Resource Conflict	Common Corridor	Minimize New Clearing	Total	*Hydrology*	*Surface WQ*	*Vegetation & Wetlands*	*Rare Plants*	*Soils and Terrain*	*Wildlife*	*Historical*	*Traditional*	
Borrow Pit S23-82-12W4	Site	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	Y
		Alternate	NA	NA	3	3	3	3	3	15	A	A	A	P	A	A	A	A	Y
	Access Road	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	Y
		Alternate	NA	NA	3	3	3	3	3	15	A	A	A	P	A	A	A	A	Y
Sump 18-82-11W4	Site	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	P	A	P	A	A	Y
		Alternate	NA	NA	1	2	2	2	3	10	A	A	A	A	A	P	A	A	Y
	Access Road	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	P	A	A	Y
		Alternate	NA	NA	1	1	3	2	2	9	A	A	A	A	A	P	A	A	Y
Sump 23-82-12W4	Site	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	Y
		Alternate	NA	NA	3	3	3	2	2	13	A	A	A	P	A	A	P	A	Y
	Access Road	Proposed	NA	NA	**3**	**3**	**3**	**3**	**3**	**15**	A	A	A	A	A	A	A	A	Y
		Alternate	NA	NA	3	3	3	3	3	15	A	A	A	A	A	A	P	A	Y

P – Sensitivity or constraint present
A – Sensitivity or constraint absent
Y – Mitigation required
NA – not applicable to facility component



REF: D. Loucks Consulting Drifter Projects Ltd. EIA Master Plan Rev 5, 27Oct09; MEMS, 2010; Hydrology from NHC, 2010.
Date of Air photo; August 2009

PROJECT:

Great Divide SAGD Expansion Project

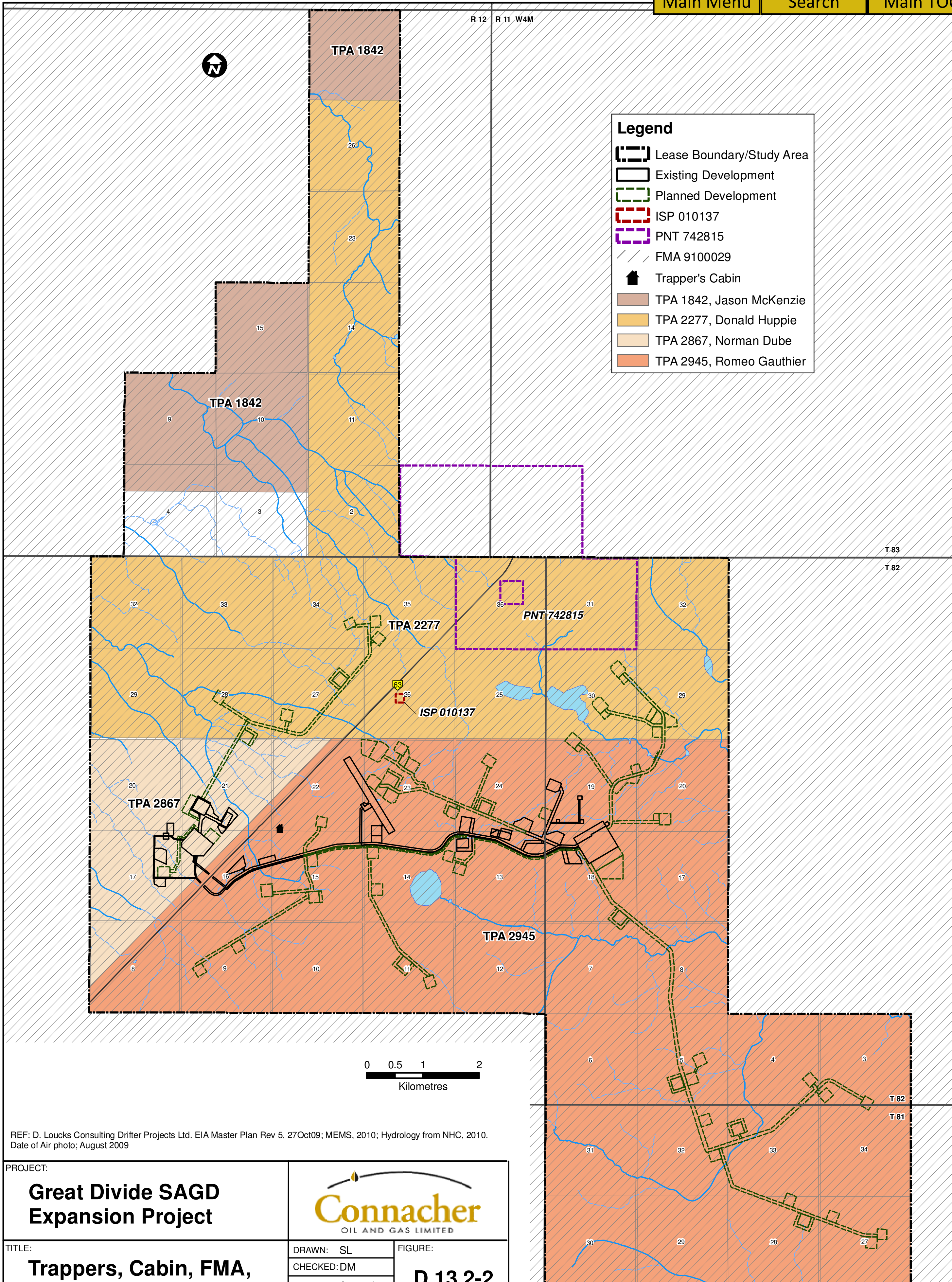
Connacher OIL AND GAS LIMITED

TITLE:

Subsurface Dispositions

DRAWN: SL
CHECKED: DM
DATE: Apr 13/10
PROJECT: 07-104

FIGURE: **D.13.2-1**



REF: D. Loucks Consulting Drifter Projects Ltd. EIA Master Plan Rev 5, 27Oct09; MEMS, 2010; Hydrology from NHC, 2010.
Date of Air photo; August 2009

PROJECT:

Great Divide SAGD Expansion Project

Connacher OIL AND GAS LIMITED

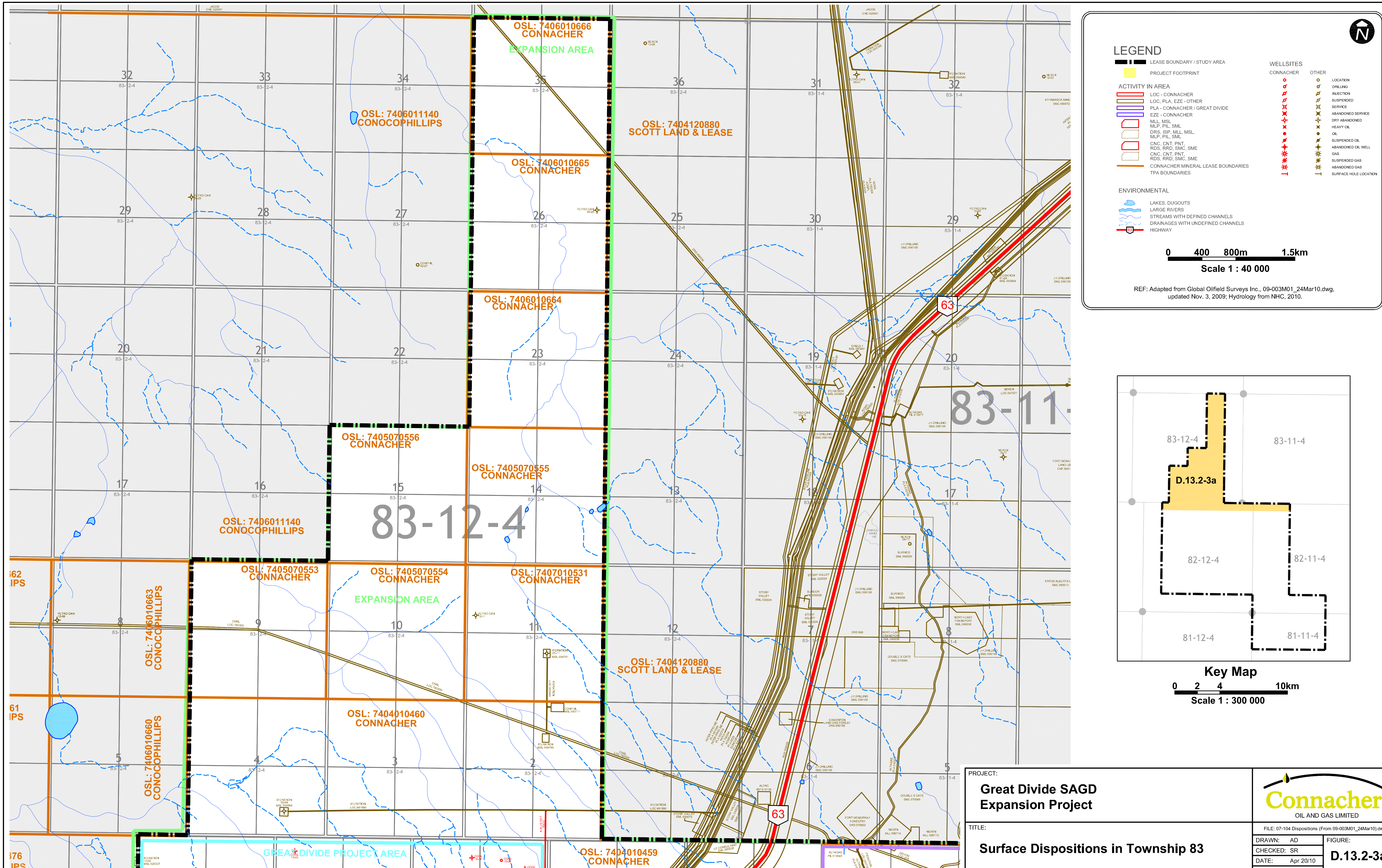
TITLE:

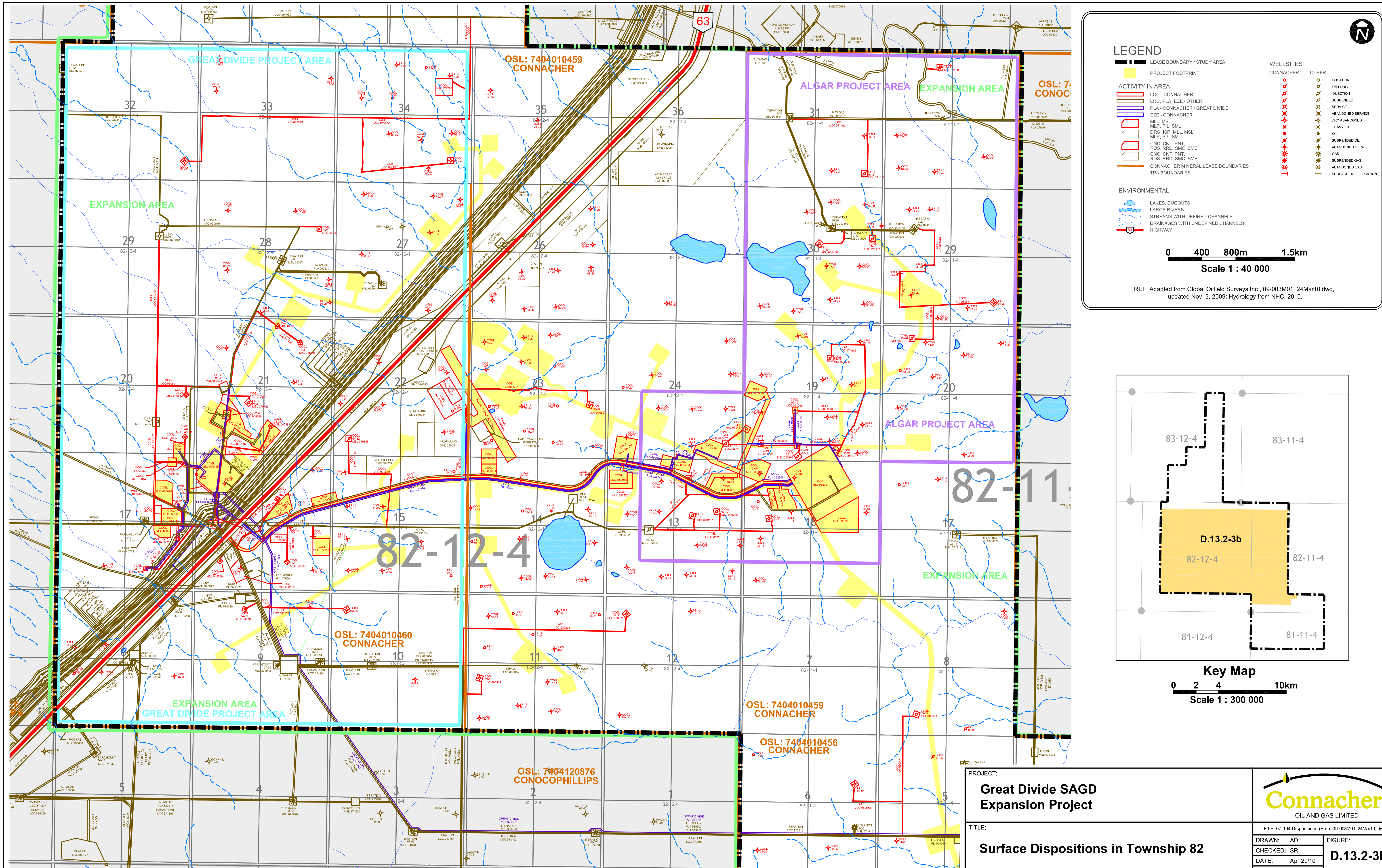
Trappers, Cabin, FMA, ISP and PNT

DRAWN: SL
CHECKED: DM
DATE: Apr 13/10
PROJECT: 07-104

FIGURE:

D.13.2-2


OSL: 7406010666
CONNACHER
EXPANSION AREA
OSL: 7406011140
CONOCOPHILLIPS
OSL: 7404120880
SCOTT LAND & LEASE
OSL: 7406010665
CONNACHER
OSL: 7406010664
CONNACHER
OSL: 7405070556
CONNACHER
OSL: 7405070555
CONNACHER
83-12-4
83-11-
OSL: 7405070553
CONNACHER
OSL: 7405070554
CONNACHER
OSL: 7407010531
CONNACHER
EXPANSION AREA
OSL: 7406010663
CONOCOPHILLIPS
OSL: 7406010660
CONOCOPHILLIPS
OSL: 7404010460
CONNACHER
OSL: 7404010459
CONNACHER
GREAT DIVIDE PROJECT AREA
63
LEGEND
LEASE BOUNDARY / STUDY AREA
PROJECT FOOTPRINT
ACTIVITY IN AREA
LOC - CONNACHER
LOC, PLA, EZE - OTHER
PLA - CONNACHER / GREAT DIVIDE
EZE - CONNACHER
CONNACHER MINERAL LEASE BOUNDARIES
TPA BOUNDARIES
WELLSITES
CONNACHER
OTHER
ENVIRONMENTAL
LAKES, DUGOUTS
LARGE RIVERS
STREAMS WITH DEFINED CHANNELS
DRAINAGES WITH UNDEFINED CHANNELS
HIGHWAY
0 400 800m 1.5km
Scale 1 : 40 000
REF: Adapted from Global Oilfield Surveys Inc., 09-003M01_24Mar10.dwg, updated Nov. 3, 2009; Hydrology from NHC, 2010.
83-12-4
83-11-4
D.13.2-3a
82-12-4
82-11-4
81-12-4
81-11-4
Key Map
0 2 4 10km
Scale 1 : 300 000
PROJECT:
Great Divide SAGD Expansion Project
TITLE:
Surface Dispositions in Township 83
Connacher
OIL AND GAS LIMITED
FILE: 07-104 Dispositions (From 09-003M01_24Mar10).dwg
DRAWN: AD
CHECKED: SR
DATE: Apr 20/10
PROJECT: 07-104
FIGURE:
D.13.2-3a



PROJECT:

Great Divide SAGD Expansion Project

TITLE:

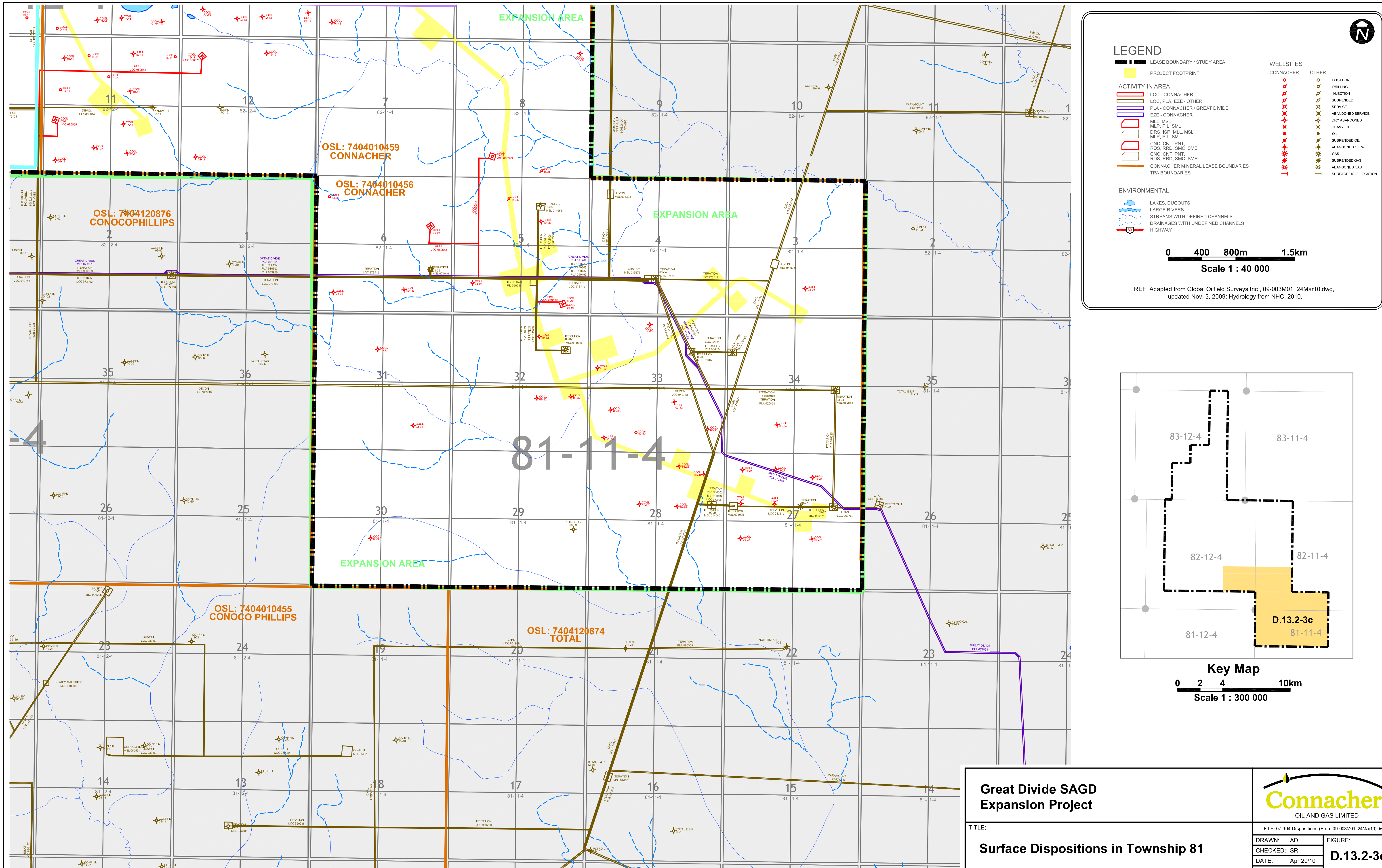
Surface Dispositions in Township 82

Connacher OIL AND GAS LIMITED

FILE: 07-104 Dispositions (From 09-003M01_24Mar10).dwg

DRAWN: AD
CHECKED: SR
DATE: Apr 20/10
PROJECT: 07-104

FIGURE: **D.13.2-3b**



Great Divide SAGD Expansion Project

Connacher OIL AND GAS LIMITED

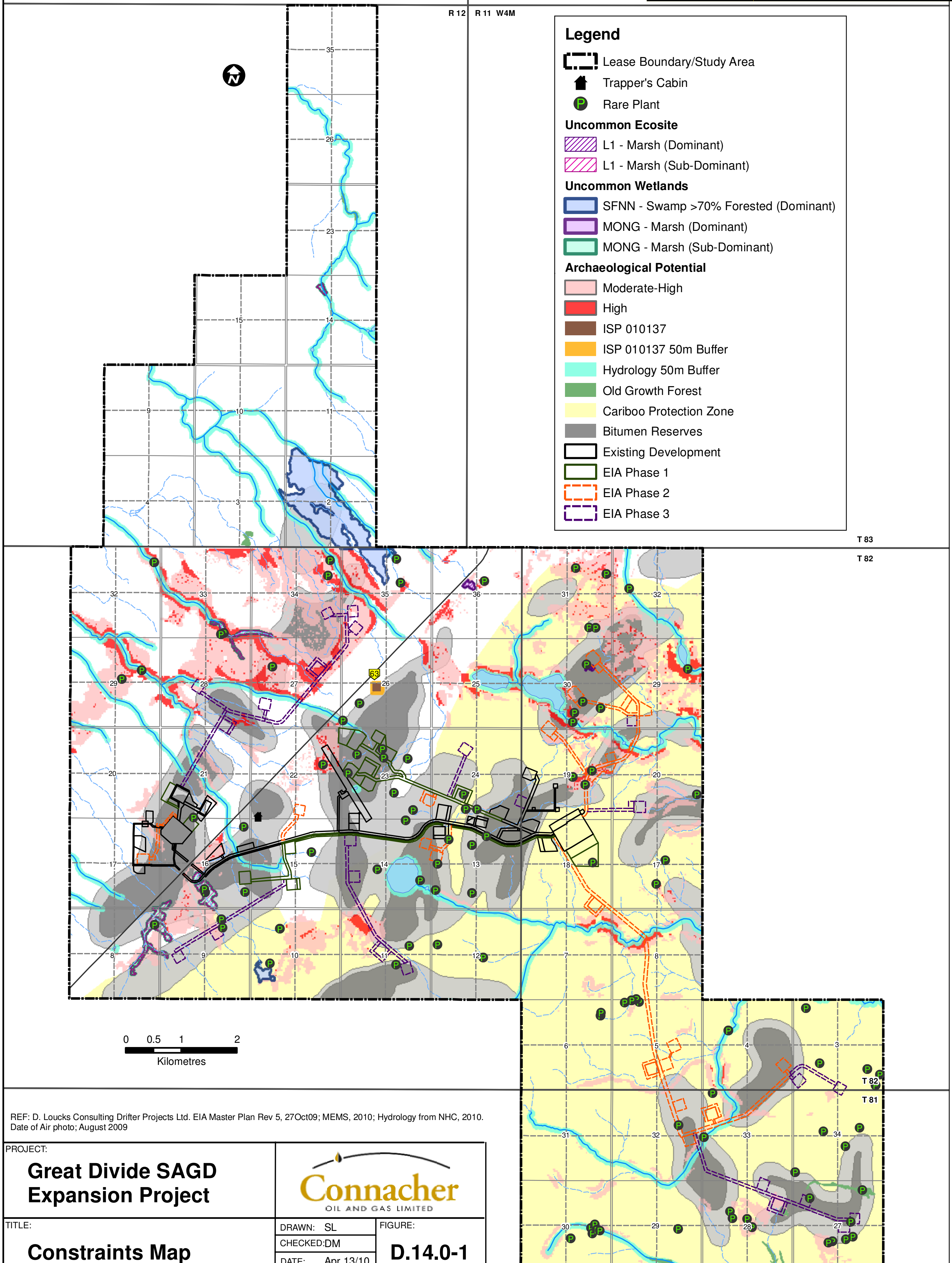
TITLE: **Surface Dispositions in Township 81**

FILE: 07-104 Dispositions (From 09-003M01_24Mar10).dwg

DRAWN: AD
CHECKED: SR
DATE: Apr 20/10
PROJECT: 07-104

FIGURE: **D.13.2-3c**

Main Menu | Search | Main TOC



REF: D. Loucks Consulting Drifter Projects Ltd. EIA Master Plan Rev 5, 27Oct09; MEMS, 2010; Hydrology from NHC, 2010.
Date of Air photo; August 2009

PROJECT: **Great Divide SAGD Expansion Project**	Connacher OIL AND GAS LIMITED	
TITLE: **Constraints Map**	DRAWN: SL CHECKED: DM DATE: Apr 13/10 PROJECT: 07-104	FIGURE: **D.14.0-1**